HKN ENERGY LTD.

Environmental Social Impact Assessment

Wellsite Production Facility
Sarsang Block
Kurdistan Region of Iraq

September 2018

Table of Contents

List of Figures

List of Tables

Abbreviations

°F	Fahrenheit degree
ALARP	As Low As Reasonably Practicable
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
Bbl	Barrel
Bopd	Barrels of Oil Per Day
DBF	Distributed Production Facilities
BPD	Barrels Per Day
BS&W	Basic sediment and water
BWPD	Barrels of water per day
°C	Degree Celsius
CCR	Central Control Room
CFC	Chlorofluorocarbon
dB(A)	A-weighted measurement in decibels
DG	Diesel Generator
DST	Drill stem test
ESIA	Environmental Social Impact Assessment
EMP	Environmental Management Plan
EMoP	Environmental Monitoring Plan
ESD	Emergency Shut Down
EWT	Extended Well Testing
FEED	Front End Engineering and Design

GE GAP	GE Global Asset Protection
GLC	Ground Level Concentration
GOR	Gas Oil Ratio
GWP	Global Warming Potential
HAZID	Hazard Identification Study
HAZOP	Hazard and Operability
HCFC	Hydro chlorofluorocarbons
HKN	HKN Energy Limited
HP	High Pressure
HSE	Health, Safety & Environment
HSEMS	Health, Safety, and Environmental Management System
IDLH	Immediately Dangerous to Life and Health
IFC/WB	International Finance Corporation/World Bank
IKRSO	Iraqi Kurdistan Regional Statistical Office
IUCN	International Union for Conservation of Nature and Natural Resources
KRG	Kurdistan Regional Government
KRI	Kurdistan Region of Iraq
KCA	Kurrachine A
KCB	Kurrachine B
KCC	Kurrachine C
LC	Least Concerned
LP	Low Pressure
m	Meter
MMsfc	Million standard cubic feet
MNR	Ministry of Natural Resources

MPH	Miles Per Hour
MSDS	Material Safety Data Sheet
NAAQS	National Ambient Air Quality Standards
NACE	National Association of Corrosion Engineers
NFPA	National Fire Protection Association
O&G	Oil & Gas
OGP	International Association of Oil and Gas Producers
OPF	Oilfield Protection Force
OPIC	Overseas Private Investment Corporation
PHPA	partially-hydrolyzed polyacrylamide drilling mud
PEL	Permissible Exposure Limit
PIA	Project Influence Area
Ppbv	Part Per Billion by Volume
Ppmv	Parts Per Million by Volume
PSC	Production Sharing Contract
Psig	Pounds per Square Inch Gauge
PSV	Pressure safety valve
PTB	Pounds per Thousand Barrels
RoW	Right of Way
SCBA	Self-contained Breathing Apparatus
scf/bbl	Square Cubic Feet/ Barrel
Scf/stb	standard cubic foot per stock tank barrel
SCSSV	Surface-Controlled Subsurface Safety Valve
SLM	Sound Level Meter
SS	Suspended Solids

ST-1	Swara Tika 1 well
STP	Sewage treatment plant
TDS	Total Dissolved Solids
TVP/RVP	True vapor pressure/ Reid vapor pressure
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compound
WBM	Water based mud
MW	Megawatt
WHFP	Wellhead Flowing Pressure
WHO	World Health Organization
WPF	Well Production Facilities

1 Executive Summary

1.1 Concise Project Description

An ESIA study was carried out to predict and assess the potential environmental and social impacts of a proposed 25,000 bopd facility (WPF) and related activities (the "Project"). The Project includes civil works to prepare for and support the WPF, construction and commissioning of the WPF, drilling oil wells which will feed the WPF, operation of the WPF and decommissioning. The facility is part of the phase 1 development in the Sarsang Field Development Plan (FDP). The Project is an expansion to HKN's existing production in the Swara Tika structure of the Sarsang concession area, located between the sub districts of Chamanke and Atrush, in the Dohuk Province of Kurdistan.

This study includes a detailed description of pre-existing conditions (baseline assessment), potential environmental impacts of Project activities (from pre-construction through decommissioning), and the net impacts of the project after taking mitigation actions. It also considers the Project's natural and ecological impacts on the human environment in the affected area and the cumulative impacts of those activities. The study has been conducted by HKN Energy Ltd, (HKN) with the help of external contractors. The ESIA study is conducted in line with the KRG's applicable environmental regulations and best international practices, as set out by the IFC and World Bank.

An environmental impact analysis was carried out with an objective of identifying and assessing all potential environmental risks and the resulting impacts from the Project, in order to develop appropriate control measures and management plans to mitigate these impacts. The resulting Environmental Management Plan (EMP) includes a monitoring plan to assess and ascertain the environmental performance of the project. The study will also act as a tool to engage with the community, NGO's, and stakeholders such as the government to inform them about the Project.

The WPF is at its conceptual phase and some data on emissions is not available. HKN have used data from nearby producing wells to estimate gas volume, production rate and gas composition. This will enable OPIC to understand the GHG emission output from the flaring activities.

The major potential negative impacts from the Project include civil construction works for site preparation, production facility construction and operation, oil storage tanks, tanker loading facilities, drilling rig operation and associated emissions and waste discharges, as well as gas flaring during testing phase and during ongoing production. In addition to accidental events (spills, well blow-out, fire and explosion). Appropriate mitigation procedures will ensure that no significant residual environmental impacts will result from the proposed project activities.

Positive socio-economic impacts are expected from the Project, including economic benefits, including increased employment, for the Dohuk province. In addition, the Project will allow for the use of treated, sweetened gas as a fuel source for ongoing facility operation and materially reduce the use of more carbon intensive diesel fuel. A planed gas handling facility for Sarsang, to be built by the KRG and commissioned by 2021, will significantly reduce the amount of long-term flaring from the WPF. This will not only substantially lower the carbon footprint of the Project but will have a positive impact on the economy and the community as a sustainable energy resource.

1.2 Identification of project sponsors

A Production Sharing Contract has been agreed between the Kurdistan Regional Governments, (KRG) Ministry of Natural Resources (MNR), HKN Energy Ltd and TEPKRI, a subsidiary of Total, for Concession Area of “Sarsang” Block, located in the Dohuk Province. The agreement designates HKN Energy Ltd, (HKN) as the operator. The Project is part of the FDP agreed by the MNR, HKN and Total for the first phase of development of the Swara Tika structure.

1.3 Description of the Sarsang Block

The Sarsang Block is in Northern Kurdistan, which contains prolific oil fields like the Kirkuk Oil Field. Sarsang is one of the larger blocks in Kurdistan and covered 1,226 square kilometres prior to the obligatory 25% relinquishment in 2012, an additional 25% of the remaining area in 2013, and the relinquishment of the Mangesh and West Swara Tika Prospects in 2014. The Sarsang Block is located close to the Tawke development and to the Turkish border, where both current and future hydrocarbon exports are expected to be delivered. The Swara Tika structure is about 110 km from Fish Khabour, where the Kurdish oil pipeline connects to the Iraq Turkey Pipeline which carries oil to Turkey. The initial block boundaries and Sarsang Block location are shown in **Figure 1-1 & Appendix 8.** The project footprint and existing operations area shown in **Figure's 1-2 to 1-4. Figure's 1-5** shows specific project layout and location.

Figure 1-1 Sarsang Block, within Kurdistan Region of Iraq

1.4 The Sarsang Development Plan background

HKN, as Operator of the Sarsang Contract Area (Sarsang Block) under the Sarsang Production Sharing Contract as amended (PSC), and also on behalf of TEPKRI (collectively the "Contractor Entities") submitted a Sarsang Development Plan (FDP) for the Swara Tika structure. The FDP submission and approval followed the discovery in the Triassic Kurra Chine horizon in the Swara Tika No. 1 (ST-1) well. The subsequent Swara Tika No. 2 (ST-2) well confirmed the extent of the Triassic discovery in ST-1. The Contractor Entities declared the discovery a Commercial discovery in accordance with the PSC.

In ST-1, Oil ranging from 35.5°API to 37.4°API was successfully flow tested from the Triassic at rates of 4,189 and 3,702 barrels of oil per day (bopd).
ST-2 was drilled on the eastern crest of the Swara Tika anticline, southeast of the ST-1 discovery well. ST-2 was placed in an optimum position to appraise the oil discovery in the Triassic.

In the FDP, HKN will endeavour to achieve production capacity of 50,000 bopd in 30 months from the Swara Tika Production Area. The Sarsang Field Development Plan was approved in October 2015 and remains the governing agreement between the MNR and the Contractor Group for the first phase of development on the Swara Tika structure.

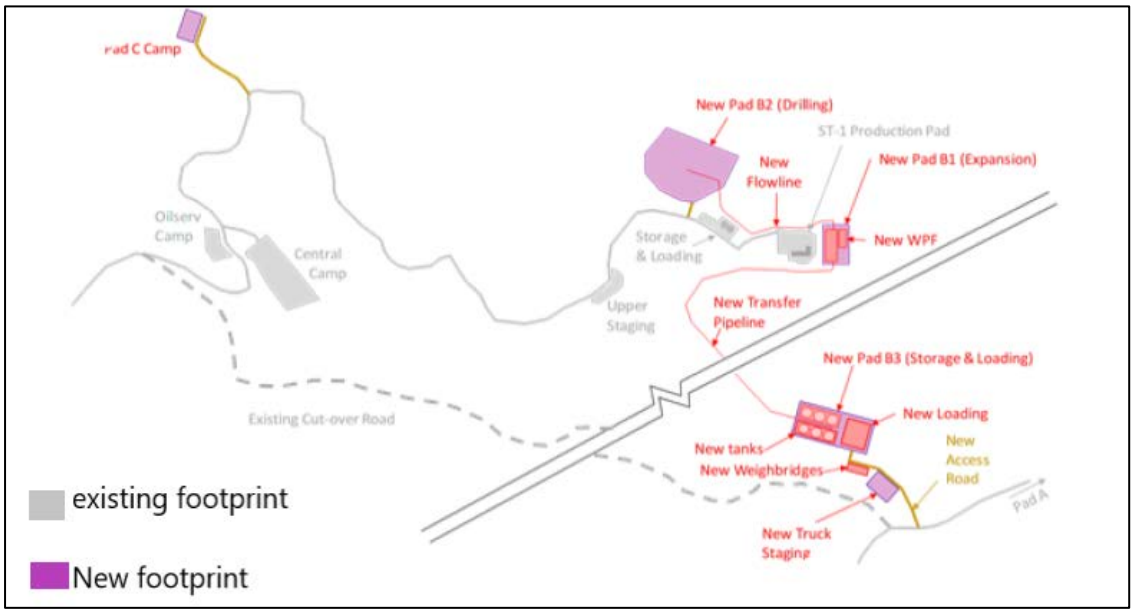


Figure 1-2 Sketch of overall project footprint and components, (not to scale)

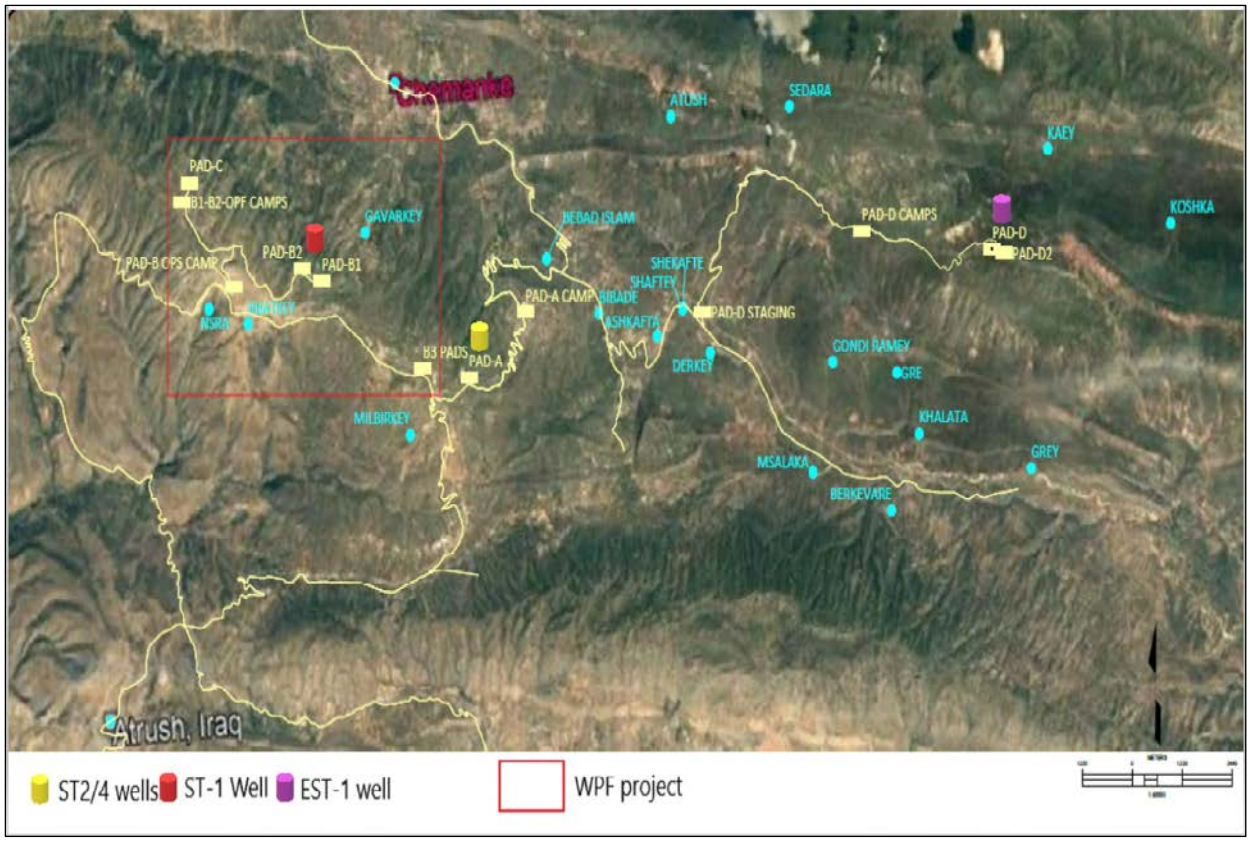


Figure 1-3 Topographic map Sarsang Block showing total drilled wells and producing wells.

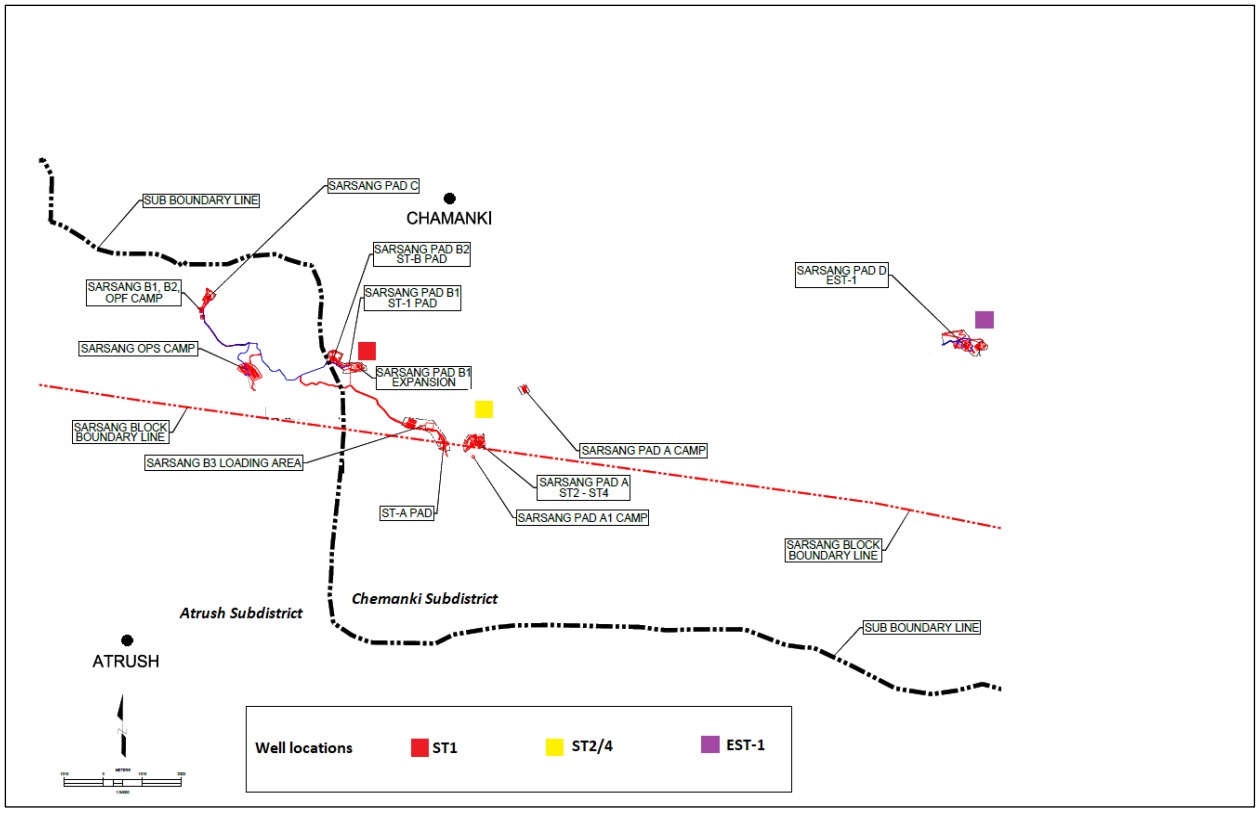
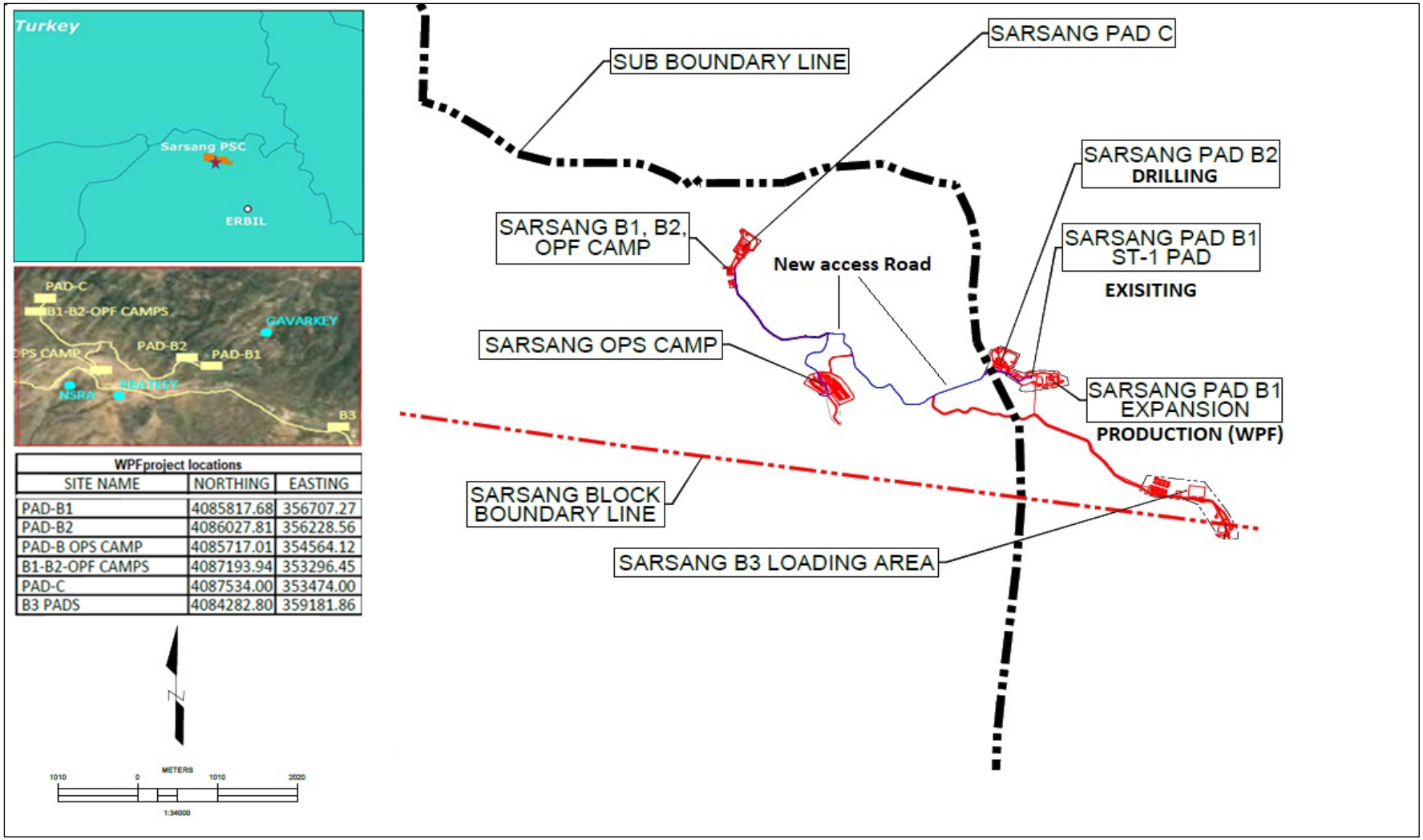


Figure 1-4 Scaled drawing showing total drilled wells and producing wells and district boundaries

Following approval of the FDP, HKN has drilled 3 additional wells on the Swara Tika structure and 1 well on the East Swara Tika Structure. On Swara Tika, the ST-4 well was drilled adjacent to ST-2, the ST-1 well was side-tracked as ST-1z, and a new B-1 well was drilled near ST-1z. Production facilities have been built on Pad A (14k bopd capacity, fed by ST-2 and ST-4) and Pad B (originally 4.5k bopd capacity, recently upgraded to 10k bopd capacity, to be fed by ST-1z and B-1). The proposed WPF will add 25k bopd capacity on Pad B and will be fed by wells B-2, B-3, B-4, B-5 and B-6, which will be drilled in 2019. After completion of the proposed WPF, total production capacity on Swara Tika will be 49k bopd.

1.5 Baseline Environmental Conditions

This ESIA study report covers the area of influence of the Project and includes results and data on environmental and socio-economic factors which HKN collected historically and currently.



WPF project locations		
SITE NAME	NORTHING	EASTING
PAD-B1	4085817.68	356707.27
PAD-B2	4086027.81	356228.56
PAD-B OPS CAMP	4085717.01	354564.12
B1-B2-OPF CAMPS	4087193.94	353296.45
PAD-C	4087534.00	353474.00
B3 PADS	4084282.80	359181.86

Figure 1-5 Over WPF project location and layout

The ESIA forecasts changes (which may be viewed as positive or negative) that may occur as a direct or indirect result of the Project, and requires a baseline understanding of the natural conditions at the proposed Project location and area of influence. The early identification of impacts that may occur in the area of influence reduces the likelihood of long-term adverse environmental effects, and permits the implementation of mitigation measures to avoid, reduce or remedy significant adverse effects.

A detailed activity-receptor matrix was used to identify the potential environmental and social impacts during the proposed activities in form of an impacts and aspects register detailed in Appendix-9. Impacts due to both planned and unplanned aspects such as potential accidents are considered in this ESIA. Baseline assessments have been made for parameters which may have potential impacts, including:

- Use of natural resources
- Atmospheric emissions
- Liquid and solid waste
- Noise and vibration
- Soil impact and disturbance
- Ground and surface Water
- Biodiversity
- Landscape and visuals
- Socio-economic impact

1.6 Applicable environmental standards

This ESIA has been conducted in accordance with the general principles and procedures outlined in the ESIA Guidelines provided by MNR and OPIC. In addition, guidance has been taken from the World Bank's Guidelines, (Instruction No.1 2014), on Environmental Assessment. Particular attention is also given to the IFC onshore guidelines, (Equator Principles III requirements), which identifies the potential impacts on the environment and recommends appropriate control measures to mitigate the impacts and ensure compliance with international standards and industry good practice.

1.7 Proposed mitigation measures

The implementation of proposed mitigation measures and plans will prevent or minimize the negative environment or social impact of the project operation activities including civil construction, drilling and production activities on natural resources and socio-economics, including flora, fauna, geological structure, archaeological site and local community. Proposed mitigation measures are summarized in Chapter 6 of this report.

1.8 Net environmental Impacts

Environmental impacts from the proposed project are, in some cases, beneficial, such as creating economic opportunities for local communities and businesses. Another positive environmental impact stems from the KRGs plan to construct a gas handling facility by 2021 which will allow for sweetened gas to be used for power generation purposes in HKN's operations and for power generation to benefit the wider Dohuk province. This gas processing will significantly reduce or eliminate the amount of gas flaring from the proposed WPF and will replace diesel as a fuel source for Dohuk power generation, therefore reducing carbon footprint and promoting sustainability.

The Project can respond to residual impact by supporting non-operational initiatives or activities which are focused on environmental research and education, and conservation. Any action in response to our residual impact should take into consideration the scale and type of all other additional activity that HKN is supporting, both at a corporate, country and project level. Such activities will be linked with the project's management of its social programs. In such cases programs will be evaluated in close collaboration with internal experts, national/local governments, national development agencies. The ESIA aims to identify key resources and habitats based on available information, which may include physical and chemical parameters, biotic/biodiversity parameters, socio-economic and cultural parameters, and health parameters, and assess the potential impact on each key resource and habitat from each identified project component.

1.9 Data gathering

The data gathered for the ESIA consist of combination of data sources from previous Sarsang ESIA's, (this includes data from HKN environmental management programs),

FDP and recent field survey for both socio economic and environmental conducted by HKN contractor Map Group. Technical data related to the Project, which includes gas emissions estimates, project design and construction is verified in collaboration with HKN's drilling, HSE, project managers, civil and operations departments. HKN has contracted Blanchard Energy consulting to carry out QC/QA checks of data and ESIA structure.

1.10 Scope and objectives of the ESIA

1.11 ESIA Approach

1.11.1 General Approach

The objective of the impact assessment process is to ensure that all impacts, direct and indirect, particularly environmental and social impacts are fully examined and addressed. HKN places great emphasis on removing/reducing environmental risks at the design stage of projects.

The ESIA aims to present sufficient detail to enable readers to judge the potential impacts (positive or negative) of the project on the environment, and how those impacts may be managed. The ESIA enables reasonable economic and technically achievable conditions to be developed to ensure that the impact of the project is reduced to acceptable levels. The level of analysis and detail in the ESIA reflects the level of significance of individual impacts.

The general aim of an ESIA process is to describe the existing environmental conditions in which a project will be operated, identify potential impacts of the project operations on the environment and, if possible, provide a basis for alterations to remove or reduce the identified potential impacts. This process of alterations is termed operational mitigation, and through this iterative process of impact identification and design review, it is often possible to reduce the overall environmental effects of operating a project. A diagram showing this generic approach is provided in **Figure 1-5.**

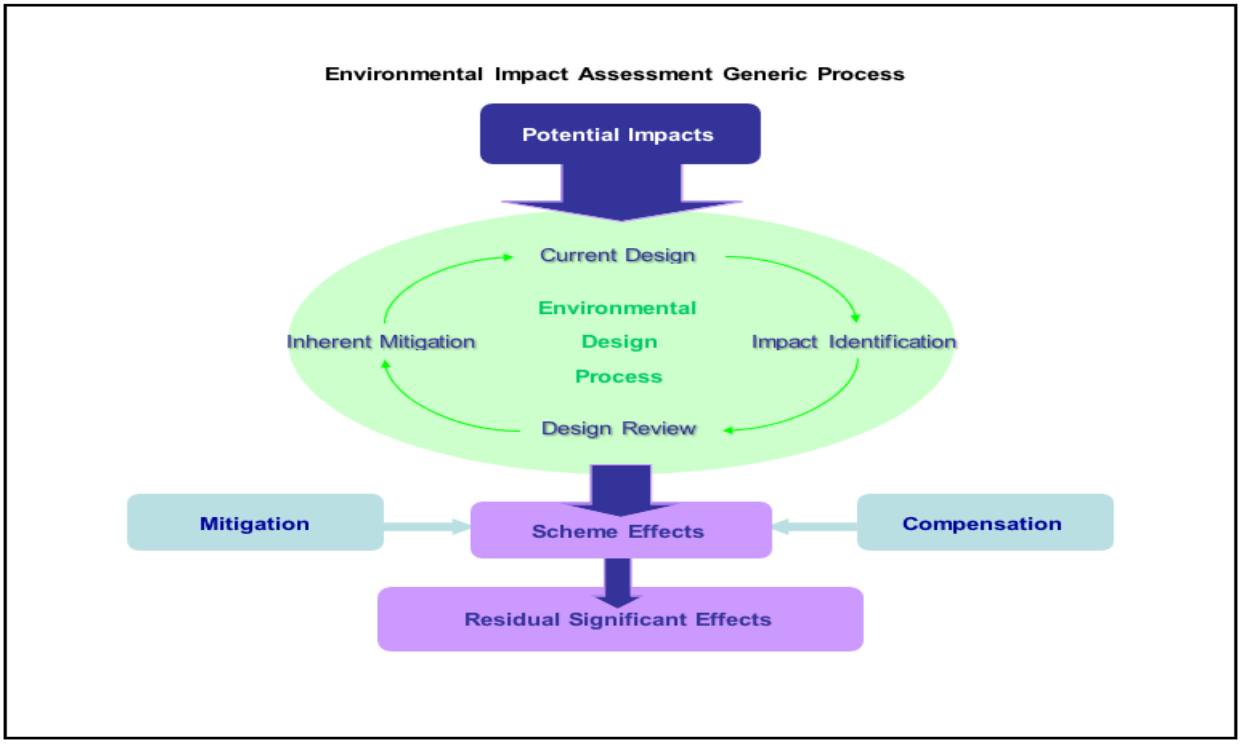


Figure 1-6 Generic Environmental approach to ESIA

Any project will give rise to potential impacts and risks to humans and the environment (large arrow entering system in **Figure 1-5** above). Through the iterative process of identification of these potential impacts and refinement of the operating procedures some potential impacts and risks can be removed. This process can be referred to as *'mitigation'*, which means the operator has taken on board the possible impact or risk and mitigated it out of the Project.

Applicable Kurdistan Region of raw environmental regulations.

1.11.2 Document Review

Review of various technical documents, drawings and information related to proposed operational activities was carried out to identify the environmental hazards associated with the project activities. In addition, the rationale for selecting the proposed project sites was reviewed. Based on the environmental hazards identified, various wastes that will be generated from the project were characterized and quantified. The control and treatment schemes for air emissions, wastewaters, solid wastes and noise proposed by HKN were also reviewed. A description of the project activities is presented in Chapter 4.

1.11.3 Scoping

A key aim of scoping is to identify the likely significant impacts of the Project that will require investigation and to develop the resulting terms of reference for the assessment studies. A scoping workshop was undertaken in Erbil, involving members of the Blanchard Energy team and HKN representatives, following which a Scoping Report was developed. The output of the Scoping Phase constituted a summary Scoping Report and Preliminary Interaction Matrix demonstrating where Project activities were likely to interact with environmental and social receptors.

1.11.4 Baseline data collection

A good understanding of the baseline is vital for understanding the nature and importance of project impacts. This ESIA predominantly uses a combination of data collected as part of the ESIA undertaken for HKN's field development plan update in 2016 and data from HKN's baseline environmental monitoring program, for noise, water soil and air during 2018. Additional information, where required, was sourced from published literature and data available on the internet. A subsequent ground-truthing exercise was carried out by an HKN contractor in April 2018 to review the status of the baseline chapter and provide additional observations and photographs for inclusion in the environmental baseline. The Baseline Section of this report provides a summary of the baseline information acquired by HKN environmental contractors Map Group and Blue Horizon and the subsequent field trip undertaken by an HKN environmental advisor.

1.11.5 Impact Assessment Stage

Following baseline data collection, an impact assessment study is undertaken. Here the magnitude of the predicted impacts is compared with the sensitivity of the receiving environment and a level of severity, termed significance, ascribed to the effect in line with the equator principle, where social risk and both negative and positive impacts are considered and assessed.

A project can have potential significant effects on a wide range of environmental receptors. The importance or significance of these effects depends upon a number of

factors, principally the level of magnitude of the impact and secondly the sensitivity of a receptor to be affected by the impact. It is therefore important to:

- Identify those processes or actions which will lead to an **impact** (i.e. a change in the environment) and evaluate the magnitude of this change; and
- Identify any environmental receptors upon which the impacts may act and evaluate its sensitivity.

It is this product of the impact acting on the receptor which produces an environmental effect. The significance of the effect is then determined by comparison, wherever possible, with a nationally or internationally accepted standard. If no standards are available then it is necessary to develop project specific limits, based on guidance or experience as necessary. Such standards or limits are referred to as the significance threshold. Wherever possible the thresholds of significance are based on a measurable value and compared with a legal, policy or guideline value.

If the size and type of effect is greater than the significance threshold, then this is termed a **significant effect**, which are further defined as High, Moderate and Low. A significant effect may be broadly defined as one which should be brought to the attention of those involved in the decision-making process. Therefore, identified significant effects need to be reported in the ESIA Report and if possible avoided or mitigated to reduce the effect to an acceptable level.

Prediction and Evaluation of Environmental Impacts

The prediction of impacts of the project has been considered against the baseline in the ESIA. The following types of impacts have been considered:

- *Direct Impacts* - A primary impact acting directly on an environmental receptor;
- *Indirect Impacts* - Impacts on the environment, which are not a direct result of the project, often produced away from or as a result of a complex pathway;
- *Direct/Indirect Impacts* - Impacts that fall into both categories;
- *Permanent Impacts* - Impacts that arise from an irreversible change to the baseline environment or which persist for the future. For the purposes of this ESIA, permanent impacts are those which will last for 20 years or more;
- *Long-term Temporary Impacts* - Impacts that persist for a limited long period of time and can be reversible;

- *Short-term Temporary Impacts* – Impacts that persist for a limited short period of time only and can be reversible;
- *Beneficial Impacts* – Impacts that have a positive, desirable, or beneficial effects on sensitive receptors; and
- *Adverse Impacts* – Impacts that have an adverse influence on sensitive receptors.

1.11.6 Mitigation and environmental management plan

The term mitigation strictly applies to the avoidance or reduction of the severity of an identified effect. The general approach to the project has been to design in order to avoid, reduce and if possible, remediate significant adverse environmental effects.

The final assessment process has been based on the full implementation of the committed mitigation measures.

In line with the mitigation measures, an Environmental Management Plan (EMP) has been developed and implemented to manage significant environmental effects during construction and operation of the Project. The EMP will provide commitments from the project sponsors that will ensure significant impacts are continually managed throughout the project life cycle.

1.12 ESIA key personnel and consultancies

Operator Name	Block Name	Contact Information
HKN	Sarsang Block	278 English Village, Erbil, Iraq +964-(0)-750-8566-228 +964-(0)-771-444-8906 hsemanager@hknenergy.com
Name of HKN's ESIA Focal Point	**Position in HKN**	**Contact Information**
Reza Khaleghi	Environmental Advisor	278 English Village, Erbil, Iraq reza.khaleghi@hknenergy.com
Name of ESIA Team Member	**Position in HKN**	**Role in Project Execution**
Bill McCleave	HKN HSE Manager	Project management and editorial review
Mike Brady	HKN Senior HSE Advisor	Project management and editorial review

Reza Khaleghi	Environmental Advisor	Project content
Jotiyar Ziad	CSR Advisor	Project content
Name of Consultancy	**Position**	**Role in Project Execution**
Map Group	Farhad Berzinji – GM	Baseline noise, air assessment and GIS mapping
Blanchard Energy Consulting	Dr. Gary Cranmer - Associate Consultant	Project QC/QA reviewer of document

1.13 Report structure

Chapter 1	Introduces the project overview and background of the proposed development. It states the objectives of the study, the scope of work and methodology entailed in conducting the ESIA.
Chapter 2	Identifies and highlights international standards and local regulations.
Chapter 3	Identifies the impacts of the project in view of the existing environmental baseline. Quantitative and qualitative impact assessment are conducted and described in this chapter.
Chapter 4	Describes the proposed activities entailed in the project, utilities, construction and development philosophy and manpower requirements along with the timeline forecast for the activities.
Chapter 5	This chapter Identifies the main environmental releases and summarizes the potential impacts
Chapter 6	This chapter specifies potential impacts on the environment from the project components which have been identified and assessed and mitigation measures to be applied.
Chapter 7	This chapter looks at alternatives represented in terms of environmental benefit obtained in case the project is not implemented in comparison to the case of implementing it.
Chapter 8	This chapter identifies the environmental uncertainties associated with the project
Chapter 9	This chapter summarizes the various mitigation measures in form of EMP to reduce or offset potential environmental impacts of the project
Chapter 10	This chapter discusses the net projected environmental impacts of the project (post-mitigation).

2 Legislations and Standards

This section of the ESIA outlines the legislation, standards and policies applicable to HKN's proposed 25k bopd Well Processing Facility on Pad B of the Swara Tika structure in the Sarsang Block.

The Kurdistan Region (**Figure 2-1**) occupies the north and north-eastern portions of Iraq. It borders Iran to the East, Turkey to the North, Syria to the west, and the rest of Iraq to the South. Iraqi Kurdistan covers an area of 40,643 km2, with a population of 5.2 million. Its capital is the city of Erbil. Iraqi Kurdistan is recognized by the 2005 Iraq Federal Constitution as an autonomous, political, ethnic and economic region of Iraq. It has been governed since 1992 by the Kurdistan Regional Government (KRG). It is divided into six governorates, four of which (Erbil, Sulaimani, Dohuk and Halabja) are entirely controlled by Kurdistan Regional Government, and the remainder are partially controlled by the KRG. Iraqi's constitution recognizes the Kurdistan Regional Government.

Figure 2-1 Kurdistan Region of Iraq, (green shaded area)

In 2006, the KRG established the Ministry of Natural Resources (MNR) to administer all operations regarding the petroleum industry activities and to define environmental standards specific for the sustainable development of Iraqi Kurdistan in line with international global targets. The MNR is actively involved in the review and approval of ESIA studies regarding the petroleum industry.

2.1 Relevant regional legislation, standards and guidelines

The WPF project will be designed, built and operated in a manner intended to conform with legislative and regulatory requirements and other guidelines and policies, the main categories of which are set forth below:

- National legislation
- The Overseas Private Investment Corporation (OPIC)
- International Finance Institution (IFI) Policies
- International Conventions
- HKN HSE and corporate social reasonability policies

Below is summary of the environmental legislation of the Kurdistan Region, relevant to HKN's production operations which impose additional environmental, health and safety requirements on the Operations. The descriptions of the laws and documents included below are summaries only and are qualified by reference to the full text of the actual laws or documents.

2.2 Kurdistan Government and Administration

The Kurdistan Region of Iraq (KRI) is an autonomous federated region in Iraq, bordering Syria to the west, Iran to the east and Turkey to the north. The establishment of the region dates back to the 1970 Autonomy Agreement between the Kurdish opposition and the then Iraqi government following years of political conflict.

Since the ratification of the Constitution of Iraq in 2005, Kurdistan has been defined as a federal entity of Iraq. The Constitution recognizes the Kurdistan Regional Government, the Kurdistan Parliament and the Kurdistan Regional Presidency as legitimate institutions for the governance of Kurdistan. Kurdistan's institutions exercise

legislative and executive authority in many areas, including policing and security, natural resources management and infrastructure development.

2.3 Environmental and regulatory framework in Kurdistan Region of Iraq

The KRG abolished the Ministry of Environment of KRI by Directive No. 23 of 2009 and its duties came under control of the Council of Ministers. Resolution No. 3 of 2010 formally established the 'Kurdistan Environmental Protection and Improvement Board' in order to assist the Council of Ministers in tackling its environmental duties. The 'Environmental Protection and Improvement Board' is therefore the main authority in charge of environmental matters within KRI. The following tasks are performed by the Board:

- Suggesting to the Council of Ministers, the general policy for environmental protection against pollution; and;
- Developing and implementing annual, medium and long-term plans for environmental protection and improvement.

The Ministry of Natural Resources' Health, Safety and Environment Department released two instructions for public consultation:

- Instruction (No. 1) of 2015 on the Abandonment and Reclamation of Land Used for Petroleum Operations; and
- Instructions of 2015 on the Framework for the Management of Waste Generated by Petroleum Operations.

These documents were issued for public consultation in draft and responses collated in late November 2014. Therefore, these documents are still under evaluation by the MNR prior to becoming law.

The Health, Safety and Environment Department ("HSED") is responsible for exercising the powers and duties of the Ministry in relation to health, safety and the environment of the Kurdistan Region. The HSED has published instructions and

guidelines addressing Environmental Impact Assessment ("ESIA") of Petroleum Operations for the Kurdistan Region, (see Figure 13).

2.3.1 Environmental Legislation in Kurdistan

The environmental regulations in KRI were developed as a response to the growing concern over environmental degradation in the Kurdistan region. This concern stemmed from the increase in population in the Kurdish areas which in turn stressed the supply of freshwater resources and increased air pollution. The main concerns of the Kurdish government began in the areas of air pollution, water pollution, waste management and the overall management of environmental quality.

2.3.2 Protected Areas and Biodiversity Management

Traditional forms for protection of rangeland are being followed by local communities in Kurdistan's rural areas and under the jurisdictions of local Mukhtar or administrators, there have been cases of local ban on de-forestation, cutting trees and restricted entry into certain areas to protect the environment. Since 2003, KRG has also put a ban on cutting trees in the Kurdistan Mountains.

Article 31 of the Law 8/2008 regulates the biodiversity conservation and prevention of desertification by prohibiting:

- Any work or activity that leads to destruction or threat to flora and fauna;
- Hunting and of fishes, birds and animals during their breeding season(s);
- Cutting or removing trees, plants and shrubs; and
- Hunting, killing, capturing or transfer of birds and animals that is rare and threatened.

Law No. 3 for the year 2010. 'The Law of Environmental Protection and Improvement Board in Iraqi Kurdistan Region' (Resolution to Law No. 8 of 2008):

1. Environmental protection and improvement, developing and preventing it from pollution.
2. Protection of environment and public health
3. Removing and treating the effect of chemical and explosive weapons.

4. Raising the level of environmental awareness and establishing individual and community responsibility to environmental protection and improvement.

*Law No. 8 of 2008 'Law for Environmental Protection and Improvement in Iraqi Kurdistan Region': (***Table-2-1***)*

To protect the regional environment as well as public health establishes the requirement to perform an ESIA for activities that might affect the environment to be evaluated by the 'Environmental Protection and Improvement Board' (formerly the Ministry of Environment of KRI).

Law No. 28 of 2007'Oil and Gas Law of Kurdistan Region-Iraq:

Establishes the Regional Government and the Minister of Natural Resources (MNR) to oversee and regulate all petroleum operations in the Kurdistan region. This Law was issued to develop the petroleum wealth of the KRI in a manner consistent with the Federal Constitution, to encourage investment and to facilitate cooperation on petroleum management with the Federal Government provided that revenue is shared equitably.

In addition, Law No. 4 of 2008 on the 'Protection and Development of Agricultural Production in the Kurdistan Region – Iraq' aims to promote local scale agricultural production, to encourage farmers to reverse migration to villages and direct them towards investment on agricultural lands. The Ministry of Agriculture is responsible for encouraging the growth of agricultural production in rural areas, compensating the owners for plantation damaged by natural disasters and providing the appropriate technologies for water conservation.

Article of Law No.8 of 2008	
Article 27	The ministry shall set the permissible emission levels to the different air polluting activities which determine: Permissible limits for emissions resulting from the combustion of fuel Permissible noise level limits Permissible limits for radiation levels or concentrations of radiating materials
Article 23	Regional standards are set for surface water, groundwater and drinking water
Article 24	The ministry shall set out the permissible levels for contaminants in drinking water, irrigation water, industrial water and services water

Table 2-1 Articles of Law No.8 of 2008 Regarding Air and Water Quality Standards

2.3.3 Production Sharing Contract (PSC)

In accordance with Kurdistan's Oil and Gas Law, the MNR has issued Production Sharing Contracts (PSC) to International Oil Companies (IOCs) (Law No. 22 of 2007) for the exploration and development of petroleum in Kurdistan. It holds primary responsibility and authority for related matters. These requirements incorporate relevant elements of regional and national laws and international guidelines and best practices.

Requirements for Development and Submission of ESIA

It is important to note that an ESIA is required by Articles 12-15 of Law No. 8 of 2008. Article 12 specifically stipulates that any person wishing to perform an activity which will have an effect on the environment must prepare an ESIA study. The ESIA study shall be reviewed and approved by the Environmental Protection and Improvement Board. In the case of oil and gas developments, the ESIA shall also be reviewed and approved by the MNR.

Instructions (No.1) of 2015 on the Environmental Impact Assessment of Petroleum Operations

On 27th May 2015, the MNR issued an instructions document that sets out the Ministry's requirements and processes for the ESIA of petroleum operations. The aim of the document is to ensure that petroleum operations are designed, managed and decommissioned in a manner that minimizes damage to the environment. The Instructions specify the following with regards to ESIA:

- The obligation to submit an ESIA report;
- The Ministry's review of ESIA reports;
- Follow up and monitoring;
- Transitional provisions (during the transitional period relating to the Instructions coming into force);

Reconsideration of the Ministry's decisions and responses (right to 'appeal'); and Supplementary provisions.

1. Additional information for inclusion in the ESIA report includes a Decommissioning Plan, Waste Management Plan, Environmental Management

Plan, Health and Safety Plan and Emergency Response Plan.

Technical Guidelines on the Environmental Impact Assessment of Petroleum Operations in the Kurdistan Region of Iraq

In addition to the Instructions (No.1) of 2015 on the Environmental Impact Assessment of Petroleum Operations, the MNR issued technical guidelines on Environmental Impact Assessments to provide general guidance and advice to companies for carrying out the assessment such as:

Purpose of the guidelines Obligation to Submit an ESIA Report Quality Standards Content of an ESIA Rep report, (**Figure 2-2**)

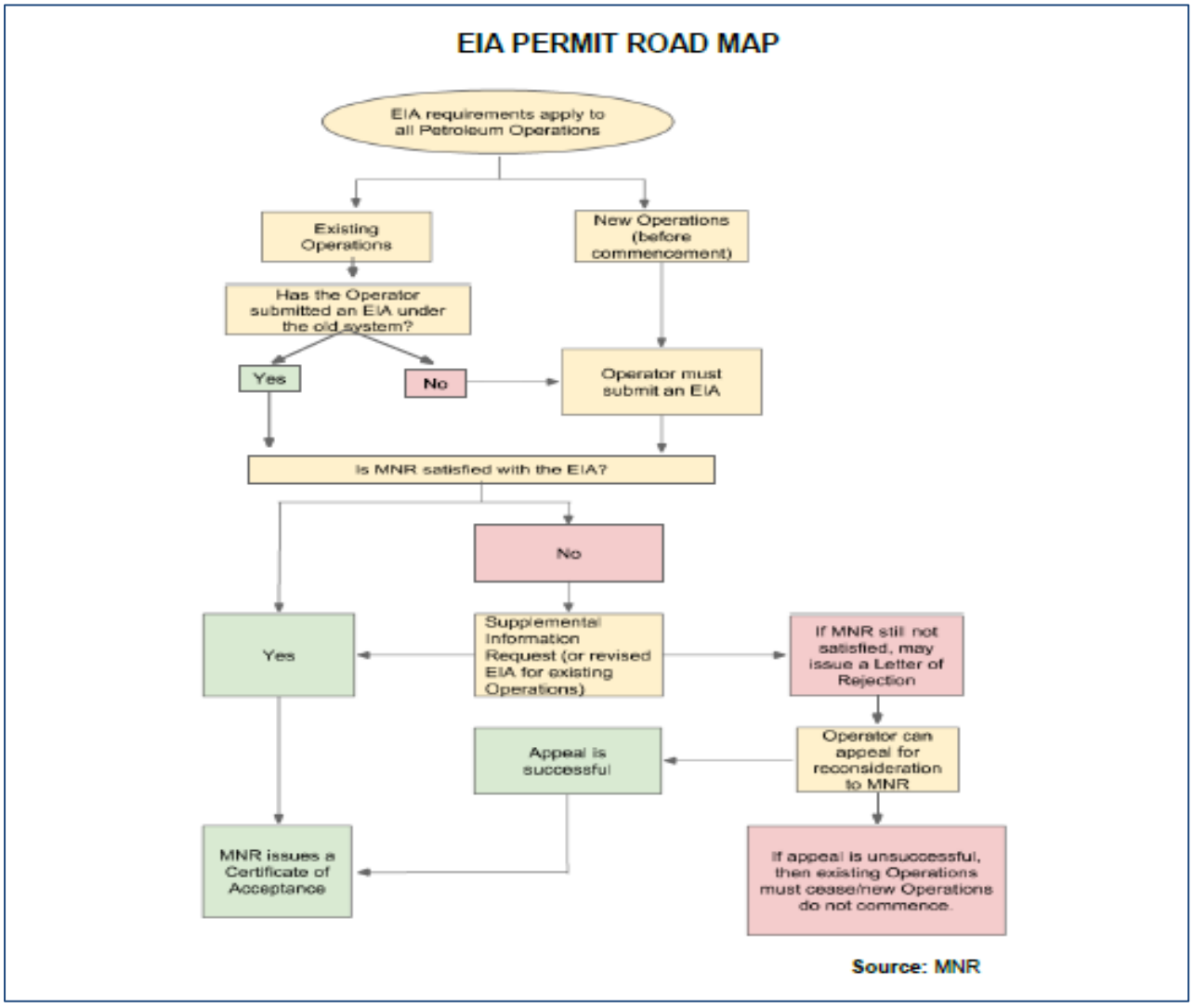


Figure 2-2 Approval procedures for an ESIA study in Iraqi Kurdistan

2.4 International Finance Institution (IFIs) policies and guideline

HKN is currently in process of negotiating financing with OPIC, based on IFC guidelines and criteria (part of the World Bank Group). This means the project requires compliance with specified environmental and social policies in accordance with the term of any provided financing. HKN also required to "conform to the environmental standards and practices, generally observed by the international community with respect to Petroleum projects. Thus, to satisfy the potential international lending agencies and to ensure good practice, all ESIA work for the project is being carried out with regard to World Bank Group and KRG policies. OPIC categorises oil and gas development and exploration projects as category A projects, due to its significant impacts to the environment in accordance to OPIC's Environmental handbook (2014). This will also entail a compliance audit to ensure environmental and social related conditions are validated within the first three years of the project.

These policies will include environmental standards applicable to the project as well as guidelines covering resettlement where applicable and other actions involved in project development and operation. The policies that will apply to the project will be set out in an environmental management plan that will be included in the project documentation.

2.4.1 IFC/World Bank Onshore Guidelines

The IFC Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice. When host country regulations are missing or differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

The ESIA also follows the Equator Principles, (EPIII 2013), updated by the IFC, which is a risk management framework adopted by financial institutions for determining,

assessing and managing environmental and social risk in projects, and is primarily intended to provide a minimum standard for due diligence and monitoring to support responsible risk decision-making.

2.4.2 HKN Corporate Policy

HKN corporate policy focuses on five areas: ethical conduct; employees; relationships; health, safety and environment; and control and finance. They apply equally to all HKN activities in Kurdistan Region of Iraq. HKN policy commitments are the foundation on which its business is built and carried out.

HKN's corporate policy states that long-term relationships founded on trust and mutual advantage are vital to HKN's business success. HKN's commitment is to create mutual advantage in all relationships so that others will always prefer to do business with HKN. This will be done by:

- Understanding the needs and aspirations of individuals, customers, contractors, suppliers, partners, communities, governments and non-government organizations
- Conducting activities in ways that bring benefits to all those with whom relationships are held
- Fulfilling obligations as a responsible member of the societies in which the HKN operates
- Demonstrating respect for human dignity and the rights of individuals

HKN is committed to working to build long-term relationships founded upon:

- High performance standards
- Delivering on promises
- Openness and flexibility
- Learning from others
- Mutual interdependence
- Sharing success

2.4.3 HSE Policy and commitment

Health, Safety & Environment Policy Statement

HKN ENERGY, LTD. ***is committed to managing and operating our assets in a manner that protects the health and safety of employees, contractors, neighbouring communities, customers, partners and the environment. We will comply with all applicable health, safety and environmental rules, laws, regulations and internal programs.***

To accomplish this, we will:

- Communicate health, safety and environmental, requirements to managers, supervisors, employees and contractors and ensure that expectations are clearly understood.
- Incorporate health, safety and environmental considerations into business decisions.
- Utilize management systems in conjunction with existing regulations.
- Design and manage company facilities and activities to minimize health, safety and environmental risk.
- Safeguard the Company's investments.
- Select competent personnel to manage activities.
- Select competent contractors and ensure that they are effectively managed.
- Monitor our operations and those of our contractors by evaluating performance against systems, procedures and regulations, while simultaneously providing a foundation for continuous improvement.
- Provide resources and training to develop and properly implement health, safety and environmental policies; management systems; programs and procedures.
- Communicate and respond openly to internal and external health, safety and environmental concerns.
- Engage actively in the communities where we work to ensure our presence has a positive impact

Dave Scott HKN VP Country Manager Kurdistan, Iraq

Figure 2-3 HKN HSE policy statement

2.4.4 Multilateral Environmental Agreements

Relevant international treaties that have been approved by the Iraqi Parliament and published in the official Gazette are listed in **Table-2-2.**

Name of Convention/Agreement	Signed/Ratified	*Acceding Iraqi legislation*[1]
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989	2011	*Law 3/2009*
United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, 1994	2010	*Law 7/2007*
Convention for the Safeguarding of the Intangible Cultural Heritage, UNESCO, 2003	2010	*Law 12/2008*
Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), 1997	2009	*Law 7/2008*
United Nations Convention on Biological Diversity, 1992	2009	*Law 31/2008*
United Nations Convention on Climate Change (UNFCCC), 1992	2009	
The Convention on Wetlands of International Importance, Ramsar Convention, 1971	2007	*Law 7/2007*
Vienna Convention for the Protection of the Ozone Layer, 1985	2008	*Law 42/2007*
Montreal Protocol on Substances that Deplete the Ozone Layer, 1987	2008	*Law 42/2007*
Convention concerning the Protection of the World Cultural and Natural Heritage, 1972	*1974*	

Table 2-2 Environmental-related Agreements to which Iraq is Party

[1] Conventions and agreements apply to the KRI administration

3 Baseline environmental conditions

This chapter presents the existing environmental conditions in the Sarsang Block and the areas in the immediate vicinity that may be potentially influenced due to the proposed project activities. HKN has previously commissioned the environmental, social and health baseline studies in Sarsang Block during the ESIA study conducted prior to seismic activities in April – May 2008. Further site surveys were conducted again during March 2010 and 2012 prior to exploratory drilling and EWT works to validate and augment the baseline environmental status in the general study area. In 2018, HKN further commissioned site visits to validate and augment the current baseline status for its master FDP ESIA. It is anticipated that the findings of this baseline study will be considered fully to ensure that the planning and execution of activities are designed in a sustainable manner.

3.1 Study and Project Area

The Sarsang Block is located approximately 39-km Northeast of Dohuk city and 93-km North-West of Erbil and covers an area of approximately 1,200 km^2 encompassing a largely mountainous terrain. There are various settlements, wadis /rivers, lake, etc., present within the concession block. There are no major industrial activities within the concession area. Commercial activities are limited to retail /wholesale shops, automobile garages, etc., associated with the villages near the concession area. No contaminated sites / oil seepage sites were identified during the site visit and drive through survey. The proposed site footprint is shown in **Figures 3-1 and 3-2.**

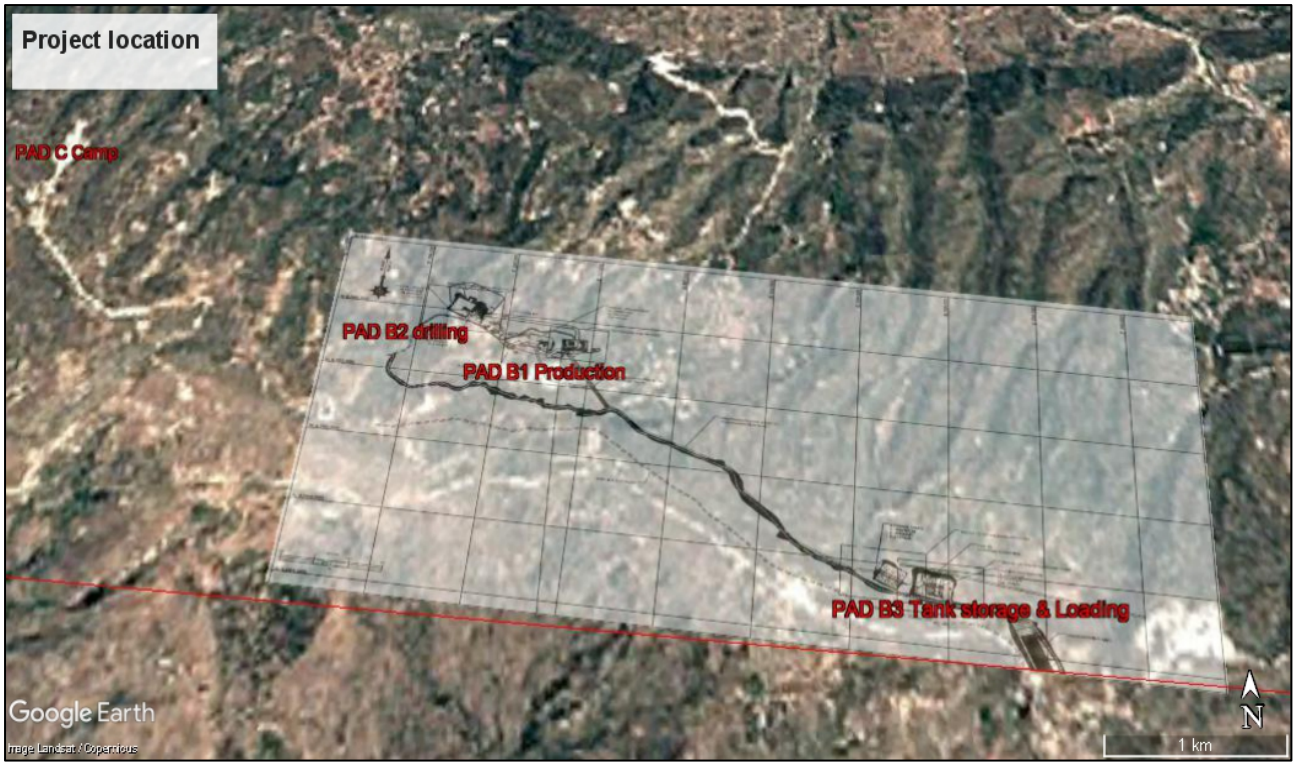


Figure 3-1 Topographic image of the overall project area

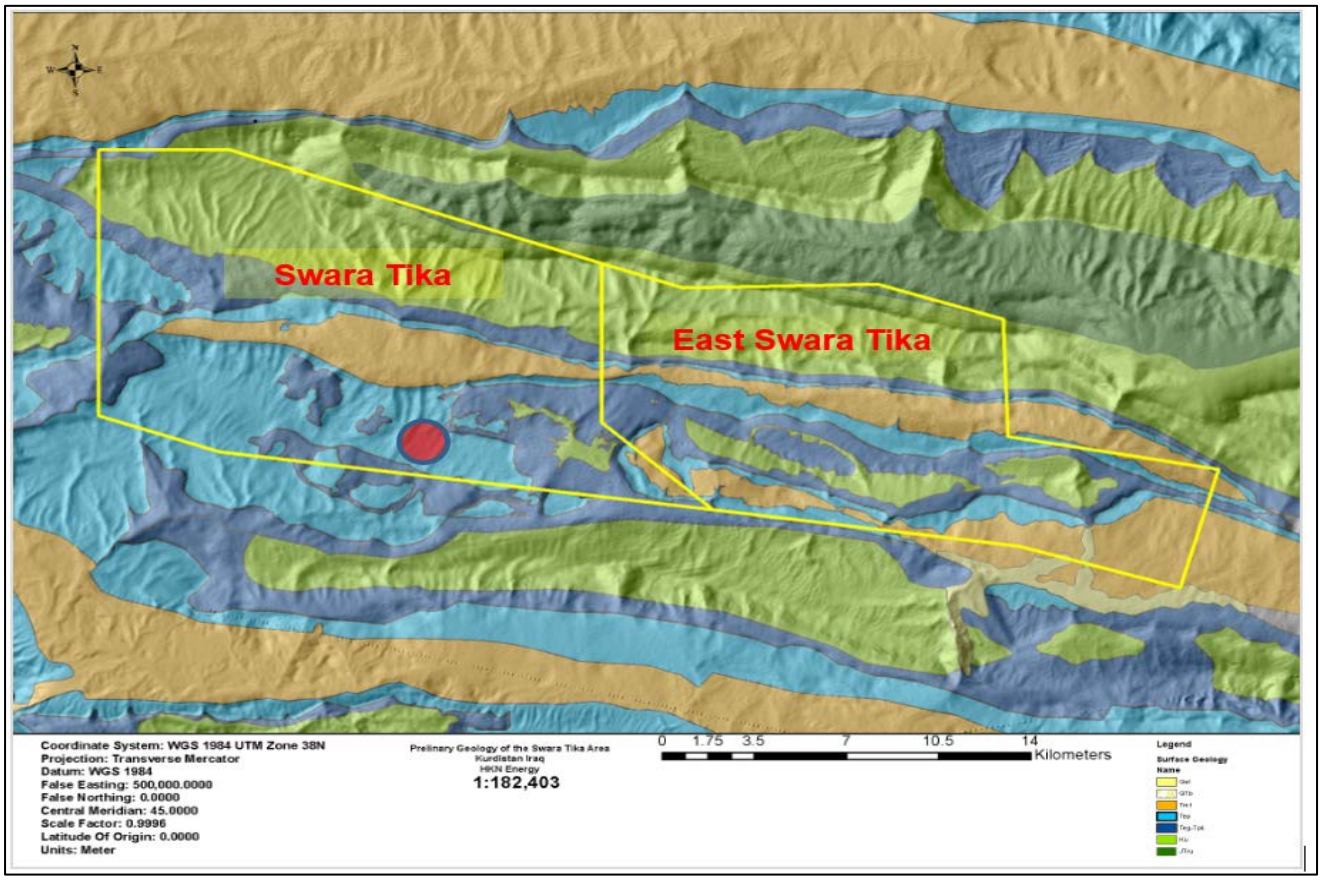


Figure 3-2 Geological map of Sarsang Swara Tika section marking the project area

3.2 Climate & Meteorology

The study area experiences a semi Mediterranean climate with temperature increasing appreciably southward, away from the mountains. The area is generally characterized by a hot, dry climate during the summer, caused by hot air masses moving with some dust from the east of the Mediterranean. A north-westerly wind system, light to moderate also blows during the summer months and is due to the establishment of a seasonal trough over Iraq and north Syria. The climate is generally cold in winter.

The maximum daily sunshine occurs in July and the minimum occurs in January. The average annual temperature was 20.1°C during the period 1988-1997. The maximum monthly temperature was 44.4°C (July 1989), while the minimum was recorded as 4.3°C in January 1992. Northern Iraq region experiences the Mediterranean climatological system and therefore its rainfall occurs during winter and spring seasons and very seldom during summer time. Most of the precipitation occurring in the area is in the form of rain or drizzle.

However, snowfall can be expected in the mountains, and hail is frequent during thunderstorms. The historical annual rainfall for Dohuk region for the period 1990 to 2003 and monthly rainfall for the year 2003, obtained from the Ministry of Agriculture and Irrigation, are shown graphically in **Figure 3-3** and **Figure 3-4** respectively. In the mountain range there is a considerable difference between the slopes facing North and those facing South in the sense that snow fields on the Northern slopes (mainly seen near the Turkish border) may persist throughout the summer, slowly melting and feeding small perennial streams, while on the South facing slopes snow is observed to have completely disappeared in June. In addition, HKN has been carrying out temperature and wind measurements in around the project site from 2013 to 2018. A snapshot of wind profile at project location is provided for reference in **Figure-3-5.**

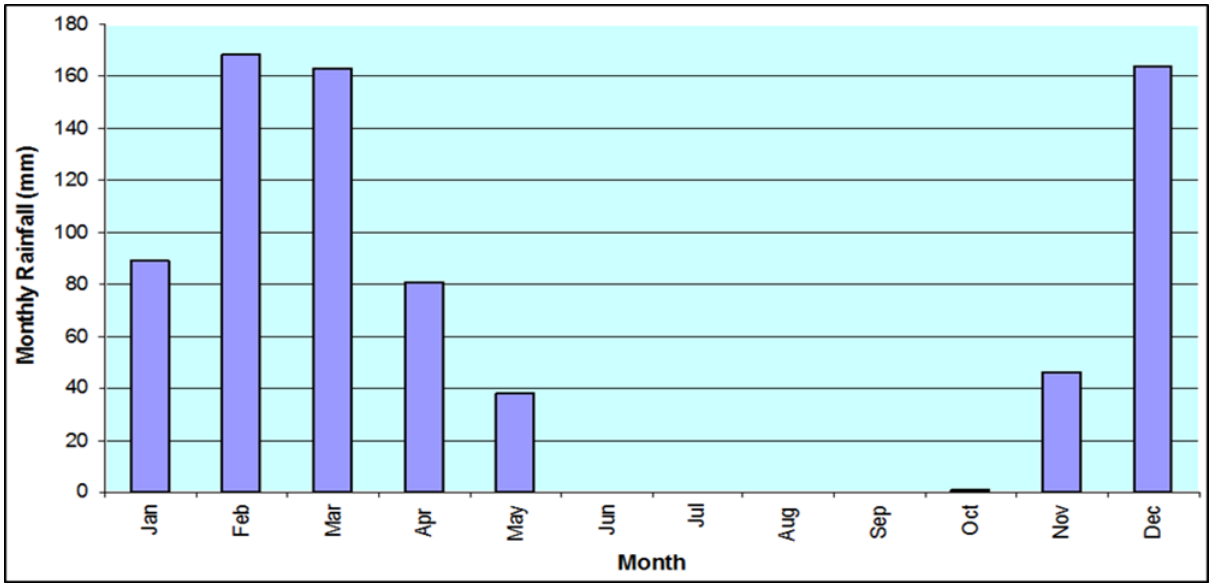


Figure 3-3 Monthly rainfall, Dohuk province

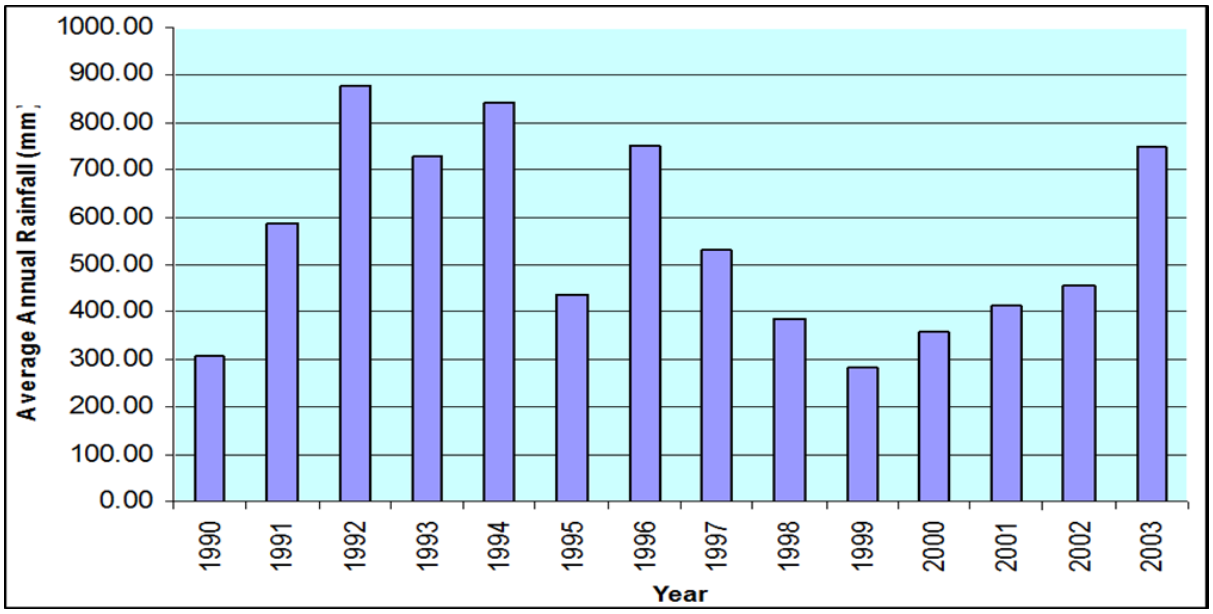


Figure 3-4 Annual rainfall, Dohuk province

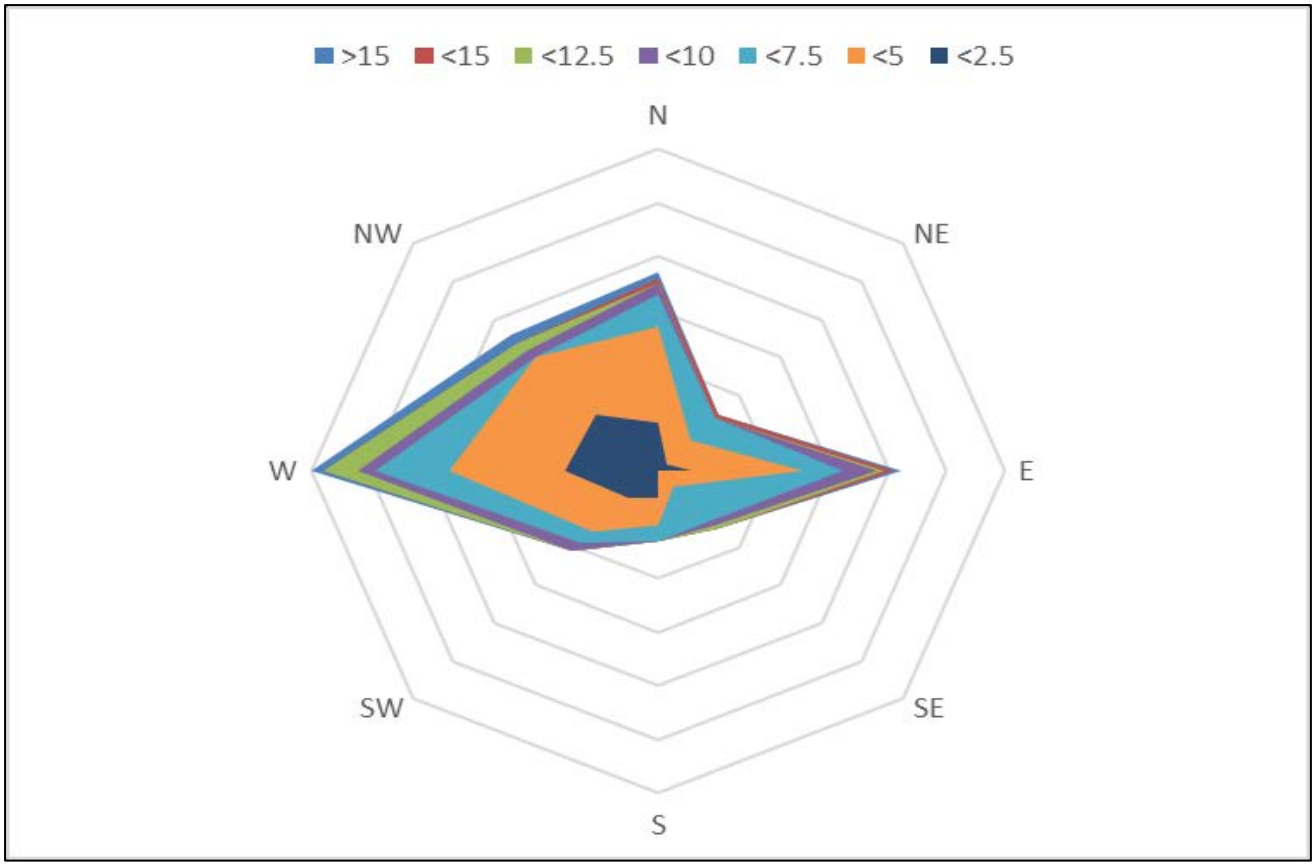


Figure 3-5 Annual wind rose for Sarsang concession, showing wind speed and direction

3.3 Topography and Landscape

The topography of the study area is characteristic of a primarily undulated terrain formed by the Mountainous ranges and relatively flat valley beds in between. HKN's elevation model within the study area the surface elevation varies from about 910 m to about 1,730m above sea level (MASL).

The majority of the mountain slopes are covered with scrub/range land that is irrigated seasonally by rainfall. This rangeland is used for livestock grazing. Photographs of typical landscape within the concession area are presented in **Figure 3-6,** showing steep gradient land formations with soil erosion evident, caused by natural climate and agricultural influences.

3.4 Natural events history (earthquakes, floods, fires, storms, volcanic eruptions)

According to the CIA World Fact Book, Iraq experiences dust storms, sandstorms and floods.

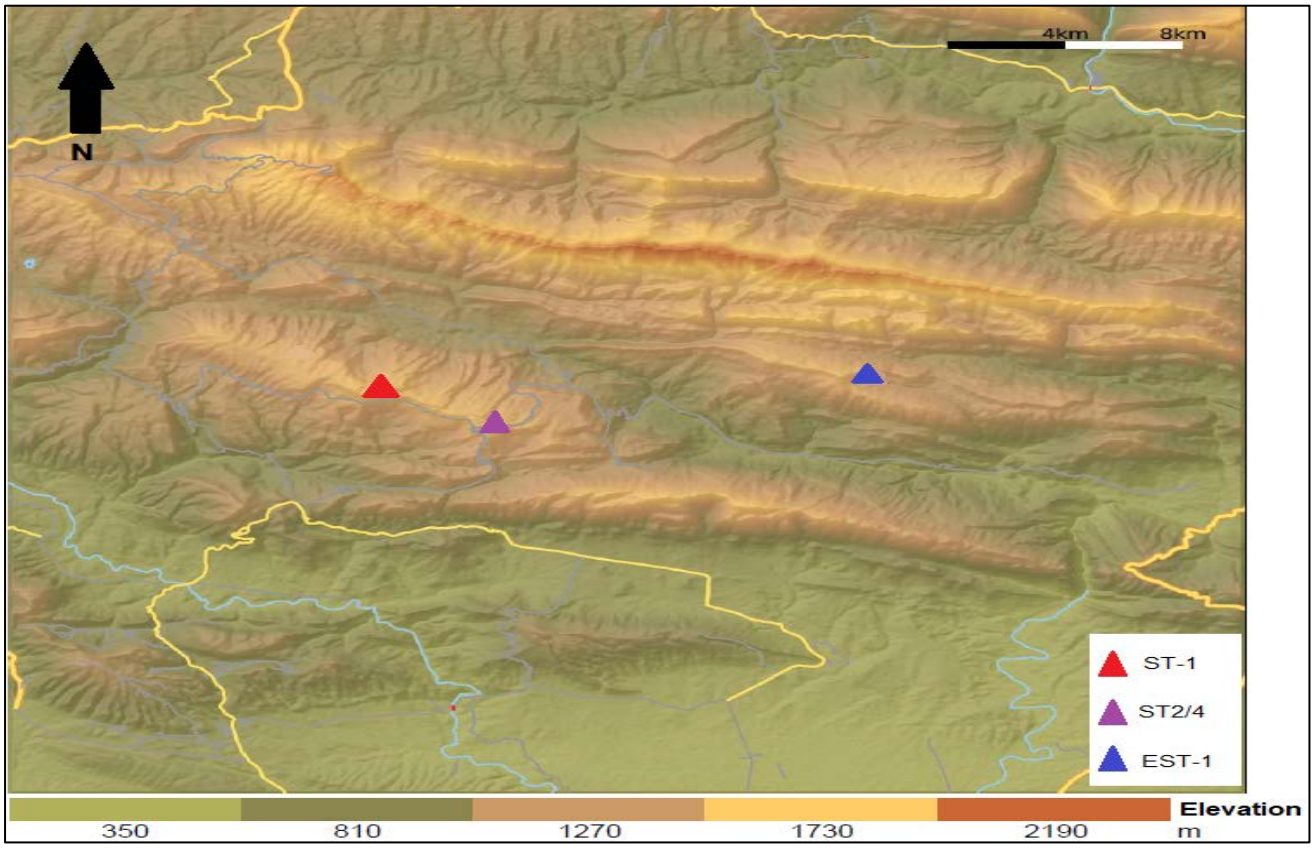


Figure 3-6 Elevation contour map of project area (25km radius)

3.5 Geology

The land formation was reviewed to analyse the geology of the area. A description of the surface geological formations of the concession block from the older to younger formations is presented in the following sub-sections. A cross section of the geological formations with an approximate thickness of the layers and age are depicted in **Figure 3-7**.

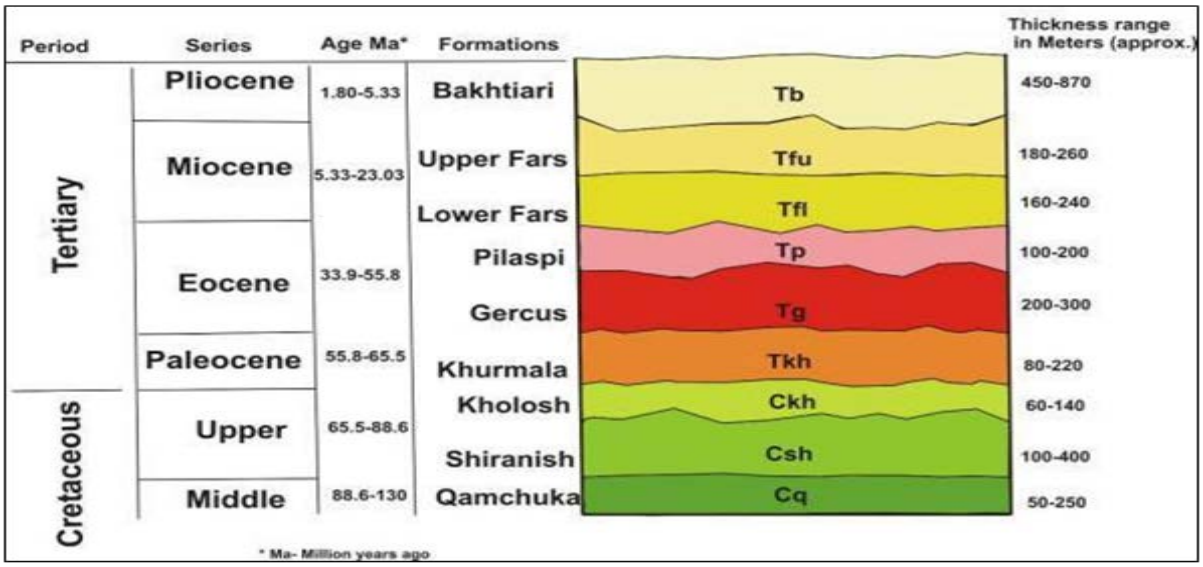


Figure 3-7 Surface geological formation layers of Sarsang concession

The Sarsang Block surface geology varies across the area and was formed during the Cretaceous and the Tertiary periods of Geological Time scale.

3.6 Soil Characteristics

The general characteristics of soil within the study area vary between mountain volcanic rocks with red soil in the plains, to alluvial deposits at surface drainage channels or wadi beds.

In the mountains the rocks are mainly sandstone, limestone and claystone rocks covered with organic soil. The plains and foothills of mountains, leaching and accumulation of lime and swelling and shrinking of the clay are seen through surface cracks in the dry season and the build-up of internal pressures in the soil, leading to varying, but usually mitigated, degrees of slickenside (sliding pressure faces) formation.

The organic matter tends to decrease due to the present land use, i.e. grazing and burning of crop residues. The soils are also thought to be self-mulching, but, probably due to low organic matter contents, soil crusting also occurs, although usually not to an extent that it causes real problems for seedling emergence.

Soil characterization, contamination assessment and sampling activities were carried out in selected areas determine the physical and chemical characteristics of the soils. The Soil Sampling team visited seven sites for investigation and assessment, during the sampling survey. Seven soil samples and one sample duplicate were collected for laboratory analysis, all of them from the surface (0.0 to 0.3 meters below ground level). Also, soil classification was recorded, and photos, GPS coordinates and field observations have been taken, (refer to **Appendix-4**)

The soil sample sites were visited and sampled, four sites were located close to ST1 (Pad C camp (SS01), Pad B2 (SS02), Pad B1 (SS03) and OilServ camp (SS04)), and three sites were located close to ST2 (New truck staging (SS05), Pad B3 (SS06), and new transfer pipeline (SS07)). All these locations within the contract area. Soil sampling sites are presented in **Figure 3-7.**

A summary of the soil sampling methodology is as follows:

- Soil samples were at the surface soil from 0 to 0.3 meters below ground level (mbgl).
- Soil samples were taken using stainless steel handheld shovel and hand auger.
- Soil samples were collected in laboratory-provided containers and put immediately in cool boxes.
- Samples for volatile organic analysis collected directly from the bucket, before mixing the sample, to minimize loss due to volatilization of contaminants.
- Soil samples were shipped for further laboratory analyses, ISO certified Laboratories.
- Soil samples were shipped to the analytical laboratories according to project-specific SOP Sample Handling and Custody.
- Equipment decontamination in the field using the decontamination procedure described in the Sampling Equipment Decontamination SOP.

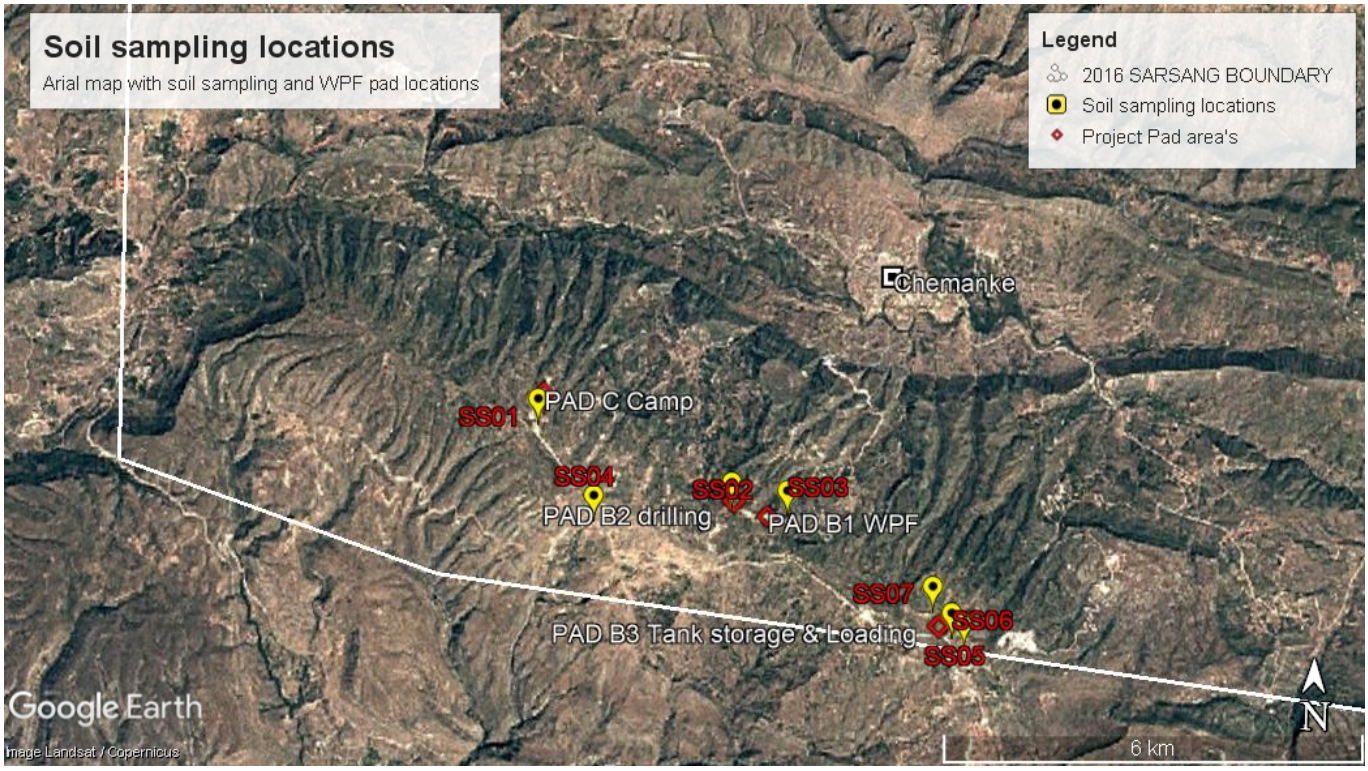


Figure 3-8 Showing the soil sampling locations at project area

Soil samples were collected directly, using stainless steel, hand-held devices such as hand auger and/or shovels. Soil sampling activities were performed in accordance with project-specific SOP Soil Sampling. Observations made during surface soil sampling were recorded in the field form for soil sampling and associated with digital photographs. Observations and visual assessment were taken at each sampling location regarding soil type and classification, grain size, colors, and soil and structure were recorded in accordance to Unified Soil classification system.

For the soil quality survey, all seven soil sites were visited and sampled. Soil sample duplicate was collected on SS03 site for laboratory QC/QA purpose. All of the sites were uncontaminated sites, except one site (SS03).

3.7 Soil sampling and analysis

In general, the characterizations of the soils were moist fine-grained soils, silt, clay, silty clay, and Loam, with medium to high plasticity; colors of the soils were reddish brown, pale brown and brown.

Appendix 4 shows the laboratory analysis of soil samples.

In the mountains the soils are mainly derived from sandstone, limestone and clay stone. Most of the plain areas in the study area covered by red soils and the wadis and river embankments are filled with alluvium deposits. In the plains and foothills of mountains, leaching and accumulation of lime and swelling and shrinking of the clay activities create surface cracks, which can be seen in the dry season.

The organic matter in the hills tends to decrease due to the present land use, i.e. grazing and burning of crop residues. The soils are also thought to be self-mulching, but, probably due to low organic matter contents. The properties are mostly not sufficiently developed due to the high calcium carbonate (CaCO3) content, which may tend to suppress the swelling behaviour of the clay.

Leaching and accumulation of lime and swelling and shrinking of the clays in the mountainous areas is generally more pronounced than in the plains and foothills. The lime accumulation horizon tends to start slightly deeper (typically, between 35 and 50 cm) than in the plains and foothills probably because of higher rainfall. Full soil analysis is presented from **Table 3-1 to 3-3.** Note in the absence of KRG guidelines for soil, sampled parameters were compared to the well-established Canadian soil quality guidelines.

Sample ID	Sample ID								Limit of Detection LOD	Units	Canadian Soil Quality Guidelines 2007- mg/kg	
	SS01	SS02	SS03	SS03-Duplicate	SS04	SS05	SS06	SS07				
Metals											Agricultural	Industrial
Aluminum	49130	53750	12770	12890	29100	32530	43830	12720	<50	mg/kg		
Antimony	3	4	<1	<1	1	2	4	<1	<1	mg/kg		
Arsenic	10.0	12.7	2.7	2.6	5.4	4.9	11.9	2.3	<0.5	mg/kg	12.0	12.0
Barium	182	139	46	71	94	89	123	43	<1	mg/kg	750.0	2000
Cadmium	0.6	0.6	0.3	0.3	0.4	0.5	2.8	0.3	<0.1	mg/kg		
Calcium	40800	31980	203900	206100	167300	109600	104500	184300	<500	mg/kg		
Chromium	129.1	159.3	49.9	50.8	97.3	104.8	141.5	40.7	<0.5	mg/kg	64.0	87.0
Cobalt	31.0	28.3	9.2	8.7	16.3	16.9	22.4	6.9	<0.5	mg/kg	40.0	300
Copper	35	42	12	12	25	27	44	12	<1	mg/kg	63.0	91.0
Iron	49970	52660	13590	14100	32150	33410	45680	14130	<20	mg/kg		
Lead	11	8	<5	<5	5	7	14	<5	<5	mg/kg	70.0	600
Lithium	32	38	15	16	21	26	29	15	<5	mg/kg		
Manganese	1321	1033	221	234	594	634	674	290	<1	mg/kg		
Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	6.6	50.0
Molybdenum	1.7	4.1	0.4	0.5	0.6	0.5	0.8	0.4	<0.1	mg/kg	5.0	40.0
Nickel	178.3	196.6	92.5	88.2	123.4	117.6	164.9	48.7	<0.7	mg/kg	50.0	50.0
Phosphorus	523	518	195	223	358	558	454	312	<10	mg/kg		
Silicon	190.5	167.5	128.5	105.8	148.9	144.5	162.8	117.5	<0.5	mg/kg		
Sodium	174	388	279	298	182	286	153	318	<5	mg/kg		

Table 3-1 heavy metal analysis from sample locations compared to Canadian Soil guidelines (where applicable)

Sample ID	Sample ID								Limit of Detection LOD	Units	Canadian Soil Quality Guidelines 2007- mg/kg	
	SS01	SS02	SS03	SS03-Duplicate	SS04	SS05	SS06	SS07				
Strontium	38	40	66	70	64	60	44	63	<5	mg/kg		
Vanadium	123	131	56	57	70	107	116	52	<1	mg/kg	130	130
Zinc	90	101	24	26	62	68	92	29	<5	mg/kg	200	360
PAH												
Naphthalene	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	mg/kg		
Acenaphthylene	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	mg/kg		
Acenaphthene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	mg/kg		
Fluorene	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	mg/kg		
Phenanthrene	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	mg/kg		
Anthracene	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	mg/kg		
Fluoranthene	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	mg/kg	0.1	50.0
Pyrene	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	mg/kg	0.1	100.0
Benzo(a)anthracene	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	mg/kg	0.1	10.0
Chrysene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	mg/kg		
Benzo(bk)fluoranthene	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	mg/kg	0.1	10.0
Benzo(a)pyrene	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	mg/kg		
Indeno(123cd) pyrene	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	mg/kg	0.1	10.0
Dibenzo(ah)anthracene	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	mg/kg	0.1	10.0
Benzo(ghi)perylene	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	mg/kg		
PAH 16 Total	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	mg/kg		
Benzo(b)fluoranthene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	mg/kg		
Benzo(k)fluoranthene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	mg/kg	0.1	10.0

Table 3-2 PAH analysis from sample locations compared to Canadian Soil guidelines (where applicable)

Sample ID	Sample ID								Limit of Detection LOD	Units	Canadian Soil Quality Guidelines 2007- mg/kg	
	SS01	SS02	SS03	SS03-Duplicate	SS04	SS05	SS06	SS07				
PAH Surrogate % Recovery	92	94	106	102	97	99	97	97	<0	%		
EPH												
EPH (C8-C40)	<30	44	145	145	39	44	<30	<30	<30	mg/kg		
Other												
Natural Moisture Content	29.2	37.0	23.2	23.8	16.9	23.3	25.9	23.7	<0.1	%		
Bromide	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	mg/kg		

Table 3-3 Hydrocarbon and natural content analysis

3.8 Water Quality and hydrology

The facility site is located at the top of mountains where there is high rainfall in the winter season (around 700- 1000 mm/ year). The mountains typically receive snow and are covered for a few days in the winter. The runoff from rainfall or from snow melt is one of the main sources of water feeding the wadis and rivers in the area around the well. There are many seasonal wadis within the concession areas, (**Figure 3-98**). Most of these wadis are dry in the summer and have flowing water in the winter.

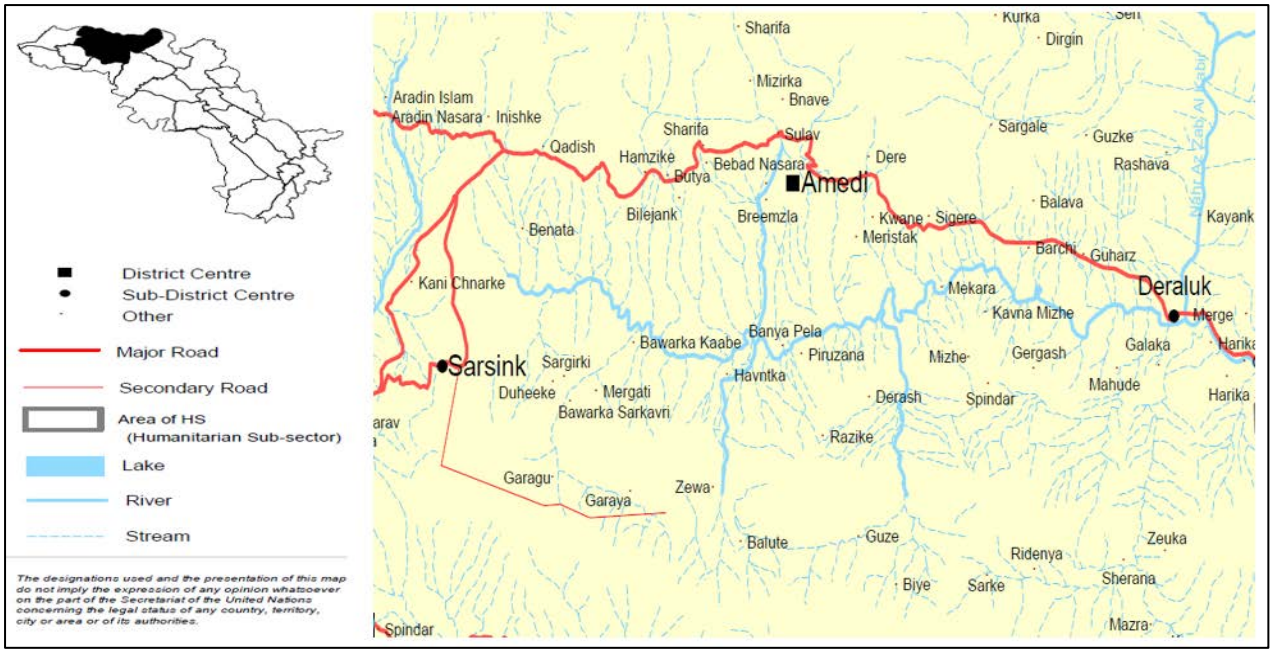


Figure 3-9 United Nations Joint Humanitarian Information Centre map showing streams and river within the HKN concession

Groundwater's are either from shallow aquifers where water depth ranges between 5 to 20 m or from deeper aquifers (limestone aquifer, and granular aquifer) where the water depth ranges from 200 to 500 m. The water quality is good from both aquifers, however HKN has found that the turbidity is higher from the shallow aquifer. The recharge of these aquifers is mainly from the Pilaspi formation outcrop area in the mountains in the north. In the dry year's springs suffer from a serious drop in water flow and in some cases become dry in the summer.

Similarly, springs are flowing from both shallow and deep aquifers. Recent and deep formation aquifer spring flows are affected by rainfall increase in the winter and decrease in the summer. During a dry year, most of these springs dry up.

The concession block is located near the north-western plunge of the Pirmam anticline. The anticline mountainous structure acts as a boundary of the basins and where the natural recharge occurs. From these mountains many wadis are originated and flowing towards different directions based on the relief which can be clearly seen in the satellite imagery. The wadis are merging at Swara Tika village and flowing in a western direction. Most of these wadis are dry in the summer and have water flowing

only in the winter. The main source of aquifer recharge in the study area is dependent upon rainfall and runoff.

Sarsang Block field campaign consisted of one round of sampling survey which took place from 27th to 29th April 2018 with one team. The work involved activities such as visual observations and surface water sampling. These activities were conducted within Sarsang concession area.

Surface water Sampling and Assessment

Seven surface water samples were collected from several spring sources within the Contract Area. While sampling, physicochemical parameters were measured in situ. Field measurements indicate that surface water in all location have low salinity and conductivity values. These values are categorized as soft surface water.

Precedents

HKN contractors Blue Horizon (BH) conducted a field survey in April 2018 on Sarsang Block for the Environmental Assessment in the Contract Area as part of the HKN's water quality monitoring programme. The tasks involved in carrying out the fieldwork included a visual inspection of proposed survey sites and water resources survey (surface water sampling).

Field Survey Objectives

The main objective from this environment survey is to provide relevant information on the visited sites, ground-truthing the data investigated, and to monitor the baseline information. For this survey, environmental team visited seven sites for investigation and assessment; eight surface water samples were collected from different water springs. Photos were taken at all visited sites, GPS coordinates were recorded, and sampling and assessment field sheets were completed.

The desktop study and the visual assessment were the major tools in collecting the hydrological and topographical information. The environmental team collected some baseline information on the existing infrastructure to provide a general understanding on contract area.

3.8.1 Surface Hydrology

For surface water assessment and sampling, seven locations were selected within 5 km radius of project location from established water monitoring sampling locations. Most of the surface water bodies are natural spring aquifers, with no water wells are present and no water treatment is applied apart from the exception of the larger populated town of Chamanke where water chlorination is applied before water is distributed to the village. In addition, Chamanke uses direct water sources from the river and conduct chlorination before distribution to homes. The villages are in a remote location and are very small with very few inhabitants, also physical measurements were recorded, and photos, GPS coordinate and field observations taken. **Figure 3-10** shows the surface water sampling locations at the study area.

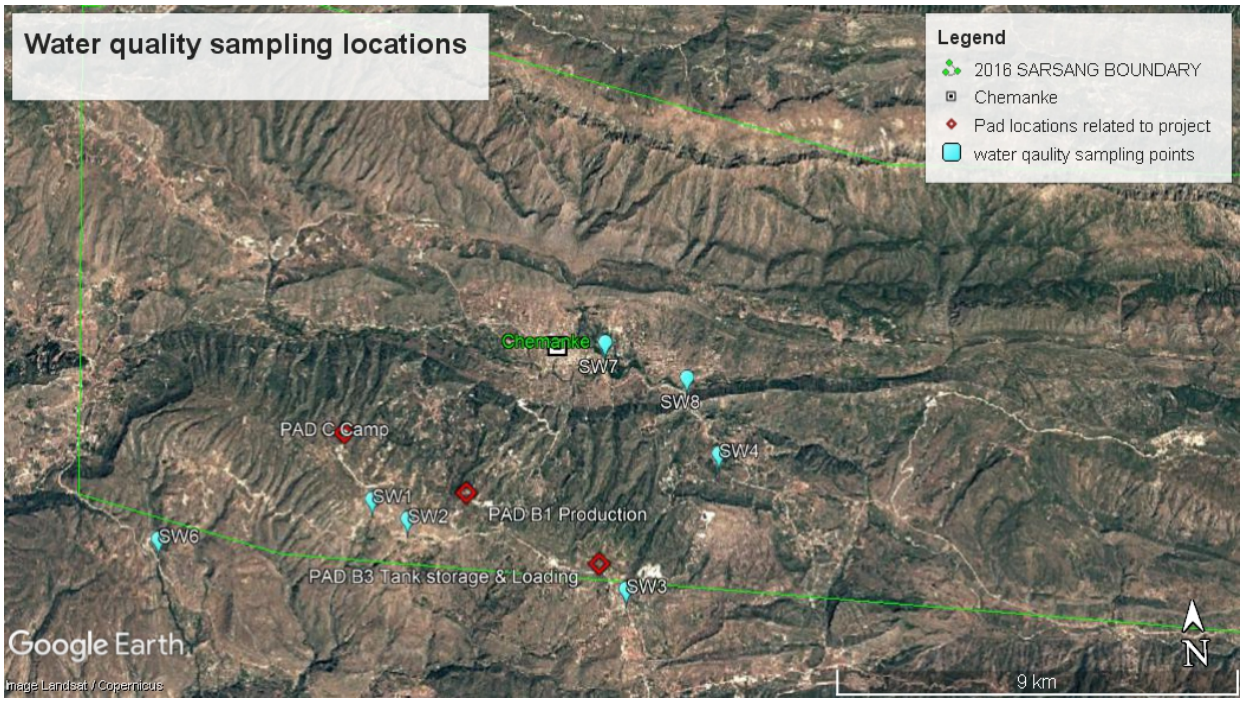


Figure 3-10 Surface Water Sampling Locations

3.8.2 Surface water sampling method

Seven surface water sites were visited and sampled, three sites were located close to Pad B2 (SW01 & SW02), two sites were located close to ST2/4. (SW03 & SW04), and two sites were located in Chamanke sub-districts (SW07 and SW08). In addition, SW6 sampling location, south west of WPF project, where water was sampled from a stream used for camp water supply. All these locations were surface spring water. Surface water sampling sites are presented in **Figure 3-10**. Surface water samples were

collected prior the field measurements at each location. The collector submersed the closed sample container, opened the bottle to collect the sample and then capped the bottle while sub-surface. The collection bottle was rinsed two times by the sample water except pre-preserved sample bottles, to avoid diluting the concentration of preservative necessary for proper sample preservation.

Water samples were collected in laboratory-provided containers and immediately preserved in cool boxes containing ice packs, then refrigerated. A total of eight surface water samples were collected from eight sites and three samples for QC/QA (one sample duplicate, field blank and reinstate blank). Surface water samples were shipped for Blue Horizon laboratory analyses, just for Metals and TPH samples shipped to ISO overseas Laboratory. Surface water samples were preserved and shipped to the analytical laboratories according to project-specific SOP Sample Handling and Custody.

Water parameters were recorded, including temperature (in degree Celsius), pH (in standard units - S.U.), salinity (in ppt), conductivity (in uS/cm), dissolved oxygen (in mg/l) and Turbidity (in NTU), at least three times during the sampling period. Sampling was done using (WTW) GmbH field instrumentation multi-parameter meter (equipped with a probe) and recorded using project-specific logs. Equipment used for measurement of in-situ surface water parameters was maintained and calibrated according to the project-specific SOP Field Equipment, (refer to **Appendix-5**)

3.8.3 Water sampling and analysis

The spring water passed through agricultural lands and residential area. In general, the characterization of surface water was fresh water in all locations. The minimum and maximum reading of physical parameters for all locations were as follows:

- Conductivity 388 to 764 µS/cm;
- pH 7.22 to 8.65;
- Dissolved Oxygen 8.04 to 11.9 mg/l; and
- Turbidity 0.61 to 27.0 NTU.

Based on the biological results, there is bacteriological presence in six sampled locations. It could be sourced from the human activities, and since the locals are using the water for domestic purpose and irrigation, then it is recommended that specific signs to be put at those locations to educate the locals on proper using of the springs.

3.9 Air and Noise baseline assessment

There are no major industrial and commercial activities within the concession block. The general area is mostly in rural settings. The ambient air quality is expected to represent the general area type.

Based on a preliminary literature review and understanding of local conditions HKN contractor Map Group coordinated with HKN and measured 8 air samples and 8 noise samples within the study area for the monitoring program at HKN facility, see **Figure-3-11.** Two, additional sampling points, for noise and air was taken (AA9 and NS9) from existing HKN production site EST-1, as baseline to understand current sound levels for an existing production facility as an indication of likely sound levels to be expected for the WPF. Coordinates of studied sampling sites explained in **Figure 3-11 and Table 3-4.** Target representative sample locations were determined before the site visit to meet objectives in which seven and 9 sampling sites were selected for air and noise respectively at and around drill sites and WPF facility.

To provide concise representation of site conditions, representative sample locations were determined in the field and include each site, (**Appendix-3**) and the potential development area and villages nearest to the study sites. Ambient noise monitoring was generally performed in conjunction with air monitoring locations and may include sensitive and residential areas. Gaseous pollutants, including CO, VOC, SO2, O3 and NO2 were analysed in the field using a portable gas analyser Aeroqual 500 with sensors for all requested gasses.

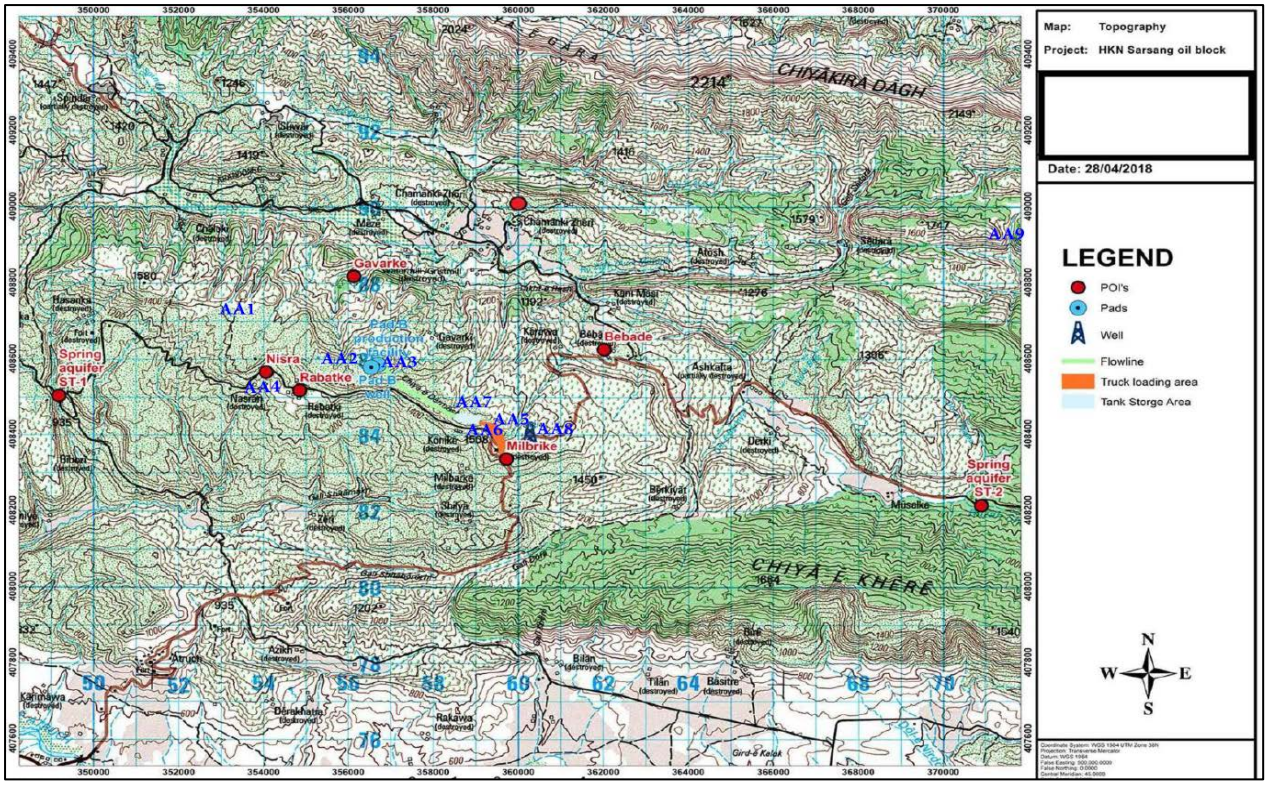


Figure 3-11 Noise and air sampling locations in blue

Ambient suspended particulate matters were measured using a direct particulate matter monitor MET-One 831 for PM 2.5 and 10. Coordinates of studied sampling sites explained in **Figure 3-11.**

3.10 Blockwide baseline air monitoring

HKN has developed an extensive air quality monitoring program and annual baseline measurements have been considered for this study. A fixed AQMesh unit positioned at Chamanke village for continual baseline air monitoring. **Figure 3-12** and **Figure 3-13** illustrate annual NO2 measurements taken from device electromagnetic sensors, measured in both 1 hour and 24-hour threshold levels from January to September 2018. O3 measurements (8-hour average, as per KRG article 4 Threshold 235ug/m3), from January 2018 to date are also illustrated in **Figure 3-16. Figure 3-14** illustrates 5-year blockwide average from 24 Gradko diffusion tubes with concentrations and threshold levels set against the KRG limits, and **Figure 3-15** shows the locations of the tube network in relation to the project footprint. It must be noted that the air monitoring program is blockwide and air quality levels represent activities within the operation areas including non HKN activities.

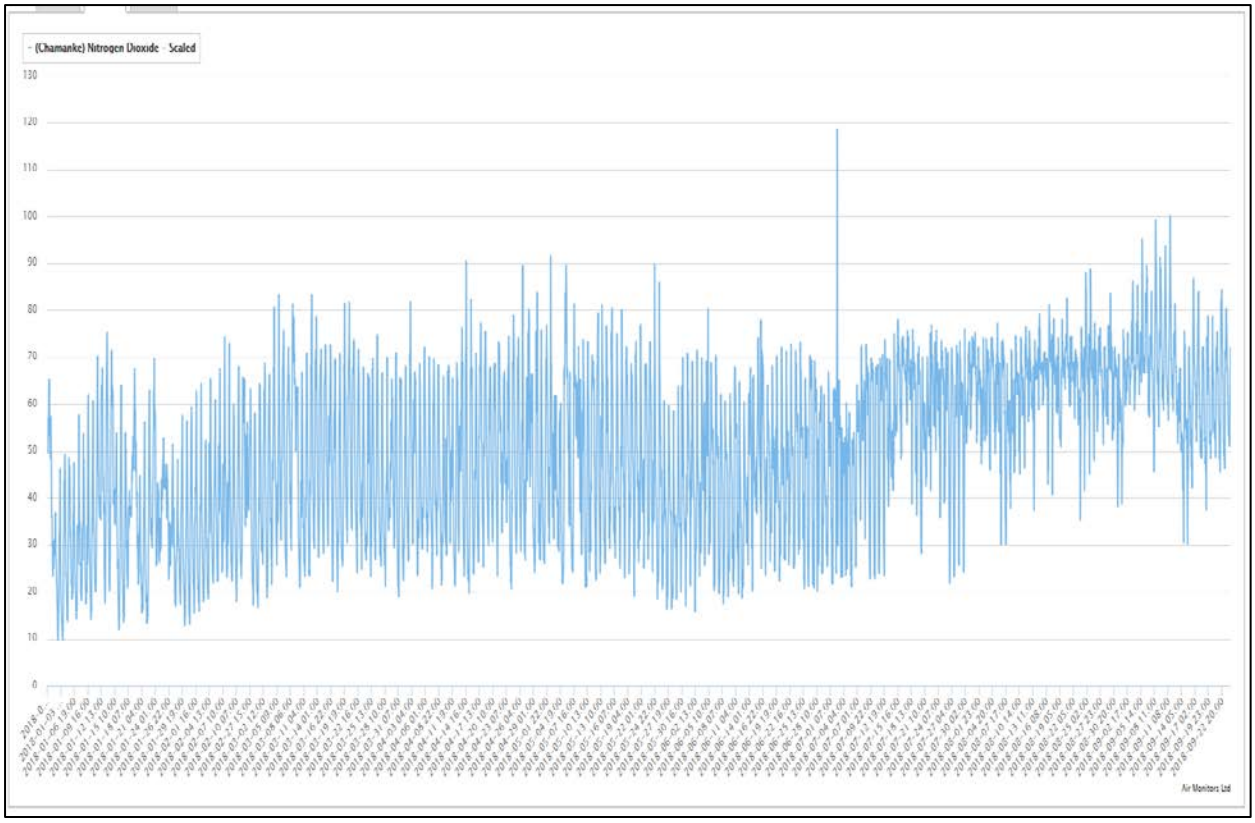


Figure 3-12 NO2 1-hour average ug/m3 (KRG Table 1 Threshold 200ug/m3)

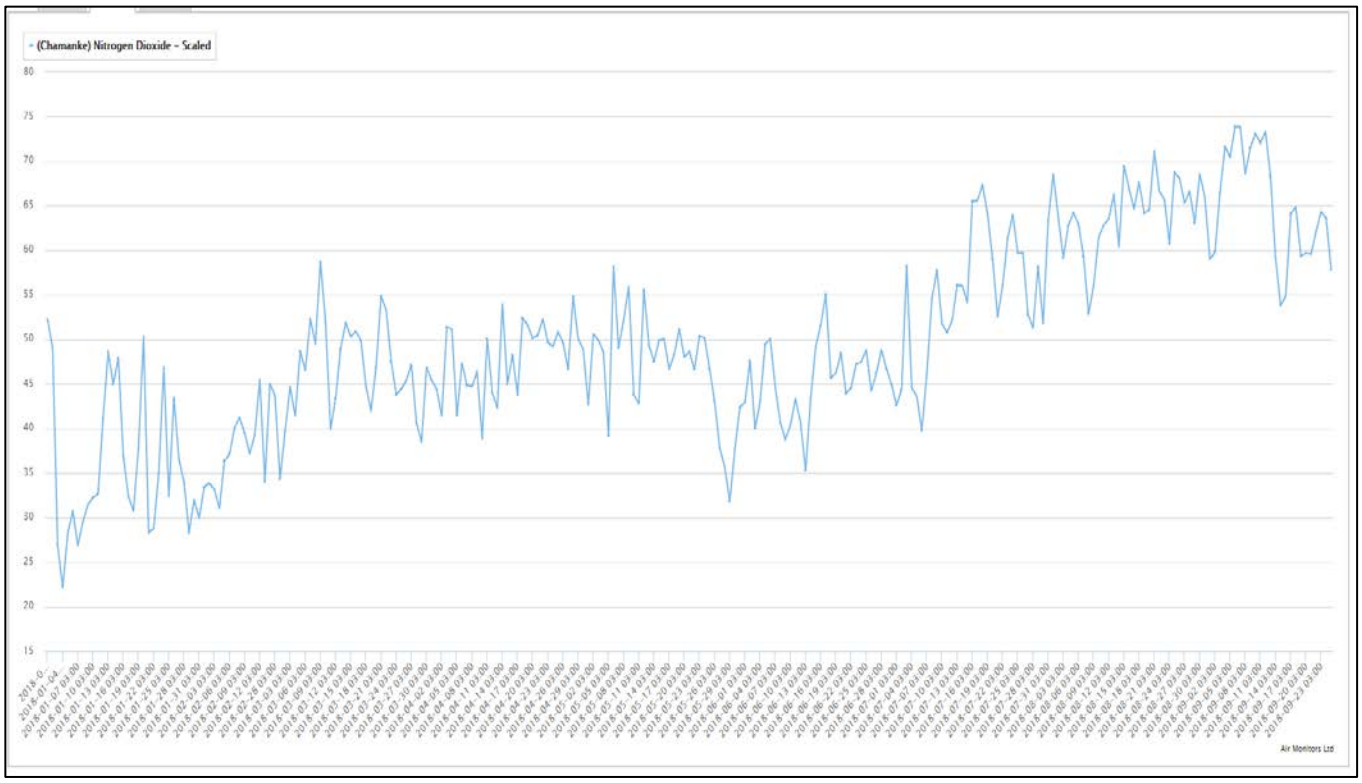


Figure 3-13 NO2 24-hour average ug/m3 (KRG Table 1 Threshold 150ug/m3

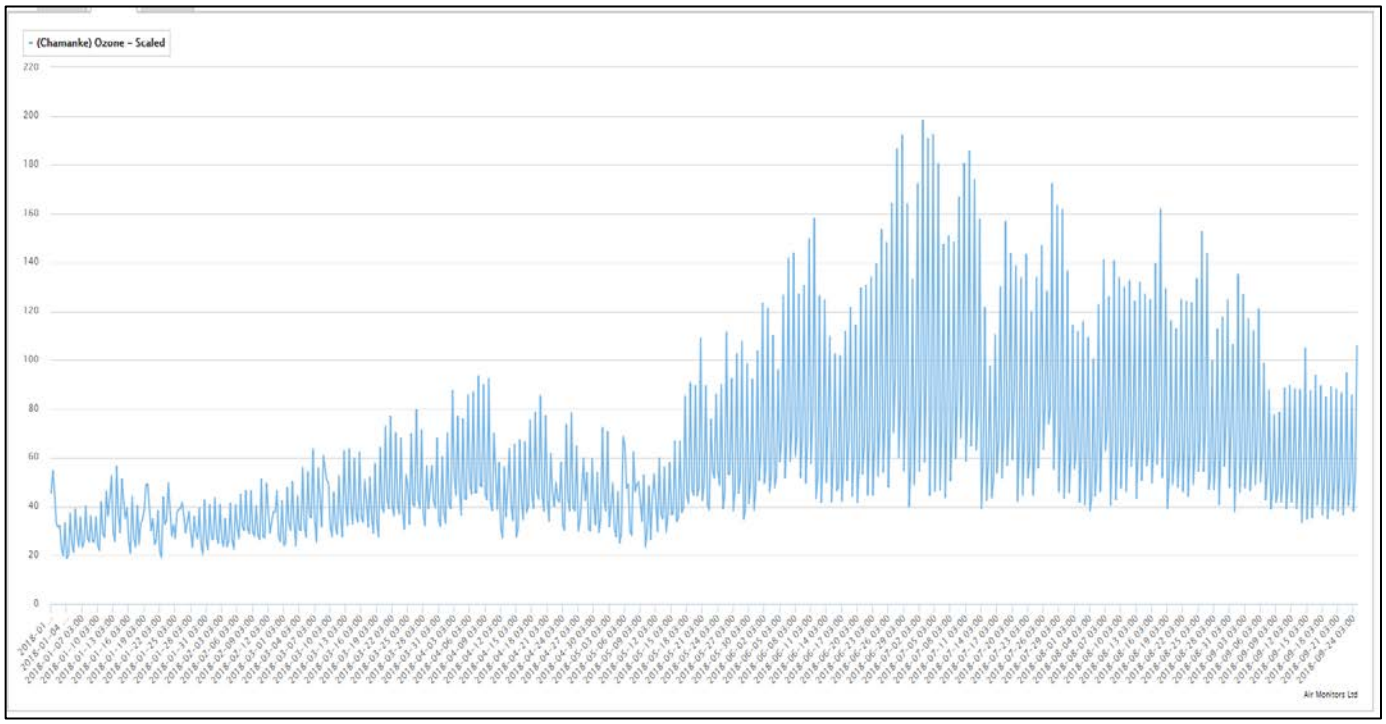


Figure 3-14 O3 8-hour average ug/m3 (KRG Article 4 Threshold 235ug/m3)

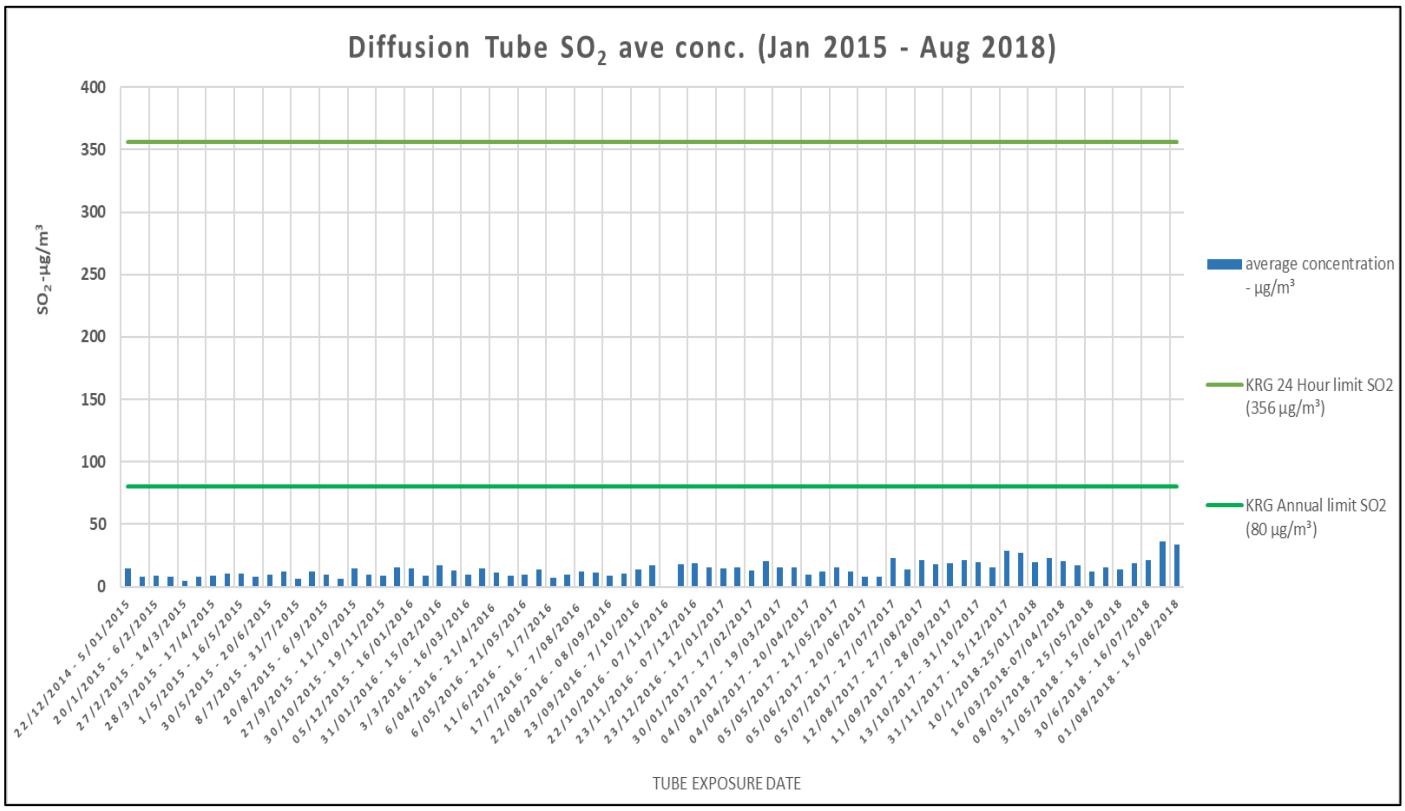


Figure 3-15 Block wide SO2 averages from 24 Diffusion Tubes (2015-2018)

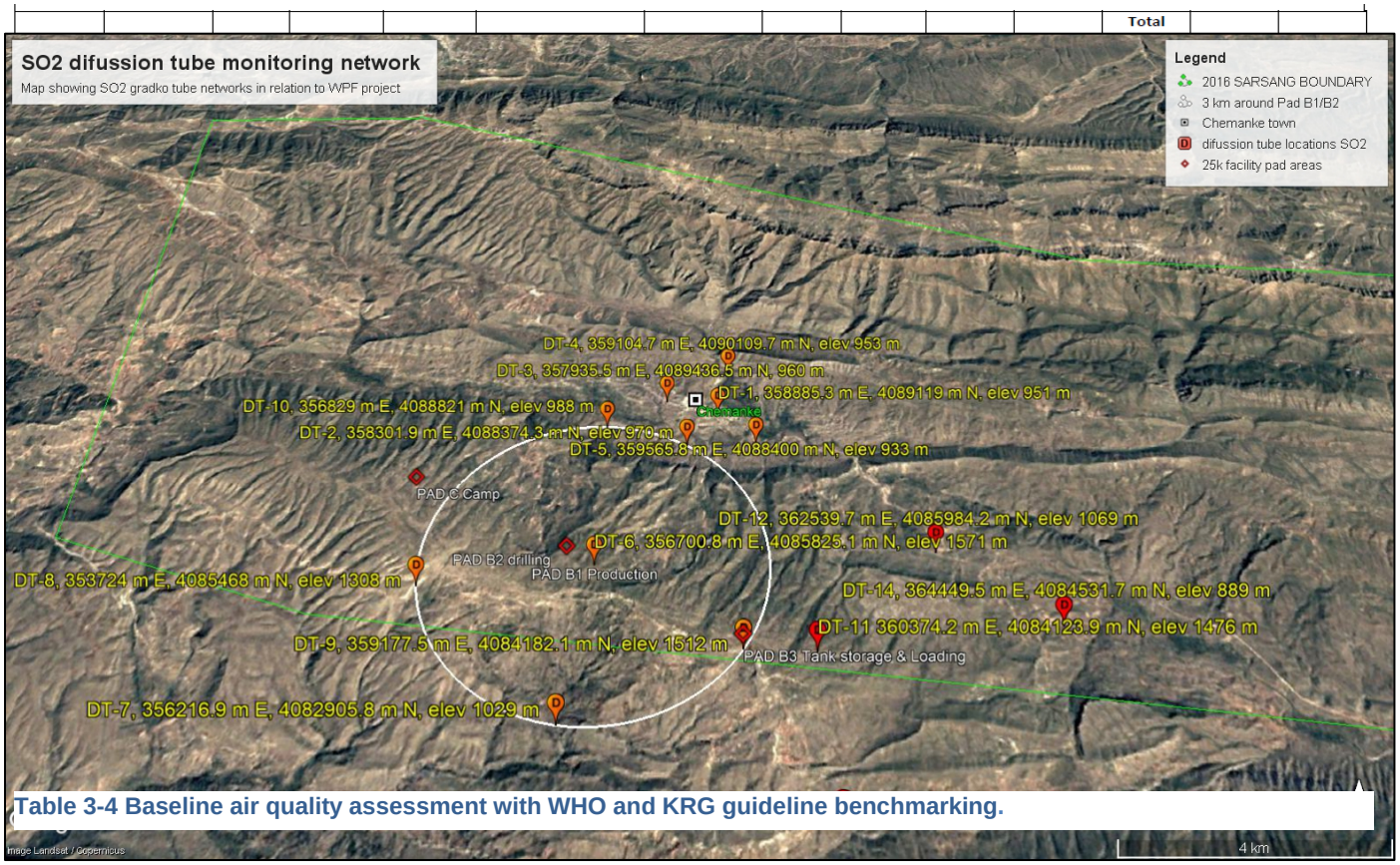


Table 3-4 Baseline air quality assessment with WHO and KRG guideline benchmarking.

Figure 3-16 Gradko tube sampling position map in relation to WPF project area

No.	Sampling sites for Ambient air quality	Sampling sites for particulate matter	Location	Easting	Northing
1	HKN- AA1	HKN -N1	Pad C Camp	353394	4087098
2	HKN - AA2	HKN -N2	New Pad B2 (Drilling)	356192	4085932
3	HKN - AA3	HKN -N3	New Pad B1 (Expansion)	356990	4085822
4	HKN - AA4	HKN -N4	Oil Serv Camp	354209	4085726
5	HKN - AA5	HKN -N5	New Truck Staging	359539	4083979
6	HKN - AA6	HKN -N6	New Pad B3	359361	4084109
7	HKN - AA7	HKN -N7	New Transfer Pipeline	359088	4084484
8	-	HKN -N8	ST2	360138	4083933
9	-	HKN -N9	EST1	373110	4086424

Table 3-5 Baseline ambient air sampling locations

Photo 1 hand held PM sampling technique

Photo 2 – hand held air quality monitoring technique

3.11 Ambient Noise Levels

The ambient noise levels within the concession block were recorded as a part of the field studies on 28th and 29th of April 20188. The noise level measurements were conducted using Integrating and Logging Sound Level Meter (SLM), Quest Model 2900 UL (intrinsically safe). The Quest 2900 UL is a Type 2 Integrating Data Logging Sound Level Meter, which enables measurement of 'A', 'C', or linear weighted sound levels. The instrument has capabilities to measure equivalent continuous noise levels (Leq) with standard measurement settings conforming to regulatory requirements. Noise levels were measured at the same locations as that of the dust measurements for about 10-15 minutes at each location during daytime. Weather conditions were normal and there was no excess wind during the measurements. The ambient noise levels are presented in **Table-3-6 and Figure 3-12.**

Location	Sample Date	Map ID	Daytime WHO (KRG) Guideline for Rural/Residential Areas LAeq (dB)	Nighttime WHO (KRG) Guideline for Rural/Residential Areas LAeq (dB)	WHO (KRG) Guideline for Industrial Areas LAeq (dB)	LAeq (dB)	Easting	Northing
1	13-5-2018	NS1	55 (55)	45 (50)	70 (60)	55	353394	4087098
2	13-5-2018	NS2				46.5	356192	4085932
3	13-5-2018	NS3				69.3	356990	4085822
4	13-5-2018	NS4				46.3	354209	4085726
5	13-5-2018	NS5				53.5	359539	4083979
6	13-5-2018	NS6				52.2	359361	4084109
7	13-5-2018	NS7				51.1	359088	4084484
8	13-5-2018	NS8				69.2	360138	4083933
9	13-5-2018	NS9				66.3	373110	4086424

Notes:
LAeq (dB) = A-weighted equivalent continuous noise level in decibels
Bold values exceed WHO Nighttime guideline for rural/residential areas
Guidelines:
From World Health Organization – Guidelines for Community Noise (1999); Rural/Residential daytime guideline applies to 16 hour time period; Rural/Residential nighttime guideline applies to 8 hour time period; Industrial guideline applies to 24 hour time period and KRG guideline for Environmental board for protection and improvement 2011

Table 3-6 Ambient Noise Levels with coordinates

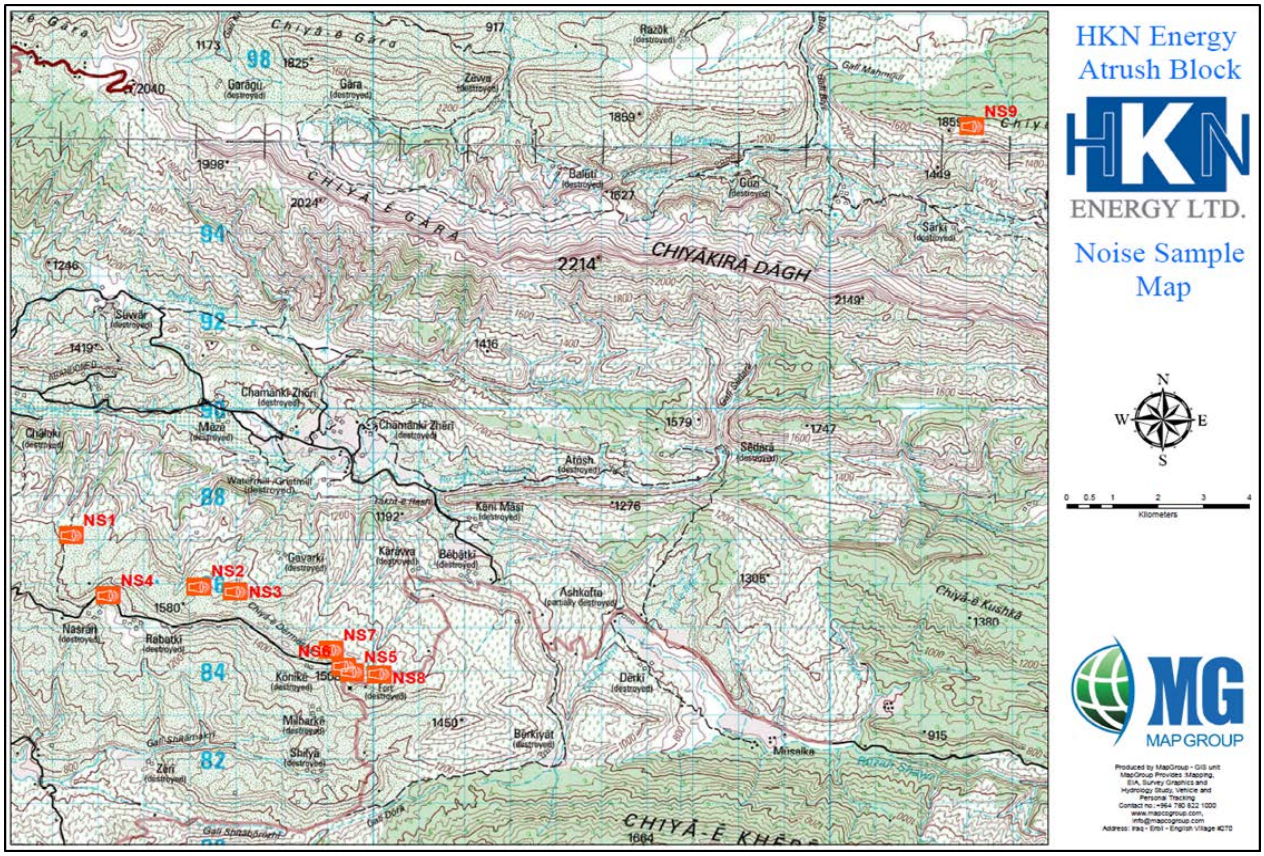


Figure 3-17 Noise sampling locations map

Photo 3 hand held sound monitor for measuring site noise levels

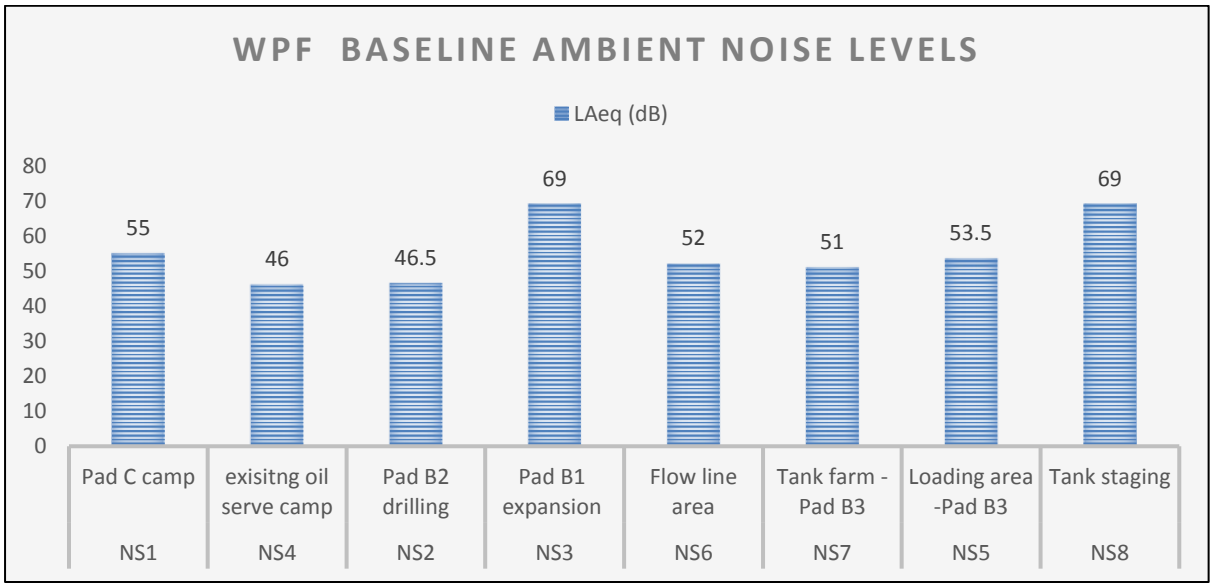


Figure 3-18 Ambient noise measurements in accordance to specific project locations.

3.12 Biological environment

There are no protected areas within the Sarsang Block, both nationally and internationally, and there are no national parks present. If any endangered, rare or threatened species are discovered they will be reported to MNR's HSE department. There are currently no renewable sources of energy at Sarsang. Diesel is the only means of fuel/power supply at the concession area.

3.12.1 Methodology of Biodiversity Study

The methodology of the biodiversity study conducted for the Sarsang Block is a result of two processes:

Literature Review- Consisting of gathering and assessing the existing biodiversity literature and official data. This comes from official data and respected international authorities. Comprehensive and reliable information about biodiversity resources and ecosystems is rarely available, especially in developing areas like the Kurdistan Region of Iraq.

Biodiversity Survey – Consisting of basic observations along the proposed development areas to characterize the habitats and identify any sensitive ecological receptors.

The field survey was conducted by using data from the original baseline survey and observations for the Sarsang Block were taken, with GPS points given below;

3.12.2 Flora

Literature Review

Most of the mountainous parts are covered with vegetation comprising mainly Oak, and Pine trees (Locally Berru and Mazi). The vegetation cover increases at the mountains crest and surfaces and decreases at the mountain's foot and along the wadis. The Oak trees are young, especially at the surface and foot of mountains. More old and dense trees are at the crest and far from populated areas. Between the trees, herbs, thorns and spiky vegetation grow as shown in the photos below. In the spring season grass grow among the trees and some colourful flowers. The grass and spring flowers dry up in the summer. Plants existing within the project area shown in **photo-6 & 7.**

The unpopulated hills have vegetative cover, mainly wheat, barley, vegetable, and fruit trees (Figure, grape, berry, peach, etc.) and olive trees. In uncultivated areas thorns and spiky vegetation grows and grass and spring flowers grow as well. The grass and flowers dry up in the summer. Along the wadis several types of shrubs and grasses

standing in the stomach valleys and lowlands, which were also exploited Grazing and have rarely been used. Most vegetation was grass, beans and pulses useful for grazing. In many of the valley bottoms and along the drainage channels several poplar species (*Populus alba*, *Populus euphratica*, *Populus nigra*) and willow species (*Salix spp.*) are commonly found. Reportedly, the stem of these are used for the production of construction poles. In the Dohuk governorate, a remnant pine forests of Pinus brutia (in Zawita, northwest of Dohuk city) are likely part of the Eastern Mediterranean conifer- sclerophyllous-broadleaf forest ecoregion that extends slightly into Iraq. On the south side of the range, the forest becomes more steppic with scattered shrubs (Ministry of Environment, Iraqi Fourth National Report to the Convention on Biological Diversity, 2010).

Photo 4 agricultural surrounding during site survey project boundary area

In the plain areas more than one type of seeds can be observed; these types are: Wheat, sesame, sunflower, beans, chickpeas and lentils. Some types are mostly depending upon rain as a source of water, so mostly the villagers use the land once a year. On the other hand, tomatoes, cucumber, watermelon, melon, onion, and garlic are also common in summer season. Most villages have orchards, which are usually irrigated during summer, and produce a considerable variety of fruit. In some areas fruit trees that tolerate cold winters are probably best adapted to the environment, especially apple, pear, cherry and walnut. At lower elevation temperate and Mediterranean fruit trees such as grape, plum, apricot, apple may coexist. Mulberry and walnut trees are also doing well in the mountain zone and are usually found in or near villages. Olive and fruit trees usually grow in the mountains, however; it can be found in the plains.

Probably the most popular summer crop in the plains is tomato and potato which is grown in every agro-ecological zone. At low elevations tomato seedlings must be planted early enough (March/April) to avoid high temperatures during flowering (temperatures reach above 40°C in July and August). In many agricultural area summer crops are grown without irrigation on residual moisture, especially melons and snake cucumber. In the non-cultivated plains notes that the vegetation becomes progressively herbs, Thorns and Dharov, natural vegetation consists of grass and weeds that were growing season after the rainy season. In the meadows a rich mixture of species may be found including valuable forage species, such as of the genera *Trifolium* and *Medicago*. A large number of *Astragalus spp*. could be observed, with *Acantholimon* and *Onobrychis* as common other genera and inter-grown with shrubs, herbs and grasses. None of the species recorded during the survey or believed to exist in the area are categorized as threatened or endangered under the IUCN Red List.

3.12.3 Fauna

Most of the villages within the block raise animals such as sheep, goats, and cows, birds (hens, ghost, and pigeon). Livestock numbers ranging from 300 to 8000 heads, cows range from 3 to 200 while there are many birds such as hens and ghost, each house has 5 to 10 birds for his needs on the slopes of the block southern mountain and wadis between hills, low-growing trees, birds and some wild animals which sometimes come down to the villages.

Wild animals can be observed by villagers, especially during night. These animals are: Ravens, Owls, Jackal, Fox, Wild Duck, Partridge, Pigeon, rabbits, Crow, Swallow, Eagle, Hawks, white storks and sometimes Pigs, ibex, lynx, gazelle, deer, wolf, fox, leopard, wild boar, hare, hedgehog, snakes, frogs and lizards.

Photo 5 & 6 illustrating sheep flock and lesser kestrel species common within the Sarsang area

The Ser Amadiya IBA is the nearest proximity to the Sarsang Block, approximately 30km to the north of the Sarsang Block The breeding bird community is characteristic of the northern uplands and comprises at least 30 species including Alectoris chukar, Caprimulgus europaeus, Dendrocopos syriacus, Hirundo rupestris, Sylvia hortensis, Parus lugubris, Lanius nubicus, Pyrrhocorax graculus, P. pyrrhocorax and Emberiza hortulana. Both Sitta tephronota and S. neumayer occur, the latter at least breeding. Prunella collaris and Montifringilla nivalis (a flock of c.150) have been noted as non-breeding visitors in March on the snowfields (Birdlife International, Ser Amadiya and Sulav Resort IBA Site Fact Sheet).

Depending on the season, in these areas there are likely to be bearded and Egyptian vultures, Eurasian griffons and Radde's accentor. There may also be white storks, chukar (partridges), white-throated robins, cinereous bunting,

Eastern and Western Rock nuthatches, Syrian woodpeckers, sombre tits, masked shrike, and red-fronted serin. Around the mountain ridge of Ser Amadiya there may also be orphean warblers, sombre tits, masked shrike, alpine chough, red-billed chough and ortolan bunting. In Aqrah villages the most common birds are hens, pigeon and ghost. Each house has at least 5 to 10 birds. It is not certain whether the Eurasian lynx (Caucasus subspecies), a wild cat, still inhabits the Kurdistan Region in Iraq, but it is considered to be threatened by the World Wildlife Fund. The Sind ibex and wild goats of Kurdistan are classified as vulnerable species.

Invertebrate species were recorded in these drainage beds and in the foothills to include scorpion's species, i.e. *Comsobuthus matthiesseini*, *Mesobuthus eupeus*, *Scorpio Maurus*, *Hemiscorpius lepturus*. Scorpions are regarded most common in the area with over 367 specimens being recorded. Some of these e.g. *Androctonus amoreux*, *Androctonus crassicauda, Hottentotta saulcyi, hemiscorpious lepturus* are the most dangerous with strikes with potential to kill humans. Amphibians observed are *Hyla savignyi*, *Bufo viridis*, *Trituras vittatus*, *Salamandra infraimmaculate* and *pelobatus syriacus.* All of these species are categorized as Least Concern (LC) under the IUCN Red List.

According to published information 37 reptilian species are expected to exist in the area. The lizard species recorded were *Acanthodectylus bosklanus*, *Assacus ellsae*, *Assacus griseonotus, carinatogecko hetropholis, Eublepharis angramainyu*. Though not observed, the endangered *Acanthodectylus schrelberi* is also thought to be present in the area. Snake species observed are *Coluber ventromaculatus*, *Elrenis persica*, *Eryx jaculus*, *Hemorrhois ravergieri* (spotted whip snake) and *Malpolan monspessulanus*.

3.13 Human Environment

3.12.1 Socioeconomic study Methodology

Information on the socioeconomic profile of the project area was obtained through desktop review of data available within HKN and from regional government data, satellite images, and published information from various government agencies. In line with the guidelines of the World Bank and IFC, the socioeconomic baseline addresses the land utilization, settlements, archaeological or cultural sites, infrastructure, and population characteristics in the project area.

HKN conducted its own internal Socio-Economic Report for the Sarsang Block in 2017. The data were collected through numerous sources: field visits, research, observations, existing government data and interviews. Various stakeholders (government officials, village leaders, etc.) were consulted. The collection includes both qualitative and quantitative data. In the absence of a formal government census

of the area and with the nature of the data being at times observational, the data are estimated and accurate as possible.

3.12. Study Area

The Sarsang Block is approximately 39-km Northeast of Dohuk city and 93-km North-West of Erbil and encompassed with largely mountainous terrain which is only sparsely inhabited.

The Kurdistan Region of Iraq is comprised of three main governorates, Sulaymaniyah, Erbil and Dohuk, with a newly established fourth governorate of Halabja. The Sarsang Block is located in the Dohuk governorate. Dohuk city is the capital and the governorate is divided into seven districts: Zakho, Akre, Amadia, Shaikhan, Bardarash, Dohuk, and Sumeil. There remain some unresolved issues between Dohuk and Ninewa regarding the administrative status of Shaikhan, Sinjar, Telafar, and Tilkaif districts.

The governorate's location at the northern border makes it strategic for international transportation lines that connect Iraq and Turkey. Duhok is crossed by the oil pipeline that passes from Khurmala to the border with Turkey at Fish Khabur. The governorate is known for its varied terrain including high mountains surrounding the capital, as well as extensive plains and agricultural resources in the southern part of the governorate. Duhok is rich in watersheds, waterfalls, and natural lakes.

Thus, Dohuk is important for agricultural and industrial production. The tourist industry is also growing in importance. The University of Dohuk, founded in 1992, is the main centre for teaching and research in Dohuk.

The Sarsang Block covers area in two sub-districts of Chamanke and Atrush. These have different corresponding districts: Chamanke Sub-district in located in the Amedi District and the Atrush Sub-district in located in the Shaikhan District. Asaish, police, Peshmerga and political offices are located in the sub-district, district and governorate centres.

All the villages in the Sarsang Block are uninhabited due to historical hardships. The uninhabited villages in the Sarsang Block located in Atrush Sub-district are Rabatke and Nisra. In the Chamake Sub-district, the uninhabited villages include: Gavarke, Milbirke, Kanika, Bebad, Chamanke, Shkafte, Sevre, Bilimbasa, Bakhere and Khalata. These villages were abandoned during the 1980's and 1990's due to intense conflict. There are no full-time residents and all former residents have migrated to more urban areas. Land is only used for agricultural purposes.

Photo 7 – Abandoned House

Photo 8 – Abandoned School

As part of this baseline and impact assessment study, the Sarsang Block study area is considered as an indirect influence area and likely impacts on the local socioeconomic and cultural factors and public health are assessed.

3.13.3 Land Use and Ownership

The ownership of the land in the Kurdistan Region of Iraq is a mix of private and public. Land is typically appropriated in parcels of "donums", which is the equivalent of approximately 2,500 square meters.

For privately owned land, ownership is proven with a land deed known as a "tapo" in addition to the government issued identification. However, documentation may be poor and out-of-date. Village land boundaries are often unclear and are frequently contested between stakeholders.

Land can also be deemed as purely public "i.e. rocky lands" in which the government owns its rights and there is no existing use of the land. In some cases, the government

officially owns the land, but the family/individuals have the equivalent of a long-term leasehold without expiration or terms. While the government may own the land, local customary law has delegated authority of that property to the families/individuals.

The presence of unexploded ordnances ("UXO") and landmines is an issue in the Duhok Governorate and Sarsang Block area dating back to the Iran-Iraq war and the first Gulf War. There are ongoing efforts from the KRG and international organizations to clear these UXOs in the area. The Iraqi Kurdistan Mine Action Agency ("IKMAA") is responsible for mine action with responsible Directorate in Duhok.

3.13.4 Demographic Profile

As indicated above, the study is based on available secondary information from Local Authorities at the Sub-District and District level.

Due to historical hardships, lack of economic opportunities, and lack of services, all former village residents in the Project Area have migrated to the urban areas. Residents live full-time in towns (e.g. Chamanke) or cities (e.g. Duhok city). In some villages, there are a vacation type houses as well as open land areas where people visit to picnic during spring and fall.

HKN's most recent gathered data (2018) shows the following demographic profile for the local official villages in the Project Area. The 'term' village designates a land boundary, not necessarily a settlement or inhabited area. All the villages in the Project Area are uninhabited. Chamanke and Atrush towns are included as the nearest settlements.

Village/Town	Inhabited (Yes or No?)	Distance from Pad B 25k Facility to Center of Village	Actual Population
Gavarke	No	0.5km	0
Rabatke	No	1km	0
Nisra	No	1.5km	0
Kanika	No	2km	0
Milbirke	No	3km	0
Chamanke	Yes	5km	1500
Atrush	Yes	8km	700

Table 3-7 Village Demographic Profile (HKN's Socio-Economic Report)

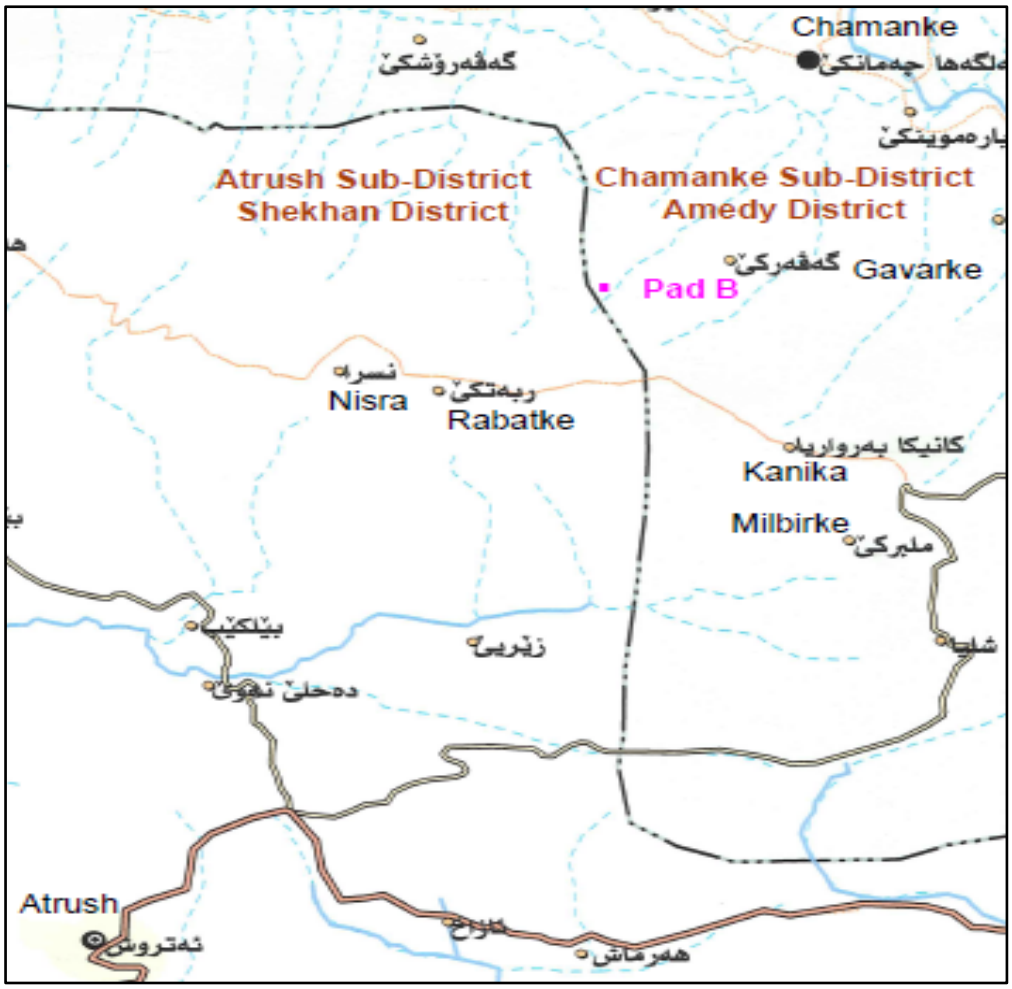


Figure 3-19 Pad B Specific Village Map – Joint Humanitarian Information Centre

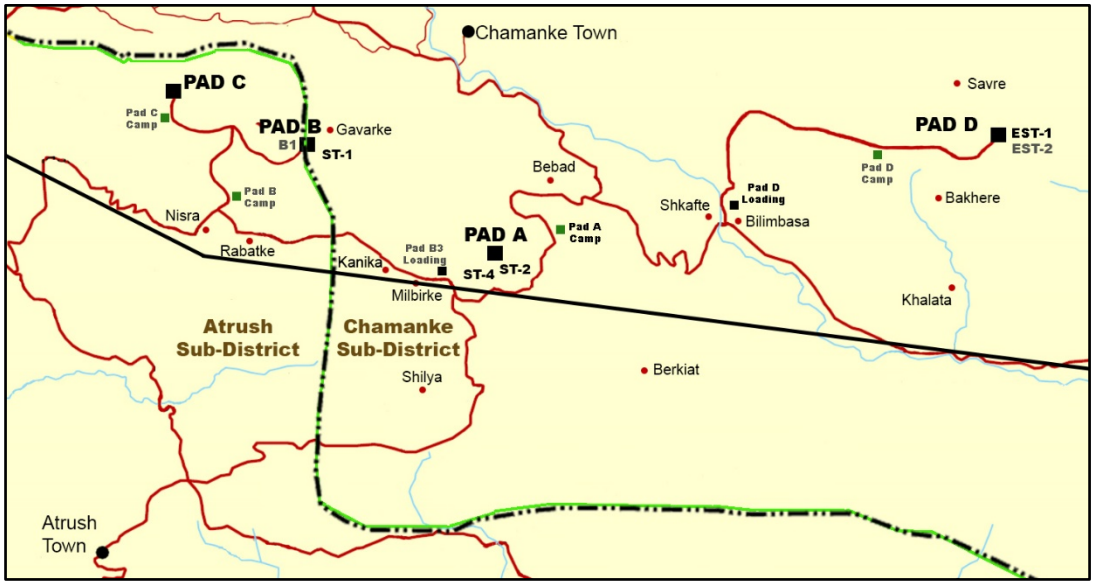


Figure 3-20 HKN internal Sarsang Block Map-Villages Names and District/Sub-District Boundaries

Relevant Villages/Towns Profiles for Project Area

Gavarke

Coordinates: N 36.91190□E 043.45111□

Sub-District: Chamanke

District:Amedy

Tribe: Berwari

Full-Time Residents: 0

Rabatke

Coordinates: N 36.90119□ E 043.37083□

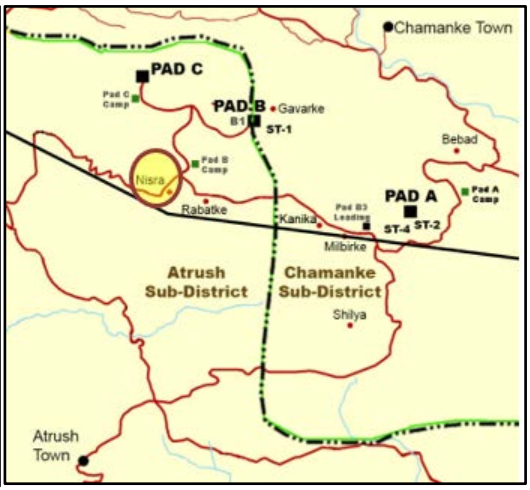
Sub-District: Atrush

District: Shekhan

Tribe: Mizuri

Full-Time Residents: 0

Nisra



Coordinates: N 36.90543° E 043.36187°

Sub-District: Atrush

District: Shekhan

Tribe: Mizuri

Full-Time Residents: 0

Milbirke

Coordinates: N 36.89902° E 043.41285°

Sub-District: Chamanke

District: Amedy

Tribe: Berwari

Full-Time Residents: 0

Kanika

Coordinates: N 36.85830° E 043.39988°

Sub-District: Chamanke

District: Amedy

Tribe: Berwari

Full-Time Residents: 0

Chamanke

Coordinates: N 36.94233° E 043.41394°

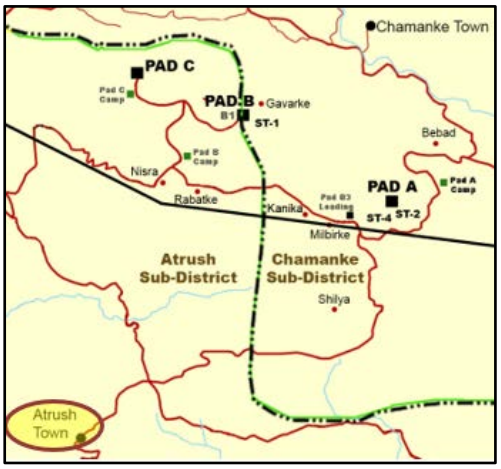
Sub-District: Chamanke

District: Amedy

Tribe: Berwari

Full-Time Residents: approximately 1500 residents

Atrush



Coordinates: N 36.83741° E 043.33488°

Sub-District: Atrush

District: Shekhan

Tribe: Mizuri

Full-Time Residents: approximately 700 residents

3.13.5 Economic Profile

To evaluate the employment characteristics of the population within the study area, available information at the district level was reviewed and economic profile is assessed in terms of livelihood pattern and income levels of the district population.

The primary sources of income are from employment through government positions, pensions or other support. The other sources of income are from traditional economic means of agriculture and animal husbandry.

According to the Kurdistan Regional Statistics Office, the employed population in the Duhok Governorate (including employees, self-employed, etc.) is 47.8% in the private sector and 51.8% in the public section. For those employed in the private sector in the Duhok Governorate, 4.6% are in the agricultural sector, 15.9% in industry, and 79.6% in services. Given the recent economic struggles in Kurdistan, there are higher unemployment rates especially for youth. Women are also vastly unrepresented in the

labor market, with only 12.1% of women in the Duhok Governorate employed in non-agricultural sector.

Increased oil and gas activity in the area has provided for new economic opportunities. The local community's benefit from the presence of oil and gas through the opportunity to provide procurement of local labor, services, equipment and materials.

3.13.5 Social Infrastructure

Health Facilities and Conditions

The table below presents a list of hospitals and clinics located at District level.

District	Health Facility Available	Population of Village
Amedi	15 Clinic and 5 Hospitals	19,587

Table 3-8 Health Profile

The uninhabited villages in the Project Area do not have medical facilities. The nearest access to medical facilities is the local towns. Chamanke and Atrush have basic clinics that can treat minor needs. The main obstacle to care at the clinics is the lack of modern medical equipment and medicine. For the major injuries/illnesses, the local population use the medical facilities in Duhok city.

Education Facilities

The table below represents the educational facilities available in the Amedi District.

District	Elementary School	Preparatory School	High School	University/ College
Amedi	16	6	0	1 (Technical Institute)

Table 3-9 Education Profile

The uninhabited villages in the area do not have a primary, intermediate or secondary school for children.

Primary school children range from ages 6 to 12. Following primary education, children attend an intermediate school from ages of 13 to 15, then a secondary school for ages 16-18. Chamanke town has a primary, intermediate and secondary school. If

education continues beyond this (e.g. university), students attend in the more urban areas (e.g. Duhok). Most children attend primary and intermediate schooling. However, enrolment rates for secondary education are usually lower, particularly for girls. This could be due to transport issues, cultural or family roles.

The physical school buildings are usually in poor shape: plumbing, electricity, lighting, windows and heating are inadequate. The school supplies are often limited as well: lack of teaching materials, textbooks, writing utensils, whiteboards, etc.

The teachers who staff the schools are designated by the government. Mostly, they do not originate from the town and reside in the urban areas. The teachers in each school rotate in and out frequently.

Water Supply

Water is produced and supplied by municipal authorities at the governorates, and their related districts and sub-districts for inhabited towns/villages. There is no meter to measure water consumption; instead, the Ministry collects minimal charges for water supply per square meter of the house. The natural spring aquifers are not treated apart from the exception of the larger populated town of Atrush where water chlorination is applied before water is distributed to the village. In addition, Chamanke uses direct water sources from the river and conduct chlorination before distribution to homes.

In the uninhabited villages in the Project Area, there are surface water sources of water used primarily for agricultural purposes. These are identified in Section 3.8-Water Quality and Hydrology.

Photo 9 and 10 – Surface Water Sources in the uninhabited Nisra and Rabatke Villages

Waste and Garbage Disposal

Appropriate procedures for disposal of waste and garbage collection do not exist in the Project area. There is no system in place to transport waste. Household garbage for inhabited towns/villages is usually placed on the backside of a hill. This has undesirable consequences on the environment, water source and health in the village. Improper disposal of waste can lead to increased occurrence of sickness and disease. Unfortunately, it is a common problem among the rural communities, and the local populace seem to be unaware of the sanitation issue.

Power Supply

For the inhabited towns, public power is intermittently supplied. Inhabited areas receive power supply from both public power grid and privately-owned generators (many of which are shared between neighbouring houses), while some receive power supply solely from either the public power grid or a privately-owned generator.

Uninhabited villages do not have public or private supply of electricity. To qualify for a government funded project to provide electricity to the area, there must be a minimum of 15 permanent inhabitants.

Photo 11 – Unconnected Electricity Poles

Photo-12 Electricity in Chamanke Tow

Access to Markets

There are no big markets in Chamanke and Atrush; however, a few small shops along the main roads are accessible. The main markets are located in the larger towns, such as Sarsang, Amedi and Dohuk. In addition, mobile shops, housed in cars / pickups, are observed, which sell goods to the townspeople.

For basic supplies, the government food ration structure called the Public Distribution System has dated back to the era of Saddam Hussein in the early 1980's. This current system is an extension of the United Nation's Oil-For-Food Program in 1996. Each family is allocated basic food supplies per month. These supplies are collected in the urban areas using a government issued ration card. The supplies include sugar, rice, oil, and flour. However, the program is in poor shape and the deliveries are highly irregular. This ration is typically only used by low income families who cannot afford other means.

Transportation

Most of the road infrastructure is very rudimentary; mostly dirt or gravel lanes that are frequently washed out by rain and snow. The winter snowfall has a dramatic effect in crippling the road access to the area. Due to HKN's operational presence in the area, local access roads have been improved in addition to the winter snow clearance activities, which significantly benefits the local community. As most of the villages are located in mountainous areas, the terrain is difficult to navigate.

Religion and Culture

The people in the Sarsang Block and the Duhok Governorate are primarily Kurds who speak Badini, which is a form of Kurmanji dialect in the Kurdish language, as opposed to the primarily Sorani dialect in Erbil, Sulaymaniyah and the Halabja Governorates. Other dialects of Kurdish include Hawrami and Zazaki. Arabic is also an official language of the Kurdistan Regional Government. Additional minority languages include Christians minorities using the Syriac language (also known as Aramaic language) and Turkmen minorities using the Turkoman language.

In the Duhok Governorate, while the predominant religion is still Sunni-Islam, there are a several religious minorities living in the area. Christian minorities are primarily

divided into three main denominations: the Chaldean Catholic Church, Assyrian Church of the East and the Syriac Orthodox. There are smaller Christian sects including Armenian Catholic, Greek Orthodox, Greek Catholic, and Protestants. There are several other ethno-religious minorities including Shabak, Sabean Mandeans, Kaka'i Yarsan and Yazidis. Before the Islamic era, the predominant religion of Kurds was Zoroastrianism, a monotheistic religion and one of the world's oldest religions. Kurds are racially Indo-European and have a recorded past dating back to the Assyrian Empire in the seventh century BC.

Towns such as Chamanke and Atrush typically have at least one Mosque and/or one church along with a Muslim and/or Christian graveyard.

Housing Structures

The majority of houses in the nearby towns are of recent construction (about ten years old), apart from the few houses with older structures. The villages in the Project Area do not have any full-time houses. There are occasionally vacation or farm houses in the rural area. Traditional houses are stone walls and mud ceiling (a combination of mud, straw and wood), with the more modern ones constructed of brick and concrete. A typical house has 2 to 3 rooms, a kitchen, a bathroom inside the house, and a toilet outside the house.

Photo 13 – Modern House

Photo 14 – Traditional House

Agriculture and Livestock

Despite no full-time residents in the villages, some of the land is still used to cultivate agriculture. Types of agriculture seen in the Sarsang Block include almonds, grapes/vine leaves, apple, tomato, cucumber, etc. Livestock and animal husbandry

are less common in the area, although there are some cases present. The primary livestock designated for generation of income are sheep (lamb) and goats.


Photo 15 and 16 – Agriculture In Gavarke Village

3.13.6 Archaeological and Tourist Sites

There are no major archaeological sites in this region and the tourist sites are mainly seen along wadis or small rivers. There are many places which attract seasonal picnics, especially in the spring and summer. In addition, there are resorts, parks, restaurants and recreation place for families. All Tourism sites are under supervision of Tourism Department in Dohuk.

Amedi district has number of picnic areas, parks, and natural pools along with several archaeological sites including the Qadesh Castle, King Faisal palace, Bayez Brash and many more. Shekhan and Dohuk boast of old palaces and homes with seasonal picnic areas. Few of the valleys which have the focus of tourism are shown in *Photos 10 & 11.*

Few archaeological and cultural sites such as castles, caves, arches, carved stones which belong to the Assyrians, Turkish and recent periods were found in the concession block. In addition, there are several graveyards found near the villages in the concession block. All Archaeological sites are under supervision of Directorate of Archaeology in Dohuk. They are responsible for the protection and rehabilitation of these sites. As per the law, any activities in or around archaeological sites are prohibited.

Photo 17 tourist hillside attraction area and wadi's characteristic of Sarsang concession

3.13.8 Stakeholder Engagement

HKN understands the importance of establishing proactive discussions with all stakeholders in its operational area and the Kurdistan Region of Iraq.

This strategy outlines how HKN conducts its stakeholder engagement process in order to integrate the needs and concerns of those affected in its operational decisions. Implementation of a stakeholder management plan will allow HKN to continue its operational success in the Kurdistan Region of Iraq. HKN considers its relationships with local community stakeholders to be a critical element of its operational success. A stakeholder is defined as anyone who is affected or can affect HKN operations in the Kurdistan Region of Iraq. The stakeholders are divided into separate levels to outline the different approaches needed:

Internal: stakeholders in HKN's organization and departments.
Immediate: stakeholders who are directly affected by HKN's operations on a daily basis.
External: stakeholders who are part of the broader engagement strategy and have long-term strategic value.

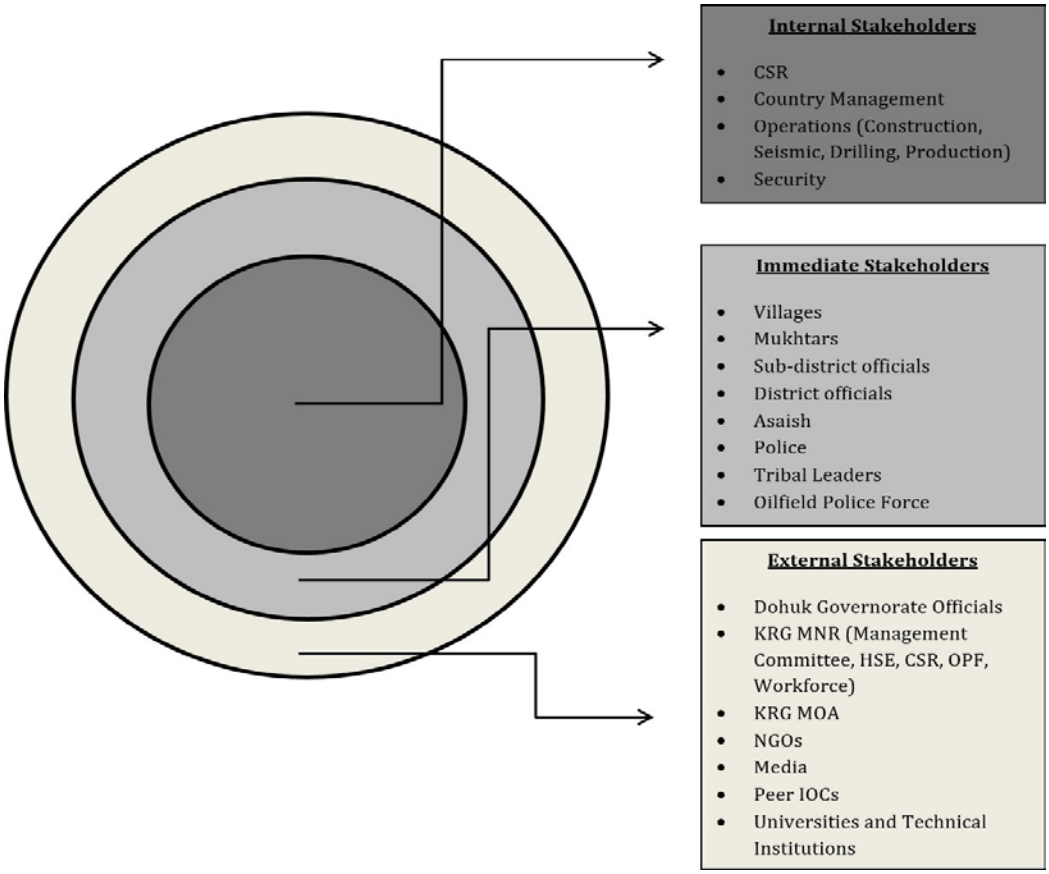


Figure 3-21 Stakeholder Engagement Overview

13.13.9 Communicating Operational Plans

Pre-Operations

HKN and its contractors take steps to proactively communicate its upcoming operational plans to the local community and necessary stakeholders. This includes discussing general opportunities for local content for the community.

Communication is completed through either community, town hall meetings or in the local authorities' office, depending on the sensitivity of the situation. Visual aids such as maps, and photos are used to assist residents in the upcoming activities.

Proactive communication is aimed at avoiding high/low expectations from the community. HKN outlines future plans to manage the local community's expectations of community benefits.

During the initial engagement period, a socioeconomic baseline survey is conducted of the area. This includes creating a database of all villages (e.g. mukhtars, population, livestock, etc.) and the living standards (e.g. health, water, education, etc.). Establishing this database assists in the overall process of community engagement planning in the area. The beginning of the CSR process is executed simultaneously with land owner surveying/negotiation. This is designed to limit discontent about government surveyors on land without landowner's knowledge, as well as to avoid dissention in village, (refer to **Appendix-2**, Land Acquisition Process).

During Operations

Once operations commence, HKN regularly communicates with local stakeholders to manage their needs and to maintain positive relations. This also entails fairly balancing jobs within different villages, coordinating with security authorities (Asaish and Police) and constant liaison with local leaders.

The HKN CSR team works with on-site operational staff to ensure that all operational activity minimize disruptions to the local community.

Post-Operations

If needed, prior to the conclusion of an operational activity that has provided income opportunities, HKN and its contractors will provide the necessary notice to the local vendors and community.

Those who have lost employment or procurement will be allowed to be integrated back through the local content strategy when opportunities become available.

Government Liaison

Extensive effort is made to establish and maintain positive working relationships with not only the communities themselves, but also the local authorities within those communities. This includes Sub-district, District and Governorate Administration officials, Asaish, Police, Oilfield Police Force (OPF), mukhtars and tribal leaders.

The authorities in the communities play a crucial role in managing local disputes and providing structure for the local hiring and procurement of services and materials. Continuing the positive working rapport is an important tool for HKN and its CSR team.

HKN, its CSR personnel and its contractors establish clear and transparent processes with the local government authorities. The following guidelines govern all local government liaison relationships:

a. Corruption and bribery shall not be tolerated
b. Political sensitives or discussions should be avoided
c. Awareness of cultural sensitives
d. Fair and respectful behavior

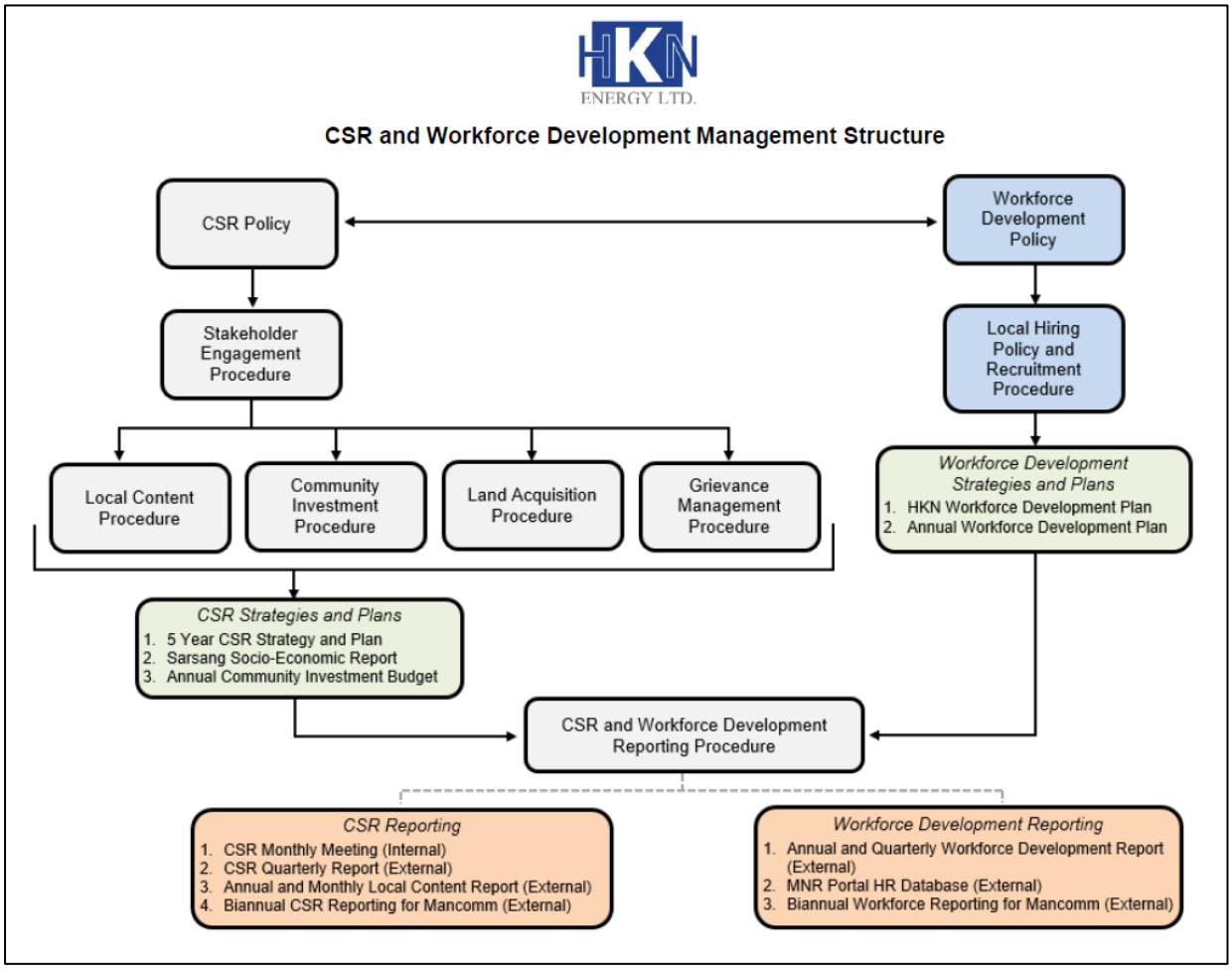


Figure 3-22 HKN CSR and workforce development structure flow chart

4 Description of Project & Operations

4.1 Project overview

As discussed, the objectives of commercial production from the Sarsang Block will be the result of multi-phased development scheme with each phase meeting critical economic hurdles. Phase 1 development is highlighted by a target of 50,000 bopd of oil production from the Swara Tika structure, as agreed in the FDP. As of October, 2018 HKN has installed production capacity on Swara Tika of 24k bopd and has drilled 4 wells. (**Figure 4-1** showing project location within Sarsang Block).

The proposed project is for the construction of a 25k bopd facility on the crest of the Swara Tika structure. HKN will drill multiple wells (up to five wells in total) to fill the facility. HKN has engaged a contractor to complete the early engineering for design of the project facility based on defined key parameters. HKN will award a contract to construct the facility to an EPC Contractor following a competitive tender process. The EPC contractor will engineer, supply, install, commission, performance test and hand-over a WPF which meets the early engineering design criteria with a capability to produce 25,000 bopd. The overall project footprint is shown in **Figure-4-2** diagram, (labelled in red) and the main project components are described below;

Project Components covered

The WPF will comprise the following main components:

- Civil construction works associated with project
- The process facilities and associated utilities;
- Storage tanks for the stabilized Oil Product;
- Truck loading and metering facility for Oil Product export by road tanker; and
- Flowlines between the facilities described above

Drilling operations for up to 5 wells which will fill the proposed facility will also be conducted during 2019.

The WPF will process the Well Stream fluids to meet the required Oil Product and produced water export specifications contained in the Design Basis. Any remaining produced sour gas will be flared after treatment. The WPF processing and utilities equipment will be designed and supplied in accordance to the Design Basis.

This chapter is divided into the above project components to understand and quantify the likely impacts. Significant deviations from the descriptions provided in the following sections are not expected. However, any modifications in the development activities that may bring about impacts not mentioned in this ESIA will be communicated and submitted to the MNR through a series of addendums before undertaking the relevant activities. It must be noted that detailed facilities drawings are not available at the stage other than main outline of the intended plan presented in schematics presented in figure 4-10.

4.2 Project location

The project is located at Sarsang Block situated approximately 30 km Northeast of Dohuk city and 100 km Northwest of Erbil and covers an area of encompassing a largely mountainous terrain. The concession area is shown in **Figure 4-1**, (the orange circle highlights the approximate project location).

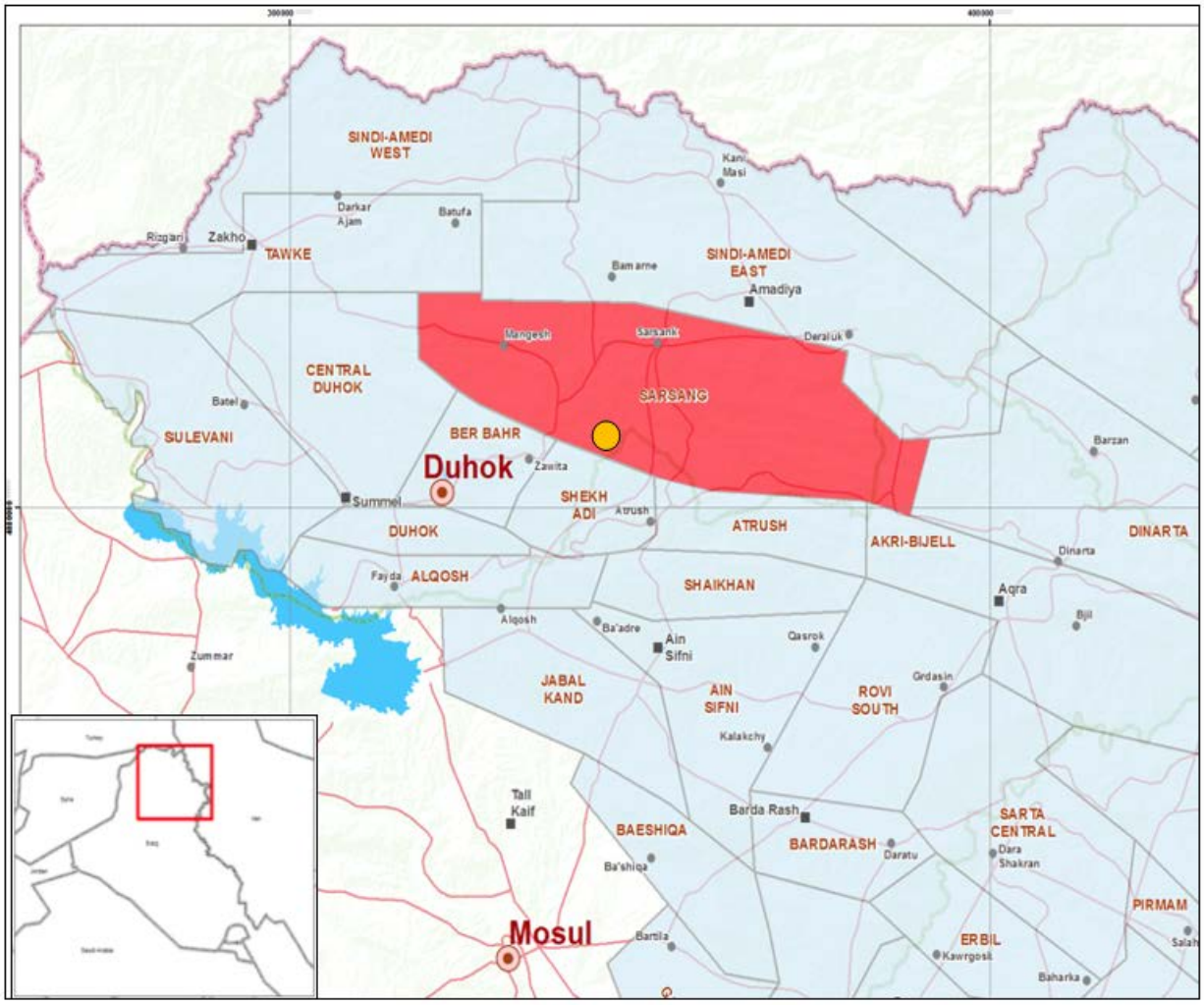


Figure 4-1 Sarsang Concession and marking project area in orange

4.3 Land Acquisition

In order to acquire the necessary land for the Pad B project, HKN follows Land Acquisition Procedures (Appendix 2). The process is guided by the KRG MNR local land compensation regulation to oil and gas operators (KRG Council of Ministers-Ministerial Order #5512), and provisions included in HKN's Production Sharing Contract for the Sarsang Block. HKN pays a one-time crop compensation payment and annual rental rates to the land owners of operational lands. This compensation process is organized by the Land Compensation Committee: Sub-District Mayor, Duhok Directorate of Agriculture, MNR Geology Surveyor and HKN representative.

HKN's land acquisition process ensures that compliance is met for all Kurdistan Region laws, as well as IFC Performance Standard 5 "Land Acquisition and

Involuntary Resettlement". This ensures that HKN minimizes adverse social and economic impacts on the communities. This includes exploring feasible alternatives during project design, fair compensation, community engagement and an effective grievance mechanism process. Displacement or forced resettlement is not applicable for this Project Area since there are no full-time settlements.

The land acquired is primarily private farm land that is currently used for agricultural purposes. Part of the land required for the Pad B facility was already required during previous ST-1 activity. The following land use amounts and associated villages (all uninhabited) are listed below.

Land Use Amounts (m2)			
#	Village Boundary	HKN Related Site	Land Use (m2)
Pre-Existing			
1	Gavarke	ST-1	145,656
2	Rabatke	ST-1 Camp and Access Road	29,847
3	Nisra	Pad C and Access Road	54,054
		Pre-Existing Sub-Total	**229,557**
New (In Process)			
4	Rabatke and Nisra	Pad B Operations Camp	227,914
5	Gavarke and Rabatke	Pad B2 Expansion	213,105
6	Gavarke	Pad B1 Expansion	168,325
7	Milbirke	Pad B3 Loading Area	464,661
8	Nisra	B1 Facility Camp, B2 Drilling Camp and OPF Camp	63,675
9	Gavarke and Milbirke	Pad B3 to B1 Transfer Line	131,229
		New (In Process) Sub-Total	**1,268,909**
		Pad B Total Project	**1,498,466**

Table 4-1 Land use amounts for Pad B project

4.4 Civil and Structural Engineering

The civils works for the overall WPF project shall include installation on a pre-prepared site with basic overall site preparation performed by HKN for multiple well drilling pad, well facility expansion pad, flowline transfer pipeline, storage, camp and loading area although covering total footprint of 7.1 Km², the pad B1 is an expansion to the existing pad B (**Figure 4-2**), flowline and pipelines will be buried. The project will be within the block boundary and not crossing any occupied residential land.

4.4.1 Site Grading

The well pad (B2), production pad (B1), storage and loading pad (B3) and the flare tower pad will be prepared +/- 2.5cm from finish grade elevations. Each of the locations will incorporate a 1% cross slope for water run-off and drainage, except for the flare tower pad

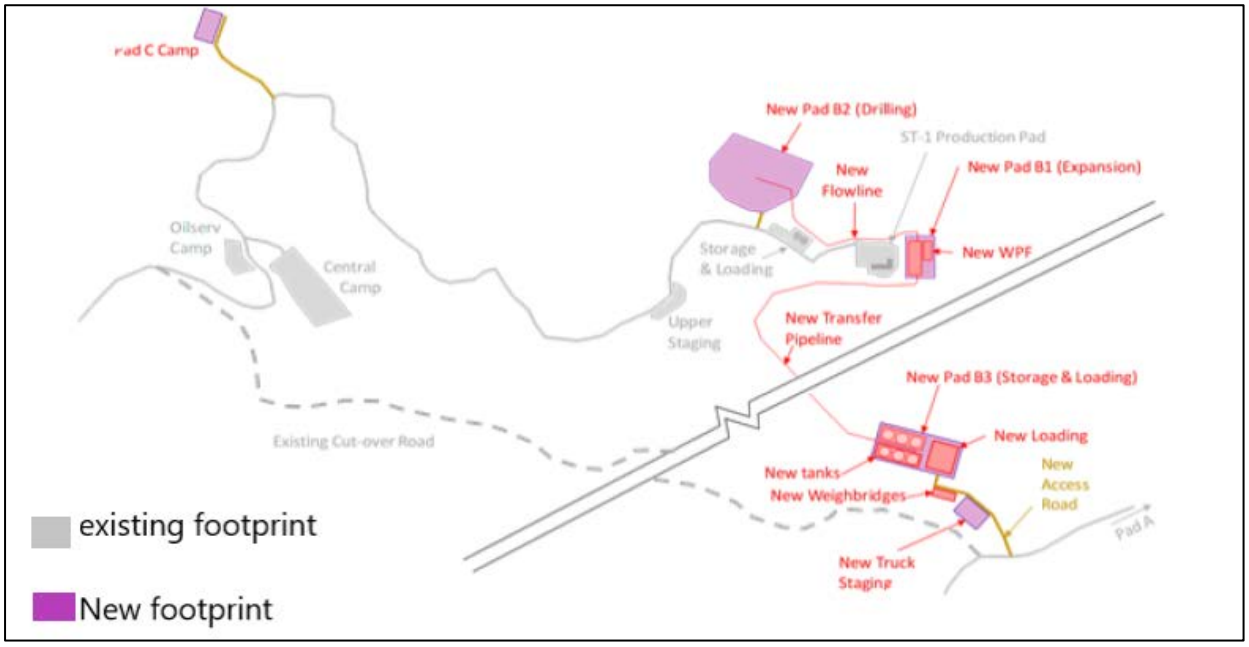


Figure 4-2 Overall Multi well facility (pad B) project showing flowline, camp, storage (pad B3), drilling (Pad B2) and loading area. (not to scale)

Site Surface Preparation

The preparation and finishing of the final surface for the well (B2), production (B1) and storage and loading (B3) pads and the flare tower pad will be completed by HKN. The three main pads will be dressed in 30cm of crushed compacted stone on a geotextile membrane prior to handover to Contractor.

Photo 15 overview of Pad B2 civils preparation

4.4.2 Perimeter Security Fencing

HKN shall install perimeter security fencing and access control for all site areas.

Flare Line

HKN shall prepare and grade the route from the outlet of the flare knockout drum to the flare stack location to allow Contractor to install the flare line. The flare line design is a Contractor responsibility; details of any civils works, foundations and/or trenching for the flare line to be carried out by HKN will be provided by Contractor within 42 Days of Contract Award.

4.5 Flare Tower Construction Access Track

HKN shall construct an access track to the flare tower location to allow construction equipment to reach the location and construct the flare tower.

The details of this work will be provided by HKN for information.

Vehicular Access

Grading, preparation and surfacing of vehicular/truck access to the production, loading and weighbridge areas will be completed by HKN.

Details of the access will be provided by HKN for information.

4.5.3 Equipment Foundations

Primary Foundation

HKN shall construct reinforced concrete pad foundations for all major equipment packages.

Contractor will be required to provide detailed designs, drawings and specifications for these foundations within 60 Days of Contract Award for HKN Approval. HKN reserves the right to modify these designs if considered appropriate.

Geotechnical data required to allow Contractor to design the foundations will be provided by HKN soon after Contract Award.

Secondary Foundations

HKN shall construct reinforced concrete foundations for secondary equipment in accordance with drawings and specifications provided by Contractor.

These will include:

- Pipe supports
- Cable tray supports
- Lighting pole foundations
- Instrument supports

Contractor will be required to provide detailed designs, drawings and specifications for these foundations within 90 Days of Contract Award for HKN Approval. HKN reserves the right to modify these designs if considered appropriate.

Geotechnical data required to allow Contractor to design the foundations will be provided by HKN soon after Contract Award.

4.5.4 Tank Foundations

HKN shall construct integrated reinforced concrete pad foundations and bund walls for the Oil Product storage tanks.

Contractor will be required to provide detailed designs, drawings and specifications for these foundations within 60 Days of Contract Award for HKN Approval. HKN reserves the right to modify these designs if considered appropriate. Bund wall will be constructed on 3 sides prior to Contractor starting the tanks, the final wall will be cast after Contractor has completed tank construction and majority of the pipework.

Geotechnical data required to allow Contractor to design the foundations will be provided by HKN soon after contract award.

4.5.5 Earth Works

HKN shall carry out general excavation and trenching work in accordance with drawings and specifications provided by Contractor. These will include:

- Trenching and back-filling for Contractor to install below-ground pipework
- Trenching and back-filling for Contractor to install below-ground cables

Contractor will be required to provide detailed designs, drawings and specifications for activities within 90 Days of Contract Award for HKN Approval. HKN reserves the right to modify these designs if considered appropriate.

4.5.6 Flow line construction

The excavation work is unlikely to disturb any groundwater aquifer, due to the shallow depths. The flowline will be placed by welded sections and shall be hydro tested by exerting 1.5 tonnes pressure, (either water or diesel) to ensure pipe integrity. The flow line detection, (purging) will ensure if any unexpected leaks occur, the pressure drop will be detected from the control room. The flowline route will be on an elevated terrain, away from any village settlements, since the pipeline will be buried, it will be out of sight from the public and will, therefore, lower risk of damage and authorized access.

Photo 16 typical excavated showing buried flow line with ditch breakers

The oil flowing through the flowline will be continuously monitored prior at the WPF for water content and tested daily for vapor pressure, H2S content and salt content. Use of chemical scavengers shall be the means of H2S removal. There is uncertainty on the salt content. Therefore, it's important to monitor the BS&W and salt content of the final product, prior to injection into export line but failure to meet the above specification will not be construed as a failure of the plant to performance. Oil rundown to storage shall be at a maximum temperature of 50 0°C/ 112 0°F.

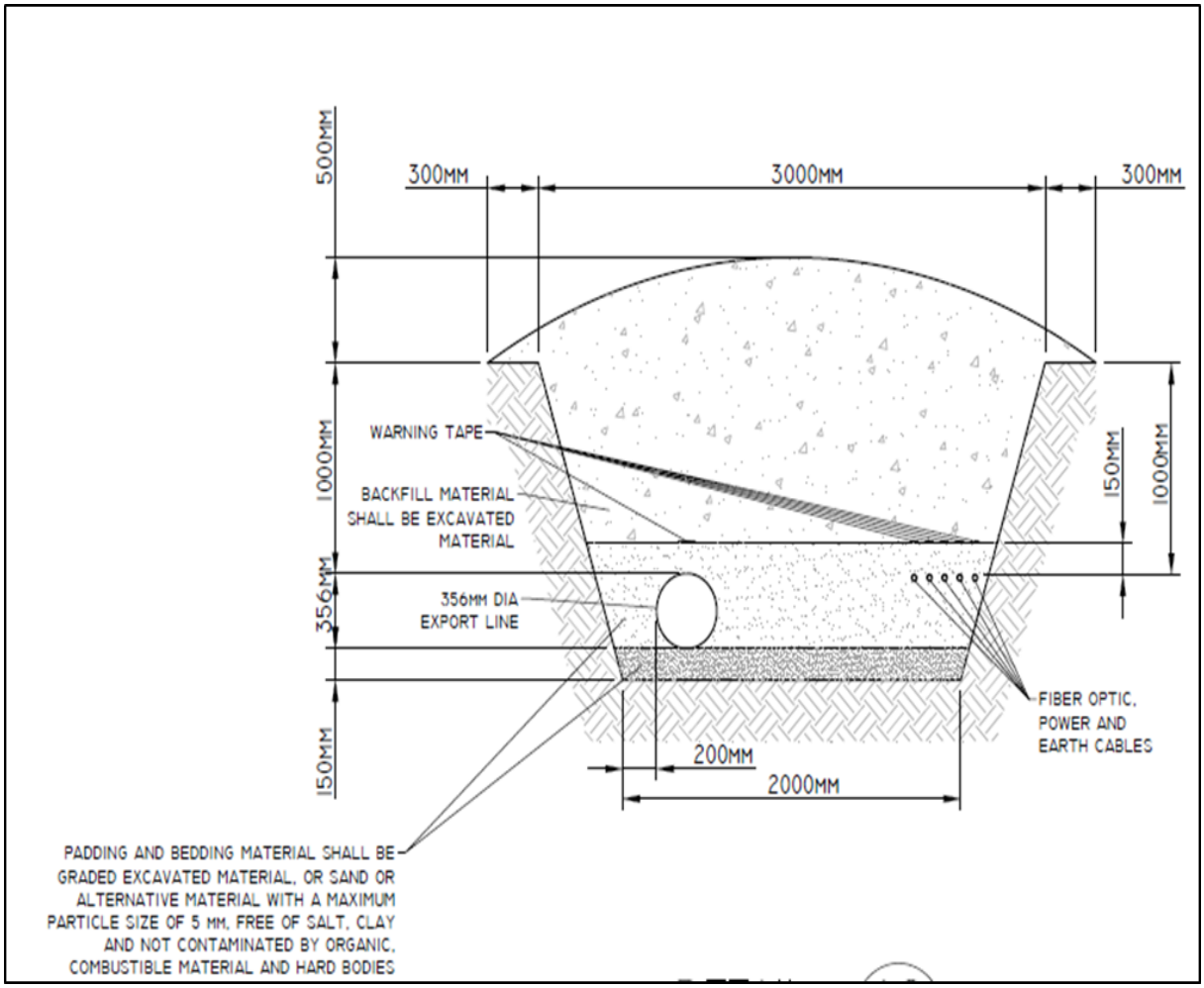


Figure 4-3 Transfer flow line cross section details

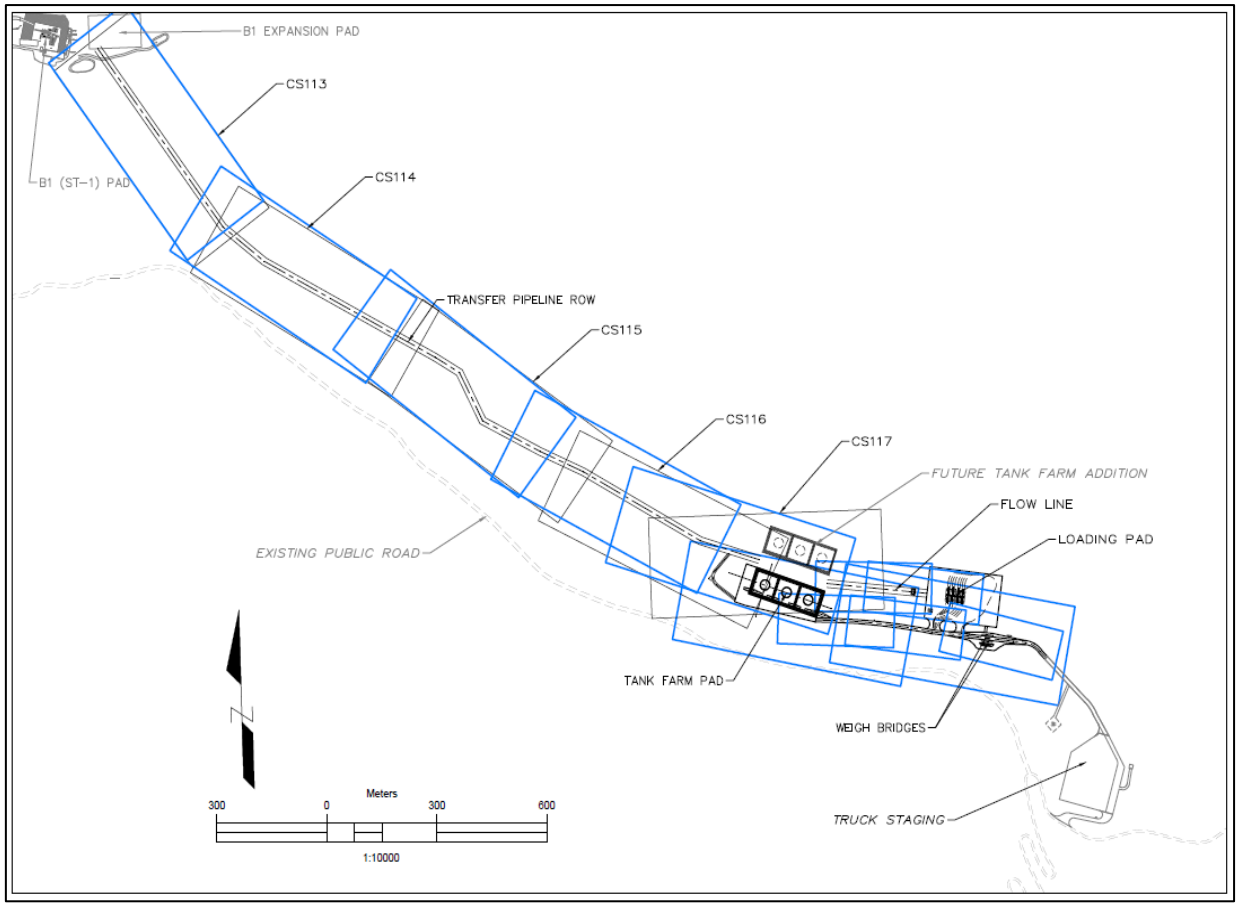


Figure 4-4 Overview diagram of transfer line sections in relation to the facilities

4.5.7 Manpower and Accommodation

Temporary camp is expected to be set up by throughout the life cycle phases of the civil works for contractor who will be awarded the works (over 150 personnel are expected to be working on rotation), to construct tank storage pad and truck loading facility, at a suitable location supervised by HKN within Sarsang concession. After the construction of tanker loading and storage pad area, the next phase of workforce requirements will involve setting up a temporary camp for construction crew who will carry civil and engineering works for flow line construction. Suitable locations will be established for both contractors and HKN will ensure that HSE guidelines and procedures are followed and familiarized with the contractor. The temporary camps are to be located as close to the operation as possible ideally on an existing pad area, minimising environmental footprint. Attention will be given to waste management, (including sewage treatment), to ensure that any handling of waste does not harm the surrounding community within the project area. HKN's CSR team will also monitor with HSE, contractor activities to ensure, local community issues are addressed as soon

as possible to prevent further escalation and safeguard smooth running of the operations.

Photo 17 Pad B2 drilling camp in the centre

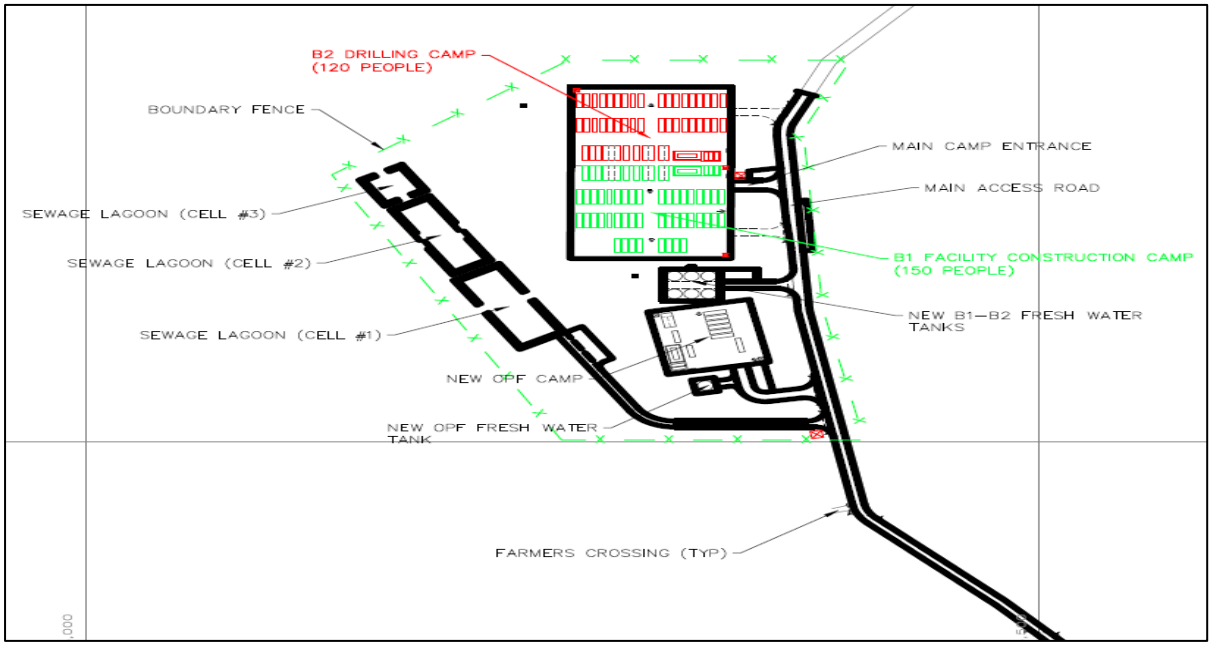


Figure 4-5 Diagram layout of Pad B camp with water treatment, lagoon sewage treatment and access road

HKN is planning a master infrastructure development plan, to build a permanent base camp (covered under Central Camp Construction ESIA Addendum), which will comprise of living accommodations and office facilities for long-term development and operation of the overall Sarsang Block development. A centralized waste treatment plant is also planned to be built within the proposed central location camp perimeter, where operational waste will be transported to the site and treated in accordance to waste type. This project is part of HKN's waste reduction plans at the concession to reduce waste volume. As soon as the project is finalised the details will be shared with MNR.

4.5.8 Access Road Construction

Accessing the Sarsang Block locations is planned along the existing road network to the extent available. HKN has already upgraded many of the existing governments and added new access roads to its existing sites. For the construction of future access roads, if necessary, HKN will build a new earthen road from existing unpaved road to the future site. HKN will engage a civil contractor for any needed construction of access roads. Although the exact construction methods are not known at this time, typical road construction will involve grading of the 7 m road corridor using a grader or earth mover and compaction. Foreign soil and fill material (gravel) may be required for road preparation at low lying areas along the route.

4.5.9 Site Preparation

Any site preparation will involve all activities required to facilitate the operation of the drilling and/or production equipment. Once the approach to the site has been developed, the site preparation activities will involve clearing, levelling and compaction of the site.

Levelling and compaction will be undertaken using graders and mechanical rollers. The location will be cleared of vegetation and rocks and subsequently graded. Topsoil, if present, will be removed and stored separately for site restoration after all activities are complete. Additional areas may be required for water pipelines and a pipeline corridor.

It is estimated by contractor round 4000 litters of fuel per day to work on each pad area and typical equipment list is used;

- Hydraulic excavators
- Bulldozers
- Rubber tire wheel loaders
- Compaction rollers
- On highway dump trucks
- 1 Motor grader
- 1 Water tanker truck
- 1 Fuel truck

Foreign earth material and gravel will be required for grading and site preparation. Although the majority of the material is expected to be available from the water and waste pit excavations, any additional material required, will be procured by the contractors while ensuring that the material is sourced from borrows and quarries within the areas nearby. A backhoe will be used for excavation and cutting activities on site. Platforms for the drill pad and all other heavy equipment systems or machinery will be made using cast in-situ concrete. The rig foundation will be approximately 30m x 15m in size. All elevated working areas will be surrounded by storm water cut off drains with sufficient gradient, to manage surface runoff and drain any collected flow to the on-site wastewater pit.

For disposal of drilling waste in the form of spent water-based drilling mud and cuttings will be to on-site specially designed pits. There will be a pit of approximately 40m x 30m for storage of drilling water. A mud pit / reserve pit of approximately 50m x 40m will be constructed adjacent to the well pad. An overflow pit of about 15m x 50m will be constructed to contain overflows of drill cutting and spent drill mud from the reserve pit. The combustible solid wastes generated at drilling rig will be combusted at the proposed incinerator plant. The wastewater will be routed to Effluent Treatment Plant (ETP) on-site.

Photo 18 truck staging area levelling works

Civils – site preparation	Duration	Start	Finish
B3 Camp Pad	219 days	Sun 01/04/18	Mon 05/11/18
Pad B1 - Production	209 days	Sun 01/04/18	Fri 26/10/18
Pad B2 - Well	92 days	Sun 01/04/18	Sun 01/07/18
Pad B3 Storage & Loading	211 days	Sun 01/04/18	Sun 28/10/18
ROW - Flowlines	192 days	Sun 01/04/18	Tue 09/10/18
ROW - Transfer Pipeline	287 days	Sun 01/04/18	Sat 12/01/19

Table 4-2 Typical time line of project engineering and civil works

4.6 Drilling Operations

HKN plan to drill five sequential wells (vertical or horizontal), on pad B2 with approximate depth between 3500m to 4000m to allow production, gather characteristics and variables of the hydrocarbon reservoir(s) and assess the viability of target formation(s). The wells will undergo an initial well stimulation and clean-up program that may extend up to 30 days for each well after completion. It is anticipated that each well would be capable of producing 5,000 bopd and hence five multiple wells producing 25,000 bopd targets. After well clean up, produced oil will be transferred to gathering manifold and transferred through production flowline to receiving manifold and production separators for undergoing crude processing.

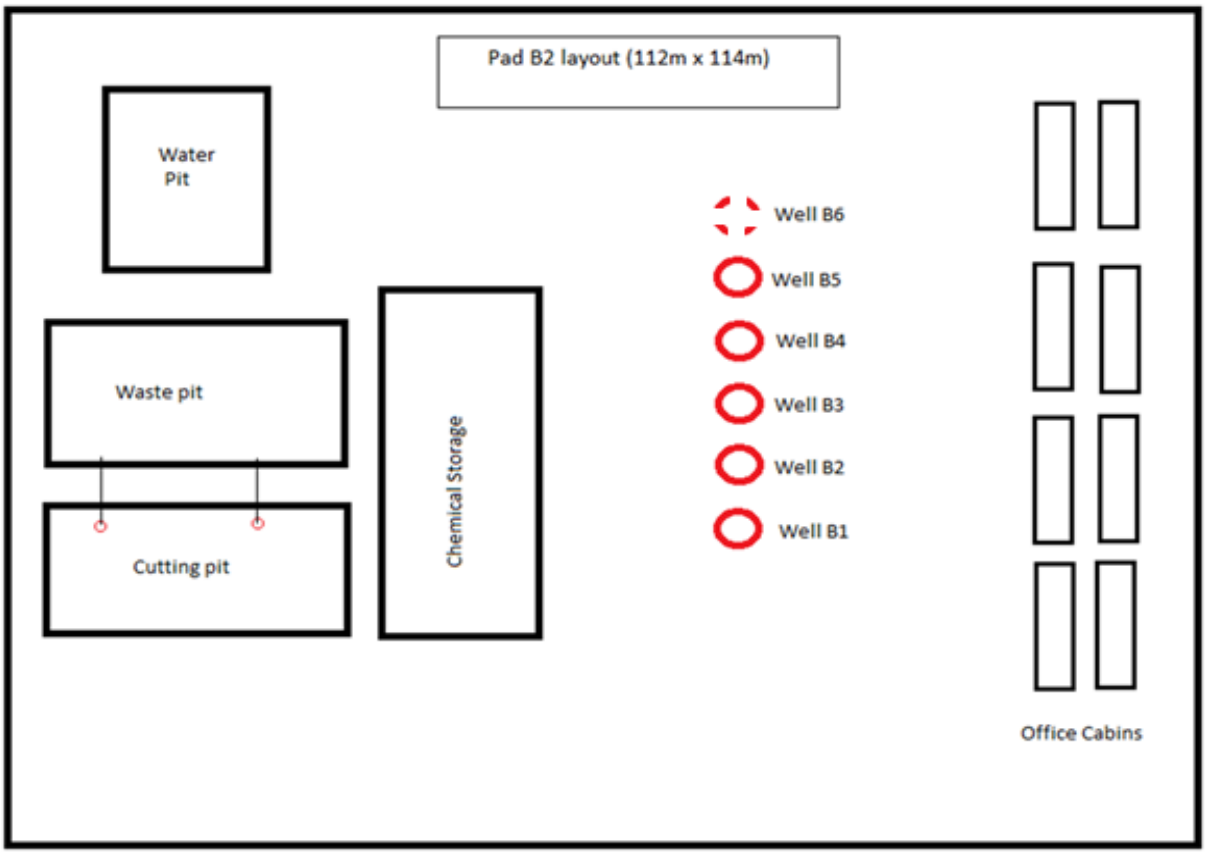


Figure 4-6 Diagram of proposed rigsite layout of pad B2, with provision for 5 wells and 1 contingency well

4.6.1 Proposed drilling program

After completion of site preparation, well B1 is planned to be the first well drilled in Q3 of 2018 (B1 well is not part of the Project) and sequentially followed by well B2 in Q4 of 2018, B3 in Q1, B4 in Q2, B5 in Q3 and B6 in Q4 of 2019. This means that the drilling program is estimated to last for 16 months, this includes mobilization and demobilization of rig.

4.6.2 The drilling Rig and overview of drilling process

The drilling process primarily involves boring a hole of varying size range between 6" and 16" diameter. A typical 2000 horse powered drilling rig will be used consisting of a drill bit attached to a long string of drill pipe. Drilling mud (drilling fluid) is pumped down through the drill pipe that comes out through the drill string bit at the bottom carrying the cut formations to the surface. A schematic of a typical drilling rig is shown in **Figure 4-7.**

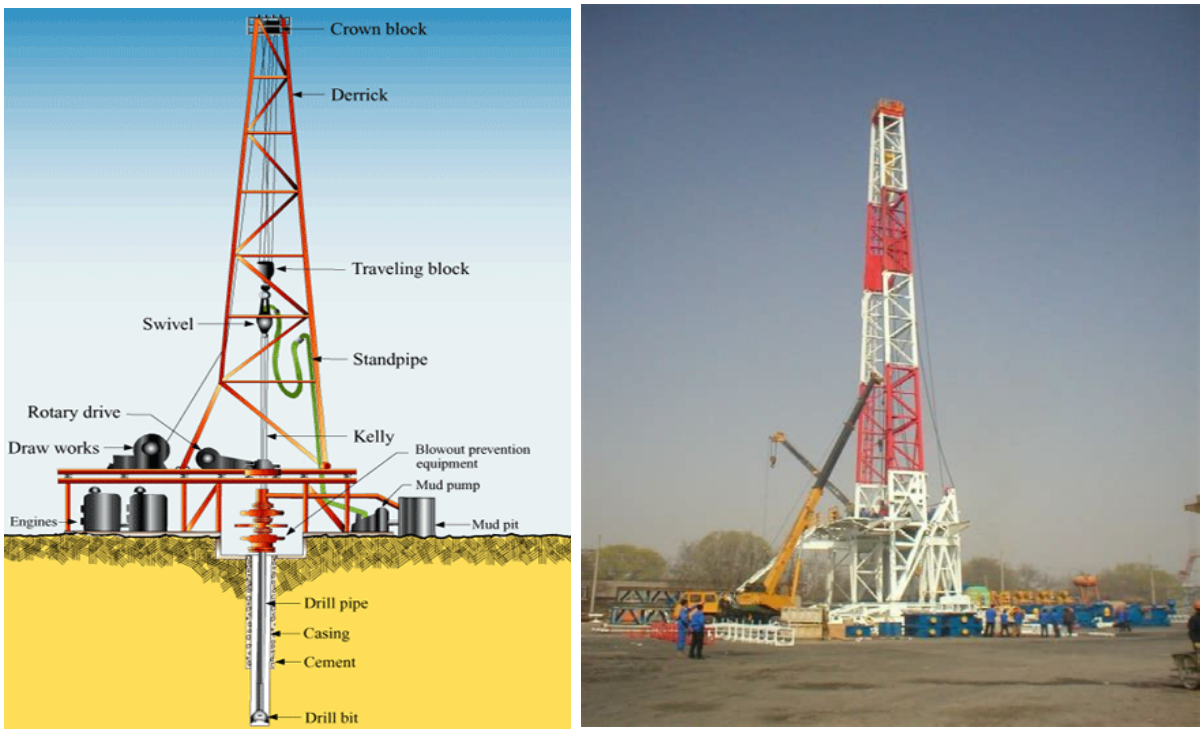


Figure 4-7 schematic and picture of typical 2000 horse power rig to be used for project

The casings will be run into the well and cemented in place, hence covering the sections drilled to keep the well stable, isolate the potential reservoir sections and to avoid cross flow between potential reservoirs and groundwater aquifers. The casing is cemented in place before further drilling is carried out. Based on the type of formation to be drilled and fluid compatibility, HKN will use water-based mud (WBM) for the drilling campaigns within Sarsang Block.

The drilling mud, (WBM/KCL) is pumped down-hole from the rig mud tanks and the returning fluid comprising mud and drilled cuttings is separated. The drilling mud returns to the mud pit for continued use while the separated cuttings are will be capsulated in concrete and recused by HKN, possibly given to the local community for building usage. On occasions the used drilling mud is also diverted to the cutting/waste fluid pits. The mud used will be placed in a lined membrane pit and evaporated.

On completion of the well the fluids in the pits will be allowed to dry/evaporate off, leaving dry cuttings and drill mud chemicals. During drilling, core sampling and well logging operations are performed to determine the Petro-physical parameters in hydrocarbon and water bearing formations. Well logging will involve the lowering and

raising of measuring devices or tools which contain radioactive material for the purpose of obtaining information about the well or formations. Well logging operations will be completed by specialist contractors experienced and trained in HSE matters. Following the drilling of a well, at expected reservoirs or upon reaching target depth, the casing length will be increased, and cementing works are further continued down depending on the type of formations encountered to prevent fluids/hydrocarbon losses at permeable zones. An initial well clean-up and production testing will be conducted following the well completion stage.

4.6.3 Drilling mud and chemicals

The main functions of drilling fluids include providing hydrostatic pressure to prevent formation fluids from entering into the well bore, drill bit lubrication, removing the drill cuttings from the bore and suspending the drill cuttings while drilling is paused, and the drilling assembly is brought in and out of the hole. The drilling fluid used for a particular job is selected to avoid formation damage and to limit corrosion. WBM will be used throughout the drilling campaign. WBM consist of water primarily mixed with Bentonite clay, Sodium Chloride, Calcium Carbonate and a small portion of additives to gain the desired drilling properties. The WBM composition depends on the density of the fluid. However, a minimum of 76% (weight %) constitutes water, the rest dominantly contributed by bentonite and barite while less than 2% make up the additives. These additives include thinners (e.g. lignosulphonate, or anionic polymers), filtration control agents (polymers such as carboxy-methyl cellulose or starch) and lubrication agents (e.g. polygynous) etc.

Some drill cuttings form small particles called “fines” which are difficult to separate and can build-up in the drilling fluid, thereby increasing the solids content and in turn degrades the flow properties of the drilling fluid. If the fines cannot be controlled efficiently, dilution with fresh drilling fluids becomes necessary to maintain the performance characteristics of the drilling fluid system. For WBM systems, when the drilling fluid in use cannot meet the critical operational properties, then that fluid may be replaced by freshly prepared drilling fluid or a different type of fluid. WBM and cuttings (TPH < 1%) will be disposed of in a dedicated drilling waste disposal pit followed by combustion in incinerator plant.

A minimum of two separate pits will be constructed for the storage of WBM and waste drilling mud at the drilling site. The wastewater generated at drilling rig will be treated at ETP. All possible measures will be taken to prevent infiltration of drilling fluids into the underground strata. A photograph of typical lined pit constructed adjacent to a rig site.

In the event of an incident whereby the drill bit gets trapped in the sub-surface, it may be necessary to use a few chemical agents or OBMs to assist its removal. Such an event is considered exceptional.

Cement volumes per well		
Casing size	Cement weight	volume
13-3/8”	15.8 ppg tail	100 bbl
9-5/8”	9 ppg lead	250 bbl
	15.8 ppg tail	80 bbl
7”	9 ppg lead	85 bbl
	15.8 ppg tail	40 bbl
Cement plug	15 ppg	30 bbl

Table 4-3 Cement weight and volume percasing size

4.6.5 Well completion and testing

The completions for Triassic wells with ESPs are selective completions. To achieve this, an ESP with bypass has been used. The pump is set as deep as possible and the 4 1/2” tubing crosses over to 2 7/8” tubing which allows entry to the completion via a “Y” sub to facilitate movement of sliding side doors and production logging.

Three days of testing is anticipated per well producing 5 MMSCF/day during flaring. The quantity for all six well based on these estimates will generate 75 MMSCF/day. Although this amount of gas emission will be over fourteen-month period.

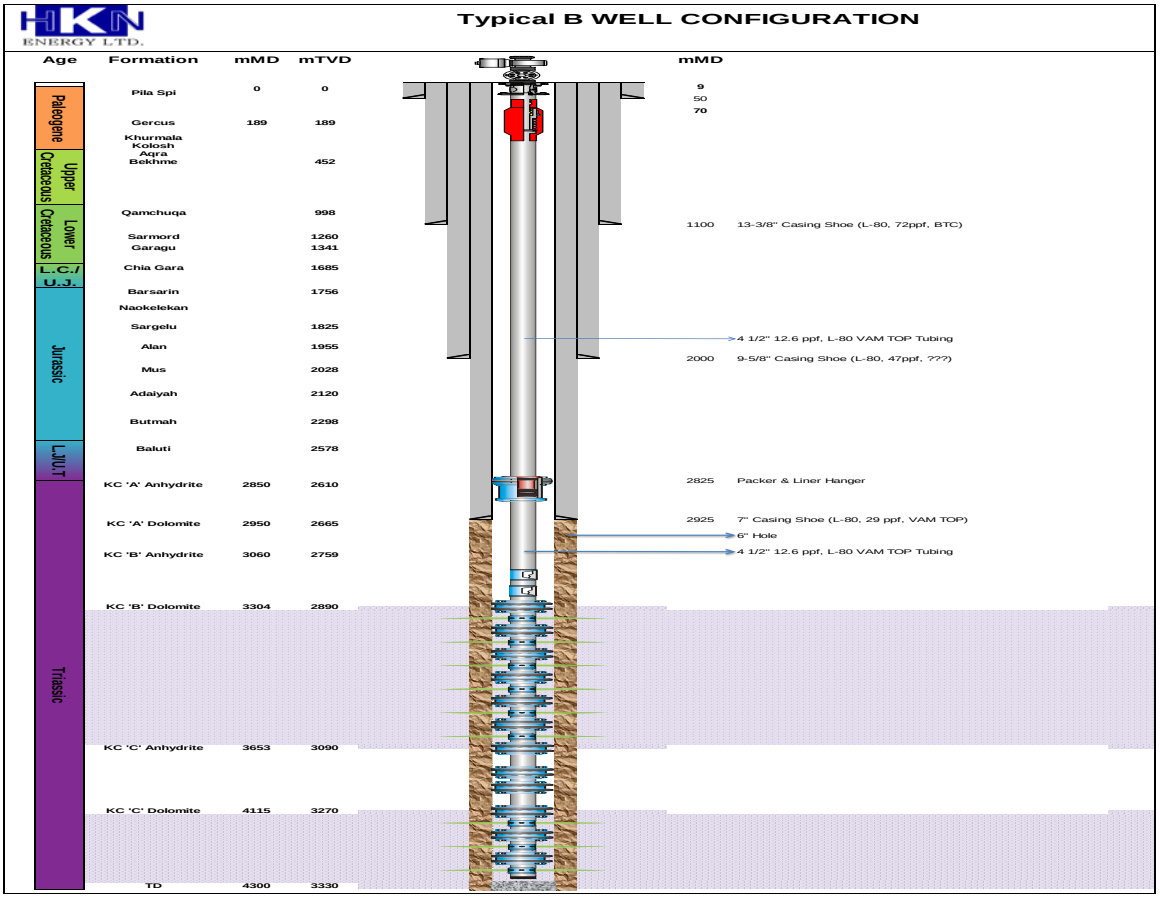


Figure 4-8 Profile f expected well and casing configuration

4.6.6 Support operations

Camp facilities

The existing Pad C camp is expected to be used once civils have completed the pad areas, although possible that other suitable locations maybe used for camp positioning. The camps are used to support day-to-day field activities.

In addition, office will be located adjacent to the well pads. The sites are sized to minimize environmental impacts. The camps are inside a fenced area. Infrastructure located on the premises may include:

- offices
- kitchen, dining room, recreation room, food storage
- residence trailers
- independent air conditioned and heated caravans
- bathroom/toilets

- locker rooms
- parking area
- generators
- fuel storage tanks
- septic tanks or sewage treatment plants (STPs) and leach fields
- potable water tanks and pressure system

Typical vehicles will be parked at the main base camps overnight. A majority of the drilling support equipment and machinery will be stationed at the drilling location. Drilling support vehicles along with some drilling materials and machinery will be temporarily stored at the main base camp location overnight. There could be approximately 100 people at the camp during the day, camp logistics, and security personnel. The main base camp will be powered by generators. The number of people at the main base camp at any one time will vary as drilling crews will be staying at accommodations at the rig site. Senior staff are normally based out of Erbil in centralized accommodations at ST-2.

Utilities and Storage Facilities

Potable water required for the project will be sourced from local (water well) source currently used for the other HKN operations It is estimated that the daily peak consumption will be approximately 480 litters per person or approximately 150 m^3 per day total.

Electricity for the main camp and rig campsites will be generated using DG units. The DG units will be run for 24 hours per day. The drilling program will use a mix of heavy vehicles, all run on diesel, including cranes, forklifts pickup trucks, cherry pickers, ambulances, and water trucks.

In addition, light plant generators and welding machines will also be in use at the sites and be run on diesel. Contractor vehicles will likely use diesel fuel. Some vehicles may run on gasoline. Dedicated diesel storage tanks would be installed at the site. All fuel storage will be provided within the camp fence line. Fuel will be stored in storage tanks within dedicated areas equipped with spill containment measures to contain any

unplanned discharges (spills and leaks). The fuel dispensing area is typically constructed with impervious flooring and/or drip collection trays will be provided adjacent to the vehicle fuel storage area.

4.6.7 Estimates of anticipated drill cuttings

HKN estimates 536 m³of wet drill cuttings to be generated for one well and for six wells this will be 3156 m³. For solid cuttings one well will produce 263 m³ of cuttings and 1572 m³ for six wells, (see table below for individual hole size and total volumes).

Solid Generated on B-1 Well		
Hole Size	**Solid Cuttings (m3)**	**Wet Cuttings (m3)**
17-1/2" Hole	167	333
12-1/4" Hole	50	100
8-1/2" Hole	26	53
6" Hole	20	40
Total Cuttings (One Well)	263	526

Table 4-4 Solid cutting volume for one well.

4.6.8 Waste management

Cutting waste management

HKN plans to treat drill cuttings using specialist equipment by incapsulating the drill cuttings into concrete. This is an absorption process where contaminants, typically oils, an absorbent material in the same way a sponge takes on water. Cement will be added to the drilling waste acting as an absorbent. The solidified product will have improved properties such as strength, compressibility and a reduced permeability, which will prevent leaching of oils and chemicals and since product is made safe, HKN plan to use the concrete material for its own purpose, such as paving and even distributing concrete to the local community.

Non-hazardous solid waste

For non-hazardous solid wastes, the waste from the drilling camp shall be transported to designated central waste management area, where segregation of waste materials on site will be carried out by HKN's green team, (local employees hired from nearby Sarsang villages), this includes plastic bottles, wood, glass, scrap metals,

paper/cardboard/polystyrene. After segregation the waste taken away by dumper trucks to a licenced government waste management facility approximately 50km from the Sarsang Block in the town of Sumeil, Dohuk province. The waste trucks are weighted when accessing site providing net weight and manifest provided to HKN. The useful products such as metals and plastics products from the waste streams will be recycled locally or shipped to neighbouring country Turkey for manufactures to be reused.

HKN also has designated incinerators at its waste management site which can be used where necessary to relief excess waste where necessary. The unit is a Sure-fire Matthews TS150 General Waste Incinerator. This incinerator is in line with World Bank Emission Standards, UK Clean Air Act, and BS3316-1987. It can be operated 10 hours per day, with a burn rate of 150 kg/hour, with a bulk density of 160 m^3. The ash from the incinerator will normally be landfilled, however HKN is in the process if exploring stabilizing the ash in order for it to be used for aggregates, similar to the drill cutting solidification process.

Liquid effluent waste

For liquid effluent waste Small quantities of produced water are expected during the well testing stage. The quantities of such effluent depend on the reservoir characteristics. In general, depending on flow rates, these effluents will either be routed to the floor for burning or routed to a designated pit at the drill site for evaporation and treatment at an effluent treatment plant. Other effluent streams include domestic sewage from both the rig site and camps. The sewage generated from the domestic use of water on-site will contain both suspended solids (SS) and total dissolved solids (TDS), with relatively high biochemical and chemical oxygen demand (BOD/COD).

This stream is expected to be 21m3/day and is planned to be holding tanks. The holding tanks will be then periodically emptied, and the contents transferred to municipal STP facilities. Run off from within the rig pad will not be allowed to sheet flow to the surrounding environment. Water from within the rig pad will be collected in ditches and routed to the waste pits for evaporation and treatment at ETP. A summary

of the liquid effluent streams, approximate quantities generated, and planned handling and disposal methods are presented in **Table-4-4.**

Source	Type & Quantity	Storage	Disposal
Spent (unusable) WBM mud and drill cuttings	Continuous; Approximately 375 m3/1,000 m of well bore drilled	Neutralization if required and routed to lined pits	Evaporated in unlined pits and the residue treated as hazardous waste and disposed at proposed incinerator.
Production/formation water and condensate	Hydrocarbon contaminated; intermittent; Quantity cannot be estimated, but the well is expected to produce very small quantities and heavy metals will be too small to measure	Flared or routed to designated pits	Flared along with the reservoir fluids if the quantity is manageable or routed to designated pits for evaporation and routed to ETP.
Grey wastewater from camp site	Non-hazardous liquid (kitchens, ablutions, toilets, laundry shops); Continuous; ~23 m3/day	Partial treatment in underground septic tanks; supernatant water routed to soak-away pits	Septic tanks will be regularly emptied and transferred to third party STPs.
Machinery washings and rig side runoff	Oily contaminated; intermittent; The quantity cannot be estimated	Lined pits if found contaminated, else disposed of in the waste drill cutting pit	Evaporation and the residue treated either as non-hazardous or hazardous waste depending on the characteristics
Storm water	Intermittent; possible contamination; Quantity cannot be estimated	Lined pits if found contaminated, else disposed of in designated waste membrane lined pit	Evaporation and the residue treated either as non-hazardous or hazardous waste depending on the characteristics

Table 4-5 Main drilling waste stream sources, storage and disposal methods

4.7 Well Based Production Facility

The WPF will comprise the following main components:

- Process facility and associated utilities,

- Product storage,
- Product metering & loading, and
- Flowlines and pipelines

HKN requirements relating to each of these main components and configuration are detailed in conjunction with **Figure 4-9.** The produced oil will be flowed through production flowline into gathering manifold and production separators, gas is separated to flaring and future plans to sweeten gas for power utilization. Whilst the design is conceptual the final configuration of the WPF will be entirely dependent on the current design. All utilities, control, safety and ancillary systems required to support the main components will be part of HKN's work scope.

4.7.1 Wellhead Interface

HKN shall complete each well with sub-surface safety valve, master and wing valves powered hydraulically from a dedicated WHCP. For the wellhead control system, and interface shall be at the hydraulic connection on the actuators.

For (production) Pad B1, the WHCP will be located adjacent to the manifold remote from the trees. The ST-1 WHCP location will be adjacent to the tree. All trees will be rated to 5,000 psi. Process monitoring shall be provided upstream of the choke valve in the form of pressure and temperature transmitters with local (LCD) display plus feedback to the production facility control system.

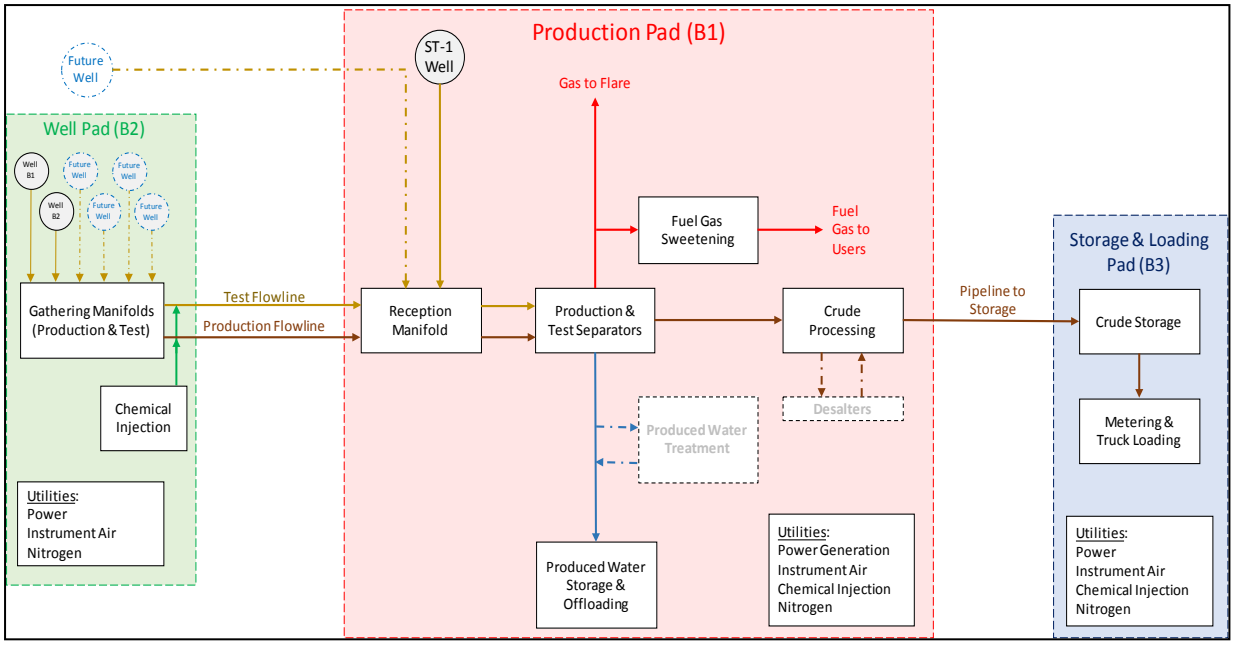


Figure 4-9 WPF proposed configuration and processes

The piping interface shall be at the downstream face of the actuated wing valve. The current assigned by HKN shall provide suitably rated choke valve, specification of which shall be in accordance with API 6A and agreed with HKN. This includes all electrical and instrument interfaces to tree components. HKN shall provide Contractor with relevant tree details so allow interfaces to be specified;

4.7.2 Manifolds & Flowlines

HKN intends to initially drill two (2) wells on the well pad (B2). In future a further four (4) wells may be drilled from the same pad to maintain total production throughput. The gathering manifold arrangement on pad B2 will therefore be required to accommodate up to six (6) wells, (**Figure 4-10**). Production and test flowlines will be routed from the well pad (B2) to the reception manifold, (shaded in red) on the production pad (B1).

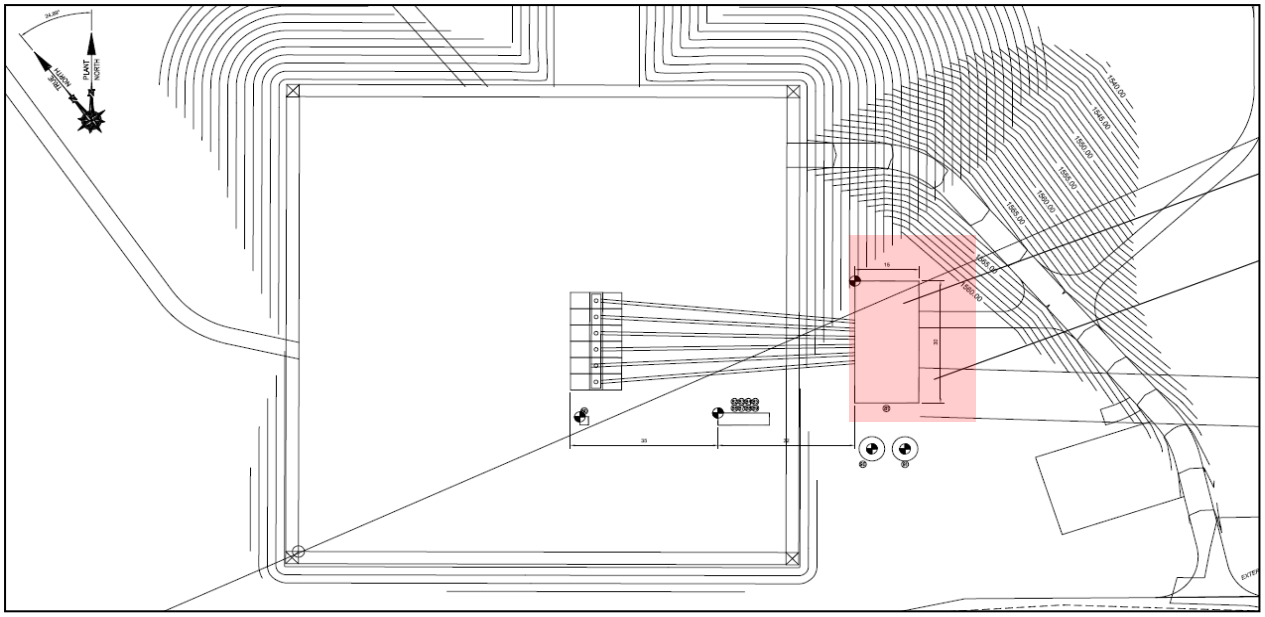


Figure 4-10 Pad B2 drawing with multiple well options, manifold area in red access and grading elevation

The reception manifold on the production pad (B1) will be required to accommodate:

- The production and test flowlines from the gathering manifold on the well pad (B2)
- the flowline from the existing ST-1 well located on the production pad (B1)
- the flowline from an additional future off-pad well. The location of this future well is yet to be determined.

The manifold and flowline arrangement shall be configured to allow the production from any single well to be routed through the test separator on the production pad (B1).

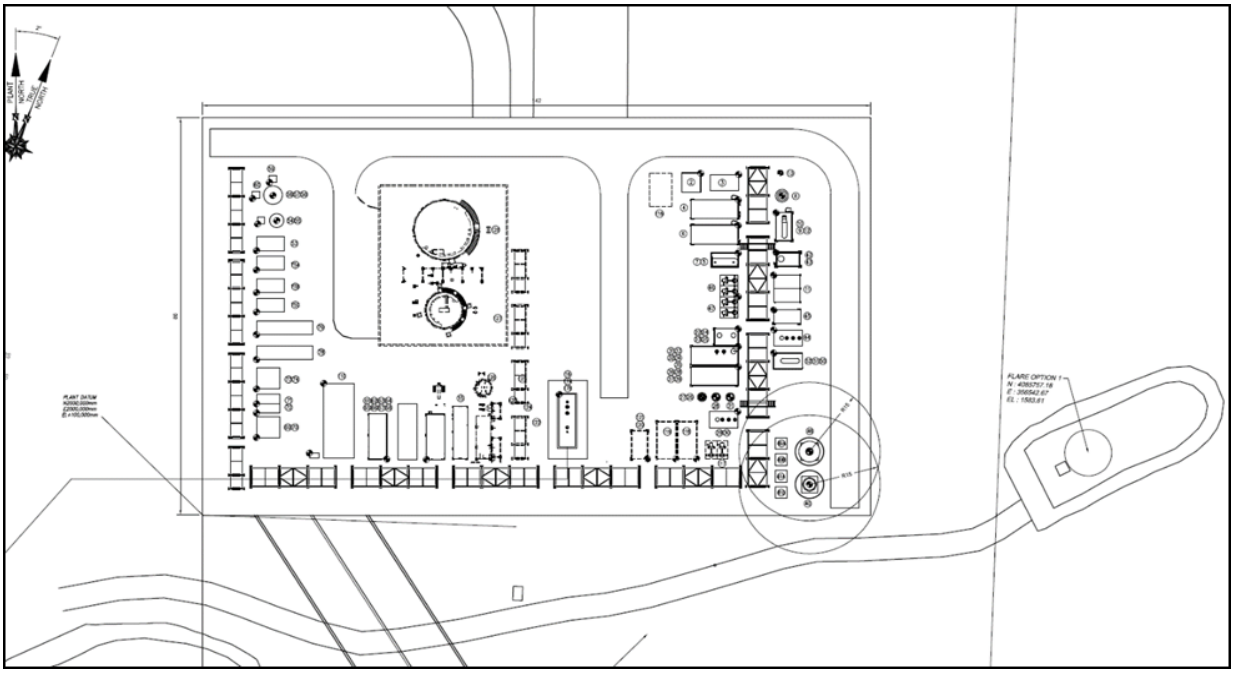


Figure 4-11 Pad B1, production facility layout.

4.7.3 Main Process

From the Tie-in Point on each well, the WPF shall include, but not be limited to, the following:

- Instrumentation for continuous wellhead pressure and temperature monitoring on all wells.
- Choke valve (API 5000# rated) on all wells.
- Flow-line downstream of the choke valve – suitable for transmission of 10,000 BPD total Well Stream fluids.
- Gathering manifold comprising of production header (30,000 BPD total well fluids) and test header suitable for routing flow from any single well (10,000 BPD total Well Stream fluids) to the test separator.
- Production and Test flowlines from the gathering manifold on the well pad (B2) to the reception manifold on the production pad (B1). Routing and profiles for these flowlines are provided in figure 2.
- Flow-line from the existing ST-1 well on the production pad (B1) to the reception manifold on the same pad.
- Three (3) phase primary production separation and associated test separator.
- Oil processing to stabilize, remove impurities and control temperature to meet Oil

Product Specification. Oil Product Specification shall be achieved without the use of chemical scavenger, however provision for injection of scavenger shall be provided. (Note: Nitrogen and other inert stripping agents will not be used).

- Initial produced water treatment for up to 1,000 BWPD to meet the produced water specification for tanker export (Ref. Design Basis).
- Provision of connections for future installation of a produced water treatment package to allow exported produced water to meet the produced water specification for injection. Provision of the produced water treatment package is not part of the current scope; however, contractor is required to provide the completed design and specification of the package as part of the Work.
- Sufficient produced water storage for 1,000 BWPD. The arrangement shall incorporate API-12F compliant tanks, facilities for scavenger injection and tank circulation pumps. Tanks will have suitable blanketing and cold venting in a safe location.
- Produced water tanker loading facilities for up to 1,000 BWPD.
- Provision of connections for future installation of equipment required to meet the BS&W specification, following water break-through. Provision of this equipment is not part of the current scope; however, HKN to provide the completed design and specification of the package as part of the Work.
- Fuel gas conditioning to determined specification (based on end user limitations).
- Gas disposal system for gathering, treatment if necessary, and ultimate flaring of residual gas.
- All necessary instrumentation, control and measurement to ensure continuous online monitoring and reporting of all critical process parameters throughout the WPF including temperature, pressure, flowrate and gas density. (Specifically, for flow, as far as practicable, all primary flow paths shall be provided with suitable and sufficient devices to ensure direct, rather than inferred by difference, measurement).

Chemical Injection

A chemical injection (centralized chemical storage and distribution) package is required at each of the following locations;

- Well Pad (B2)

- Production Pad (B1)
- Storage & Loading Area (B3)

Each package shall be capable of injecting a minimum of four chemicals. Storage shall be nominally sized for not less than seven (7) Days storage of each chemical.

Injection pumps shall be either electric or pneumatically driven. Where multiple end users are identified, suitable injection rate control devices (IRCD) shall be employed to ensure optimization.

4.7.4 Product Pipeline

On exit from the production facility, the Oil Product, which meets the Oil Product Specification will be pumped to the Storage & Loading facility located on pad B3.

This pipeline shall be sized to accommodate a total flowrate of 40,000 BOPD in order to accommodate possible future production. The transfer pumps provided as part of the WPF shall be sized to accommodate 20,000 BOPD, with provision for future expansion. Pipeline shall include pigging facilities. All equipment, pumps, pipework, valves and controls required to deliver the Oil Product meeting the Oil Product Specification, at the Production Capacity, to the storage tanks

4.7.5 Product Storage

Product storage shall include, but not be limited to, the following:

- Permanent, welded, internal floating roof, API650-compliant Oil Product storage tanks, with the capacity specified in the Design Basis.
- Storage tanks shall be configured to allow the installation of future heating coils.
- Recirculation / mixing pumps to be provided to allow product rolling and chemical injection if required.
- Such pipework, manifolds, valves and controls as are required to operate a zoned storage system with segregation between the storage tanks being used for offloading, storing, and receiving Oil Product.
- All required level monitoring and control.

- Any atmospheric vents to be routed to a safe location and equipped with dual parallel flame arrestors configured to allow one to be taken off-line for maintenance without compromising the tank integrity.

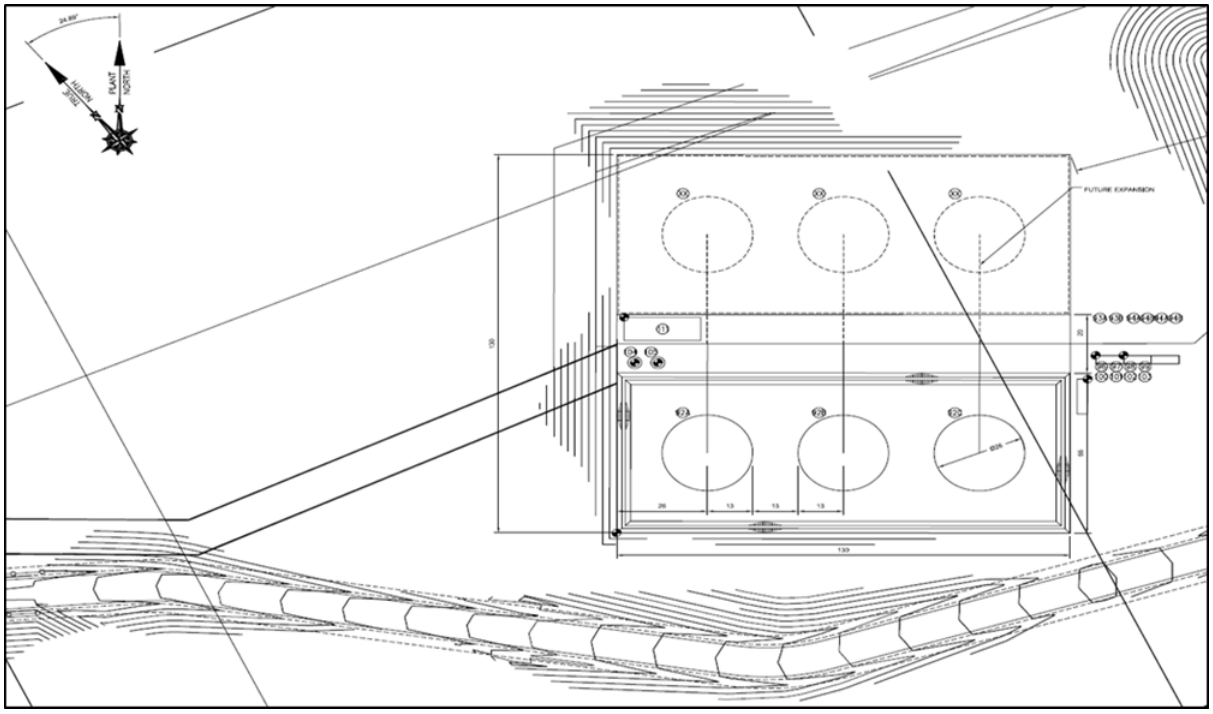


Figure 4-12 Tank storage layout, with initial 3 tanks with expansion plan for 6 tanks

4.7.6 Product Metering & Loading

Processed Oil will be loaded into road transportation tankers for export. The loading system shall be designed and operated to allow the volumes specified in the Design Basis to be safely transferred to road tankers and include provision for future expansion.

The loading and metering component shall include, but not be limited to:

- Oil loading pumps.
- Pipework, valves and manifolds to deliver Oil from the tanks to the metering skid and onward to the loading arms.
- Coriolis meters (one for each arm) for custody transfer grade metering of the Oil in accordance with the API standard. (Automated volumetric loading control system.

- Truck earthing connection with loading ESD function.
- System will have capability to print-out tickets locally in any combination of measured data/units by mass and/or volume with appropriate temperature correction.
- Meter prover connections.
- Sampling system immediately upstream of the meter.
- Loading gantry (top loading) incorporating trace heating, vapor recovery to safe location and automatic tanker level monitoring for overfill protection.
- Gantry to include access platforms, stairs and cascade air breathing system. Gantry arrangement to be capable of accommodating all expected tanker configurations.
- Facility for returning the contents of a filled tanker, safely back into storage, including any pipework and pumps.
- Two (2) weighbridges each with a 100 T maximum capacity and a footprint of 18m x 3m with computerized weigh systems and automatic ticket printer.
- Any lighting required to facilitate safe loading and movement of tankers 24 hours per day.

Any paved areas for the loading arms and weighbridge will be provided by HKN as part of the civil work scope.

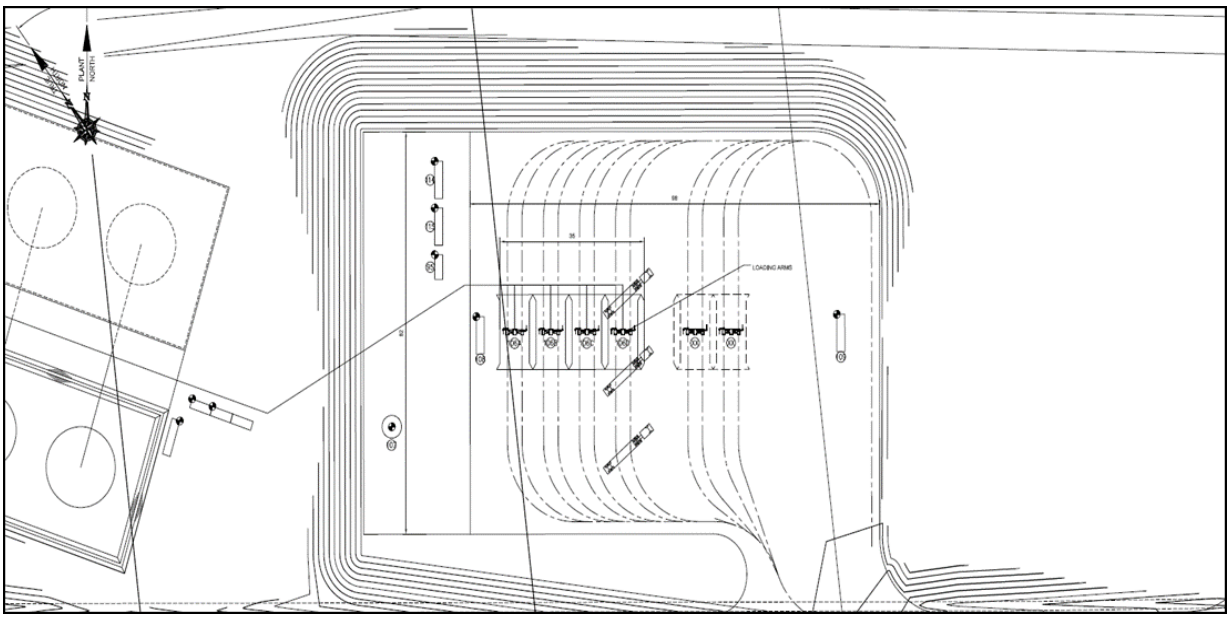


Figure 4-13 Tanker loading facility area adjacent to tank storage

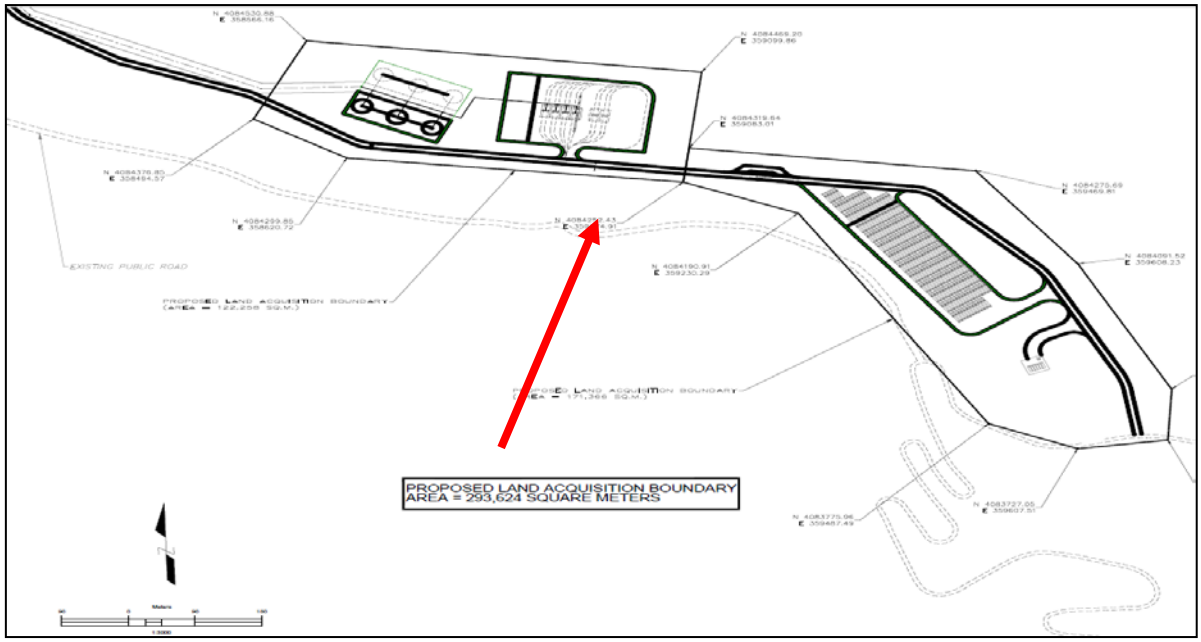


Figure 4-14 Land acquisition for tanker loading facility (pointed out with red arrow) with tank storage and tanker parking area

4.7.7 Flare System

All residual gas will be flared. The flare will incorporate a high combustion efficiency flare tip which shall provide full range of WPF design capacity. The flare stack height shall be minimum forty-five (45) metres determined by air dispersion modelling, (refer to **Figure 5-1 to 5.4**).

Flare system to include, but not be limited to:

- Flare knockout drum
- Flare lines (from knockout to flare)
- Flare structure
- Flare tip
- Ignition system
- Black start propane
- Pilot gas supply for steady state
- Flame-out monitoring linked to plant ESD

The flare line shall be sized to accommodate 20% in excess of calculated maximum gas flow rate. The preparation of the approach route to the flare shall be part of the

HKN's civil construction scope. Any foundations and supporting structures between these foundations and the flare lines shall be included in the Work.

4.7.8 Control System

Process Safety and Process Control Systems shall be fully independent of each other.

Process Safety System

A comprehensive Process Safety System shall be provided, which proposed to demonstrate, full compliance with the requirements of API14C.

The system will protect personnel, the environment and the facility from threats to safety caused by the production process. All Process Safety System data will be visible in the CCR.

The Process Safety System shall provide:

- automatic monitoring and automatic protective action if an abnormal condition is detected within the process,
- automatic protective action if manually actuated by personnel who observe or are alerted to an unsafe condition by an alarm,
- continuous protection by systems that minimize the effects of escaping hydrocarbons, and
- two levels of protection to prevent or minimize the effects of an equipment failure within the process, in addition to the control devices used in normal process operation.

Process Control System

The Process Control System will be designed for safety, reliability and ease of operation.

All production, safety and metering data will be provided to the control system for local monitoring and data storage.

The control system hardware will be located in the CCR. All control and shutdown systems shall be powered by Uninterruptable Power Systems (UPS) as described in later sections of this document.

The control system shall have full data history capture functionality as specified in the Design Basis.

All data and records generated by, or stored within, the control system shall be the property of HKN.

Equipment and End Devices

End devices may be pneumatic or electronic; however electronic transmitters shall be provided wherever applicable. All electronic devices will be intrinsically safe and/or suitable for area classification for the area intended.

All instruments and piping that could be subject to freezing shall be appropriately winterized. All vents and/or drains from instruments, cages, and other devices shall be piped to appropriate closed drain or vent system with 316L SS tubing. All instrument tubing, junction boxes, etc. shall be a minimum 316L stainless steel.

All devices and equipment shall be suitable for onshore environment with a minimum of IP54 enclosures where applicable. All local pressure and temperature gauges will have dual unit indicators.

All electronic transmitters will have integral local indication.

ESD System

The Emergency Shutdown System for the WPF shall follow industry best practice, and as a minimum, be capable of:

- Shutting down all and part of the production systems and equipment
- Isolating hydrocarbon inventories
- Isolating electrical equipment
- Preventing escalation of events
- Stopping hydrocarbon flow
- Depressurizing / Blowing down the WPF to the flare
-

Wellhead ESD

The HKN supplied tree shall incorporate an actuated hydraulic upper master valve and an actuated hydraulic wing valve, which will form the emergency shutdown barrier at the tree. The current design shall integrate these components and the SSSV into the WPF ESD System, which includes providing the required wellhead control panel for the sequenced actuation of these devices.

Electrical Systems

General Definition

The power system shall be designed to provide adequate power to all end users at all three pads. HKN will ensure dependable operations within the confines of economic practicality.

Power Supply

Power generation shall be provided to supply the WPF to include, but not be limited to:

- Dual fuel engine driven electricity generators of sufficient capacity to start-up and operate the WPF. Consideration needs to be given to all three pads and the location of equipment / power users.
- System configuration must be aligned with WPF availability targets.
- Diesel storage tanks and supply lines. The diesel tank bunding and foundations will be provided by HKN as part of the civil work scope.
- The generators will be supplied with individual “open-able side” weather-resistant enclosures.

Uninterruptible Power Supplies (UPS) and DC Systems

A UPS will be provided for critical loads that require AC power during normal power failure situations. All control and shutdown systems shall be powered by UPS capable of maintaining all systems operational for a time sufficient to re-establish normal power or to complete a normal shutdown if power cannot be re-established.

Lighting System

Provision of suitable and sufficient illumination on all parts of the WPF Site will be in the scope of work. The lighting system shall comprise normal and emergency lighting systems.

The AC emergency lighting system shall be designed to allow for Personnel to be able to see egress routes and critical equipment during main power outages.

Electrical Grounding

A plant-wide grounding system shall be designed by to protect all process equipment and electrical / control systems. The system shall include an independent clean ground for analogue controls systems.

The effectiveness of the system shall be demonstrated through documented on-site testing.

HKN shall ensure that the perimeter fence is grounded to the WPF.

HKN shall carry out trenching and back-filling to allow the installation the below-ground components of the system.

Lightning Protection

A plant-wide lightning protection system shall be designed by Contractor to protect any WPF component that could be damaged by lightning in accordance with IEC 62305.

The lightning protection system shall be independent of the grounding system and the resistance checked and demonstrated to be in accordance with Contractor's system design.

HKN shall carry out trenching and back-filling to allow Contractor to install the below-ground components of the system.

Area classification philosophy

Site area classification will be in accordance with IEC 60079.

Communication Systems

On-Site Communication

HKN shall provide suitable and sufficient communication/alarm systems on the Site, which shall include as a minimum:

- An audible alarm system, which will relay separate alarm sounds for general and toxic gas alarms to all areas of the Site including the camp location. The system will be clearly audible when the WPF is online and will be comprehensively tested prior to WPF commissioning.
- A public address (PA) system which will allow communications from the CCR to be relayed to all areas of the Site including the camp location. The system will be clearly audible when the WPF is online and will be comprehensively tested prior to WPF commissioning.
- Two-way portable digital radios (10 units) during construction, to be handed over on completion.

Off-Site Communication

HKN will provide internet connectivity at the Site meeting the following specification

- Nominal bandwidth ≥10Mbs-1.
- Average latency ≤100ms. Measured by sending 100 packets of ICMP data with a packet size of 32bytes to a well-known website, e.g. yahoo.com and recording the mean Round-Trip Time.
- All concerned locations will either be interconnected or will have a similar provision.
- Endpoints to be presented over a Local Area Network (LAN) bearing ≥100Mbs-1 by ≥Cat5 UTP or Wi-Fi.

Back-up (emergency) communications by V-sat or similar meeting the following specification will be provided as follows:

- Bandwidth ≥2Mbs-1
- Latency ≤700ms
- Download limit ≥50GB
- Band: Ku

4.7.9 Drains Systems

Drain system is to include, but shall not be limited to:

- Closed drain that directs equipment pressurized drains to the drain sump – separate from open drain system.

4.7.10 Instrument Air

Instrument air system to include, but shall not be limited to:

- Air compressors, dryers and receivers of sufficient capacity to supply all WPF consumers, configured and with sufficient redundancy to meet the WPF availability specifications.
- Instrument air distribution system.

Nitrogen

Nitrogen system to include, but shall not be limited to:

- Nitrogen generation system capable of producing and storing sufficient volume of Nitrogen of adequate purity for use across the WPF for purging and blanketing functions.
- Nitrogen distribution system.

Breathing Air

Breathing air system shall include, but not be limited to:

- Cascade system at loading arms on Pad B3
- Cylinder filling facility

4.7.11 Main Control Room

Climate controlled portable building suitable for housing:

- Process Control and Safety Systems & HMIs
- UPS to provide power for all essential 230 VAC and 24 VDC loads for normal operation.
- MCC.
- Switchgear.
- CCTV for flare.

4.7.12 Diesel

Diesel storage tanks, filters, transfer pumps and distribution pipework for all Site-based equipment shall be provided including any chemicals or additional equipment required to treat the diesel. Consideration needs to be given to the winter conditions when designing this system along with secondary containment (bunding). The diesel filtration and treatment shall consider the quality of diesel available in Kurdistan.

Life Support Systems

Contractor shall provide all systems required to support the Contractor and HKN construction and operations Personnel at the Work Site. Unless noted below these facilities are to be considered permanent and should be suitable for the design life of 20 years. This shall include, but not be limited to:

- HKN office on Pad B1; full size climate-controlled, portable building with central restroom facility. One half to be equipped as office with work stations for 4 persons, the other half to be equipped as conference / meeting room. Building to be suitable for climatic conditions.
- Loading Area office on Pad B3: full size climate-controlled, portable building with central restroom facility. One half to be equipped as office with work stations for 4 persons and access to the automated loading systems – volumetric and weight. The other half to be equipped as the MNR office, equipped with work stations for two persons. Building to be suitable for climatic conditions.
- Operations Offices on Pad B1: two (2) full size climate-controlled, portable buildings with central restroom facility. Each half to be equipped as office with work stations for 4 persons. Building to be suitable for climatic conditions
- Sufficient climate-controlled portable buildings for use as Contractor office with restroom facilities. (During construction only).
- Prayer Room with suitable ablution facilities.
- Sewage / drain collection system and storage tank for all site office facilities. Sewage removal by truck, suitable for use in Kurdistan winter / summer conditions.
- Water supply system for all site office facilities. System to be suitable for use in Kurdistan winter / summer conditions.

- Power generation and supply system for all Site office facilities.
- Solid waste collection, removal and disposal (During construction only)
- Daily cleaning and maintenance of all Site office facilities. (During construction only)

4.7.13 Chemical Storage Facility

A suitably located chemical storage facility shall be provided. Facility shall include weather protection, secondary containment, ventilation and connection to the closed drain system.

4.7.18 Project Utilities

Power Requirement

Diesel generator (DG) units will be used for start-up power. Once the plant is running and producing treated fuel gas, power will be suitable to gas engine generators. It is expected that standard sized DG sets of 1,100 kVA, that will be used for power generation for storage tank location. The camps, worker camp and construction sites will be serviced by DG sets of 375 kVA (1 operating + 1 standby).

Fuel usage

Diesel will be used as fuel for the DG units, and various machinery/equipment, heavy vehicles and passenger vehicles (saloon and 4-wheel drive light vehicles) used during the project. Dedicated storage for fuel in above ground tanks, will be provided at the site and camp. Fuel will be trucked into the storage area by authorized suppliers operating in the area.

Access Road Construction

Accessing the Sarsang Block locations is planned along the existing road network to the extent available. HKN has already upgraded many of the existing governments and added new access roads to its existing sites. For the construction of future access roads, if necessary, HKN will build a new earthen road from existing unpaved road to the future site. HKN will engage a civil contractor for any needed construction of access roads. Although the exact construction methods are not known at this time, typical road construction will involve grading of the 7 m road corridor using a grader or earth

mover and compaction. Foreign soil and fill material (gravel) may be required for road preparation at low lying areas along the route.

4.7.19 Key Personnel

Sufficient and suitably qualified Personnel is proposed to execute all phases of the Work. Key Personnel are identified in the table below, along with required selection and availability criteria for each position.

All Key Personnel will be subject to HKN review and Approval prior to assignment to the Work. Such Approval shall be at HKN's sole discretion but shall not be unreasonably withheld.

Failure to provide Approved Key Personnel who meet the selection and availability criteria set out below, will attract financial penalties.

Key Personnel	Selection Criteria	Availability Criteria
Contractor Representative	Recent relevant experience of managing WPF production contracts.	Must be available full time from CA until issuance of the FAC and in Erbil from the date Contractor has a presence on the Site.
Project Manager	Recent relevant experience of delivering all phases of similar WPF projects. Must include significant work experience in regulated and controlled operating environments both the Middle East plus either Europe or North America.	To be assigned full time to the Work from Contract Award until completion of the Performance Tests. To be located as appropriate for managing the Work. Initially expected to be in the engineering center, with re-location to Erbil / Site as the Work progresses. Timing of relocation to be agreed and approved by HKN. Any periods of non-availability to be approved by HKN. In such cases, delegation of authority to be clearly defined and Approved by HKN.
Quality Supervisor	Recent relevant experience of managing sub-contractor and on-site quality for similar modularized WPF projects, including tanks. Must include significant work experience in regulated and controlled operating environments both the Middle East plus either Europe or North America.	To be assigned full time to the project from Contract Award until completion of the Performance Tests. Will be present on-Site full time from the commencement of construction, until issuance of FAC. Any periods of non-availability to be approved by HKN. In such cases, delegation of authority to be clearly defined and Approved by HKN.

Key Personnel	Selection Criteria	Availability Criteria
Construction Manager	Recent relevant experience of constructing similar modularized WPF projects. Must include significant work experience in regulated and controlled operating environments both the Middle East plus either Europe or North America.	Must also be available to provide construction input during engineering phase as required. To be assigned full time to the Work from the date Contractor has a presence on the Site, until Mechanical Completion and closure of all punch list items. Any periods of non-availability must be covered by HKN Approved back to back resources.
Safety Supervisor (Construction)	Recent relevant experience of construction safety on similar modularized WPF projects, including tanks. Must include significant work experience in regulated and controlled operating environments both the Middle East plus either Europe or North America.	To be assigned full time to the Work from the date Contractor has a presence on the Site, until Mechanical Completion. Full shift coverage required. Any periods of non-availability must be covered by HKN Approved back to back resources.
Commissioning Manager	Recent relevant experience of commissioning similar modularized WPF projects, including tanks. Must include significant work experience in regulated and controlled operating environments both the Middle East plus either Europe or North America.	Must also be available to provide completions management and planning input during engineering phase as required. To be available on-Site full time during any periods when pre-commissioning / commissioning activities are being carried out. Full shift coverage required. Any periods of non-availability must be covered by HKN Approved back to back resources.

Table 4-6 Key Project engineering personnel and responsibility

4.7.20 Production Operations

The Sarsang Field Development Plan calls for a central facility to handle storage, oil exports and water disposal, and several Distributed Production Facilities (DPFs) at or near the well sites. The schedule, HSE and economics of the various options will be further evaluated and defined during the Concept Select stage.

HKN have previously been allocated land by the government for the Central Processing Facility (CPF) incorporating provisions for oil processing, gas processing, oil storage and loading, Sulphur storage, accommodation etc. HKN and the

government have agreed the best location to place the government provided Gas Processing Facility is within the previously allocated land already identified by the HKN for gas processing, when it was awarded the land-and HKN shall return such land to the government for such use. HKN will, where possible, identify joint use facilities to minimize cost, but are not obliged to do so.

In order to accelerate production and reservoir information, HKN will utilize pre-fabricated DPFs to treat the oil to sales specifications at the well sites. These pre-packaged units will be standardized and modularized with off- the-shelf equipment to the greatest extent possible. They will be installed and operated Initially by the DPF packager/vendor. All required processing equipment, utilities, storage and truck loading facilities will be included in the vendor package.

Associated gas will initially be separated at DPF sites and flared. The KRG is responsible for Centralized Gas Processing Facilities (CGPF) and infrastructure. HKN may install processing equipment to treat some of the associated gas for fuel gas for its operations. Once those facilities and infrastructure are in place, the raw gas not consumed during operations will be piped from the well site facilities for delivery to the KRG at the CGPF. Priority will be given to maximizing oil recovery and production in a safe and environmentally responsible manner.

A Central Oil Facility (COF) will be installed. Oil will be piped from the well site facilities to the COF for storage and sale, either via the KRG export pipeline or by truck.
The current plan is subject to change pending the outcome of the Concept Select stage work, drilling results, reservoir performance, and or further discussions to be made with MNR.

4.7.20 Product Storage

The treated and stabilized crude will be stored in portable crude oil storage tanks located adjacent to the WPF process facilities. Tanks shall be API 12F Compliant.

The storage capacity must be sufficient to allow all crude oil products a minimum of twelve (12) hours residence time in the tanks before being loaded. Only product

meeting the Oil Product Specifications shall be sent to the storage tanks and regular testing of Oil Product Specifications shall be carried out.

Tanks will be designed with suitable and sufficient level monitoring, pressure relief and provision for the future installation of heating coils. The tanks will be designed to be rolled and include required pumps.

The configuration of the headers and valves must be suitable for a two-zone operational approach, with one zone of tanks being filled, whilst the second zone is in export mode, with minimal manual valve adjustments.

All tanks will be nitrogen blanketed and have vent lines routed to a safe location.

4.7.21 Product Loading & Metering

The export of Oil will be initially by road tanker. The tanker loading system must have sufficient capacity to complete the required number of loads during daylight operations in a safe and environmentally responsible manner matching one zone volume.

The loading system must be top-loading and incorporate trace heating, vapor recovery and automatic tanker level monitoring for overfill protection.

Automated metering system will be provided which allows accurate monitoring of loading rates and totalized volumes and allows sampling to determine the quality of the product. Water content shall be continuously monitored. Coriolis metering (will display and print tickets in any combination of units) for custody transfer grade metering. Meter prover connections shall be provided.

In addition to the metering system, weighbridges will be provided and configured such that the same weighbridge may be used by tankers entering and leaving the loading area and all measurements automatically recorded and stored.

It is assumed that the capacity in the KRG's export pipeline system is available at commercial terms consistent with international standards by the third quarter of 2017.

The oil shall be continuously monitored at the WPF for water content and tested daily for vapor pressure, H2S content and salt content. Use of chemical scavengers shall not be the means of H2S removal.

There is uncertainty on the salt content, therefore it's important to monitor the BS&W and Salt Content of the final product, but failure to meet the above specification will not be construed as a failure of the plant to performance. Oil rundown to storage shall be at a maximum temperature of 50 ^{0}C / 1 12 ^{0}F.

Power Requirements

Diesel generator (DG) units will be used for power sources at both the sites and camps. It is expected that standard sized DG sets of 1,100 kVA (3 operating) will be used for power generation for a drilling rig. The camps, worker camp and construction sites will be serviced by DG sets of 375 kVA (1 operating + 1 standby).

Water Requirement

Water requirement is identified mainly at camps and for cementing and the formulation of any required drilling mud. It is estimated that the fresh water requirement for an accommodation camp will be up to 26.4m3/day. The drilling water volume is expected to be about 255m3/day and up to 84m3/day of drilling fluid make-up water. The potable water requirements at camps will be sourced through suitable treatment units.

Fuel and Chemicals

Diesel will be used as fuel for the DG units and various machineries / equipment, heavy vehicles and passenger vehicles (saloon and 4-wheel drive light vehicles) used during the project. Dedicated storage for fuel in above ground tanks, two tanks of 60m3 capacity each, will be provided at the rig site and camp. Fuel will be trucked in to the storage area by authorized suppliers operating in the area.

The chemicals will be stored in dedicated areas within the well site until use. Chemical storage facilities be shaded from direct sunlight wherever possible and be designed to the drilling contractor's HSE Management Plan and according to the guidelines detailed in the material safety data sheets (MSDS) of the chemicals. Chemical

handling, storage and utility records will be maintained. Care will be taken to protect these storage areas from rain and storm water. Unused chemicals will be returned to the suppliers while the spent chemicals disposal is planned through neutralization followed by evaporation to dry to ensure non-hazardous nature.

4.7.22 Waste Management Facilities

All the domestic wastewater generated at the rig site and worker camp will be routed to a subsurface holding tank. Wastewater from the holding tanks will be trucked to municipal sewage treatment plant (STP) approved by concerned authorities.
Non-hazardous waste will be segregated and stored in designated storage skips / areas provided at both the rig site and camp. Hazardous wastes will be segregated and stored in secured locations. The non-hazardous and hazardous waste will be incinerated periodically which is currently accepted practice in the region. The generated solid waste and wastewater at rig site will be treated and disposed-off at proposed ETP and incinerator plant.

Incineration: Incineration technology uses high temperatures to reclaim or destroy drilling cuts and water-based mud. In this treatment, it is efficient for destroying organics and reducing the volume and mobility of inorganics such as metals and salts. It is an interim process to reduce toxicity and volume and prepare a waste stream for further treatment or disposal (e.g., landfill).

4.7.23 Naturally Occurring Radioactive Materials (NORM)

Sludge, scale, or NORM-impacted equipment should be treated, processed, or isolated so that potential future human exposures to the treated waste would be within internationally accepted risk-based limits.

Depending on the field reservoir characteristics, naturally occurring radioactive material (NORM) may precipitate as scale or sludge's in process piping and production vessels. A NORM survey, sampling, and analysis will be performed by HKN to determine if a facility has NORM contamination. The three types of radiation emitted by NORM are: Alpha (α), Beta (β), and Gamma (γ). If removal of NORM is required for

occupational health reasons, HKN will determine the most effective disposal options and will consult with MNR's EHS advisor in disposal options. HKN will explore best industry practice, which includes canister disposal during well abandonment; deep well or salt cavern injection; injection into the annular space of a well or disposal to landfill in sealed containers as the optimum solution in accordance to IFC's EHS onshore Oil & Gas Development guidelines.

4.7.24 Project Schedule

The tentative development program as foreseen during the ESIA study is given below;

WPF engineering	Duration	Start	Finish
Contract Negotiation	92 days	Sun 01/04/18	Sun 01/12/18
Contract Award	0 days	Sun 01/12/18	Sun 01/12/18
Engineering	196 days	Mon 16/12/18	Sun 27/12/19
Design Verification (Exodus)	80 days	Thu 26/12/18	Sat 13/10/18
Procurement	226 days	Mon 16/12/18	Tue 26/02/19
Camp Installation	60 days	Sun 30/02/19	Wed 28/11/18
Installation (Pad B1 - Production)	140 days	Mon 28/04/19	Sun 16/06/19
Installation (Pad B2 - Well)	60 days	Fri 29/07/19	Mon 27/05/19
Installation (Pad B3 - Storage & Loading)	180 days	Tue 30/10/18	Sat 27/04/19
Installation (Flowlines)	45 days	Fri 29/03/19	Sun 12/05/19
Installation (Transfer Pipeline)	160 days	Mon 19/11/18	Sat 27/04/19
Commissioning & Start-up	47 days	Mon 17/06/19	Fri 02/08/19
First Oil	0 days	Fri 02/08/19	Fri 02/08/19

Table 4-7 Typical time line of project engineering and civil works.

5 Potential environmental, Health and safety impacts

5.1 Overview

In this chapter, potential impacts on the environment from the entire WPF Project, including the drilling, commissioning and operations of production facilities , and associated civils construction have been identified and assessed. Identification and assessment of environmental impacts, in general, is carried out in accordance with *section 32* of the guidelines and requirements set out by the MNR. Guidance was also taken from the “Good Practice Manual for Environmental Analysis and Review of Projects” issued by IFC/WB.

The distinction between short-term and long-term impacts depends on many factors but is ultimately a value-judgment based on scientific evaluation and the level of community acceptance. These factors are generally related to climatic events, differing terrain units, vegetation units and timing of operations.

In general, the impacts that are irreversible or that are expected to take a long period to recover are defined as ‘long-term impacts.' Considering the significance of project activities and site sensitivities, it is appropriate to assess potential impacts based on the inherent hazards associated with each activity. This allows for a subsequent assessment of environmental risks and consequences.

5.2 Methodology

The identification and assessment of environmental impacts are based on the guidelines provided in ISO 14001 series of standards and include the following steps:

- Identification of major activities during the construction and operation phases of the WPF project based on discussions on project components provided in Chapter 4;
- Identification of potential impacts from the project considering the identified environmental and social aspects and various environmental and social elements / sensitivities (receptors) that are likely to be influenced due to the

project activities;

- Assessment of environmental impacts based on severity of impact and its duration / likelihood of occurrence, **(Table 5-1).**

Wherever interactions exist between the identified aspects and sensitivities, they are further analyzed to determine potential impacts from the Project. Impacts may be classified as beneficial/adverse, direct/indirect, reversible/irreversible and short term/long term. More than one activity may contribute to an impact.

The assessment of potential impacts is carried out utilizing both qualitative and quantitative assessment techniques. In qualitative assessment, the impacts are rated as 'negligible, minor, ***low, 'medium, major or 'severe'***. Severity of any impact will depend on the nature and size of the activity/aspect and the environmental/social sensitivity. The impacts (severity and likelihood) are assessed by the following criteria as presented in **Table 5-2.**

In reviewing the impact assessment, project activities, related environmental aspects and associated impacts are presented together to facilitate subsequent rating. The ratings are primarily based on qualitative assessment of the situation and its interaction with the environmental elements. The impacts, which are rated as low are considered to be acceptable or within "As Low As Reasonably Practicable (ALARP)" levels. Control measures for further mitigation of these impacts may not be viable. Impacts that are rated as medium and high (significant impacts) will be managed through mitigation measures and implementation of the environmental and management plan to reduce the residual risks / impacts to ALARP levels.

The severity of any impact will depend on the nature and size of the activity/aspect and the environmental/social sensitivity. An impact assessment matrix, as presented in **Table 5-4**, is used for combining the two assessment criteria.

For impacts resulting from unplanned and accidental aspects the activities assessment is based on consideration of the impact severity and the likelihood of its occurrence. While the impact severity depends on the nature and size of the activity /

aspect and the environmental/social sensitivity, the likelihood depends upon the nature of the activity / aspect and the control measures in place. An impact assessment matrix, as presented in **Table 5-3**, is used for combining the two assessment criteria, i.e., the severity of impact and the likelihood of its occurrence.

Likelihood	Definition
Certain	Will occur under normal operating conditions.
Very likely	Very likely to occur under normal operational conditions
Likely	Likely to occur at some time under normal operating conditions
Unlikely	Unlikely, but may occur at some time under normal operating conditions.
Very unlikely	Very unlikely to occur under normal operating conditions but may occur in exceptional circumstances.

Table 5-1 Definitions of Likelihood categories

Duration Severity	Momentary <1 Week	Short Term <1 Year	Medium Term 1-10 Years	Long Term 10-50 Years	Long Term >50 Years
Slight Effect	NEGLIGIBLE				
Minor Effect		**LOW IMPACT**			
Localized Effect			MEDIUM IMPACT		
Major Effect				HIGH IMPACT	
Massive Effect					

Table 5-2 Impact Assessment Matrix for Planned Aspects

Likelihood Severity	Very unlikely	Unlikely	Likely	Very Likely	Certain
Slight Effect					
Minor Effect		**LOW IMPACT**			
Localized Effect			MEDIUM IMPACT		
Major Effect				HIGH IMPACT	
Massive Effect					

Table 5-3 Impact Assessment Matrix for Unplanned Aspects

Severity	Definition
Massive Effect	-Persistent severe environmental damage or severe nuisance extending over a large area -Constant, high exceedance of statutory or prescribed limits (representing a threat to human health in both the long and short term). -In terms of commercial or recreational use or nature conservancy, a major economic loss for the company.
	Potential Consequence -Causing widespread nuisance both on and off site -Significant, widespread and permanent loss of resource -Major contribution to a known global environmental problem with demonstrable effects
Major Effect	-Severe environmental damage -Extended surpassing of statutory or prescribed limits. -The company is required to take extensive measures to restore the contaminated environment to its original state.
	Potential Consequence -Highly noticeable effects on the environment, difficult to reverse. -Widespread degradation of resources restricting potential for further usage -Significant contribution to a known global environmental problem when compared with oil and gas industry world-wide -Statutory or prescribed guidelines approaching occupational exposure limits -Periodic widespread nuisance both on and off site.
Localized Effect	-Release of quantifiable discharges of known toxicity. -Repeated exceedance of statutory or prescribed limit. -Causing localized nuisance both on and off site.
	Potential Consequence -Noticeable effects on the environment, reversible over the long term. -Localized degradation of resources restricting potential for usage. -Elevated contribution to global air pollution problem partly due to preventable releases.
Severity	Definition
Minor Effect	-Contamination -Damage sufficiently large to attack the environment -No permanent effects to the environment -Single exceedance of statutory or prescribed criterion. -Single complaint.

	Potential Consequence -Noticeable effects on the environment but returning to original condition in the medium term without specific mitigation measures. -Slight local degradation of resources, but not jeopardizing further usage. -Small contribution to global air problem through unavoidable releases. -Elevation in ambient pollutant levels greater than 50% of statutory or prescribed guidelines. -Infrequent localized nuisance.
Slight Effect	-Local environmental damage. -Within the fence and within systems. -Negligible financial consequences.
	Potential Consequence -No noticeable or limited local effect upon the environment, rapidly returning to original state by natural action. -Unlikely to affect resources to noticeable degree. -No significant contribution to global air pollution problem. -Minor elevation in ambient pollutant levels, but well below statutory or prescribed guidelines. -No reported nuisance effects.
Positive Effect	-Activity has a net-positive and beneficial affect resulting in sustainable environmental improvement (such as ecosystem health). -Increase in magnitude or quality of habitat for those species known to naturally occur in the area. -Growth in naturally occurring populations of flora and fauna. -Positive feedback from stakeholders. -Potential financial gains.

Table 5-4 Definitions of Severity categories

5.3 Environmental Impact Identification

The initial environmental evaluation was divided into three major stages: identification, estimation, and comparison of impacts. The identification stage consists of the determining the environmental features which may be affected by the project. The estimation step provides an assessment of the magnitude of the potential impacts identified. Finally, the comparison stage summarizes or aggregates the significant impacts in a form suitable for communication.

The identification of environmental impacts establishes the possible consequences (impacts) of a given set of activities on environmental elements. The activities and environmental elements refer to the actions comprising the project and the physical,

biological or human components of the ecosystem affected, respectively. Since the estimation and comparison of the impacts depend directly on the identification, it is essential, to begin with, an effective identification of the impacts. To be effective, the identification must be based on a complete and sufficiently detailed description of both the project and the environment. Incomplete or overly general characterizations can lead to the omission of significant impacts. On the other hand, the identification has not included impacts that are unlikely or insignificant. The distribution of the impacts over time and geography must have been considered.

After a review and critique of the current identification methods, the proposed identification system is described. The approach is illustrated with a simple environmental evaluation problem.

An environmental impact has been defined as a cause-effect relationship between a source, the cause of the impact, and a receptor, the environmental element affected by the impact. Indirect impacts (also referred as higher-order impacts) are impacts between interacting environmental elements. Thus, for direct and indirect impacts, the sources are project activities and environmental elements, respectively.

Identification methods can be differentiated according to how these relate the sources to the receptors. Four main approaches are generally used to assist the identification of environmental impacts: map overlays, impact checklists, impact matrices and cause-effect networks.

Impact matrices used in the study transform the checklists into matrices relating actions to the affected environmental elements. Each entry in the matrix corresponds to a possible cause-effect relationship between an activity (source) and an environmental element (receptor).

Matrices and cause-effect and impact networks are all different ways to represent the impacts of a project on the environment. Only the impact matrix and the cause-effect and impact networks identify the environmental impacts by establishing the important causal links between the sources and the receptors of the impacts.

The assessment of potential impacts is carried out utilizing both qualitative and quantitative assessment techniques. In the qualitative assessment, the impacts are rated, where both negative, positive and likelihood of impact rating is determined.

The severity of any impact will depend on the nature and size of the activity/aspect and the environmental /social sensitivity.

Impacts that are rated as medium and high will be managed through mitigation measures and implementation of an EMP, which includes monitoring plans to reduce the residual risks /impacts to ALARP levels. The EMP chapter 9 of this report. In reviewing the impact mitigation tables, it should be noted that the project activities related environmental aspects and associated impacts are presented together to facilitate subsequent rating. These ratings relate to the severity of the impact (slight/minor/localized/major /massive) and likelihood of its occurrence (very unlikely/unlikely/likely/very likely/certain). The ratings are primarily based on qualitative assessment of the situation and its interaction with the environmental elements.

5.4 Overall potential impacts on the Project

This section considers the various activities associated with proposed development activities in the subject exploration block and the potential impacts on the local populations and the surrounding environment. The identification of potential environmental impacts and their source due to the overall project construction are summarized in **Table 5-8**. Assessment of these impacts is further discussed in in chapter 6.

5.5 Analysis of alternative measures

HKN will provide measures that are adequate to minimize environmental, social and economic impact to the surrounding community. Prudent international best practices and local practice will be employed throughout operations. HKN will explore alternative measures prior to project execution and after project has been commissioned as a continued cycle of commitment in safeguarding the environment and community. In

some cases there are no alternative measures that can be taken to prevent an impact from occurring, or where mitigation is restricted for technical reasons. In these cases HKN will either put in place adequate control measures or halt activity. In all cases HKN will carry out both HAZOP and HAZID studies as well as ENVID to weigh up the risks.

5.6 Assessment of Impacts during project operations

The significant project activities and the potential environmental impacts due to activities during the project were identified. There could be more than one source (cause) if a potential impact. The net impact on each receiving environment due to the various causes are presented in the following sub-sections, along with a preliminary development of mitigation measures that HKN's intends to institute during base camp construction and operation.

5.6.1 Project foot print

The proposed WPF will take up an overall area of 7.1 square km within the Sarsang Block. The Project is an extension of existing HKN activity in the same area. The block is mountainous, remote and empty, with small, livestock farms and some grazing land on the mountain slopes. There will be some access roads constructed to enable movement of drilling rig and facilities operations to take place, including tanker access. The 25,000 bopd facility is part of HKN's overall FDP in achieving 50,000 bopd. The five wells which will feed the 25,000 bopd facility (B2-B6) are planned to be drilled in 2019

The selection of the chosen project footprint will consider all of the information presented in this document and will be located away from sensitive areas and settlements. Overall impact on land-use and settlement will be low, as this is a an extension of the existing ST-1 production facility and the project area is remote. HKN has also taken further steps in reducing footprint by centralizing workers in a central camp area (pad C2 area).

5.6.2 Natural biological resources

The significant activities that may have potential impacts on natural resources during the project are consumption of fuel for power generation to run the camps for drilling, civils, production and vehicles, and water requirements for camp (i.e., potable water supply, sanitation, kitchen, and laundry facilities) and equipment maintenance/washing. Gasoline and diesel oil will be used as fuels. Power will be generated onsite by varied size diesel powered generators. HKN uses suppliers of refined petroleum products that can supply these quantities without any adverse impact on the local demand/upply balance. Potable water is required for base camp usage, which will either be sourced through local third-party suppliers or from surface/stream waters from local springs without causing any major stress on existing users or influencing the groundwater users within the block. Expected impacts to natural resources caused by fuel consumption will be short term (for the site preparation by civils contractors) medium term (multi well drilling operations) and long term (operation of the WPF). Despite the multiple project activities demand is expected to be met without effecting the local resources. Expected impacts to natural resources caused by water supply disruption will be short term and are unlikely to impact local demands.

Flora

Flora may be affected during the all project phases, mostly civil works activities for land clearing, but also risks from drilling, exploration, production and Oil/Gas transferring activities. Non-routine events such as leaks, and spills, fires, explosions and blowouts are only likely to occur on the camp site, drilling pad and access routes.

Fauna

The food web in the mountainous area is well balanced and impact on one of the elements of the web is unlikely to be affected. Fauna may be affected directly by injury or death from vehicle movements impacts from civil work activities indirectly by disruption or destruction of the food supply (flora or other fauna) or shelter and habitat (flora, rock and burrows).

The project component that has the largest potential to impact on faunal habitat is civils activities such as land grading and levelling, clearing works, site preparation activities including the construction of the drilling and camp sites and the creation of access routes. This is an indirect impact mainly related to changes in the landscape and the potential disturbances to nests.

Animal communities can also be affected by noise, extraneous light, and dust. The effects can be manifested by changes in an animal community's habitat, foraging, breeding and migration habits.

In general, animals shy away from human activity, but the opposite can occur, particularly where animals may be attracted to the water pit, or by inappropriately disposed of, or uncovered, food waste at the various camp sites. Wildlife contact with waste or hazardous material could result in disease or even death depending on the type of waste or material. There is also the potential for animals to become a disease vector. These impacts may also result from site restoration procedures that are not adequate or not properly implemented. As with flora, non-routine events such as leaks, and spills, fires and explosions and blowouts are unlikely to affect fauna as their effects would largely be limited to the area of the camp site and drilling pad.

5.6.3 Soil and Ground water

Civil construction activities

The civil activities to prepare the site will alter surface drainage patterns, although HKN will include in all design provisions adequate culverts and surface drainage. Access roads crossing streams, creeks and surface drainage channels within the concession will use available crossings to the extent possible. If any new crossings are required, HKN will provide appropriately designed culverts to minimize road restrictions during the rainy season when these channels receive water flow. Waste disposal will be in accordance with HKN's waste management systems and no hazardous materials are expected to be handled apart from fuel or lubricant. Any on-site disposal of waste is unlikely to contaminate surface water flow. All hazardous materials used in the project will be stored in suitable facilities to avoid surface run off. All wastes will be managed

and disposed of in accordance with local requirements and/or industry best practices. No significant impacts on surface water flow and surface water quality are envisioned.

Drilling operations

The drilling activities will impact soil surfaces during mobilization and demobilization stages, as heavy lifting equipment and truck movements will take place. HKN will include in all design provisions adequate culverts and surface drainage. Waste disposal will be in accordance to HKN's waste management systems and hazardous materials will be kept to a minimum and OMB will be used which is nontoxic. Other hazardous liquids such as solvents, chemicals and fuel or lubricant will be disposed of and recycled in accordance with HKN waste management system and policy. Any on-site disposal of waste is unlikely to contaminate surface water flow. All hazardous materials used in the project will be stored in suitable facilities to avoid surface run off. HKN will solidify cuttings by applying cement and reuse the material once tested safe, thus preventing leaching of liquid in pits. No significant impacts on surface water flow and surface water quality are envisioned, however there are risks from surface run offs of water into nearby seasonal wadis. Ground water contamination from spudding to well completion can also pose a risk.

WPF including tank farm, tanker loading area and pipelines

There is risk of fuel leak in tanker loading area during oil loading , which could run off during heavy rainfall, leaching fuel into the soil. A similar risk exists in the tank farm area, however this will be well contained within bunding area and adequate drainage system fitted. There will be two transfer lines from the manifold pad at B2 to the main facility (pad B1 extension). The production flow line is expected to be 16" in diameter and test line expected to be 8", all buried at depth of 1.5 meters. Soil impact will be incurred during trenching and excavation work to remove soil top layer. The excavation works run the risk of flooding from rain and hence causing overflow and surface wash offs, which could wash off to wadis, although it's unlikely due to seasonal factors. There is also an opportunity for ground water to be affected although it's unlikely given the depth of the trenches.

Impact of gas flaring from the production WPF may pose a risk, both long term and short-term impact on the soil and possibly surface water quality, sourced from composition of associated gas such as methane, ethane, propane, isobutane, n-butane, isopentane, n-pentane, n-hexane, C02, H2S, He and N2. In addition, decreasing soil pH caused by acidification process.

5.6.4 Project Air Quality Impact

Civil construction activities

The major sources of potential impact on air quality during project civil activities are from the generation of dust from construction and the movement of vehicles on unpaved surfaces, the release of fuel- powered engine and generator emissions, and particulate emissions from incineration of approved site-generated waste. Base camp development will have a site preparation component, including clearing, excavation, grading, and utility installation, that has the potential for dust generation. Bulldozers will be used to clear and develop roadways and camp areas.

During construction, land will be impacted by bulldozing, grading and other preparations required to establish a proper project layout that will accommodate pipeline, flowlines, tank farm and production facility. Based on past practices and experience, it is reasonable to conclude that any adverse impacts will be short term. If required, water will be spread over unpaved or dirt areas and roads to suppress dust generation. Vehicles will also operate in a responsible and mindful manner with a goal of keeping dust generation to a minimum. Burn pits will be monitored to ensure controlled burning techniques, and only approved waste will be permitted to be incinerated to minimize release of hazardous materials. Some nuisance odours may be associated with generation of organic waste, sewage, and wastewater; however, these will be temporary and minor and will dissipate with time and treatment.

GHG emissions from diesel generators to power civils camp

The emissions sources will be from the diesel-powered generators (2 x 550kv, both not in use simultaneously on standby), used to power up pad the civils camp, (Pad C

camp location), this is where the civils workers will be temporary rotating from during the estimated twelve months in completing the civils work activities, it is estimated that 100 litres of fuel will be used per hour running continuously to power up lights, air conditioning units, lighting, communication equipment and electrical sockets. In addition, emissions from vehicle movements and heavy equipment between each pad areas, the calculated CO2e value, (total GHG) would be over 230 tCO2e for a 12-month period, (short term). The estimated tonnes of CO2 equivalent calculation are based on international guidelines set out by the Intergovernmental Panel on Climate Change (IPCC) and applying the ISO 14064-1 principles.

Gas emissions from Well testing operations

The sources of potential impact on air quality during pad B drilling activities come from various sources at different phases of the operation, as follows;

The release of gas emissions from diesel generators running the 2000 horse powered rig, temporary drilling camp and vehicles transporting the rig and its components. The movement of vehicles will produce dust on unpaved surfaces, particularly during mobilization and demobilization of rig and the release emissions from engine and generator emissions. Initially two wells are planned to be drilled on Pad B2 with eventual plans to sequentially drill four further wells on the same Pad, (wells B1 to B5, possibly B6 depending on reservoir performance). The testing program will have the most air emissions impact as each well, when tested, is estimated to produce 5 MMSCF/day of associated gas. The associated gases produced from flaring include VOC's, SO2, NO2, CH4 etc. Testing will likely continue for only three days and therefore this will be a temporary release.

Emissions from diesel generators to power up drilling rig and camp

The main stationary emissions sources for the drilling operation activities will be from 5 designated diesel-powered generators, (Baylor S637RUT-551, 1500 kva and 1 generator Kato Reliance 1030-S 1287 kVA, this includes back up), to power up a 2000 horse powered rig and components. In addition, the drilling camp will be powered by 2 x 455 kva, (both not in use simultaneously). Diesel usage can vary depending on

power load in accordance to operational activities and it is estimated that 8600 litre of fuel will be used per day (on average) running continuously to power up the drilling rig and camps, this includes lighting, air conditioning units, communication equipment. There will be some emissions from pickup trucks and heavy lifting equipment, these emissions will vary, and minimal impact and peak emissions are expected during mobilization/demobilization of the rig. The calculated GWP value, (total GHG) would be 13,681 tons of CO2e, over a 3-month period, (expected for and drilling and testing operations). The total GWP value for five wells would give a conservative estimate of 82,088 tons of CO2e, based over a sixteen-month period.

WPF operations including tank farm, tanker loading area and pipelines

The sources of potential impact on air quality will occur during production processes, storage, tanker loading and support services are as follows;
The release of gas emissions from diesel generators running powering camps for production personnel, the movement of HKN contractors by vehicles and tanker movement for oil export activities will produce dust on unpaved surfaces, as well as contribute to emissions of typical gases, such as CO, CO2, Nox, SOx) from exhausts. There are number of emission sources from production facility, during separation and truck loading. Common emission releases will be from flaring, flue gas usage, and diesel usage. Below, **Table 5-5** illustrates source of emission and source releases including fugitive emissions from typical onshore production facility.

Detailed calculations on source type emission releases cannot be performed, (particularly fugitive emissions from pipeline, flowline, storage vents such as potential leak), as the production facility is at its early design phase and conceptual.

Onshore Production Source Type	Specific Emission Sources	Potential Pollutants[a]
Oil and Gas Well Wellheads	Emissions from wellhead assemblies and rod pumps	VOC
Compressor Engines	Combustion emissions from compressor engines associated with oil and gas production	SO_2, NO_x, VOC, PM_{10}, $PM_{2.5}$, CO
Dehydrators/Separators	Emissions from glycol dehydrator reboilers	VOC
Heater Treaters	Emissions from natural gas-fired heater treaters	NO_x, CO
Oil and Condensate Storage Tanks	Working, breathing, and flashing losses from oil and condensate storage tanks	VOC
Loading of Oil and Condensate	Fugitive emissions from truck and/or railcar loading	VOC
Pump and Piping Component Fugitive Losses	Fugitive emissions from pumps and piping components	VOC

Table 5-5 Potential gas pollutants and source type for onshore production

Flare emissions estimation

The Sarsang field is currently producing from 3 Triassic reservoirs, the KCA, KCB and KCC. Each of the reservoirs have different Gas composition and Gas Oil Ratio (GOR).

HKN have not drilled the wells yet and the GOR and gas compositions used in the emission estimations are taken from similar producing wells in same reservoirs. The GOR's are actual producing GOR higher than the Bubble point GOR, and are:

KCA GOR = 950 scf/stb
KCB GOR= 1350 scf/stb
KCC GOR= 500 scf/stb

HKN Initially plans to have 2 wells producing from KCA, 1 well from KCB and 2 wells producing from KCC. The KCA and KCB well stream gas compositions is very similar with 8-10 % H2S whereas the KCC well stream gas composition has much lower H2S content of 2-3%.

The composition of the gas will initially be flared until the gas handling facility become operational. The engineering design of the that facility is ongoing and hence the actual output gas stream composition available in this study.

To estimate the emissions from the new 25k facility HKN have used composition of actual gas sampled at the ST2/4 facility with one well producing from KCA and another well producing from KCB. The composition of the comingled KCA/KCB outlet gas, (**Table-5-6**). Similarly, the composition of the KCC outlet gas is sampled at HKN contractor facility only producing from KCC, (**Appendix-6 & 7**).

Each well is planned to produce 5,000 bopd, and the well gas production rate is calculated by multiplying 5000 bopd by the GOR and total daily gas production is 21.25 MMscf. Currently HKN estimates that 4 MMscf gas is used for fuel for the new 25,000-barrel facility and hence 17.25 MMscf of gas will be flared per day in the commissioning period until the gas handling plant is in operation. This commissioning period is estimated to be 2-3 years' time.

Well Type	GOR [scf/stb]	Oil rate [bopd]	Gas rate [MMscf/d]	*Gas Composition
KCA	950	5000	4.75	1
KCA	950	5000	4.75	1
KCB	1350	5000	6.75	1
KCC	500	5000	2.5	2
KCC	500	5000	2.5	2

Total	25000	21.25

Gas fuel for the 25k facility	4.00

Total gas flared per day	17.25

Table 5-6 Estimated total gas flaring from five producing wells * refer to appendix 6&7 for gas composition

GHG emission and estimates from the WPF

It is assumed that pad B2 wells will produce 25,000 barrels of crude oil per day and 3,333 MT of associated gas per day will be flared until gas handling plant will be commissioned. In order to provide a conservative estimate of GHG emissions from the operations, it is assumed that all wells would produce at their maximum rates for 365 days per year and will have similar GOR to ST-2/4 facilities, as in **Table 5-6.**

In relation to contingency from non-combustion releases such as fugitive emissions, the WPF will be designed to be;

- Engineered to reduce the likelihood of any hydrocarbon releases. Apart from being good practice, this will be a necessity because crude contains high levels of H2S making any kind of release an immediate risk to human health.
- Sufficiently protected by gas detection systems and emergency shutdown systems will be in place that will limit the duration of any release and limit the volume of any inventory feeding such a release, should it occur.
- Covered by appropriate ongoing integrity management programmes which monitor any degradation and identify threats to containment integrity, which are then dealt with.
- Stabilized oil in a stabilization column and then flashed to atmospheric pressure in a flash tank. Flash tank emissions will be very low when stabilization column is in operation. As oil is stabilized much better in the stabilization column the resultant emissions at Pad B3 storage and tanker loading will be minimal.

Since the project is at its earlier stages of engineering developments, calculations were performed using E&P forum methodology in estimating atmospheric emissions (report No. 259/197 (OGP).

5.6.5 Air dispersion modelling

HKN has carried site-specific flare simulations to evaluate effects of SO2 dispersion for the referenced Pad B2 and the other producing wells at ST-2 and EST-1 giving overall special dispersion patterns based in proposed 45 m flare stack. Analysis has been conducted to help assess for compliance with regulatory standards for levels of

production up to 40,000 bopd of associated gas. The model has also been used to help determine the air monitoring locations. Ambient Air Quality Objectives and Standards selected for use in analysis have been indicated in **Table-5-7** and **Table 5-8.**

Parts per million	Milligrams per cubic meter	Averaging Time [hr]	Applicable Regulations
0.03	0.079	Annual	Kurdistan Regional Government Air Quality Limit[1,2]
0.14	0.356	24	Kurdistan Regional Government Air Quality Limit[1]
0.5	1.300	3	Kurdistan Regional Government Air Quality Limit[1]

Table 5-7 Ambient air quality regulation objectives

Regulatory Standard	Criteria
Kurdistan Regional Government Air Quality Limit	Based on US EPA Prior to 2010 National Ambient Air Quality Standards, 1300 µg/m^3 SO_2 for 3 hours and 356 µg/m^3 SO_2 for 24 hours, not to be exceeded more than once per year. Additionally, 79 µg/m^3 SO_2 annual average.

Table 5-8 Analysis criteria to meet regulatory requirements

EPA approved, conservative Integrated Modelling software AERMOD has used with site-specific meteorological data to determine the predicted SO2 impact for the referenced simulations. AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and flat, elevated and complex terrain. Cultivated land and desert were selected for land cover from the European Space Agency Land Cover dataset.

AERMOD simulations have been completed for all months of historical weather modelling using inputs from the Assessed Source Input Parameters section. SO_2 simulation input parameters have been calculated from input flow rates, gas compositions and stack dimensions. The dimensions of ST-2 flare has been used as a proxy for the pad B2 flare (72 m/s tip exit speed, 65 m/s maximum tip exit speed and 255 mm diameter, closest to achieve 0.2 match for normal conditions).

The flare simulations are simulations of combusted gas from a flare stack. In the models the flares are assumed to operate continuously for all months of the year. All the H2S in the gas is assumed to be converted to SO2.

[2] Based upon US National Air Quality Standard Prior to 2010, History of the National Ambient Air Quality Standards for Oxides of Sulphur During the Period 1971-2010, US EPA

Flare combustion and conversion efficiency depends primarily on wind speed, and to a certain extent relative humidity, pressure, and other meteorological conditions. For this assessment, the predicted flare combustion and conversion efficiency of H2S is predicted to be greater than 99% at wind speeds up to 32 ft/s (10 m/s). High wind speeds can decrease flare combustion and conversion efficiency; however, this also increases turbulence and therefore dispersion, lowering downwind H2S concentrations. The flare locations analysed are existing producers Swara Tika-2, (ST-2) and East Swara Tika-1, (EST-1) in addition to Swara Tika-1 (Pad B2 wells).

Flare Location	Latitude [°]	Longitude [°]	UTM Zone 38		Elevation Above Sea Level [3] [m]
			Easting [m]	Northing [m]	
Swara Tika-1 Flare (Pad B)	36.908743°	43.386062°	356221	4085965	1575
Swara Tika-2 (ST-2)	36.891976°	43.430256°	360128	4084039	1506
East Swara Tika-1 Flare (EST-1)	36.917570°	43.570850°	372699	4086682	1455

Table 5-9 Flare simulation locations

Predicted exceedances of regulatory standards for SO2 are decreased more by increasing stack height than by limiting overall production. Designing the stack height at WPF location to 45m reduces potential exceedances of the Kurdistan Regional Government Air Quality Limit most significantly. The maximum predicted ground level SO2 concentrations occur in elevated terrain.

AERMOD simulation output in spatial distributions of SO2 concentration contours are presented in Figures 5.1 to 5.4. Figures show that maximum SO2 concentrations are predicted to occur in elevated terrain near the flare locations, and in elevated terrain to the north of the flare locations.

[3] The elevation above sea level has been adjusted to match the digital elevation model data

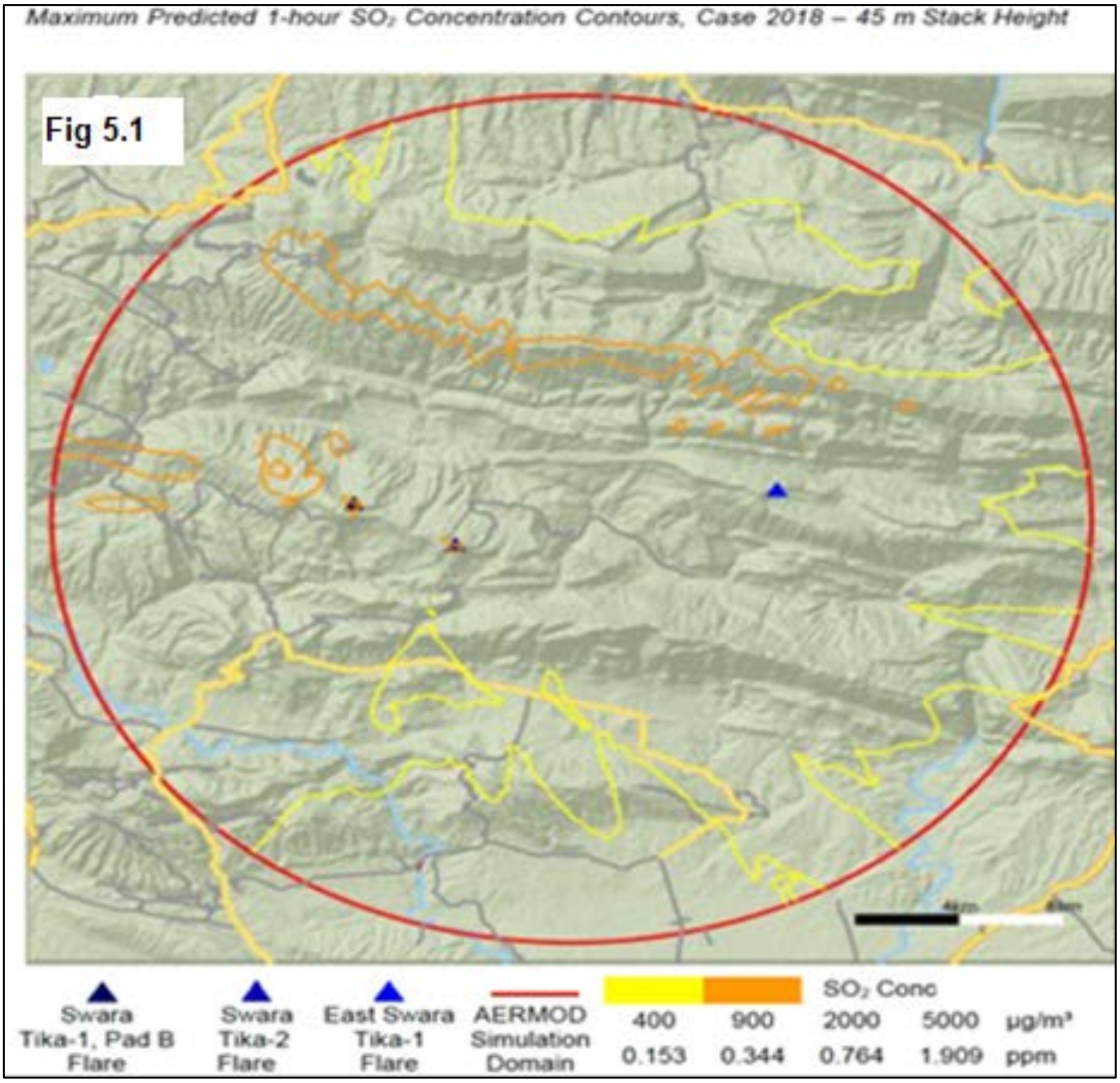


Figure 5-1 Maximum Predicted 1-hour SO_2 Concentration Contour, Case 2018 - 45 m Stack Height

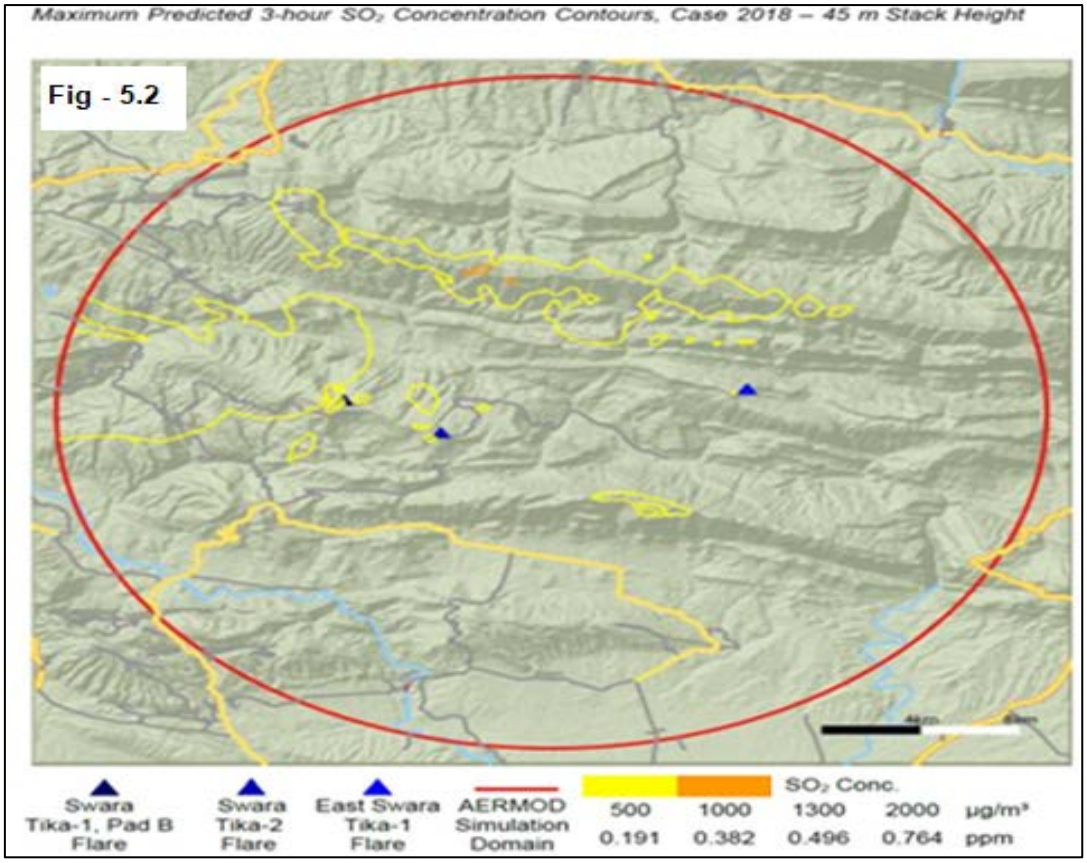


Figure 5-2 Maximum Predicted 3-hour SO_2 Concentration Contour, Case 2018 - 45 m Stack Height

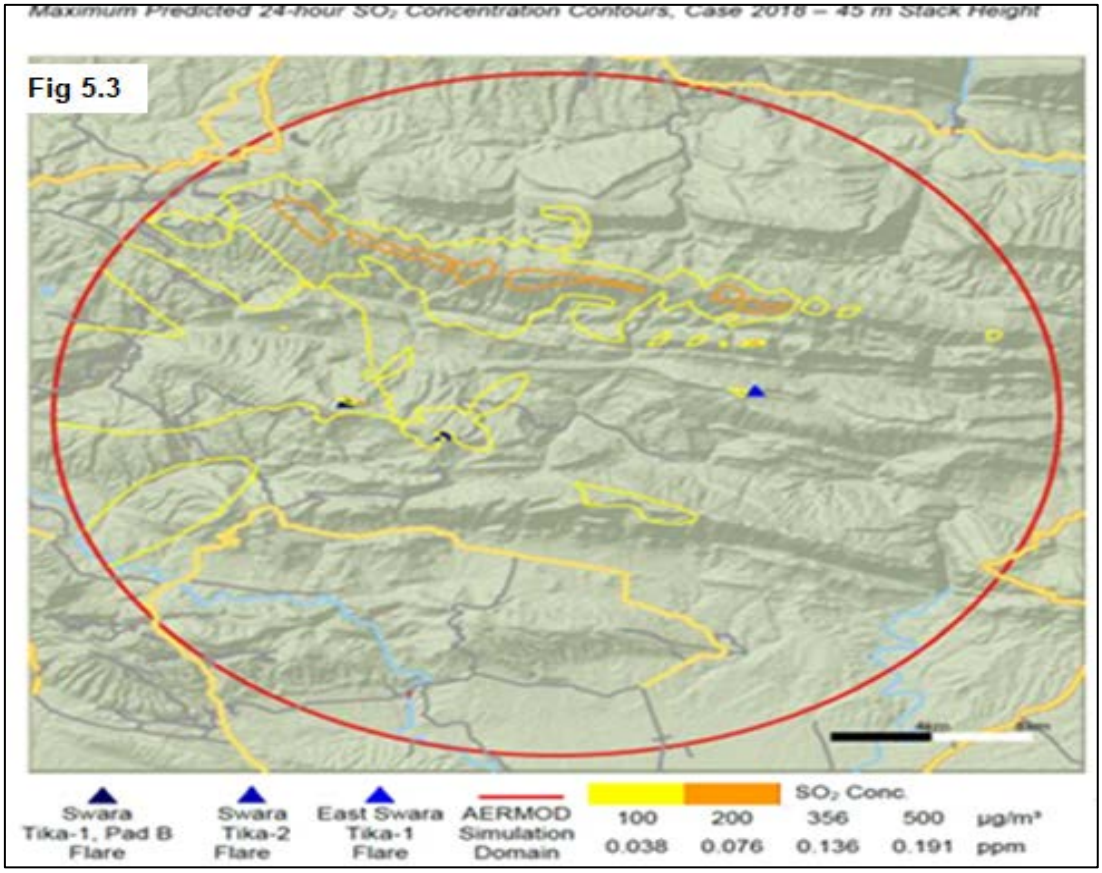


Figure 5-3 Maximum Predicted 24-hour SO_2 Concentration Contour, Case 2018 - 45 m Stack Height

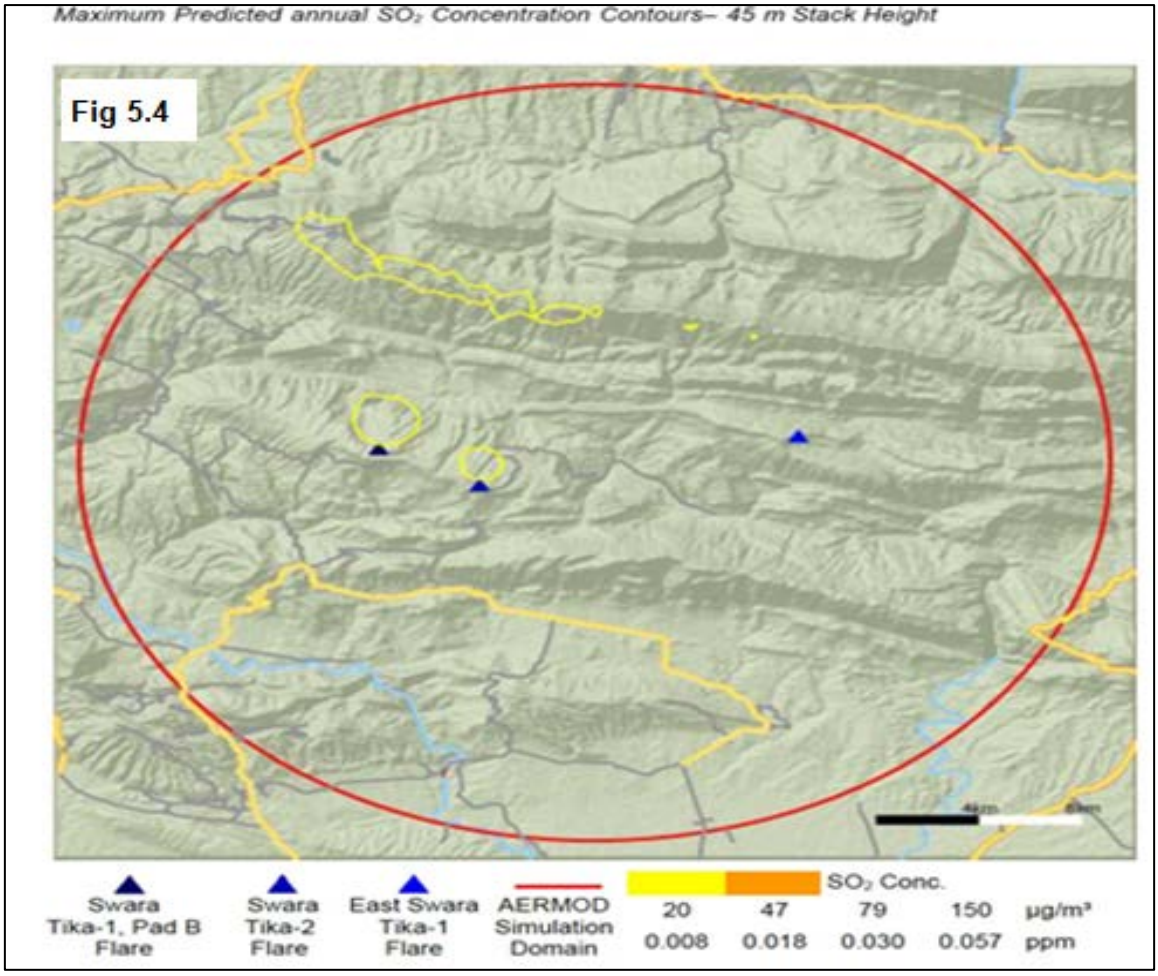


Figure 5-4 Maximum Predicted Annual SO_2 Concentration Contour, Case 2018 - 45 m Stack Height

5.6.7 Noise and vibration

Drilling operations are generally considered to make the most noise. Some Noise level impact is expected during the drilling, (well test flaring, DG set operation), civil works activities, (such as trenching, and excavation works). In terms of production facilities, the flaring would be the most significant noise source.

Workers within the rig site will be impacted by the intermittent high noise levels. The villages closest to the WPF project and within a 3km radius (Milbirke, Nisra and Gavarke)are uninhabited, with some farming activity.. Typical background noise levels would be expected to be around 50dBA in such rural areas.

Although past studies from pad B have shown that noise levels drop by about 40 dB (A) at 100 m distance from a source based on standard sound wave divergence in homogeneous loss-free environment, it is very likely that the activities on-site will not affect the ambient noise levels of surrounding villages. The increased vehicular traffic

movement may result an increase in ambient noise levels in the vicinity. Residents of these areas will experience adverse impacts to ambient noise levels. However, these noise levels will be intermittent and generated for short-term duration for civils and well testing activities and longer term for flaring. In addition, studies from Blanchard Energy have shown that sound levels are generally considered to decrease by approximately 6dBA every time the distance from the source is doubled, therefore a rig's noise levels would be estimated to fall to about ambient levels at about 100m from source. These levels are 'typical' and there many other factors like that will affect sound propagation, including absorption by the atmosphere and ground, blocking by obstructions and uneven terrain and weather effects such as wind, heat and humidity. Weather characteristics on the Sarsang Block are hot and dry in summer with colder winters and generally calm winds. A significant factor is that project area is highly elevated at approximately 1350m above sea level in high mountainous area.

From the baseline study, the highest noise levels recorded within EST-1 production site (sample location NS9) measured 66.3 Laq(dB) and within ST-2 production site, (sample point NS8) measured at 69.2 Laq(dB). In addition, at sample location NS3, measurement of 69.3 Laq(dB) was recorded, this is within the drilling Pad B area where construction has started. All these levels are within the KRG and WHO industrialized area limits. Noise levels taken were during peak activities during daytime. Below table **(Table 5-7)** taken from study by Blanchard Energy illustrating stationary equipment noise levels over 1 minute and 12-hour periods and noise level impact over 50 feet distance over duration, which will act as a baseline for HKN, used as baseline for the study.

Equipment	**Equipment Activity**		**Noise level at 50 feet (dBA)**	
	Min/Hr.	**Hr./12-Hr**	**Typical Maximum Leq (1min), dBA**	**12-Hour Leg (12) dBA**
Earth Moving				
Front loader	30	12	87	84
Backhoe	15	12	84	78
Tractor, dozer	30	12	88	85
Scraper, grader	30	12	89	86
Paver	10	12	89	81
Truck (water, fuel, equip, etc.)	10	12	89	81
Dump truck	10	12	84	76

Equipment	Equipment Activity		Noise level at 50 feet (dBA)	
	Min/Hr.	Hr./12-Hr	Typical Maximum Leq (1min), dBA	12-Hour Leg (12) dBA
Excavator	10	12	85	77
Roller	10	12	80	72
Materials –Handling				
Concrete truck	10	12	85	77
Concrete mixer	30	12	85	82
Concrete pump	30	12	82	79
Crane (moveable)	15	12	87	81
Crane (derrick)	15	12	88	82
Stationary				
Drill rig	60	12	88	88
Generator	60	12	84	84
Compressor	60	12	90	90
Impact				
Pneumatic tools	15	12	85	79
Jackhammers	10	12	89	81
Compactors	30	12	82	79

Table 5-10 Equipment type and noise levels over activity periods from 50ft distance

5.6.8 Light

The most significant light impact from the WPF project will be from flaring, other light sources will be from passing vehicles such as pick-ups and tankers. The pad locations, (drilling, loading, tanker, production facilities) will also have perimeter lighting. Light impact from the project footprint is unlikely to disturb local community and fauna in the area, as it situated in a remote location and night driving will be limited. There are currently no known sensitive receptors at risk. However, HKN will keep the local community informed about the project activities.

5.6.9 Potential occupational health and Safety

Occupational health and safety risks include working in the extremely hot climates during the summer months. Other important parameters specific to oil and gas operations are H2S gas exposure which can irritate lungs, throat, nose, eyes if gone beyond the exposure limits. Under high levels of H2S, poisoning can be quick and fatal with little warning. Working at heights, exposure to chemicals, such as drilling fluids,

fuels, inhalation of dust particles and potential presence of radioactive materials are also an impact risk.

5.6.10 Potential for major safety and health hazards beyond the workplace

Non-routine events such as leaks and spills, fires, explosions and blowouts are only likely to occur on the camp site, drilling pad and access routes associated with generated hazardous solid wastes include absorbents used for spill clean-up, oily rags, batteries, used oil filters of engines, fluorescent light bulbs, paint material generated from any painting or coating activities, and empty drums with chemical/oil residue; are expected to be the major safety and health hazards. Other activities such as gas emissions and hydrocarbon spills from pipeline rupture and flare out can be a factor

5.6.11 Potential human impacts

People living in the near villages or/and cities may be subject to various impacts, potentially both positive and negative. The impacts will mainly be related to peripheral activities associated with the project, including transport of the workforce and equipment from drilling locations, and procurement of supplies. The main negative impact to communities may be associated with traffic increase due to the transport of heavy loads on the main access roads to interest locations during the mobilization and demobilization phases.

Workforce employment is recognized as a positive socio-economic impact. Due to the technical nature of drilling, civils and production activities and consequent requirement for a largely skilled workforce, most staff will travel from outside the area. However, there will be opportunity for local employment, particularly relating to security issues and supply of the base camp. Other opportunities such as unskilled workers position will be available for such roles in catering, logistics and manual work. Although HKN will work with the local mayor's office and the MNR to recognise the employment of skilled Kurdish workforce if trained and available. The opportunities can be both short-term and long term depending on the project but there is an added advantage that staff having this experience and potentially undergoing training in new skills may more easily find employment subsequently.

5.6.12 Tourism

No outside tourism is expected in this remote location, other than local community traveling to the mountainous, hilly areas for picnics and gatherings. These areas will be a considerable distance from the project site in the city of Dohuk which is over 40km away.

5.6.13 Existing infrastructure

The movement of heavy loads during mobilization and demobilization of heavy equipment, rig and other equipment for the production facilities phases could damage the existing roads which play an important role in the regional economy. In addition, after commissioning stage of project, tankers may occasionally be lifting oil for export, for example if there are pipeline outages or other technical problems. The export pipeline is expected to be operational before the WPF is commissioned and will link Sarsang oil production via 12" pipeline to existing pipeline infrastructure for oil export. Any trucking of oil (if necessary) will increase traffic levels and further damage roads

5.6.14 Archaeological and cultural sites

There are no archaeological and cultural sites within the project boundary and footprint.

5.6.15 Summary of impacts

Table 5-8 below provides a summary of the overall impact assessment undertaken for the proposed WPF project. It links project operations to specific work/tasks and interlinks them with possible, physical, biological and human impacts and **Appendix-9** provides detailed aspects table on risks and impacts.

Project operations	Specific activities and equipment	Physical impact				Biological impact			Human impact					
		Ground Water	Surface water	Air quality	Soil	Biodiversity	Flora	Fauna	Workers	Archaeological and cultural sites	Tourism/Leisure	Grazing land and farm	Existing infrastructure	Local community/population
Civils construction	Site grading			■	■		■	■		■	■	■		■
	Surface preparation, (all pad areas)			■	■		■	■		■	■	■		■
	Flare tower access track			■	■		■	■		■		■		■
	Equipment foundation			■	■		■	■		■				
	Production facility foundations			■	■		■	■						
	Truck loading area foundations			■	■			■						
	Storage tank foundations			■	■			■						
	Excavation - flowline/pipelines	■		■	■			■	■	■		■		■
	Access road construction			■	■		■	■		■				■
	Perimeter fencing all pad locations				■									
	Pit excavations, (drilling and prod)	■		■	■			■	■	■		■		■
	Diesel generators for power supply			■			■	■	■					■
	Dumber, pick trucks, excavators			■	■			■	■					■
	Temporary camp set up			■	■			■						■
Drilling operations	Rig mobilization			■	■		■	■	■			■	■	■
	Surface hole drilling (spudding)	■	■		■				■					
	Casing/cementing		■						■					
	Well testing		■	■	■		■	■	■			■		■
	Rig demobilization				■									
	Temporary camp set up and mob			■										
	Diesel generator for power supply			■	■			■	■					■
	Temporary camp demobilization			■	■			■	■					■
	chemical and equipment storage								■					
	pick up trucks for transportation			■	■			■						■
Well production facility	Diesel for power generation			■										
	Camp installation			■	■		■	■	■					■
	Production facility installation			■				■	■					■
	Well installation			■				■	■					■
	Storage tank installation			■	■				■					■
	tanker loading facilities installation		■	■	■		■	■						
	Flowline and pipeline installation			■					■					■
	commissioning			■					■					
	flaring		■	■	■		■	■	■			■		■
	pick up trucks for transportation			■	■			■	■					
	Oil trucking for export			■	■		■	■	■				■	■
Unplanned events	Well blowout	■	■	■	■	■	■	■	■			■		■
	pipeline / flowline rupture			■			■	■	■			■		■
	pilot light failure/flame out			■			■	■	■			■		■
	Major oil spill (tier II)	■		■	■	■	■	■	■			■		■

Table 5-11 Overall project impact matrix in relation to physical, biological and human impacts

6 Environmental Prevention and mitigation measures

6.1 Introduction

This section describes procedures to be implemented by HKN Energy Ltd and its contractors to minimize the potential negative impacts associated with the proposed project. Preventive/mitigation measures will be considered during project planning, execution and decommissioning. These are based on industry-standard onshore operations and procedures to be adapted to the Sarsang Block and some measures specific to the project location. HKN has adopted the MNR ESIA guidelines, (*section 35*) when compiling the mitigation measures where detailed tables are presented considering the impacts and mitigation measures for drilling operations.

HKN have built significant mitigation measures into the project design; company policies and their commitment to adhere to industry good practice are such that preventative measures against detrimental impacts will be in place before the project starts.

The mitigations described in this section apply to planned project operations for the Project and responses to emergency situations, such as fire or hazardous liquid spill.

6.2 Waste minimization measures

The principles of good waste management are firstly to avoid or minimize the generation of waste and, secondly, to discharge or dispose of any unavoidable waste in an environmentally responsible manner. The order of preference for waste management is as follows:

- Wherever possible avoid generating waste;
- Where waste is generated, attempt to minimize it;
- Where waste is generated, reuse, recycle or recover to the maximum extent possible; Treatment should only be considered after the recovery and recycling options have been exhausted, (**Figure 6-1**).

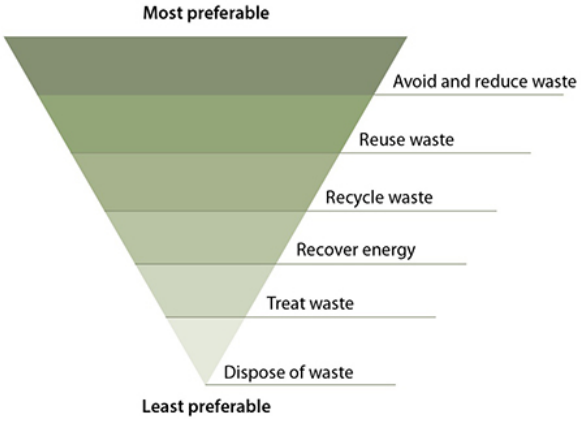


Figure 6-1 Waste hierarchy

6.2.1 Specific Minimum Requirements

HKN overall waste management strategy is based on the principle that waste generation should be minimized and that waste material should be managed as close to the source of its generation as practicable. This is combined with application of a hierarchical approach to selecting appropriate waste management solutions, which prioritizes waste minimization consistent with best practical techniques methodology. This hierarchy consists of the following options:

Source reduction methods

This means eliminating or decreasing, to the extent practical, the volume or relative toxicity of wastes generated by using alternate materials, processes or procedures. Process modification may be possible through more effective use of mechanical components, such as more effective drill bit rather than chemical additions. Gravel packs and screens may significantly reduce the volume of formation solid / sludge produced. Improved controls will help minimize mud changes, engine oil changes and solvent usage.

Toxicity reduction means the substitution of products that will result in the generation of less toxic wastes and should be investigated. For example, biocides, corrosion, inhibitors, cleaners, solvents, dispersants, emulsion breakers, scale inhibitors viscosities and weighting agents should be selected with minimum potential environmental impacts or disposal needs. Some example are the selection of mud and

additives that do not contain significant levels of biologically available heavy metals or toxic components, and the use of mineral oils in place of diesel oil for stuck drill pipe.

Other efforts include efficient planning so that all commercial chemical products are used on-site or returned unused to vendors. Consideration of bulk chemical purchases to eliminate drums and use of insulated septic, skimmers and sumps to collect and segregate spills.

This waste management strategy and hierarchy will be adopted by all HKN contractors and subcontractors undertaking HKN work and subsequently generating HKN waste.

6.3 Waste treatment and disposal measures

HKN will adopt its overall waste management strategy for the WPF project based on the principle that waste generation should be minimized and that waste material should be managed as close to the source of its generation as practicable. This is combined with application of a hierarchical approach to selecting appropriate waste management solutions, which prioritizes waste minimization consistent with best practical techniques methodology. This hierarchy consists of the following options:

6.3.1 Source reduction methods

This means eliminating or decreasing, to the extent practical, the volume or relative toxicity of wastes generated by using alternate materials, processes or procedures. Process modification may be possible through more effective use of mechanical components, such as more effective drill bit rather than chemical additions. Gravel packs and screens may significantly reduce the volume of formation solid / sludge produced. Improved controls will help minimize mud changes, engine oil changes and solvent usage.

Toxicity reduction means the substitution of products that will result in the generation of less toxic wastes and should be investigated. For example, biocides, corrosion, inhibitors, cleaners, solvents, dispersants, emulsion breakers, scale inhibitors viscosities and weighting agents should be selected with minimum potential

environmental impacts or disposal needs. Some example are the selection of mud and additives that do not contain significant levels of biologically available heavy metals or toxic components, and the use of mineral oils in place of diesel oil for stuck drill pipe. Other efforts should include efficient planning so that all commercial chemical products are used on-site or returned unused vendors. Consideration of bulk chemical purchases to eliminate drums and use of insulated septic, skimmers and sumps to collect and segregate spills.

This waste management strategy and hierarchy shall be adopted by all HKN contractors and subcontractors undertaking HKN work and subsequently generating HKN waste.

6.3.2 Waste Transportation

HKN shall use waste transportation contractors that have, whenever possible, approved for use by the HKN HSE Department. Contractors shall comply with HKN Waste Management Standards (Table 10-1).

6.3.3 Waste Treatment, Storage and Disposal

After maximizing reuse, recycling and resource recovery options, there may remain a balance of wastes requiring treatment and/or disposal. Where practical, such wastes shall be treated to reduce or eliminate any potential environmental hazard prior to disposal (e.g., volume/toxicity reduction, stabilization, incineration, etc.).

Prior to removal from the facility or site where generated, waste materials shall be stored in designated short-term waste storage areas. These waste storage areas shall include appropriate controls as specified in the site waste management plan(s).

There is the potential for wastes to be generated for which and environmentally sound recycling, reuse, recovery, treatment or disposal options are limited in the location, region or even in Kurdistan. Long-term storage or export options will be explored options for these hazardous wastes. Long-term storage facilities shall meet the requirements for a hazardous storage facility.

6.3.4 Hazardous waste

Hazardous waste storage facility shall comply with the following security requirements.

- Peripheral fencing
- Lockable gate
- Signboard posted at the main gate indicating the hazards.

Adequate overhead protection to ensure migration of waste to environment is not possible

Each waste stream generated shall be managed according to applicable requirements based on the type of waste and its Hazard Class. This includes all aspects of waste management, including but not limited to container selection, labelling (in Kurdish and English, or as appropriate), transportation, recycling, reuse, treatment, storage and disposal.

Mixing of different types of waste shall be avoided to the extent practicable. Chemically or physically incompatible wastes shall not be mixed even if the wastes are in the same Hazard Class.

Self-contained field operations shall dispose of domestic waste at the nearest landfill site is located within 50 km of a camp. Otherwise domestic waste from these areas shall be disposed of through an acceptable waste disposal system such as a mobile refuse incinerator or another method that is accepted by the HKN HSE department.

Waste lubricants shall be segregated and stored in a water tight container. Waste lubricants shall be recycled into the crude oil system via the oil saver pits if available; alternatively, disposal facility capable of treating this waste.

Contaminated oily sand will be transferred to a waste management facility capable of accepting the waste. Alternative treatment and disposal (i.e. land farming) may be agreed in conjunction with the HKN HSE Department.

Dry cell batteries that cannot be recycled shall be placed in ordinary refuse bags together with domestic waste.

Recyclable Hazardous Batteries -Lead acid batteries, wet type lithium batteries and nickel cadmium batteries shall be fully discharged, and all battery terminals are to be covered with electrical tape. The batteries shall then be segregated, labelled and transferred to a licensed waste management facility and stored on rigid wooden pallets. Large wet type lithium batteries and nickel-cadmium batteries shall be returned to the manufacturer for recycling, if possible. Batteries may be stock piled until suitable disposal route is identified.

Transformer cooling fluids known to contain greater than 50 (ppm) Polychlorinated Biphenyls (PCBs) shall be handled by a specialist waste disposal contractor. Transformers not containing greater than 50 ppm PCBs shall be transported to a designated waste facility, to decant off the cooling fluids. The cooling fluids shall be recycled into the crude oil system via an oil saver pit.

Clinical wastes including medical wastes and medical ‘sharps’ shall be stored in dedicated yellow bags or cartons (U.N. Hazardous Material Standard Number Din. U 30 739) designated for this purpose. Clinical waste shall be transported to clinical waste incinerators.

Hazardous material/chemical containers shall be decontaminated by full drainage and triple rinsing prior to being considered as Empty Containers. Wastewater from the triple- rinse procedure shall be managed according to the requirements of the Standard for Aqueous Discharges to Land & Water.

Empty Containers shall be disposed of as required depending on the material of their construction.

Empty Containers that previously contained hazardous materials or chemicals shall not be reused other than for storage of a material that is the same as or compatible with the material previously stored.

Hazardous material and chemical containers that have not been triple rinsed may be reused to store a material that is the same as that previously stored.

6.3.5 Storage and Landfarming

Prior to use, and at least annually thereafter, HKN shall inspect and approve all off-site treatment, storage and disposal facilities used for management of HKN waste streams. The HSE Department shall maintain a list of approved treatment, off-site storage and disposal facilities.

Treatment, off-site storage and disposal of waste shall only be conducted with licensed and approved waste management Contractors and/or at licensed and approved waste management facilities. These facilities shall be operated in compliance with the conditions of their licenses/permits and applicable regulatory requirements.

Land farming of oily waste material shall only be performed at approved facilities that are licensed and have received all required Government approvals. Case study and approval must be carried out by HKN HSE Department.

6.3.6 Drilling waste and cuttings

Water based drilling mud and cuttings (Total Petroleum Hydrocarbon TPH < 10 000 mg/kg) shall be disposed of in a dedicated drilling waste disposal pit. The design agreed and authorized by with the HKN HSE Department.

Oil / Synthetic based mud and OBM cuttings shall be stored in water-tight skips or vessels. Disposal of OBM and OBM cuttings shall be to a licensed hazardous waste complex only, which is capable of treating this waste. Drying and pre-treatment prior to disposal may be authorized by the HSE department. Used oil-based drilling muds (OBM), used synthetic-based drilling muds (SBM), and associated OBM and SBM cuttings shall not be discharged without prior drying and other treatment. The use of OBM and SBM require that systems be in place to prevent their loss to the land. Used OBM, used SBM and associated cuttings shall be injected down hole, reprocessed on site or transported to an adequate location for recycling, treatment and/or disposal.

6.3.7 Waste pits

The use of pits, earthen or lined, is an integral part of E&P waste management operations. Historically, on-site pits have been used for the management of drilling

solids, evaporation and storage of produced water, management of work over/completion fluids and for emergency containment of produced fluids.
In general, pits should be as small as possible and be strategically located to prevent spillage of waste materials onto the drilling or production site.

Pits should be lined unless site characteristics ensure that there will be no significant threat to water resources. In areas where it may be necessary to construct pits adjacent to water bodies or on sloping terrain, special engineering precautions should be taken to ensure the integrity of the pit.

Free hydrocarbons should be removed from pits and returned to the production process for recovery as soon as possible, and precautions should be taken to prevent pit disposal of chemicals, refuse, debris or any other materials which were originally not intended to be placed in pits. These materials can alter the nature of the bulk fluids in the pit and make disposal more difficult. Pits should be closed as soon as practicable and their closure should follow the required or generally accepted practices of the region.

6.3.8 Record Keeping and Reporting

A Waste Consignment Note or similar note shall be raised by the waste generator for both hazardous and non-hazardous wastes. Separate Waste Consignment Notes are required for hazardous and non-hazardous wastes. A Waste Consignment Note shall accompany a waste load and shall be signed when the waste has been received at the disposal location.

A signed copy shall then be returned to the ‘Waste Originator’ as proof that the waste arrived safely at the correct place. The Waste Contractor will provide the Waste Originators with a monthly summary of waste received.

Records of each HKN waste from the time of its generation to its final destination (e.g., reuse, recycling, treatment, storage, disposal, etc.) shall be prepared and maintained according to the requirements of the site-specific Waste Management Plan.

Records shall be subject to HSE audit

6.3.9 Reports

Waste data reports shall be prepared as required for the purpose of demonstrating compliance with the conditions of waste management licenses / permits and applicable regulatory requirements along with any contractual agreements. Waste management activity reports relating to individual HKN assets, departments, contractors and subcontractors shall be prepared as part of monthly HSE data reporting schedule. HKN and its associated contractors and subcontractors shall establish targets for waste management and minimization to demonstrate continuous performance improvement and shall report progress against these targets. Contract Holders shall be responsible for collecting waste management and minimization performance data from Contractors, and for reporting it to the HSE Department. Other waste management performance data shall be submitted to the HSE Department as required.

6.4 Natural resource management

6.4.1 Fuel demand

Activities that may have potential impacts on natural resources are consumption of diesel for powering up during construction works and general power supply and transport vehicles;

The approved local suppliers of refined petroleum products in KRG can easily supply the required quantities without any adverse impact on the local supply-demand balance. HKN will minimize impacts by using authorized local suppliers to minimize transportation distances and to benefit the local economy.

6.4.2 Flora

Natural vegetation identified in the baseline survey is present near areas of interest. There are no endangered or protected species in the project area. The nature conservation value is increased as the flora also provides sustenance and shelter and

habitat for fauna. Local flora could potentially be affected by reduction in air quality (air pollutant emissions and dust), and particularly by physical damage or removal during civil works construction activities, site and access road preparation, which would be regarded as a significant impact. Once the WPF is set up, it will be in a designated pad area with bunding and any leaks or surface wash off from rain will be captured by drainage system.

The nature of vegetation in the areas of interest is relatively easy to remove, and tree removal will be avoided where possible. Non-routine events such as leaks, and spills, fires, explosions and blowouts are only likely to occur within the facilities such as the camp site, production rea, drilling pad and access routes, which will be devoid of vegetation. It is not anticipated, therefore, that there will be any additional adverse impacts to flora associated with these non-routine events.

6.4.3 Fauna

Fauna may be affected directly by injury or death from vehicle movements, light effects from the flare and indirectly by disruption or destruction of the food supply (flora or other fauna) or shelter and habitat (flora, rock outcrops, and burrows).

The food chain in Sarsang area is finely balanced and the project impact on one of the elements of the web will unlikely to make a significant impact on the system.

The project component that has the largest potential to impact on faunal habitat is civil works construction, site preparation activities including the construction of the drilling and camp sites and the creation of access routes. This is an indirect impact mainly related to changes in the landscape and the potential disturbances to nests or dens. The risk of direct impact should not be great since most animals tend to avoid vehicles. The risk may be increased at night since many are nocturnal. It is, however, the policy of HKN is not to undertake driving at night, except in emergency.

Animal communities can also be affected by noise, extraneous light, and dust. The effects can be manifested by changes in an animal community's habitat, foraging, breeding and migration habits. In general, animals shy away from human activity and

therefore the risk of impact may be considered as low. However, the opposite case can occur, particularly where animals may be attracted to the water pit, or by inappropriately disposed of, or uncovered, food waste at the rig and camp sites.

Wildlife contact with waste or hazardous material could result in disease or even death depending on the type of waste or material. There is also the potential for animals to become a disease vector. These impacts may also result from site restoration procedures that are not adequate or not properly implemented.

As with flora, non-routine events such as leaks, and spills, fires and explosions and blowouts are unlikely to affect fauna as their effects would largely be limited to the area of the camp site and drilling and production pad.

6.4.4 Mitigation of human impact

The most important mitigation measure for potential negative impacts to local communities to ensure the communities are aware of the project activities.

HKN actively engages with village elders, through the Mayor's office. This will be achieved in consultation with appropriate authorities in nearest cities/villages, in HKN's case it will be the town of Chemanke and Dohuk governate as well as the MNR's CSR department.

The above stakeholders will be consulted with regard to access creation, seismic and WPF project sites, and the presence of any known sensitivities in the area. In addition, restoration plans will be discussed in the future concerning reclamation/decommissioning plans particularly with regard to potential future use of access routes created during the project as well as land acquisition.

Furthermore, HKN will compensate for public land take and crop compensation, (if relevant). This process will be in accordance to MNR's regulation and HKN have illustrated the process in more detail in **Appendix- 2** of this report.

6.4.5 Occupational health and safety measures

HKN will apply its corporate HSE guidelines to enforce measures in all phases of the project, as part of its corporate HSE management system and policy. This includes safeguarding workers from the likely exposures to hazardous gases, waste (liquid and solid), high noise levels and dust particles applicable to the nature of the operations. In all cases HKN workers will wear adequate PPE to safeguard against potential impacts caused by accidents. In addition, HKN will also address the possibilities of community impacts from occupational health and safety.

Personal protective equipment

Personal Protective Equipment (PPE) provides additional protection to workers exposed to workplace hazards in conjunction with other facility controls and safety systems. PPE is considered to be a last resort that is above and beyond the other facility controls and provides the worker with an extra level of personal protection. **Table 6-1** presents general examples of occupational hazards and types of PPE available for different purposes. Recommended measures for use of PPE in the workplace include:

- Active use of PPE if alternative technologies, work plans, or procedures cannot eliminate, or sufficiently reduce, a hazard or exposure.
- Identification and provision of appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors, without incurring unnecessary inconvenience to the individual.
- Proper maintenance of PPE, including cleaning when dirty and replacement when damaged or worn out. Proper use of PPE should be part of the recurrent training programs for Employees.
- Selection of PPE should be based on the hazard and risk ranking and selected according to criteria on performance and testing established by recognized organizations.

Objective	Workplace Hazards	Suggested PPE
Eye and face protection	Flying particles, molten metal, liquid chemicals, gases or vapours, light radiation.	Safety glasses with side-shields, protective shades, etc.

Objective	Workplace Hazards	Suggested PPE
Head protection	Falling objects, inadequate height clearance, and overhead power cords.	Plastic Helmets with top and side impact protection.
Hearing protection	Noise, ultra-sound.	Hearing protectors (ear plugs or ear muffs).
Foot protection	Falling or rolling objects, pointed objects. Corrosive or hot liquids.	Safety shoes and boots for protection against moving & falling objects, liquids and chemicals.
Hand protection	Hazardous materials, cuts or lacerations, vibrations, extreme temperatures.	Gloves made of rubber or synthetic materials, leather, steel, insulating materials, etc.
Respiratory protection	Dust, fogs, fumes, mists, gases, smokes, vapours.	Facemasks with appropriate filters for dust removal and air purification (chemicals, mists, vapours and gases). Single or multi-gas personal monitors, if available.
	Oxygen deficiency	Portable or supplied air (fixed lines). On-site rescue equipment.
Body/leg protection	Extreme temperatures, hazardous materials, biological agents, cutting and laceration.	Insulating clothing, body suits, aprons etc. of appropriate materials.

Table 6-1 Summary of Recommended PPE According to Hazard

6.4.6 Physical hazards

Noise

Noise limits for different working environments are provided in **Table 6-2** (ref: World Bank/IFC requirements, 2006).

No employee should be exposed to a noise level greater than 85 dB(A) for a duration of more than 8 hours per day without hearing protection. In addition, no unprotected ear should be exposed to a peak sound pressure level (instantaneous) of more than 140 dB(C).

The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reach 140 dB(C), or the average maximum sound level reaches 110dB(A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85 dB(A).

- Although hearing protection is preferred for any period of noise exposure in excess of 85 dB(A), an equivalent level of protection can be obtained, but less easily managed, by limiting the duration of noise exposure. For every 3 dB(A) increase in sound levels, the 'allowed' exposure period or duration should be reduced by 50%.

- Prior to the issuance of hearing protective devices as the final control mechanism, use of acoustic insulating materials, isolation of the noise source, and other engineering controls should be investigated and implemented, where feasible.

Table 1.7.1- Noise Level Guidelines[54]		
	One Hour L_{Aeq} (dBA)	
Receptor	Daytime 07:00 - 22:00	Nighttime 22:00 - 07:00
Residential; institutional; educational[55]	55	45
Industrial; commercial	70	70

Table 6-2 IFC/WB noise level guidelines

Vibration

Exposure to hand-arm vibration from equipment such as hand and power tools, or whole-body vibrations from surfaces on which the worker stands or sits, should be controlled through choice of equipment, installation of vibration dampening pads or devices, and limiting the duration of exposure. Limits for vibration and action values, (i.e. the level of exposure at which remediation should be initiated) are provided by the UK HSE (http://www.hse.gov.uk/vibration/). Exposure levels should be checked on the basis of daily exposure time and data provided by equipment manufacturers.

Industrial Vehicle Driving and Site Traffic

Poorly trained or inexperienced industrial vehicle drivers have increased risk of accident with other vehicles, pedestrians, and equipment. Industrial vehicles and delivery vehicles, as well as private vehicles on-site, also represent potential collision scenarios. Industrial vehicle driving, and site traffic safety practices include:

- Training and licensing industrial vehicle operators in the safe operation of specialized vehicles such as forklifts, including safe loading/unloading, load limits.
- Ensuring drivers undergo medical surveillance.
- Ensuring moving equipment with restricted rear visibility is outfitted with audible back-up alarms.
- Establishing rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures (e.g. prohibiting operation of forklifts with forks in down position), and control of traffic patterns or direction.
- Restricting the circulation of delivery and private vehicles to defined routes and areas, giving preference to 'one-way' circulation, where appropriate.

6.4.7 Chemical Hazards

Chemical hazards represent potential for illness or injury due to single acute exposure or chronic repetitive exposure to toxic, corrosive, sensitizing or oxidative substances. They also represent a risk of uncontrolled reaction, including the risk of fire and explosion, if incompatible chemicals are inadvertently mixed. Chemical hazards can most effectively be prevented through a hierarchical approach that includes:

- Replacement of the hazardous substance with a less hazardous substitute.
- Implementation of engineering and administrative control measures to avoid or minimize the release of hazardous substances into the work environment keeping the level of exposure below internationally established or recognized limits.
- Keeping the number of employees exposed, or likely to become exposed, to a minimum.
- Communicating chemical hazards to workers through labelling and marking according to national and internationally recognized requirements and standards, including the International Chemical Safety Cards (ICSC), Materials Safety Data Sheets (MSDS), or equivalent. Any means of written communication should be in an easily understood language and be readily available to exposed workers and first-aid personnel.
- Training workers in the use of the available information (such as MSDSs), safe work practices, and appropriate use of PPE.

Air Quality

Poor air quality due to the release of contaminants into the work place can result in possible respiratory irritation, discomfort, or illness to workers. Appropriate measures shall be taken to maintain air quality in the work area. These include:

- Maintaining levels of contaminant dusts, vapors and gases in the work environment at concentrations below TLVs (threshold limit value)—concentrations to which most workers can be exposed repeatedly (8 hours/day, 40 hrs./week, week-after-week), without sustaining adverse health effects.
- Developing and implementing work practices to minimize release of contaminants into the work environment including:
- Direct piping of liquid and gaseous materials.
- Minimized handling of dry powdered materials.
- Enclosed operations.
- Local exhaust ventilation at emission / release points.
- Vacuum transfer of dry material rather than mechanical or pneumatic conveyance
- Indoor secure storage, and sealed containers rather than loose storage.
- Where ambient air contains several materials that have similar effects on the same body organs (additive effects), taking into account combined exposures.
- Where work shifts extend beyond eight (8) hours, calculating adjusted workplace exposure criteria.

Corrosive, Oxidizing and Reactive Chemicals

Corrosive, oxidizing, and reactive chemicals present similar hazards and require similar control measures as flammable materials. However, the added hazard of these chemicals is that inadvertent mixing or intermixing may cause serious adverse reactions. This can lead to the release of flammable or toxic materials and gases and may lead directly to fires and explosions. These types of substances have the additional hazard of causing significant personal injury upon direct contact, regardless of any intermixing issues. The following controls should be observed in the work environment when handling such chemicals:

- Corrosive, oxidizing and reactive chemicals should be segregated from

flammable materials and from other chemicals of incompatible class (acids vs. bases, oxidizers vs. reducers, water sensitive vs. water based, etc.), stored in ventilated areas and in containers with appropriate secondary containment to minimize intermixing during spills.

- Workers who are required to handle corrosive, oxidizing, or reactive chemicals should be provided with specialized training and provided with, and wear, appropriate PPE (gloves, apron, splash suits, face shield or goggles, etc.).
- Where corrosive, oxidizing, or reactive chemicals are used, handled, or stored, qualified first-aid should be ensured at all times. Appropriately equipped first-aid stations should be easily accessible throughout the place of work, and eye-wash stations and/or emergency showers should be provided close to all workstations where the recommended first-aid response is immediate flushing with water.

A procedure for the control and management of radioactive sources used during oil and gas operations should be prepared along with a designated shielded container for storage when the source is not in use. The container should be locked in a secure store that is exclusively used for this purpose.

6.4.8 Well blowouts

A blowout can be caused by the uncontrolled flow of reservoir fluids into the wellbore which may result in an uncontrolled release of hydrocarbons.

Blowout prevention measures during drilling should focus on maintaining wellbore hydrostatic pressure by effectively estimating formation fluid pressures and strength of subsurface formations. This can be achieved with techniques such as: proper pre-well planning, drilling fluid logging; using sufficient density drilling fluid or completion fluid to balance the pressures in the wellbore.

A Blow Out Preventer (BOP) system must be installed on all wells so that the well can be rapidly closed in the event of an uncontrolled influx of formation fluids. The BOP allows the well to be circulated to safety. BOP is operated hydraulically and triggered automatically; they must be tested at regular intervals.

Facility personnel should conduct well control drills at regular intervals and key personnel should attend a certified well control school periodically.

During production, wellheads should be regularly maintained and monitored, by corrosion control and inspection and pressure monitoring. Blow out contingency measures should be included in the facility Emergency Response Plan, **(refer to Appendix-1)**

6.4.9 COMMUNITY HEALTH AND SAFETY

Communication and Consultation

Impacts to community health and safety from typical oil and gas facility operations vary from location to location. Broadly the approach adopted by the company is:

- Determine the potential hazard footprint and controls that are planned to minimize this - this should include any findings from the environmental and social/socio-economic impact assessment – so an integrated approach can be made.
- Identify the various stakeholders and stakeholder interests and assess level and nature of the interest – this might require some preliminary discussions with key 'opinion formers' to assess various interests and positions.
- Develop and implement a communications strategy / plan.

The complexity of this process will vary from location to location, depending on the nature of the activity, location, sensitivity of the population to industry, sensitivity of the environment, prime economies of the area, economic health of the community etc.

Physical Hazards

Community health and safety issues specific to oil and gas facilities may include potential exposure to spills, fires, and explosions.

To protect nearby communities and related facilities from these hazards, the location of the project facilities and an adequate safety zone around the facilities should be established based on a risk assessment. A community emergency preparedness and

response plan that considers the role of communities and community infrastructure as appropriate should also be developed.

Communities may be exposed to physical hazards associated with the facilities including wells and pipeline networks. Hazards may result from contact with hot components, equipment failure, the presence of operational pipelines or active and abandoned wells and abandoned infrastructure which may generate confined space or falling hazards.

To prevent public contact with dangerous locations and equipment and hazardous materials, access deterrents such as fences, and warning signs should be installed around permanent facilities and temporary structures. Public training to warn of existing hazards, along with clear guidance on access and land use limitations in safety zones or pipeline rights of way should be provided.

Hydrogen Sulphide

The potential for exposure of members of the community to facility air emissions should be carefully considered during the facility design and operations planning process. All necessary precautions in the facility design, facility siting and / or working systems and procedures should be implemented to ensure no health impacts to human populations and the workforce will result from activities.

When there is a risk of community exposure to hydrogen sulphide from activities, the following measures should be implemented:

- Installation of a hydrogen Sulphide gas monitoring network with the number and location of monitoring stations determined through air dispersion modelling, taking into account the location of emissions sources and areas of community use and habitation;
- Continuous operation of the hydrogen Sulphide gas monitoring systems to facilitate early detection and warning;
- Emergency planning involving community input to allow for effective response to monitoring system warnings.

6.4.10 Security

Unauthorized access to facilities should be avoided by perimeter fencing surrounding the facility and controlled access points (guarded gates). Public access control should be applied.

Adequate signs and closed areas should establish the areas where security controls begin at the property boundaries.

Vehicular traffic signs should clearly designate the separate entrances for trucks / deliveries and visitor / employee vehicles.

Means for detecting intrusion (for example, closed-circuit television) should be considered. To maximize opportunities for surveillance and minimize possibilities for trespassers, the facility should have adequate lighting.

6.5 Summary of impact and mitigation table for all phases of the project

Project phase 1: Civil works				
Category	Resources/Habitat	Impact	Project activity	Mitigation
Land	Landscape Visual Physical presence Physical disturbance	Soil erosion Modification of natural drainage patters Open access to human activity (local community)	Site grading Surface preparation of pad areas Flare tower access track Production facility foundation Truck loading foundation area Storage tank foundations Excavation of pipeline and flowlines Access road construction Perimeter fencing on all access roads Pit excavations	Planned journey management to minimize unnecessary movement and disturbance The workforce will undergo training in landscape sensitivity awareness A 'single track' policy will be adhered to unless conditions dictate otherwise Journeys will be planned, controlled and minimized

			Temporary camp set up Use of heavy lifting civils equipment, (mechanical diggers, dumper trucks and pickup trucks	Stakeholders made aware of HKN's civil activities and footprint area expected to be covered
Air and climate	Air quality	Reduction in ambient air quality due to exhaust and vapor emissions, and dust generation	Site grading Surface preparation of pad areas Flare tower access track Production facility foundation Truck loading foundation area Storage tank foundations Excavation of pipeline and flowlines Access road construction Perimeter fencing on all access roads Pit excavations Temporary camp set up Use of heavy lifting civils equipment, (mechanical diggers, dumper trucks and pickup trucks Diesel generators for power supply	Civil works and dust generating activities will not take place in windy conditions where excessive wind-blown sand could be generated Engine and equipment use will be minimized to only use equipment for its intention. Preference will be given to fuel-efficient generators and vehicles Regular maintenance will be undertaken for all equipment in accordance to manufactures specifications Speed limits will be enforced to reduce dust levels and emissions output. Appropriate procedure for fuel transfer to

				minimize vapor loss Use alternative energy where possible such as solar power
Ecology and biodiversity	Flora Fauna	Disturbance of flora and fauna	Site grading Surface preparation of pad areas Flare tower access track Production facility foundation Truck loading foundation area Storage tank foundations Excavation of pipeline and flowlines Access road construction Perimeter fencing on all access roads Pit excavations Temporary camp set up Use of heavy lifting civils equipment, (mechanical diggers, dumper trucks and pickup trucks Diesel generators for power supply	Disturbance of vegetation will be avoided during access road construction by mapping out the project area Field staff will undergo training to ensure that personnel are aware of environmental sensitivities. • Food storage and waste management procedures will be designed such that animals will not be attracted to camps. • Areas which may attract fauna will be fenced off. • Lights will be oriented towards specific work areas • Night driving will not be undertaken except in emergency
Water resources	Ground water	Increased demand in water resources	Camp operation	Minimize the demand for water by reusing

			All site preparations as mentioned above.	and recycling, setting strict water conservation targets and by monitoring water consumption
Human environment	Local community	Nuisance due to increased traffic and land clearing and construction. Disturbance to public picnic areas and local farmers Accidents due to increased vehicle movements	Site grading Surface preparation of pad areas Flare tower access track Production facility foundation Truck loading foundation area Storage tank foundations Excavation of pipeline and flowlines Access road construction Perimeter fencing on all access roads Pit excavations Temporary camp set up Use of heavy lifting civils equipment, (mechanical diggers, dumper trucks and pickup trucks Diesel generators for power supply	Community engagement will take place via local authorities to ensure that local people are aware of the project. Traffic disturbance during mobilization and demobilization will be minimized Deliveries and trips between communities and base camp will be minimized Speed limits will be strictly enforced Night driving will not be undertaken except in emergency All drivers will undergo appropriate training
		Increase in business/trade	Procurement of supplies and equipment	Local trade will be encouraged
		Increased employment opportunity	Staffing Procurement of supplies and equipment	Local employment will be encouraged

		Skills / technology transfer	Staffing	Local employment and training will be encouraged
	Local tourism	Disruption	Access road construction and excavation works	Local tourism will benefit from the use of improved access routes
	Existing infrastructure	Damage to local economy	Procurement of local supplies	The workforce will be made aware of local infrastructure Buffer zones will be established around infrastructure where appropriate
	Archeological and cultural site	Disturbance	access roads preparation and site clearing works	Archaeological and cultural sites will not be disturbed

Table 6-3 Project phase 1 - Civil works

Project phase 2: Drilling and testing				
Category	Resources/Habitat	Impact	Project activity	Mitigation
Land	**Landscape** **Visual** **Physical presence** **Physical disturbance**	**Soil erosion** **Modification of natural drainage patters** **Open access to human activity (local community)**	Rig mobilization Camp mobilization Surface hole drilling (spudding) Casing/cementing Well testing Rig demobilization Temporary camp set up and mob Diesel generator for power supply Temporary camp demobilization	**Planned journey management to minimize unnecessary movement and disturbance** The workforce will undergo training in landscape sensitivity awareness A 'single track' policy will be adhered to unless conditions dictate otherwise Journeys will be planned,

			chemical and equipment storage	controlled and minimized Stakeholders made aware of HKN's civil activities and footprint area expected to be covered
Air and climate	Air quality	Flaring during well testing Well testing Site reclamation and abandonment • Reduction in ambient air quality due to exhaust and vapor emissions, and dust generation	Rig mobilization Well testing Rig demobilization Temporary camp set up and mob Diesel generator for power supply Temporary camp demobilization	Civil works and dust generating activities will not take place in windy conditions where excessive wind-blown sand could be generated Engine and equipment use will be minimized to only use equipment for its intention. Preference will be given to fuel-efficient generators and vehicles Regular maintenance will be undertaken for all equipment in accordance to manufactures specifications Speed limits will be enforced to reduce dust levels and emissions output.

				Appropriate procedure for fuel transfer to minimize vapor loss Use alternative energy where possible such as solar power
		Reduction in local air quality and smoke output	**Well evaluation** **Waste management**	If flaring is the chosen option, the quantities to be flared will be minimized. Use of a confined incinerator unit to burn waste
Ecology and biodiversity	Flora Fauna	**Disturbance of flora and fauna**	Rig mobilization Surface hole drilling (spudding) Well testing Rig demobilization Temporary camp set up and mob Diesel generator for power supply Temporary camp demobilization	Disturbance of vegetation will be avoided during access road construction by mapping out the project area Field staff will undergo training to ensure that personnel are aware of environmental sensitivities. Food storage and waste management procedures will be designed such that animals will not be attracted to camps. • Areas which may attract fauna will be fenced off.

				• Lights will be oriented towards specific work areas • Night driving will not be undertaken except in emergency
Water resources	Ground water	Increased demand in water resources	Site preparation including access road construction Camp operations Drilling operations	Minimize the demand for water by reusing and recycling, setting strict water conservation targets and by monitoring water consumption
Human environment	Local community	Nuisance due to increased traffic and land clearing and construction. Accidents due to increased vehicle movements		Community engagement will take place via local authorities to ensure that local people are aware of the project. • Traffic disturbance during mobilization and demobilization will be minimized Deliveries and trips between communities and base camp will be minimized Speed limits will be strictly enforced

				Night driving will not be undertaken except in emergency All drivers will Undergo appropriate training
		Increase in business/trade	Procurement of supplies and equipment	Local trade will be encouraged
		Increased employment opportunity		Local employment will be encouraged
		Skills / technology transfer		Local employment and training will be encouraged
	Local tourism	Disruption		Local tourism will benefit from the use of improved access routes
	Existing infrastructure	Damage to local economy		The workforce will be made aware of local infrastructure Buffer zones will be established around infrastructure where appropriate
	Archeological and cultural site	Disturbance		Archaeological and cultural sites will not be disturbed
	Unplanned event	Well blowout		Activate emergency response process Action site and community evacuation plan

				Inform authorities and mobilize oil response team Table top exercises and training

Table 6-4 Project phase 2 - Drilling and testing

Project phase 3: Well production facility and activities				
Category	Resources/Habitat	Impact	Project activity	Mitigation
Land	**Landscape** **Visual** **Physical presence** **Physical disturbance**	**Soil erosion** **Modification of natural drainage patters** **Open access to human activity (local community)**	Diesel for power generation Camp installation Production facility installation Well installation Storage tank installation Tanker loading facilities installation Flowline And pipeline installation Commissioning flaring pickup trucks for transportation personnel Oil trucking for export	**Planned journey management to minimize unnecessary movement and disturbance** The workforce will undergo training in landscape sensitivity awareness Trucking activity and journey management will be on a designated route away from community settlements and sensitive ecological areas Journeys will be planned, controlled and minimized Stakeholders made aware of HKN's production activities and footprint area expected to be covered

Air and climate	**Air quality**	Stack emissions Production camp operations • Reduction in ambient air quality due to exhaust and vapor emissions, and dust generation	Gas flaring from production Temporary camp set up and mob Diesel generator for power supply Temporary camp demobilization	Civil works and dust generating activities will not take place in windy conditions where excessive wind-blown sand could be generated Engine and equipment use will be minimized to only use equipment for its intention. Preference will be given to fuel-efficient generators and vehicles Regular maintenance will be undertaken for all equipment in accordance to manufactures specifications Speed limits will be enforced to reduce dust levels and emissions output. Appropriate procedure for fuel transfer to minimize vapor loss Use alternative energy where possible such as solar power

		Reduction in local air quality and smoke output	**Waste management**	If flaring is the chosen option, the quantities to be flared will be minimized. Use of a confined incinerator unit to burn solid waste Produced water deep well injection option or consider reusing after treatment Segregate and recycle solid non-hazardous waste and organic waste
Ecology and biodiversity	**Flora** **Fauna**	**Disturbance of flora and fauna**	Camp installation Production facility installation Storage tank installation tanker loading facilities installation Flowline and pipeline installation Flaring pickup trucks for transportation Oil trucking for export	Disturbance of vegetation will be avoided during access road tanker movements Field staff will undergo training to ensure that personnel are aware of environmental sensitivities. Food storage and waste management procedures will be designed such that animals will not be attracted to camps. Areas which may attract

				fauna will be fenced off. • Lights will be oriented towards specific work areas • Night driving will not be undertaken except in emergency
Water resources	Ground water	Increased demand in water resources	Camp operations	Minimize the demand for water by reusing and recycling, setting strict water conservation targets and by monitoring water consumption
Human environment	Local community	Nuisance due to increased traffic and land clearing and construction. Accidents due to increased vehicle/tanker movements		Community Engagement will take place via local authorities to ensure that local people are aware of the project. Deliveries and trips between communities and base camp will be minimized Speed limits will be strictly enforced Night driving will not be undertaken except in emergency All drivers will Undergo appropriate training

		Increase in business/trade	Procurement of supplies and equipment	Local trade will be encouraged
		Increased employment opportunity		Local employment will be encouraged
		Skills / technology transfer		Local employment and training will be encouraged
	Existing infrastructure	Damage to local economy. Increased wear and tear and traffic on road infrastructure		The workforce will be made aware of local infrastructure Buffer zones will be established around infrastructure where appropriate
	Archeological and cultural site	Disturbance		Archaeological and cultural sites will not be disturbed

Table 6-5 Project phase 3 - Well production facility and activities

7 Key Alternatives

7.1 The "No Action" Alternative

This alternative represents the environmental benefit obtained in case the project is not implemented in comparison to the case of implementing it. The 'do nothing' alternative would not represent a viable option since it would compromise compliance of HKN's commitments with the Kurdistan Regional Government and consequently it would not fulfil the Kurdistan Regional Government's goals to expand their oil and gas exploration and production capacity. The project shall therefore be considered as a strategic development for contributing to the overall economic growth of the Region.

HKN believes that the implementation of the project will not lead to significant environmental changes during or after carrying out the project. The main purpose of conducting the environmental impact assessment studies for new development projects is to support, not to hinder development activities through identifying both negative and positive impacts of the projects along with protecting resources against the deterioration or depletion through identifying and analyzing its environmental impacts and applying mitigation measures.

7.2 Location of Well Alternatives

The exact location of the development is chosen on the previous geophysical and geological information obtained from seismic campaigns of the Sarsang prospect area and HKN's successful exploratory drilling program. HKN will attempt to maximize its existing infrastructure and facility resources. In addition, the project site is an extension of the existing operations, (ST-1) and therefore environmental footprint and land take is minimized and within the PSC license area.

7.3 Accommodation Alternatives

Different options for accommodation for HKN personnel operating onsite will be considered. A main accommodation camp will be used as the primary option on pad C, this will act as a central camp for civils and production thus lowering the footprint and the need for temporary camps elsewhere.

8 Uncertainties

The methodology for data collection has been established in the report. All relevant information during the literature review process has been used. For certain areas of the environmental baseline, particularly the socioeconomic data, there is a lack of official literature and data. Given that the Kurdistan Region of Iraq is relatively newly established, official government data are still in the process of being gathered and not finalized (e.g. government census). To overcome any limitations of these uncertainties, the best available literature and data, along with extensive field surveys, were utilized.

Impact predictions have been made based on extensive project-related surveys and with the best data, methods and scientific knowledge available at this time. Where significant uncertainty remains, this is acknowledged within this report. In line with best practice, this ESIA has adopted a precautionary approach to the identification and assessment of impacts. Where it has not been possible to make direct predictions of the likely level of impact, limits on the maximum likely impact have been reported and the design and implementation of the project (including the use of appropriate mitigation measures) will ensure that these are not exceeded. Throughout the assessment this conservative approach has been adopted. Monitoring of the ongoing implementation of the Project is important both to ensure that data is gathered on the actual effects of project interventions and to assess the effectiveness of mitigation and management measures.

8.1 Final project design

The WPF final design is still at an early engineering stage and many of the project elements are subject to final design factors which incorporate the recommendations of this ESIA report.

8.2 Final staffing numbers

Although HKN has planned the project and realizes the scale of the requirements, staffing numbers at present are uncertain and this will be determined once the project plan and scope if finalized.

8.3 Data

There is some degree of uncertainty about the data used in assessing the impact of the WPF project, Although HKN has carried out numerous studies over the years on the baseline environmental conditions of the Sarsang Block for various projects, technical data for the gas estimates are on currently producing wells and the power requirement for the camps and facilities are to be determined when final basis of design is determined. HKN is confident that these data will be similar to what will be expected for the project emissions.

9 Environmental Management plan

9.1 Overview

This chapter summarizes the various mitigation measures to reduce or offset potential environmental impacts of the project that have been discussed in Chapter 2 through Chapter 5. The proposed EMP includes specific mitigation measures for each adverse impact identified in Chapter 5, along with the appropriate monitoring program. This EMP will be incorporated into HKN's existing HSE management systems for the concession (refer to EMP table in this chapter).

9.2 Organization and Responsibilities

HKN has established an organizational structure for health, safety and environment (HSE) management. HSE management will ensure effective implementation of the EMP. Any contractors will also retain HSE personnel to manage, control, document and report the contractor's environmental and social performance.

Roles:

HKN HSE Manager - The HSE manager shall be a suitably qualified professional having similar experience and will maintain constant interactions with other staff throughout the project period. Manage all high-level aspects of HSE and the EMP. Reports to HKN Country Manager and VP of Operations.

HKN Field HSE Supervisor - The HSE Field Supervisor will be responsible for day-to-day HSE management on site. He/she shall make daily inspections of the work site(s) and camp to ensure strict observance of the requirements by site personnel. Observations from these inspections shall be documented, and if required, be made available for review by concerned authorities. The HSE manager shall be a suitably qualified professional having similar experience and will maintain constant interactions with other contractors and on-site staff during the project period. Reports to HKN HSE Manager, with functional reporting to HKN Senior Site Supervisor.

HKN Environmental Team – Coordinate environmental monitoring and progress for HKN for its corporate and MNR reports. Reports to HKN HSE Manager. The Environmental Team shall consist of suitably qualified professionals having similar experience and will maintain constant interactions with other staff throughout the project period.

Contractor HSE Personnel - Responsible to implement HKN's policies, procedures and mitigation measures. Includes auditing and managing its subcontractors. Reports to HKN Field HSE Supervisor.

The environmental and social mitigation measures for the project are presented in table below. The mitigation measures have been developed in line with requirements of the KRG regulations. This is in line with HKN's Environmental Management Plan.

	Environmental Aspect	source/location / activity	Mitigation Measures	Scope of Monitoring	Verification Method	Lifecycle duration of Project	Responsible Person
1	Use of Natural resource – fuel supply and storage	Consumption of fuel	Diesel fuel sourcing shall be through approved suppliers; The idling times of heavy equipment shall be minimized, by planning of various activities; Fuel consumption shall be recorded every day or at the end of each shift; and; Fuel efficient DG units, for operations. Unnecessary use of fuel for either vehicles and/or machines shall be restricted. Fuel storage and handling areas, suitable containment measures (Bunding area) shall be provided. The volume of the containment area shall be equal to 110% of the total volume of fuel stored.	Audit, (site inspection), of fuel storage area. Tracking of fuel inventory. Contractor performance review; in terms of HSE performance and fuel quality Testing of fuel specifications for purpose of QC	Regular Audit and Verification	Full Project life cycle	HKN
2	Groundwater and Surface Water use		The source of water will be so chosen that the stress to competing users is minimal; Water intended for human consumption shall be tested	Physico-chemical & TPH Analysis. Tracking of water inventory	Regular Audit and Verification	Full Project life cycle	HKN

			to ensure compliance with WHO standards; Consumption of water for drilling activities should be minimized which will automatically minimize liquid effluent generation rate; Fresh water consumption shall be minimized by identifying and implementing water conservation and re-use measures wherever feasible.				
3	Ambient Air Quality	Operation of DGs and heavy machinery	Generators, vehicles and other equipment/machinery shall be maintained in good working condition; and Routine inspection and maintenance of engines, generators and other equipment to minimize air emission. Wherever applicable, implement BAT exhausts. Unnecessary use of generators shall be restricted.	Regular air monitoring of H_2S, SO_2, NO_2 and O_3 (as minimum). Using fixed and mobile units. Regular measurement of climatic conditions, (temperature, wind speed, wind direction as minimum). Dust particulate measurements, ($PM_{2.5}$ & PM_{10})	Regular Audit and Verification	Full Life cycle of project,	HKN
		Access Road grading & gravel works.	Approach road shall be made to sufficient standards to		Regular Audit and Verification	Civil work's project cycle, which will include grading works.	

			minimize generation of suspended dust; Fixed roof tanks for storage of fuel oils shall be provided to minimize evaporative losses, alternatively adequately designed fuel dispensing tankers shall be used; and Adequate PPE shall be provided to workers to reduce inhalation of toxic fumes. Continue use of dust-suppression techniques to minimize damaging ambient air quality.				
		Vehicle movement	Water shall be sprayed at dust prone areas to minimize dust emissions; and Vehicle speed will be controlled to minimize dust emissions. Unnecessary vehicle movement shall be restricted.		Regular Audit and Verification		
4	Noise levels	Operation of DGs, heavy equipment	Generators and other equipment / machinery shall be maintained in good working condition; High noise generating equipment and generators shall be kept within	Maximum noise level threshold monitoring for	Regular Audit and Verification	Full Life cycle of operations	HKN

			enclosures wherever practicable to offset the source noise levels; using BAT where applicable to provide lowest noise generating machines. Restrict the use of high noise generating equipment to day time; unless it notified before. Use of ear muffs/plugs and other protective devices should be provided to the workforce in noise prone areas. Enclosures around noise sources may be provided depending on the size of the unit; and While procuring major noise generating equipment such as diesel generators etc. it should be checked that all mufflers are in good working order and that the manufacturers have taken the normal measures for minimizing the noise levels.	both background and within operations. Appropriate use of PPE, such as ear plugs, depending on noise exposure. Ensure standard operating procedures are in place and monitor performance. Monitor speed restrictions for noise level reduction and safety levels.			
		Vehicle movement	Speed limits shall be 20kmph on earthen roads and access roads and 5kmph within the rig site and camp. Official speed limits will be observed on tarmac roads;		Regular Audit and Verification	Full Life cycle of operations	HKN and contractor

			Logistics shall be planned to restrict the vehicle movement near settlements and during night times; and Vehicles shall have mufflers attached.				
5	Geology, Soil and Groundwater	Waste management, (hazardous & non-hazardous).	Oil contaminated waste or soil shall be treated and managed as hazardous waste; Separate waste storage areas / bins shall be provided for domestic waste (kitchen wastes), non-hazardous wastes and hazardous waste streams. The storage areas / bins shall be designed to handle the maximum quantities of wastes expected to be generated; Hazardous waste such as waste oils and lubes shall be appropriately packed, labelled and accompanied by a waste consignment note when transported to approved recyclers Within camp area, solid wastes shall be kept in waste bins located within a designated area; In the unlikely case that oil-based mud is used (not	Carry out regular water quality testing for groundwater, as part of water quality monitoring program, to ensure physiochemical parameters are in line with that of IFC/WHO guideline limits. Monitor waste managing operations to ensure proper handling of waste management Ensure regular site inspections of pits or sites containing hazardous wastes. Particularly to mitigate leachate into soil and spillage from transportation.	Regular Audit and Verification	Full Project life cycle	HKN and contractor

			currently planned) it will not be discharged in the effluent pits. It should be stored in steel barrels and brought to the basecamp for proper disposal; Non-recyclable waste shall be stored separately onsite and sent to authorized landfill. Waste consignment and 'Duty of Care' records shall be maintained; and No hazardous waste shall be mixed with any other type of waste. Non-hazardous waste shall be segregated and send to local recycling facilities. This includes, glass, plastics, paper and metals.				
		Wastewater management	Sewage and grey wastewater (wastewater from laundry, kitchen washings, and showers) shall be directed to a septic tank designed for the maximum wastewater quantity expected; Black and grey water will be collected in septic tanks for temporary camps	Carry out regular water quality testing for groundwater, as part of water quality monitoring program, to ensure physiochemical parameters are in line with that of IFC/WHO guideline limits. Visual inspection of waste pits and lining for signs of leaks and damages.	Regular Audit and Verification	Full life cycle of the project	

			Approvals from the Local Municipality shall be obtained for transportation of sewage and disposal at third party STP; and All the possible measures shall be taken to avoid contamination from equipment and vehicular washings;	HSE inspection of vacuum trucks			
		Drilling operation	Well bores shall be cased and cemented in order to avoid cross contamination; Drill mud shall be recycled to the extent possible; Drilling mud returns, and cuttings shall be routed to designated lined pits for drying; and Drill cutting after drying shall be retained in the waste pit until the final disposal method is finalized in consultation with the MNR; Closed loop system or stabilization methods to be applied where facilities are available and obtainable	Follow company waste management plan and audit waste streams.	Regular Audit and Verification	Full Life cycle of project	

		Accidental spills	Vehicles and their fuel tanks shall be checked regularly for fuel or oil leaks; Any contaminated soils (e.g. by accidental spills of fuel, lubricants, hydraulic fluids, saline produced water) will be treated on site or if necessary, be removed from the site to an appropriate landfill for further remediation In fuel/oil storage and handling areas, suitable containment measures shall be provided to prevent soil contamination in case of leaks or spills. The volume of the containment area shall be equal to 110% of the total volume of fuel stored; Spill kits shall be kept near fuel and oil storage area to minimize the spillage hazard. Emergency response plan to respond to a spill / leak shall be in place Local community is fully briefed and an incorporated in the ERP through a local community ERP appendix 1.	Visual inspection of vehicles for fuel and oil leaks. Apply soil monitoring program on suspected soil contamination from accidental chemical and HC spills. Monitor local community matters after major oil/chemical spill. Engagement should include cleanup operations and possibility of further testing upstream/downstream of potential village concerns Carry out periodic ER drills and scenarios to ensure adequate control procedures are in place for both personnel and community		Duration should be until desired limits have been met after remediation & treatment of soil and water.	

			The fuel and other hazardous liquid storage tanks shall be inspected regularly for leaks.				
		Drilling discharges from development drilling	Drilling discharges (cuttings) and wasted drilling fluid (WBM) shall be appropriately disposed and remediated in consultation with MNR;	Monitor treatment and disposal of drilling fluids, by means of site inspection. Conduct audit on third part contractor for waste treatment method disposal and management.	Regular Audit and Verification	Life cycle of project.	
7	Ecology and wildlife	Effects of drilling operations on Fauna and Flora. *Drilling site, access road / camp site locations.*	Gentle start of earthen work to allow wild animals to move off. Tree cuttings shall be avoided or minimized to the possible extent; Workers should not engage in hunting of any wild animal/bird for their meat in the exploratory drilling and adjoining areas; Disturbance of grazing and foraging areas shall be kept to a minimum. Disturbance to the domestic animals (sheep and cattle in particular) moving around or grazing shall be kept to a minimum;	Incorporate habitat monitoring as part of overall environmental management program. Any displaced wildlife to be relocated to other natural environmental away from the drilling operations. Monitor concession grazing activities near project area to ensure that animal herds are clear form any transportation of materials for the project or in immediate risk of injury from excavated pits and warehousing	Regular Audit and Verification	Life cycle of project	HKN

			Special care must be taken to protect localized animals; Accidental injuries or kills to these animals shall be reported to the authorities; In case of injuries of “owned animals”; the owner shall be informed immediately, and all necessary veterinarian procedures shall be done. Water runoff, erosion and siltation should be minimum; Project site shall be appropriately fenced to avoid unauthorized entry; Well sites and camps shall be appropriately fenced; Lights required at the drill pads and camp shall be kept to the minimum other than for safe working and security purposes; and Night time driving, and off-road driving will be restricted to emergencies only, subject to the approval of the Company Man. Cutting of trees/shrubs/tall grasses and damage to agricultural crops should be avoided as far as possible;				

8 9	Land use Decommissioning	Land tenure	The appropriate authorities and Mayor shall be consulted prior to starting of the project facilities; Care shall be taken not to disturb the major surface drainage patterns; Collection, characterization and assessment of representative soil samples within the study area; Physical footprint of the temporary facilities shall be minimized to reduce environmental impact. Community resource / infrastructure shall not be used unless prior disclosure through authorities and village committee headed by the Mayor Avoid archaeological areas and grave yards; All project related community grievances shall be attended as appropriate in consultation with concerned authorities/stakeholders; Stakeholders shall be consulted for disclosure of	Monitor land boundaries to ensure any expansion of operations are clear and approval process is transparent between land owners and local authorities. Any environmental complaints from the local landowners shall be addressed and assessed in accordance to guidelines from the MNR.	Regular Audit and Verification	Life cycle of project	HKN

			project activities prior to, during and after the drilling and construction activities to avoid possible community issues.				
		Site restoration	All materials and equipment shall be demobilization safely and temporary markers, cables, flags, left over wastes from the camp and drilling / construction sites will be removed; All plastic liners and concrete footings shall be removed to ensure full restoration; unless it requested by the locals and agreed on Sites shall be restored to the conditions of normal terrain consistent with agreement by relevant government agencies; Total area acquired for preparation of drill site shall be restored after completion of drilling operation leaving no waste material at site Grievances from public entities shall be tracked and addressed during demobilization.	HKN shall undergo decommissioning processes in coordination with MNR. Site restoration to be monitored and observed to ensure restoration to natural surroundings are achieved. Earthworks where possible shall be from native surroundings to ensure that it matched the original natural ecosystem, before commencement of operations.	Final audit and verification	decommissioning phase	

10	Health and Safety	Drilling site, access road / camp site	Waste and wastewater shall be managed to prevent contamination of the livestock food chain; A sewage disposal system will be established in the campsite during the drilling operation. Being a temporary activity, the sewage should be diverted to septic tank or soak pit; Deploy signage indicating speed limits, settlements, livestock crossings at appropriate locations along the project traffic route; Appropriate First Aid shall be made available at work site and camp. An ambulance shall be made available at the site; The medical staff will be trained for all types of first-aid and check-up; Records and trends of the medical treatment will be maintained at the site; The radioactive material will be stored in sealed containers and stored appropriately as	HKN to apply its corporate (onshore) HSE Management system to adopt Health and Safety guidelines and procedures in accordance to local KRG and recognized international system standards Incidences should be recorded, such as near misses and injuries purposes. Medical facilities such as ambulances, clinics and drug supplies should be inspected to ensure adequate support is available in case of medical treatments and medical transfers to hospital.	Regular Audit and Verification	Life cycle of project	HKN

			required for such material to prevent radiation exposure; Site HSE plans shall be prepared and followed; importance shall be given on the usage of PPEs, hygienic conditions at drilling site and camp accommodation; Proper awareness signage shall be installed at required places. Health information pertaining to drilling and construction activities shall be communicated to the local community through the KRG; HSE training and awareness programs for staff shall be undertaken; Emergency response plan shall be prepared covering accidental releases, H2S release, well blow-out, and fire and explosion events; Staff working at the site shall be made aware of emergency response procedures; and Fire extinguishers and fire safety measures shall be				

			made available throughout the work site				
10	Local economy	Drilling and surface facility location	Unskilled Labor should be hired from local communities if feasible; Where possible interviews should be held, but with a limited number of interviewees called at one time. Procurement and purchasing should consider availability and quantity of local supplies and local use of material; Procurement of scarce or locally sensitive goods should be conducted outside of the study area; and Preference should be given to locals within the study area for un-skilled jobs.	As part of commitment to localization and sustainability economy HKN shall precure general goods from surrounding villages where possible. HKN to monitor performance of local vendors to ensure standards of goods and products are procured to the required standards and quality. Advise and training to be provided in form of workshops to make sure corporate standards are achieved. Provide training and support to local community workers by monitoring staff and contractor performance.		Life cycle of project	HKN
11	Archaeology and Culture	Drilling and surface facility location	Workers shall be made aware about local culture and traditions to avoid social issues; Drilling sites, access roads and camp shall maintain setbacks distance from the cultural and potential archaeological sites	HKN to address any discovered archeological sites within the local KRG authorities.	Regular monitoring and audit	Life cycle of project	HKN

			Regular Audit and Verification if available; Community cultural/ religious resource (mosque) shall be used only after informing the KRG; Field based reviews shall be undertaken to determine the location of known or potential cultural property prior to determining the location of any future planned activities, facilities and operations; Workers shall receive a briefing on recognizing archaeological / cultural artefacts and how to respond when found; and A procedure shall be developed and implemented in areas where there is potential for previously unknown cultural property to be found during construction of facilities. Collection of archaeological artefacts shall not be allowed. All graveyards shall be considered as a highly valuable and restricted areas. They need to be marked on				

			all maps and awareness program among workers shall be undertaken for this issue.				

10. Projected Net Environmental Impacts

10.1 Summary

Based on the above assessments, the WPF development will consist five wells to feed the 25,000 bopd facility. The MNR are in process of negotiating a deal with external investors to build and operate a gas handling facility to receive all production gas streams from HKN, clean and treat the gas, and sell the sweet gas to MNR for power generation and reinject the acid gas (H2S, CO2), reducing the emissions to absolute minimum. The gas handling plant is expected to be in operation two to three years after the 25k WPF facility and production starts. During the period prior to the operation of a gas handling plant a portion of the associated gas from production will be used as fuel for the facility and the rest will be flared without exceeding the KRG emission standards. The Project is economically beneficial to the Kurdistan region as it increases much needed revenue streams for the government to support social costs and infrastructure development. The gas handling plant will have further benefits by supporting cleaner and less expensive power generation for the Dohuk region as the use of natural gas replaced diesel for electricity generation.

The Project as envisaged will have limited adverse impacts that are localized The impacts will be minimized by implementation of EMP and significant long-term potential impacts will be negligible if environmental performance is assessed frequently to plan and implement site mitigation measures with the objective of continual performance improvement.

The ESIA identifies various potential environmental impacts of the proposed expansion of facilities based on the project activities, environmental releases and the environmental settings of the project area. The adverse impacts vary over time and are what is expected of a typical onshore oil and gas development project. The opportunity for both short-term and long-term employment will be a beneficial impact and as part of sustainable development to train local workforce.

This ESIA describes the physical, social and ecological environments that exist in the Sarsang Block to focus on the immediate surroundings of the sites. Site surveys were

conducted to identify sensitive receptors in the concession area to assist in the planning of surface facilities.

The ESIA determines the environmental releases from the proposed development activities, identifies related environmental impacts/risks and assesses them in terms of their significance and duration or likelihood of occurrence. A proposal for suitable control/mitigation measures and monitoring program to minimize significant impacts is also included in this ESIA along with appropriate management plan.

The natural environment of the block area is characterized by simple ecosystem with a food chain mainly based on the browsing of sparse vegetation in the wadi channels by a variety of faunal species. There are no endangered species of fauna and flora present within the concession and project area. Based on information obtained during the preliminary site visit no sites of contamination have been identified in the concession area. However, it is suggested that any chance findings during the project activities be recorded and reported to relevant government authorities, (MNR HSE department).

Potential impacts have been identified based on the project activities and its influence on the existing environment. The impact assessment has shown that these impacts would be localized. The significant medium term and long-term impacts would be brought down to ALARP by implementation of the proposed EMP.

The construction of the WPF facility will have a short-term impact. However, the facility operation will be long term and flow line is the only structure which would most likely be left in place after decommissioning. Thus, if all the appropriate environment protection requirements are implemented, then the project will not have a significant impact on the environment.

Should HKN extend any drilling operation with initial well testing, it is recommended that HKN shall plan for continuous ambient air quality monitoring stations (covering upwind, downwind and sensitive receptor locations within project area) at the project site to record, assess and demonstrate the emissions and compliance with local regulatory authorities. Such records provide HKN valuable authenticated information on the

environmental releases to ambient environment, prevailing meteorological scenarios and the distribution of pollutants. It also helps in assessing the performance of the control measures adopted and gives the precise information for required mitigation measures.

The EMP along with mitigation measures is provided to minimize the impacts to ALARP levels and to achieve compliance with applicable environmental regulations. After implementation of the control / mitigation measures, the proposed project activities are not likely to result in any long term, irreversible impacts to the environment including the local population. Accordingly, the project can be acceptable from an environmental standpoint based on the requirements of applicable local and international environmental regulations.

10.2 Physical impacts (topography, ground and surface water supply, soil conservation).

10.2.1 Topography

Residual impacts will be restricted to landscape disruption due to access route creation and disturbed areas at the well locations, which are inherent consequences of initial civils, drilling and production activities in undulated terrain. The Sarsang area is remote with few inhabitants with no amenities in the footprint areas of the project. Since effects will be localized and secondary receptors including communities and faunal habitats (including flora) are scarce, potential impacts are not considered to be significant. Most sites require grading, levelling and compaction works. Grazing and Agriculture remains an important economic and subsistence activity within the concession. The area will be fenced and unavailable for grazing/agriculture during project activities.

10.2.2. Surface and ground water

The risk of contamination of surface water, groundwater reserves from project activities will be minimized by the adoption of appropriate operating procedures combined with ongoing water quality monitoring program; the residual impacts on surface water will be minimal as water supply from camps and operational processes are taken from multiple streams and rivers within the concession, running from the

Gara mountains. Therefore, this will not pose strain on the natural resources and as a result the use of ground water will be limited due to abundant water availability within the project with low residual risks to the water courses.

10.3 Biological impacts (flora, fauna and related habitat with attention to threatened and endangered species; natural resources. e.g. primary forests, coral reefs, mangroves, etc.)

10.3.1 Flora

Land clearing will not pose any threats, to any endangered species as there are non-present. It is not anticipated that there will be any additional adverse impacts to flora associated with these non-routine events, such as leaks, and spills, fires, explosions and blowouts are only likely to occur on the camp site, drilling pad and access routes, which will be devoid of vegetation.

10.3.2 Fauna

The risk of direct impact should not be great since most animals tend to avoid vehicles. The risk may be collision risk increased at night. It is, however, the policy of HKN not to undertake driving at night, except in emergency. The area is remote and mountainous and risk to Fauna will be insignificant and there are no endangered species present.

10.4 Net discharges of airborne, liquid and solid wastes and resulting ambient impacts as compared to applicable host country, World Bank and other relevant regulatory standards and guidelines

10.4.1 Airborne

The project's cumulative impact footprint both globally and in country will be very small, compared to Iraq's central government's southern fields producing over four million bopd and flaring over 1.5 billion cubic meters of associated gas per day. Nevertheless, industry good practice requires that the significance of cumulative impacts be acknowledged by all projects and activities. HKN has demonstrated this by

implementing plans to reduce and eventually eliminate emissions. HKN will make the WPF project sustainable by utilizing that 4 MMscf gas per day (from the five well 21 MMscf/d) to use as fuel source for the new 25,000 pobd facility, which means that it will reduce the flare emissions by up to 20% and it will eliminate diesel generator usage from day one which accounts contributes to GHG emissions. With future plans to utilize gas handling plant in 2021, HKN aims to completely eliminate flaring and substantially reducing the carbon footprint and creating a net positive impact.

10.4.2 Liquid and Solid waste

If the mitigation measures procedures implemented, the residual impacts of the liquid and solid wastes can be considered insignificant impacts. As HKN plans to use local recycling plants in Dohuk to handle all non-hazardous waste and in addition use its existing onsite incinerators.

HKN has taken the initiative of treating waste domestic water using biological method of facultative lagoon system. This series of evaporating ponds have been very successful for other operations due to land availability and Kurdistan climate and will pose insignificant impacts

All hazardous solid wastes are handled using HKN's waste management system and government licensed contractors who will dispose and treat the waste accordingly with waste manifest system in place.

10.4.3 Net exposure to workers to safety and health hazards

Non-routine events such as exposures by workers to safety and health hazards by leaks
and spills, fires, explosions and blowouts are only likely to occur on the camp site, drilling pad and access routes.

The EMP will include a detailed Emergency Response Plan (ERP) to deal with nonroutine incidents that may occur during the field program (See **Appendix-1**). Given the nature of the project and environment, the four-priority emergency response considerations outlined in this plan are likely to be:

- Emergency medical evacuation;
- Fire response;
- Spill response; and,
- Blowout Prevention Plan

ERP procedures will be routinely practiced by appropriate personnel before and during operations. Records will be maintained, and analysed, and weak points assessed and corrected allowing continuous improvement of the ERP.

10.5 Net potential for major hazards

Non-routine events such as leaks, and spills, fires, explosions and blowouts are only likely to occur on the camp site, drilling pad and possible events at the production facility such as flowline or pipeline ruptures, etc will trigger the automated ESD system as pressure loses will be detected. Other areas such as access routes, which could be considered the major net potential hazards to the all environmental features including local communities and workers. It is not anticipated, therefore, that there will be any additional adverse impacts to the environment with these non-routine events.

10.6 Consistency with applicable international agreements

HKN will work consistently to follow relevant international guidelines and standards as mentioned in chapter 2 (Legislation and standards); the main objective of the ESIA is to meet or surpass the relevant national and international environmental legislative requirements and guidelines, including regional and international agreements and conventions.

Appendix 1. Emergency response plan

GENERAL EMERGENCY RESPONSE PLAN

HKN-KRI-HSE-PLA-00001-E

PREPARATION & APPROVAL				
	Name	Title	Date	Signature
Author	Bill McCleave	HSE Manager		
Reviewer	Ferdi Burbler	Operation Support Manager		
Reviewer	Rasmus Engell	Well Operations Manager		
Approver	Dave Scott	VP Operations / GM		
CHANGES TO THIS DOCUMENT SHALL ONLY BE MADE BY THE AUTHOR OR DESIGNATE				

ISSUE SUMMARY		
ISSUE NUMBER	DATE	DESCRIPTION OF REVISION OR AMENDMENT
Rev-0	06-12-2014	Issued for Approval
Rev-1	01-20-2015	Yearly Review
Rev-2	03-13-2016	Addition of Community ERP Appendix

1.0 Purpose

This document describes the emergency response system, roles and responsibilities of the HKN personnel in the KRI. The document is intended to

interface with the contractors' Emergency Procedures. Ownership of this document will remain with the Erbil Management Team

2.0 Emergency Response Objectives

2.1 Objectives

HKN Emergency Management objective is to prevent harm to people, the environment and property. To achieve this requires a robust emergency and crisis management system. This is described in this document.

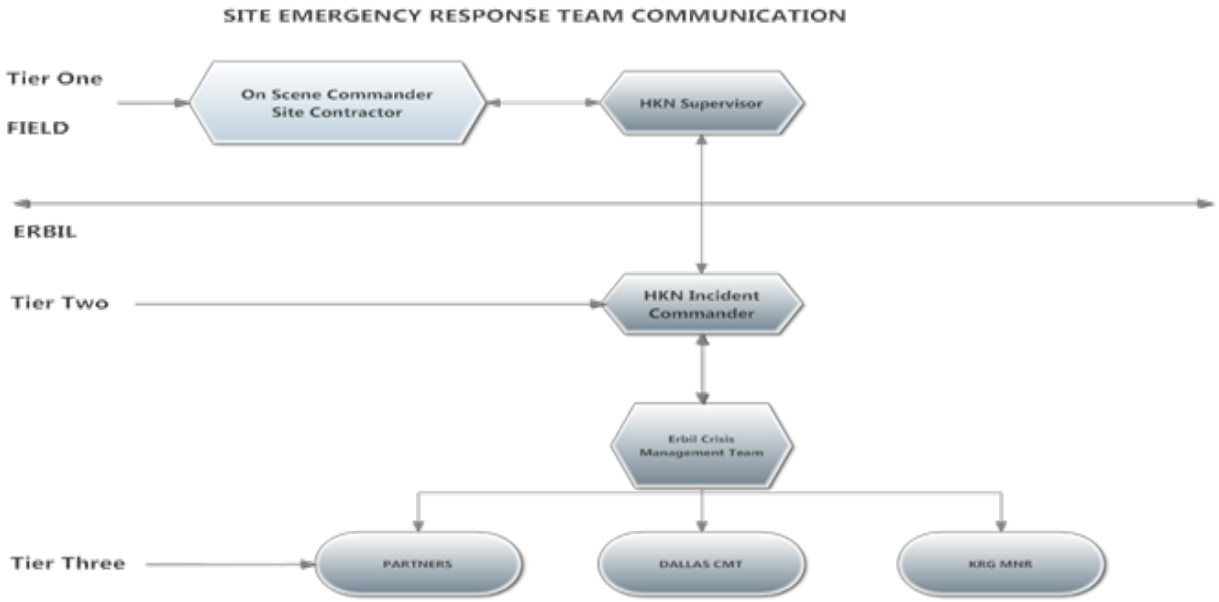
2.2 Primacy

All onsite activities during emergencies will be managed in accordance with the prime contractor on site Emergency Response Plan. The Senior Supervisor is the on-scene commander (OSC) whose duties are defined in their respective ERP. All persons allocated to the emergency teams will be appropriately trained and conversant with the emergency procedures. The senior HKN Energy Supervisor on site will be included in the prime contractors Emergency Management Team and they will provide the interface to the HKN Energy Emergency Response Team. The prime contractor's senior site supervisor shall facilitate weekly emergency training and testing to ensure their emergency preparedness.

3.0 Emergency Organisation

3.1 Site Emergency Response Team (SERT):

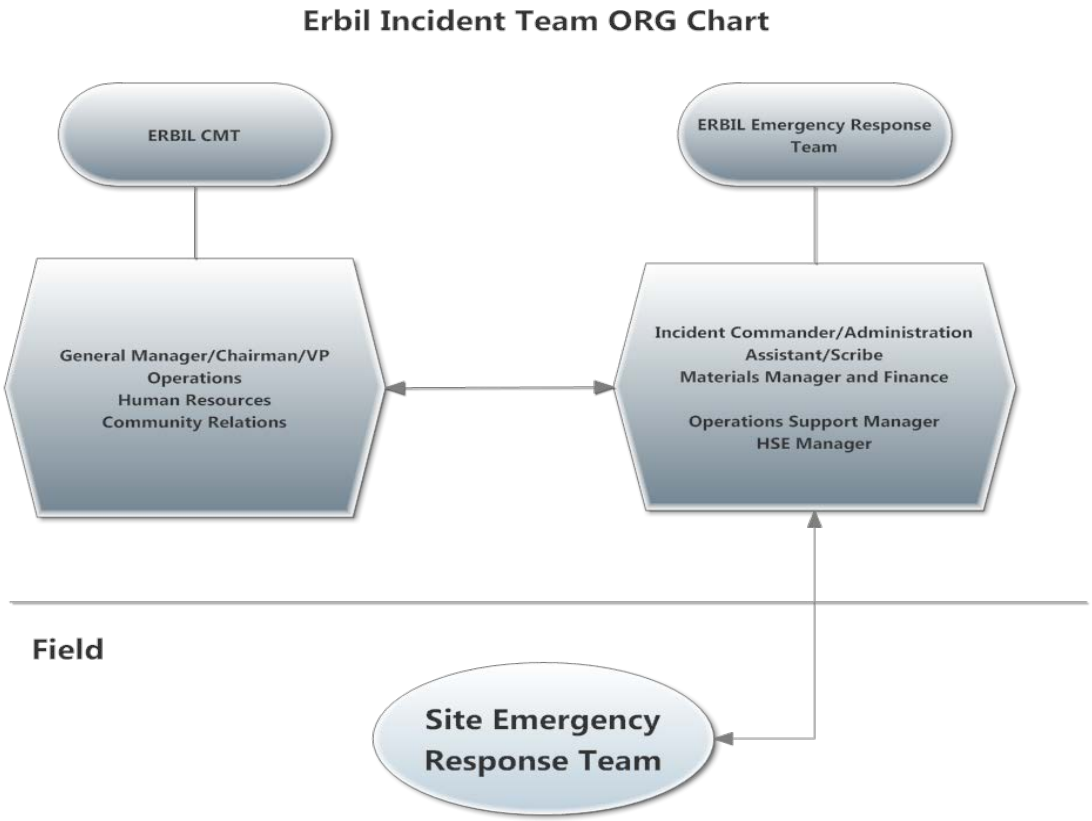
Primary response will be provided by personnel located on the site and in the field to control the incident and resolve the situation.



3.2 Erbil Emergency Response Team (EERT):

The HKN Operations Team in Erbil will provide technical and logistical support to the Site Emergency Response Team through an Emergency Operations Centre (EOC).

3.3 Crisis Management Team (CMT) –Erbil



3.4 Crisis Management Team (CMT) Dallas:

CMT role is to consider and manage any long-term, strategic implications and financial support to the Erbil Emergency Response Team.

3.5 External Organizations

Relevant external organizations are identified and incorporated as appropriate into these Emergency Response Plans and procedures. This includes

- Contractors and subcontractors whose personnel are directly involved in the incident
- Statutory Regulators such as the Ministry of Natural Resources
- Response organizations for
- Medical - ISOS
- Well Control I Blow-Out - Boots & Coots
- Media - using protocols established in this document
- Local civil authorities in Kurdistan

4.0 RESPONSE LEVELS

TIER 1 INCIDENT: Managed by the facility /site (Drilling activities or other)

TIER 2 INCIDENTS: Will require ERT support to site. Depending on the nature of the incident not all ERT members may be called. Erbil Office - Emergency Response Team (ERT Erbil)

TIER 3 INCIDENTS: Crisis Management Team, Erbil Office. Will require full organization report and immediate notification to Dallas by the CMT Chairman (HKN General Manager or his stand-in.)

5.0 SITE EMERGENCY RESPONSE TEAM

5.1 ON SCENE COMMANDER

Role: Upon being made aware of an incident, manage the incident response. Pass on all possible information on the situation to the HKN senior site supervisor

Key Responsibilities:

Deploy the site Emergency Response Team.

Liaise and collaborate with the HKN Senior Site Supervisor.

5.2 SITE EMERGENCY RESPONSE TEAM

Role: The Site Emergency Response Team responds to the incident on site (i.e. on or near the site.) Focus on protecting lives, protecting the environment and company assets

5.3 HKN SENIOR SITE SUPERVISOR

Key Responsibilities:

Collaborate with and support the On-Scene Commander

Manage near-site Incident Response (i.e. Community Relations, OPF, Site Security, HKN Medic, and HSE)

Liaise with the Incident Commander and advise if additional resources are required.

5.4 SITE SECURITY MANAGER

Key Responsibilities:

Collaborate with and take instruction from the HKN senior site supervisor

5.6 MEDIC / SITE DOCTOR

Key Responsibilities:

Collaborate with and take instruction from the HKN senior site supervisor

Collaborate with HKN HSE supervisor any POB issues.

Ensure adequate medical care is administered to all injured parties.

Communicate potential evacuation needs to Senior site supervisor

5.7 FIELD COMMUNITY LIASION

Key Responsibilities:

Support the On-Scene Commander and Senior Site Supervisor in Community related issues.

Directly engage with any local population in the area.

Communicate with local officials at the sub-district, district and governorate level.

Coordinate evacuation of local residents, transportation and relocation if required.

Report to Community Lead in Erbil Emergency Response Team.

6.0 ERBIL EMERGENCY RESPONSE TEAM

6.1 INCIDENT COMMANDER:

Key Responsibilities:

Establish the Emergency Operations Centre (EOC)

Obtain details from emergency site and assess the situation.

Establish incident objectives, strategies, and priorities

Brief staff and ensure meetings and briefings are scheduled as required

Manage requests for additional resources.

Order demobilization of the ERT as appropriate.

6.2 ADMINISTRATION ASSISTANT

Key Responsibilities:

Ensure that the team has sufficient stationery supplies and food/ beverages.

6.3 SCRIBE

Key Responsibilities:

Collect/log all information (calls, data, etc.) in the EOC. Copy information to team members.

6.4 MATERIALS MANAGER and FINANCE

Key Responsibilities:

As instructed proceed to the EOC and obtain an understanding of the situation from the Incident Commander.

As instructed oversee the mobilization and transport of required resources, keeping a log of positions and movements of vehicles in the field.

As instructed determine material and equipment needs and track resources supplied.

As instructed keep records of any resources bought and hired.

6.5 OPERATIONS SUPPORT and the HSE MANAGER

Key Responsibilities:

As instructed proceed to the EOC and obtain an understanding of the situation from the Incident Commander.
Maintain the operation of the EOC (communications, stationery, hardware/software etc.) and ensure that logs of events are kept.
Advise on designated safe vehicle and aircraft routes for transport of resources. In event of an evacuation liaise with the General Manager on the approved procedure.
Co-ordinate air/land personnel movement to and from the field locations.
Increase office security as required.

6.6 COMMUNITY (CSR) LEAD

Role: The Community (CSR) Lead in the EMT ERBIL will support the Incident Commander in all aspects relevant to Community issues.
Liaise with the field Community Liaison
Contact Regional authorities including KRG MNR CSR Advisor.
Alert and liaise with local authorities (governorate, district, sub-district, Asaish, police).

7.0 CRISIS MANAGEMENT TEAM

Role: Crisis management is a situation-based management system that includes clear roles and responsibilities and process related organizational requirements company-wide. The response shall include action in the following areas: crisis assessment, crisis handling and crisis termination. The aim of crisis management is to be well prepared for crisis, ensure a rapid and adequate response to the crisis, maintaining clear lines of reporting and communication in the event of crisis and agreeing rules for crisis termination.

7.1 GENERAL MANAGER/CHAIRMAN/VP Operations

Primary role is to provide the strategic direction and decision-making capability within the team.

Key Responsibilities

Confirm the composition of the team, including all ancillary roles
Receive briefs on the incident from the Incident Commander
Notify and keep external stakeholders informed

Check the facts of the situation

Media and communications control

Ensure the correct process is followed

Be responsible for the conduct of the response to the incident

Delegate work streams to team members according to their responsibilities

7.2 HUMAN RESOURCES (HR)

Key Responsibilities

Generate Person on Board/on Site (POB/POS) and NOK lists for the site affected by the incident;

Reconciles lists of (POB/POS) with information received from the incident site

Contacts NOK for Kurdish local staff - in accordance with approved procedures and any legal requirements

Establishes and maintains links to HR Dallas for expatriate staff. Dallas will notify NOK

Establishes and maintains links to relevant contractor HR for contract staff - reports details

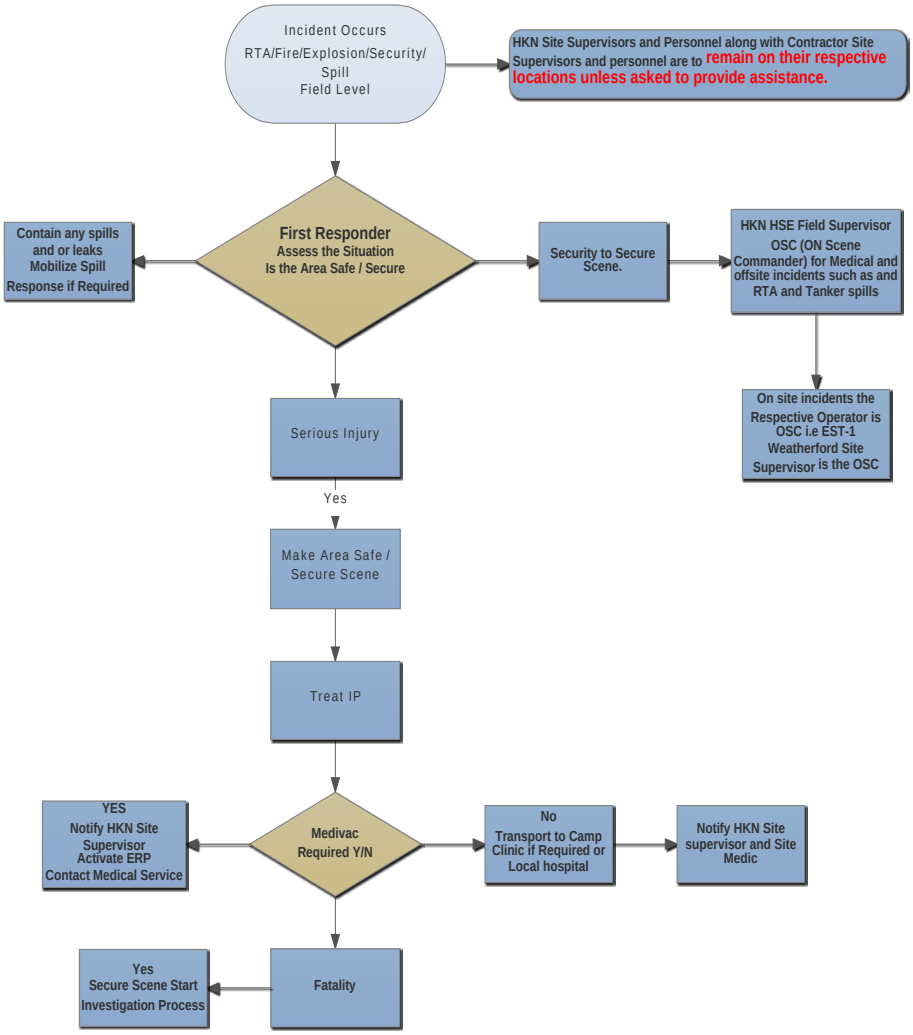
Liaises with the Authorities with respect to POB and NOK details;

As necessary, arranges for HKN ENERGY representatives to attend hospitals or reception centres for all personnel returning onshore or otherwise evacuating a site during an incident.

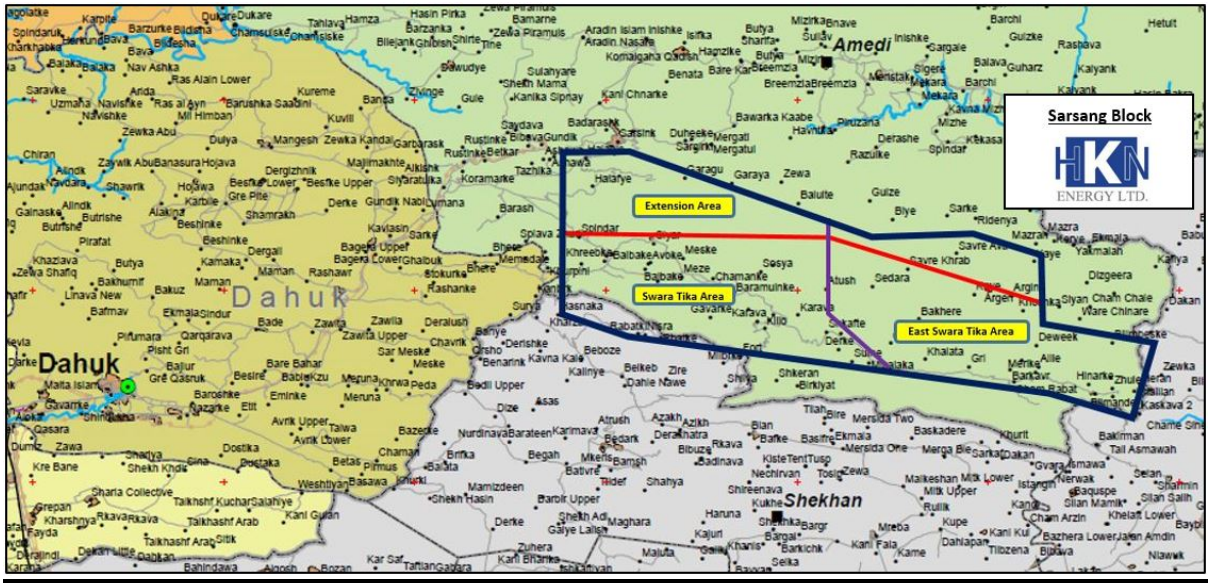
Holds details of Contractor contacts and NOK Emergency contact details for HKN Energy Staff

Note: EOC: is established in the Erbil office and should accommodate more than eight individuals. It is equipped with at least one telephone, satellite phone, PC with internet connection. A fax machine and a photocopier are within easy access. The HSE Manager will be responsible to ensure all the items listed above are in place and communication is tested minimally once a week. If this centre becomes inoperable or is not accessible, then an alternate centre shall be established after consultation with the CMT and communication to this effect shall be passed on to the relevant personnel.

Field Level First Responder ER Flow Chart



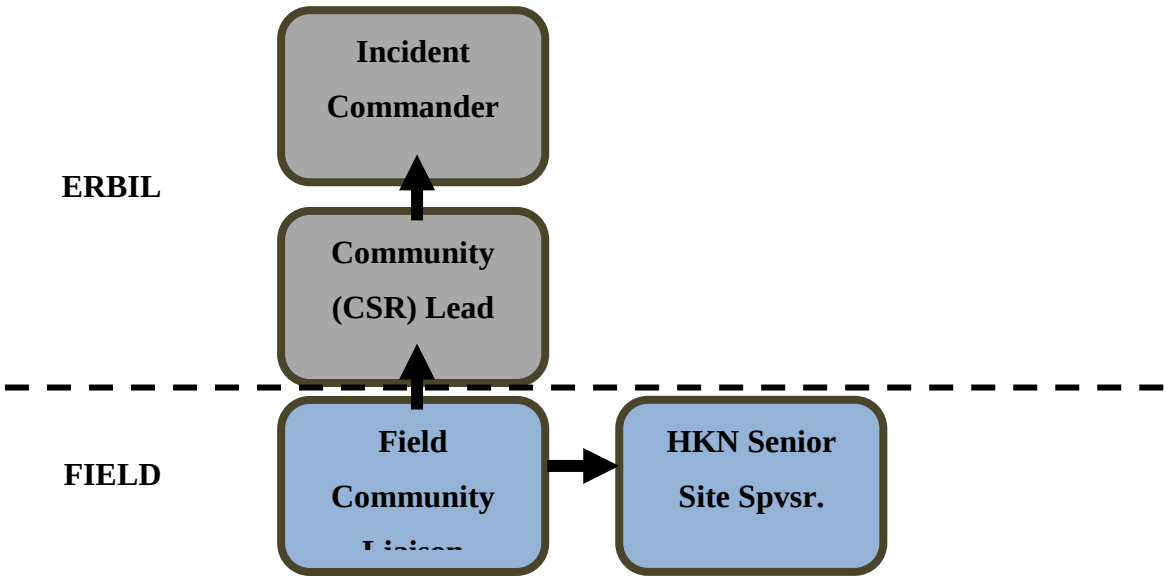
Appendix 2: Sarsang Community ERP Plan *EVACUATION PLAN*



HKN will ensure that the local Sarsang community is fully incorporated into the General Emergency Response. The health and safety of the local population is a critical priority to HKN.

Internal Communication

In the case that there is risk to the local Sarsang community and surrounding villages, the following organizational chart and outlines structure of internal communication:



External Communication

HKN Field Community Liaison Staff Action

Alert local stakeholders, especially those who will have immediate impact to a potential danger, including:

Local Asaish and Police

Sub-District Mayor and other officials in Chamanke and Atrush

Dohuk Governorate Officials

Village Mukhtars

HKN Community (CSR) Lead Action

Alert regional governmental officials in Erbil and the KRG:

Advise the Ministry of Natural Resources – CSR Advisor

Coordination with HKN Management and ICC Team.

Oversight of CSR Field Staff

Contacting Villages

HKN will communicate to the local villages to ensure that the correct information is being relayed and expectations are being managed. Many of the existing villages in the area have limited population living and residing in the villages on a day-to-day basis. HKN will rely upon contact information for village Mukhtars to get correct message to the local population:

Relevant Village Mukhtars				
Location	**Name**	**Contact**	**Position**	**Nearest Site**
Bakhere	Ibrahim Haji	0750 424 7591	Muktar	EST-1
Bedad	Jafar Mohammed	0750 480 1191	Muktar	ST-2/ST-4
Bilimbasa	Tayib Suleman	0750 456 4419	Muktar	EST-1
Gaverke	Mahmood Ahmed	0750 450 9247	Muktar	ST-1
Khalata	Shakir Mohammed	0750 494 8910	Muktar	EST-1
Milbirke	Luqman Murad	0750 480 1197	Muktar	ST-2/ST-4
Nisra	Muhamad Rashid Ibrahim	0750 450 9812	Muktar	ST-1
Rabatke	Muhamad Ali Suleman	0750 417 6371	Muktar	ST-1

Sevre	Abdulaziz Tahir	0750 491 9626	Muktar	EST-1
Shkafte	Rasheed Hasan	0750 474 4921	Muktar	EST-1

Contacting Authorities

Local authorities will be used to coordinate the communication and any necessary precautions for the local population. The following is a list of relevant local officials and their contact information.

Relevant Local Officials			
Jurisdiction	**Name**	**Contact**	**Title**
Atrush	Nashwan Hussni	0750 457 7315	Sub-District Mayor
Amedi	Hussein Khalid	0750 445 5919	District Mayor
Chamanke	Haval Muhamad Shareef	0750 452 6442	Sub-District Mayor
Dohuk	Botan Muhsin	0750 455 1087	District Mayor
Sarsang	Sami Benyamin Ashand	0750 450 7507	Sub-District Mayor
Shekhan	Ismail Mustafa	0750 446 0378	District Mayor
MNR	Shaho Hussein	0750 854 9476	MNR CSR Advisor

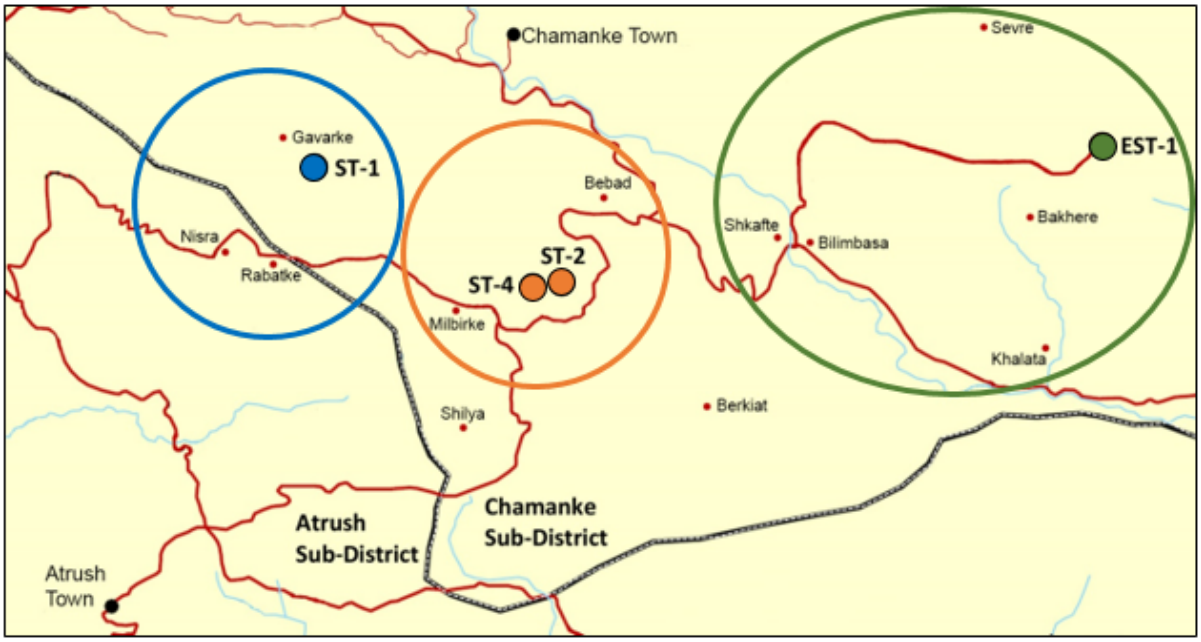
Contact during Planning and Pre-event awareness

HKN staff maintains routine communication with all village Mukhtars and local officials within close proximity of its operations. If there is an emergency, HKN will establish a formal line of communication (could be recorded message, daily calls to make sure telephones are working) to continually update the status. This will be done in the careful way to mitigate the creation of panic.

Muster Points

In the case of evacuation, muster points will be created for the local communities. This is designed to allow for best possible evacuation routes to limit people entering the central most affected areas.

The following is the area of influence for each existing operation. Muster points and organization will be organized as per the potential effected areas.


Chamanke Town
Sevre
Gavarke
ST-1
EST-1
Bebad
Nisra
Rabatke
ST-2
ST-4
Shkafte
Bilimbasa
Bakhere
Milbirke
Khalata
Shilya
Berkiat
Atrush
Sub-District
Chamanke
Sub-District
Atrush
Town

Appendix 2. Land acquisition Procedure

Land Acquisition Procedure

HKN-KRI-CSR-PRO-0001

PREPARATION & APPROVAL				
	Name	Title	Date	Signature
Author	Jotiar Ziad	Advisor	07-23-2018	
Reviewer	Nizar Said	CSR Manager	07-23-2018	
Approver	Paul Todd	Country Manager	07-23-2018	
CHANGES TO THIS DOCUMENT SHALL ONLY BE MADE BY THE AUTHOR OR DESIGNATE				

ISSUE SUMMARY		
ISSUE NUMBER	DATE	DESCRIPTION OF REVISION OR AMENDMENT
Rev-0	04-15-2017	Issued for Approval
Rev-1	07-23-2018	Updated version re-issued

INTRODUCTION

HKN Energy Ltd. ("HKN") and its contractors take measures to limit adverse impacts on the local land and communities in the Kurdistan Region of Iraq. This document outlines the Land Acquisition Procedures to ensure that these principles are fully integrated into HKN's operational planning, decision-making and implementation.

HKN and its contractors commit to abiding by all relevant local land acquisition laws and regulations from the Kurdistan Regional Government. Relevant international and industry standards on land acquisition will also be observed, including IFC Performance Standard “Land Acquisition and Involuntary Resettlement”.

The objective is to establish clear and transparent land acquisition procedures to ensure that operational deadlines can be achieved without delay and that the laws and regulations are complied with.

APPROACH

HKN takes a proactive role in engaging landowners and affected parties on land acquisition. This is consistent with HKN's overall stakeholder holder engagement principles. HKN will consider feasible alternatives during project design phase to avoid/minimize physical/economic displacement. HKN’s Grievance Management Procedure will be applied to ensure the HKN receives and responds to concerns/complaints in an impartial manner.

HKN establishes and maintains proactive communication with all impacted land owners and users regarding access to and impacts on to their land and livelihoods during development and future operations. Communicating the land acquisition procedures to affected stakeholders is key to mitigating potential community grievances.

Close coordination with local government is a key element of our land acquisition procedures. This occurs at the Ministry, Governorate, District and Sub-district levels with the relevant officials.

Land ownership is a sensitive subject to local communities and should be approached carefully by HKN and its contractors. HKN's activities on the land will not commence until the proper Ministry of Natural Resources ("MNR") and local government approvals have been achieved.

LAND COMPENSATION/RENTAL

HKN is currently required to pay compensation/rental for any private land that is used for sites and new access roads. According to HKN's Production Sharing Contract, HKN should pay compensation/rental to private landowners until the expropriation process is complete. There is a ministerial order that states the process for future expropriation of land, but to-date, action has not been implemented for any operators in the Kurdistan Region.

The Kurdistan Regional Government may also request for HKN to pay rental fees on public land (termed as 'rocky or grasslands'). However, this is not currently being implemented and the validity of these requests will be determined appropriately by HKN in the future.

HKN compensates private land owners and farmers based on Kurdistan Regional Government rates and standards. HKN will compensate landowners and farmers based on the government regulated rates. There are two types of payments for land:

Tree Compensation (Government Form in Appendix C) - This is a one-time payment to land owners or land users (even if government officially owns the land), that compensates based on the type and age of the trees on the land.

Annual Rent and Crop Compensation (Government Form in Appendix B) - This is an annual payment for rental of the land and compensation for crop loss (barley or wheat) only for land owners.

HOUSE/STRUCTURES COMPENSATION

HKN will avoid involuntary resettlement of full-time residencies if possible. If there are existing houses or other physical structures on the land that HKN must acquire due to safety or operational reasons, a one-time compensation

will be established for the owners of those structures in addition to land compensation/rental. The resettlement will be the responsibility of the Kurdistan Regional Government, but HKN will play an active role in planning, implementation and monitoring. This will follow similar government procedure as the tree compensation and rentals. This will be done in accordance with the appropriate socio-economic baseline data and the relevant government agency.

The compensation will be based on the value established by the Land Compensation Committee, as well as a Civil Engineer and Surveyor appointed by the respective District. The house/structure will be surveyed to assess value. Any contents of the house/structure that can be removed, will not be included in the value. After the compensation is complete, the owner relinquishes any rights or ownership to the house/structure. The relinquishment to the house/structure will be documented by HKN's Legal Representative.

ROLES AND RESPONSIBILITIES

HKN CSR Manager - Primary Contact for Land Acquisition and Management. Provides oversight and coordination with operations.

HKN CSR Field Officer - Responsible for implementation of Land Acquisition and coordination with local authorities (sub-district, district and governorate).

HKN Government Relations Coordinator - Ensures accurate and up-to-date communication with Ministry of Natural Resources on land acquisition.

HKN Civils - Provides accurate survey and details on requested land to the HKN CSR and Government Relations team. Maintains up-to-date map of HKN compensation and rental lands.

HKN Finance - Facilitates transparent and recordable payment process to private landowners.

HKN CSR Advisor - Record keeper in Erbil office to ensure documents are archived in hard and soft copy for an accurate database of all HKN land acquisition files.

Land Compensation Committee - This committee coordinates and prepares all documentation for land acquisition process. The committee consists of HKN Field CSR, Sub-District Mayor, Dohuk Directorate of Agriculture and Geology Surveyor from the MNR. If physical structure is present, Civil Engineer and Surveyor from the District are included.

Supreme Land Committee - This committee provides oversight and approval for the submitted land acquisition documents at the Dohuk Governorate level. The committee consists of an MNR Representative, Dohuk Governorate Representative, Council of Ministers Representative, Dohuk Real Estate Representative, and the Representative of Dohuk Agriculture.

Kurdistan Regional Government - Various authorities in the Kurdistan Regional Government participate in the process of land acquisition. These include: Ministry of Natural Resources, Ministry of Agriculture, the Ministry of Finance, the Dohuk Governorate, the District and Sub-district levels.

TRANSPARENCY

HKN takes considerable measures to ensure that the payment process is transparent and accurately recorded. In line with HKN's Core Values, HKN is committed to transparency and anti-corruption principles.

Land owners must produce the necessary land ownership and property documents to be eligible for compensation. The payment process is coordinated by HKN's Finance team in the presence of the Land Compensation Committee with records of issued cheques, contracts, and government issued identification.

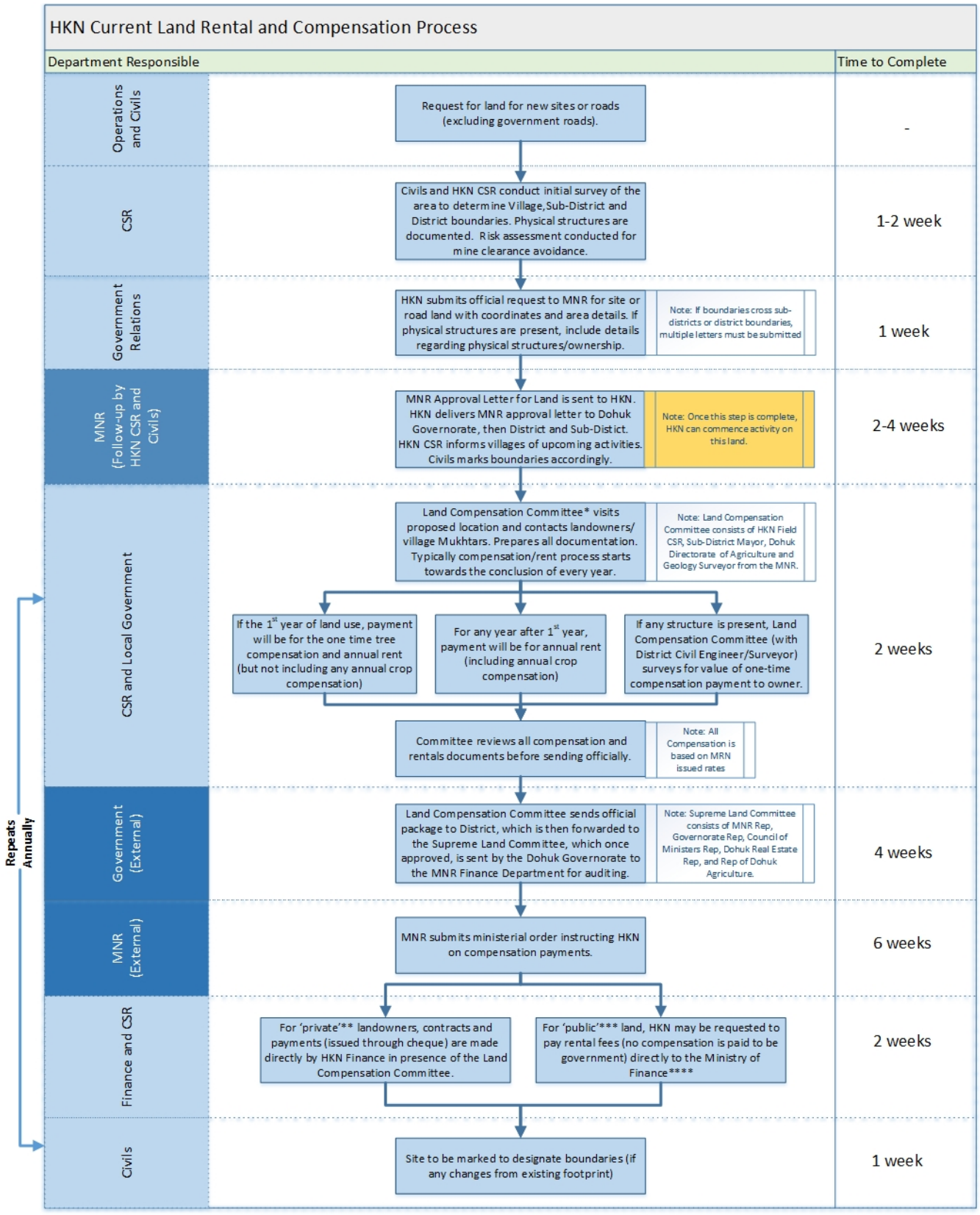
All payments for compensation shall remain confidential.

RECORDS

All hard and soft copies of land acquisition records are held by HKN in the Erbil office. Ongoing files are held by CSR Field Officer in Dohuk until finalization of that year's compensation or rental. Maps of HKN rented/compensated land are kept up-to-date and submitted to the MNR annually.

LAND ACQUISITION PROCESS

HKN follows the general guidelines and outline set out by the Kurdistan Regional Government and the Ministry of Natural Resources. The government process is subject to future revisions, so HKN must adapt its land acquisition procedures accordingly. HKN's detailed process can be seen in Appendix A.



* HKN pays the individuals on the Land Compensation Committee monthly for their time as per ministerial order.
**private land is defined currently or formerly inhabited by families, government may still officially own the land, but designated to a family for long-term (i.e. long term lease).
***public land is defined as non-assigned land and is termed by the KRG and MNR as 'rocky or grasslands'
**** According to the PSC, it is not clearly defined that HKN should pay for use of these 'public' lands. Therefore, HKN has not paid any amount to the Ministry of Finance to-date.

GOVERNMENT ANNUAL LAND RENTING FORM

Form No.1

Land owner Name **Annual Land Renting Form**
Farmer Name
Land plot No:
Mobile No:
Village Name:
Sub-District Name:

No	Crop type	Land			Product Kg/m^2	Total Crop(kg)	Price/kg (ID)	Sub-total (ID)	Comments
		Length(m)	Width (m)	Area (m2)					
1	Wheat				0.15		1500		
2	Wheat				0.25		1500		
3	Barley				0.15		1500		
4	Barley				0.30		1500		
5	Chik peas				0.15		1500		
6	Lintels				0.15		1500		
7	Broad beans				1.20		1500		
8	Green onion				1.20		750		
9	Spinach				1.20		750		
10	Radish				1.20		750		
11	Turnip				1.20		750		
12	Cabbage				1.20		1500		
13	Carrots				0.40		500		
14	Lettuce				1.20		500		
15	Cauliflower				0.40		1500		
16	Tomato				1.40		1000		
17	Cucumber				1.60		750		
18	Eggplant				1.00		750		
19	Sunflower				0.15		2000		
20	Cozzette				0.60		750		
21	Watermelon				0.80		750		
22	Okra				0.10		3000		
23	Green beans				0.10		2000		
24	Sesame				0.10		2000		
25	Pepper				0.20		1000		
26	Corn				0.30		2500		
27	Melon				0.20		1500		
28	Tarozy				0.10		750		
29	Tarozy				0.20		750		
30	Potato				1.00		1000		
31	Dry onion				1.00		750		
Grand Total									

Annual Rental Paid to the Land owner according to the type of the vegetables / fruits

1	Bare land	Annual	120000	Dinar/Acre	Total amount of the above table
2	Land with the right of dispose	Annual	120000	Dinar/Acre	Total amount of the above table
3	Glebe	Annual	120000	Dinar/Acre	Total amount of the above table
4	Undivided Land	Annual	108000	Dinar/Acre	Total amount of the above table
5	Agricultural land, to be divided	Annual	98000	Dinar/Acre	Total amount of the above table
6	Rocky and grassland	Annual	80000	Dinar/Acre	Total amount of the above table
7	Unused land	Annual	72000	Dinar/Acre	Total amount of the above table

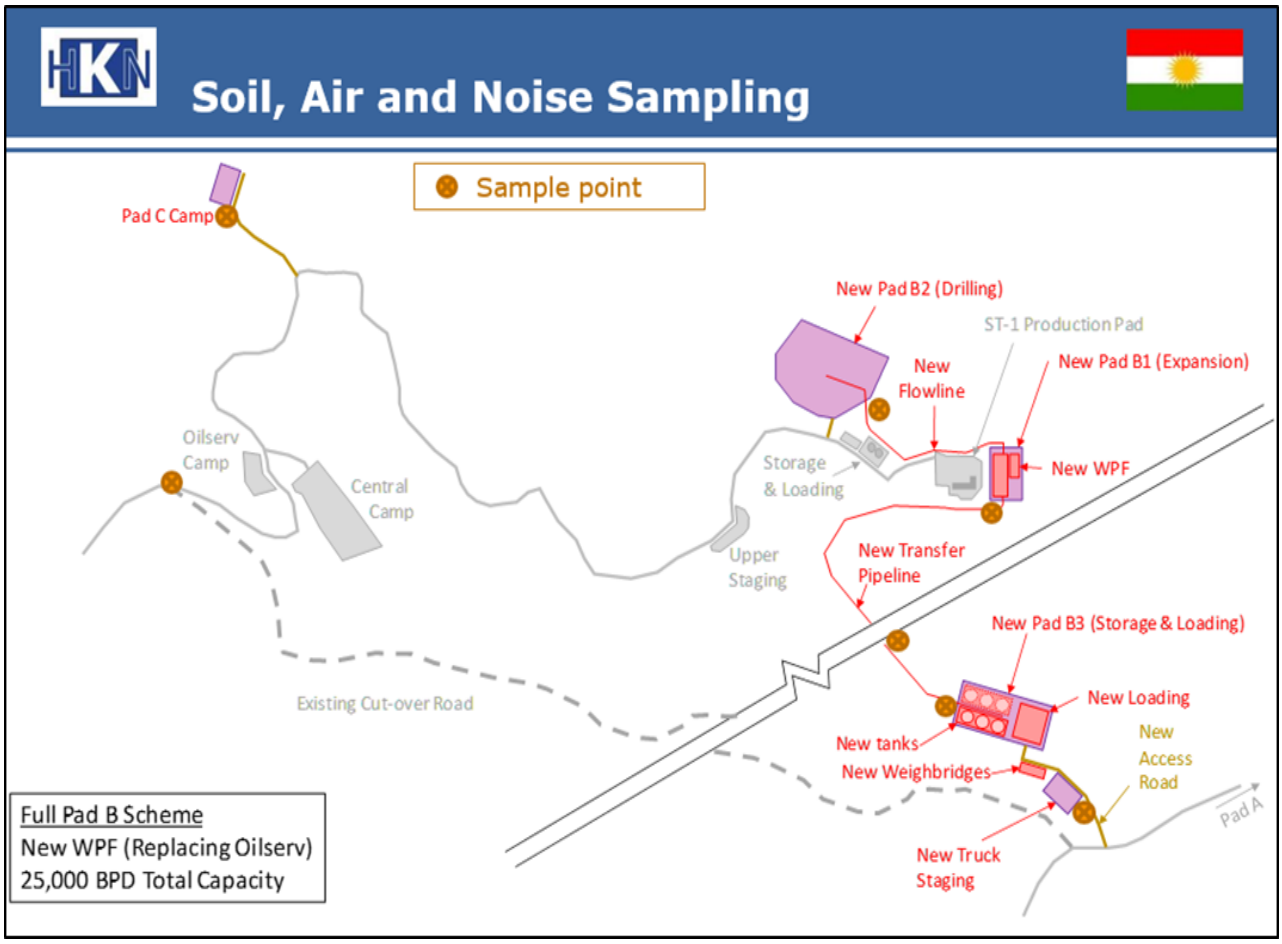
GOVERNMENT TREE COMPENSATION FORM

Form No.2

Land owner Name **Annual Land Renting Form**
Farmer Name
Land plot No:
Mobile No:
Village Name:
Sub-District Name:

No	Trees type	Land			Product Kg/m^2	Total Crop(kg)	Price/kg (ID)	Sub-total (ID)	Comments
		Length(m)	Width (m)	Area (m2)					
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
GRAND TOTAL									

Appendix 3. Air, (dust), noise and soil sampling location plan



Appendix 4. Soil sampling and analysis

Pad C - Camp location/SS01

Soil sample collected close to the pad C camp, the location still under construction, there were heavy vehicles working close to the location. Sample collected from the original soil layer.

SS01-P5	
Location Name	Pad C Camp
Sample Code	SS01
GPS	38 S 353394 4087098
Sampling date	7-5-2018

SS01-P1

SS01-P2

SS01-P3

SS01-P4

SS01 Directions Photos (Pad C Camp)

SS01 sample, Geology and Geomorphology-Field results

Field Observation						
Name of Area investigated	Sample ID	Soil Sample photo	Depth m	Texture	Color	Soil Classification
Pad C Cam	SS01		0.0-0.30	SiCL	Reddish brown	SiCL, Silty Clay, medium to high plasticity, with gravel, moist, reddish brown, no contaminated evidence

New Pad B2 (Drilling) /SS02

Soil sample collected close to the new well pad (B2), the location still under construction, also there were heavy vehicles working close to the location. Sample collected from the original soil layer.

SS02-P5	
Location Name	New Pad B2 (Drilling)
Sample Code	SS02
GPS	38 S 356192 4085932
Sampling date	7-5-2018

SS02-P1

SS02-P2

SS02-P3

SS02-P4

SS02 Directions Photos (New Pad B2)

SS02 sample, Geology and Geomorphology-Field results

Field Observation						
Name of Area investigated	Sample ID	Soil Sample photo	Depth m	Texture	Color	Soil Classification
New Pad B2 (Drilling)	SS02		0.0-0.30	SiCL	Reddish brown	SiCL, Silty Clay, medium to high plasticity, with gravel, moist, reddish brown, no contaminated evidence

New Pad B1 (Expansion) /SS03

Composite soil sample collected from this location, the location is expansion of new well pad B1, this location still under construction, also there were heavy vehicles working in this location. Composite sample was collected to represent whole the location. Sample duplicate for QC/QA collected from this site.

SS03-P5	
Location Name	New Pad B1 (Expansion)
Sample Code	SS03
GPS	38 S 356990 4085822
Sampling date	7-5-2018

SS03-P1

SS03-P2

SS03-P3

SS03-P4

SS03 Directions Photos (New Pad B1)

SS03 sample, Geology and Geomorphology-Field results

Field Observation						
Name of Area investigated	Sample ID	Soil Sample photo	Depth m	Texture	Color	Soil Classification
New Pad B1 (Expansion)	SS02		0.0-0.30	SiCL	Reddish brown	SiCL, Silty Clay, medium to high plasticity, moist, pale brown, contaminated evidence

Oil Serve Camp /SS04

This location is located on the road between ST1 and ST-2, the location is still natural, oil trucks and HKN employees' vehicles have been passed through this road.

SS04-P5	
Location Name	Oil Serve Camp
Sample Code	SS04
GPS	38 S 354209 4085726
Sampling date	7-5-2018

SS04-P1

SS04-P2

SS04-P3

SS04-P4

SS04 Directions Photos (Oil Serve Camp)

SS04 sample, Geology and Geomorphology-Field results

Field Observation						
Name of Area investigated	Sample ID	Soil Sample photo	Depth m	Texture	Color	Soil Classification
Oil Serve Camp	SS04		0.0-0.30	SiCL	Reddish brown	SiCL, Silty Clay, medium to high plasticity, with gravel, moist, reddish brown, No contaminated evidence

Truck Staging area /SS05

This location is located around 1km west of the ST-1, the location is agricultural land, there are several farms and houses surrounding the location. The location is still natural, no oil activities have been noticed.

SS05-P5

Location Name	New Truck Staging
Sample Code	SS05
GPS	38 S 359539 4083979
Sampling date	7-5-2018

SS05-P1

SS05-P2

SS05-P3

SS05-P4

SS05 Directions Photos (New Truck Staging)

SS05 sample, Geology and Geomorphology-Field results

Field Observation						
Name of Area investigated	Sample ID	Soil Sample photo	Depth m	Texture	Color	Soil Classification
New Truck Staging	SS05		0.0-0.30	SiCL	Reddish brown	SiCL, Silty Clay, medium to high plasticity, with gravel, moist, reddish brown, No contaminated evidence

New Pad 3/SS06

This location is located around 1km west of the ST-1, the location is agricultural land, and there are several farms and houses surrounding the location. The location is still natural, no oil activities have been noticed.

SS06-P5	
Location Name	New Pad 3
Sample Code	SS06
GPS	38 S 359361 4084109
Sampling date	7-5-2018


SS06-P1


SS06-P2


SS06-P3


SS06-P4

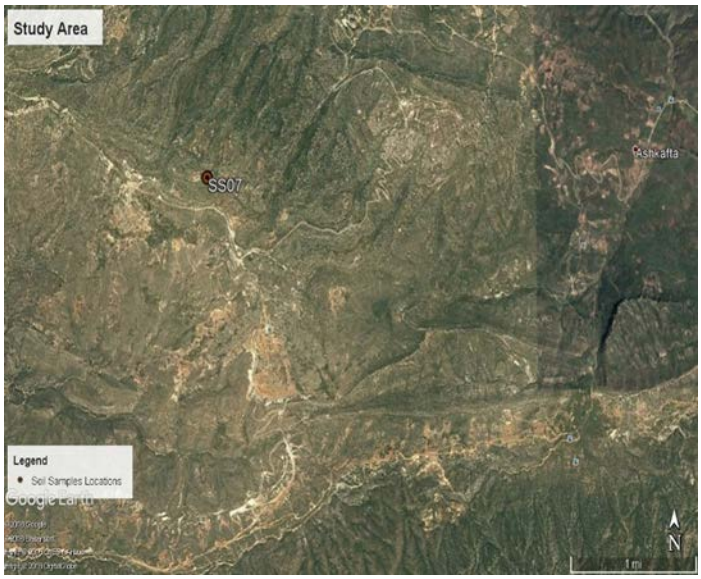
SS06 Directions Photos (New Pad 3)

TaSS06 sample, Geology and Geomorphology-Field results

Field Observation						
Name of Area investigated	Sample ID	Soil Sample photo	Depth m	Texture	Color	Soil Classification
New Pad 3	SS06		0.0-0.30	SiCL	Reddish brown	SiCL, Silty Clay, medium to high plasticity, with gravel, moist, reddish brown, No contaminated evidence

New Transfer Pipeline/ SW07

This location is located top of the hill, around 2km west north of the ST-1, the location is agricultural land, and there are several farms and houses surrounding the location. The location is still natural, no oil activities have been noticed.



SS07-P5	
Location Name	New Transfer Pipeline
Sample Code	SS07
GPS	38 S 359088 4084484
Sampling date	7-5-2018

SS07-P1

SS07-P2

SS07-P3

SS07-P4

SS07 Directions Photos (New Transfer Pipeline)

SS07 sample, Geology and Geomorphology-Field results

Field Observation						
Name of Area investigated	Sample ID	Soil Sample photo	Depth m	Texture	Color	Soil Classification
New Transfer Pipeline	SS07		0.0-0.30	SiCL	brown	SiCL, Silty Clay, medium to high plasticity, with gravel, moist, brown, No contaminated evidence

Appendix 5. Water sampling and analysis

Field Results

Nisra/SW01

The location is at Duhok governorate, close to main road of HKN permanent camp. The water source comes from spring water aquifer, the location surrounding by two houses and vegetation coverage. The water goes directly to agricultural lands and to the houses of the village. The location is considered within a small village. The water use is drinking, domestic purpose and irrigation. Weather was raining during water sampling.

SW01-P5	
Location Name	Nisra village
Sample Code	SW01
GPS	38 S 354059 4085634
Sampling date	28-4-2018

SW01-P1

SW01-P2

SW01-P3

SW01-P4

SW01 Directions Photos (Nisra village) close to central camp

SW01 sample, field measurements

Parameters	Results	β WHO Guideline values
Air Temperature (ċ)	13.2	*
Water Temperature (ċ)	14.8	*
PH	7.91	*
Salinity (ppt)	0.1	*
Electric Conductivity EC (µs/cm)	764	*
Dissolved Oxygen (mg/l)	8.38	*
Turbidity (NTU)	1.13	*
Water color	Transparent	*

SW01 sample, lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Hardness	271	*
Total Dissolved Solid (TDS)	638	*
Nitrate (NO_3)	6.21	50
Chloride (Cl)	71.8	*
Sulphate (SO_4)	11.71	*
Calcium (Ca)	90.6	*
Magnesium (Mg)	34.8	*
Cyanide	<0.01	*

SW01 sample, microbiology test

Parameters	Conc. (MPN/100 ml)	β WHO Guideline values (MPN/100 ml)
Coliform	0.0	0.0
E. coli	Absence	Absence

SW01 sample, heavy metals and hydrocarbons lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Petroleum Hydrocarbons (TPH)	<0.01	*
Antimony (Sb)	<0.002	0.02
Arsenic (As)	<0.002	0.01
Cadmium (Cd)	<0.001	0.003
Chromium (Cr)	<0.001	0.05
Copper (Cu)	<0.007	2.0
Iron (Fe)	<0.02	*
Lead (Pb)	<0.005	0.01
Manganese (Mn)	<0.002	*
Mercury (Hg)	<0.001	0.006

Nickel (Ni)	**<0.002**	**0.07**
Selenium (Se)	**<0.003**	**0.04**
Zinc (Zn)	**0.149**	*****

Notes:

β World Health Organization (WHO), Guideline values for chemicals that are of health significance in drinking-water Guideline-2017. *Chemicals for which guideline values have not been established.

Rabatke /SW02

The location is at Duhok governorate, approximately 1 KM from Nisra village. The location surrounding by two houses and agricultural lands and it is considered within a small village. The water source is spring, the water is using for drinking, domestic purpose and irrigation. A historic cave is close by. Weather was raining during samples collection.

SW02-P5	
Location Name	Rabatke village
Sample Code	SW02
GPS	38 S 354850 4085150
Sampling date	28-4-2018


SW02-P1


SW02-P2


SW02-P3


SW02-P4

SW02 Directions Photos (Rabatke village)

SW02 sample, Field measurements

Parameters	Results	β WHO Guideline values
Air Temperature (ċ)	11.8	*
Water Temperature (ċ)	13.5	*
PH	8.06	*
Salinity (ppt)	ND	*
Electric Conductivity EC (µs/cm)	564	*
Dissolved Oxygen (mg/l)	8.04	*
Turbidity (NTU)	0.61	*
Water color	Transparent	*

SW02 sample, lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Hardness	243	*
Total Dissolved Solid (TDS)	480	*
Nitrate (NO_3)	11.91	50
Chloride (Cl)	5.5	*
Sulphate (SO_4)	17.05	*
Calcium (Ca)	82.9	*
Magnesium (Mg)	29.1	*
Cyanide	<0.01	*

SW02 sample, microbiology test

Parameters	Conc. (MPN/100 ml)	β WHO Guideline values (MPN/100 ml)
Coliform	49.0	0.0
E. coli	Presence	Absence

SW02 sample, heavy metals and hydrocarbons lab analysis

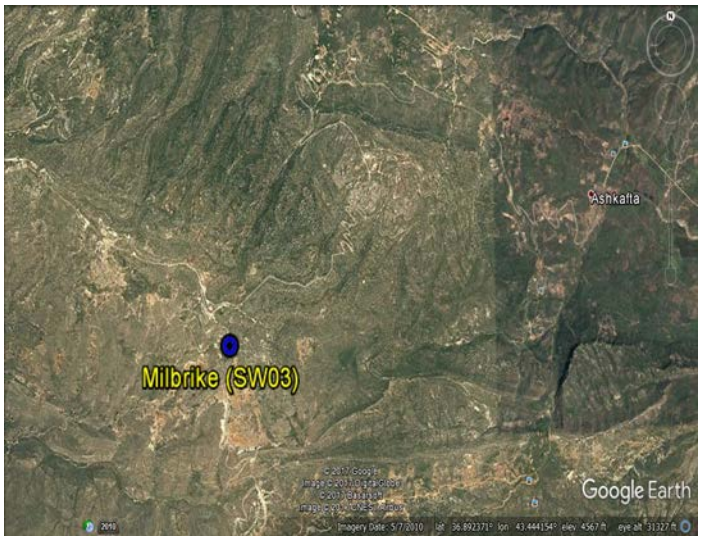
Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Petroleum Hydrocarbons (TPH)	<0.01	*
Antimony (Sb)	<0.002	0.02
Arsenic (As)	<0.002	0.01
Cadmium (Cd)	<0.001	0.003
Chromium (Cr)	<0.001	0.05
Copper (Cu)	<0.007	2.0
Iron (Fe)	<0.02	*
Lead (Pb)	<0.005	0.01

Manganese (Mn)	<0.002	*
Mercury (Hg)	<0.001	0.006
Nickel (Ni)	<0.002	0.07
Selenium (Se)	<0.003	0.04
Zinc (Zn)	0.183	*

Note: The tested parameters of this site fall within the acceptable standard limits except for microbiology test.

Milbirke /SW03

This location is located at Duhok governorate. The water source is spring, the location surrounding by three to four houses. Close to main road of oilfield. The water goes directly to agricultural lands.



SW03-P5	
Location Name	Milbirke village
Sample Code	SW03
GPS	38 S 359728 4083328
Sampling date	29-4-2018


SW03-P1


SW03-P2


SW03-P3


SW03-P4

Figure 27: SW03 Directions Photos (Milbirke village)

SW03 sample, field measurements

Parameters	Results	β WHO Guideline values
Air Temperature (ċ)	16.0	*
Water Temperature (ċ)	14.0	*
PH	7.80	*
Salinity (ppt)	0.1	*
Electric Conductivity EC (µs/cm)	693	*
Dissolved Oxygen (mg/l)	8.40	*
Turbidity (NTU)	0.65	*
Water color	Transparent	*

SW03 sample, lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Hardness	280	*
Total Dissolved Solid (TDS)	573	*
Nitrate (NO_3)	4.74	50
Chloride (Cl)	14.83	*
Sulphate (SO_4)	22.17	*
Calcium (Ca)	98.5	*
Magnesium (Mg)	42.8	*
Cyanide	<0.01	*

SW03 sample, microbiology test

Parameters	Conc. (MPN/100 ml)	β WHO Guideline values (MPN/100 ml)
Coliform	0.0	0.0
E. coli	Absence	Absence

SW03 sample, heavy metals and hydrocarbons lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Petroleum Hydrocarbons (TPH)	<0.01	*
Antimony (Sb)	<0.002	0.02
Arsenic (As)	<0.002	0.01
Cadmium (Cd)	<0.001	0.003
Chromium (Cr)	<0.001	0.05
Copper (Cu)	<0.007	2.0
Iron (Fe)	<0.02	*
Lead (Pb)	<0.005	0.01
Manganese (Mn)	<0.002	*
Mercury (Hg)	<0.001	0.006

Nickel (Ni)	<0.002	0.07
Selenium (Se)	<0.003	0.04
Zinc (Zn)	0.138	*

Bebad /SW04

This location is at Duhok governorate. The water source is spring water, the location surrounding by farms, natural trees and plants. The water goes directly to agricultural lands.

SW04-P5	
Location Name	Bebad village
Sample Code	SW04
GPS	38 S 362022 4086219
Sampling date	29-4-2018


SW04-P1


SW04-P2


SW04-P3


SW04-P4

Figure 28: SW04 Directions Photos (Bebad village)

SW04 sample, field measurements

Parameters	Results	β WHO Guideline values
Air Temperature (ċ)	15.4	*
Water Temperature (ċ)	13.3	*
PH	7.22	*
Salinity (ppt)	0.1	*
Electric Conductivity EC (µs/cm)	637	*

Dissolved Oxygen (mg/l)	9.41	*
Turbidity (NTU)	0.63	*
Water color	Transparent	*

SW04 sample, lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Hardness	243	*
Total Dissolved Solid (TDS)	479	*
Nitrate (NO_3)	5.03	50
Chloride (Cl)	1.78	*
Sulphate (SO_4)	12.35	*
Calcium (Ca)	89.6	*
Magnesium (Mg)	36.4	*
Cyanide	<0.01	*

SW04 sample, microbiology test

Parameters	Conc. (MPN/100 ml)	β WHO Guideline values (MPN/100 ml)
Coliform	240	0.0
E. coli	Presence	Absence

SW04 sample, heavy metals and hydrocarbons lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Petroleum Hydrocarbons (TPH)	<0.01	*
Antimony (Sb)	<0.002	0.02
Arsenic (As)	<0.002	0.01
Cadmium (Cd)	<0.001	0.003
Chromium (Cr)	<0.001	0.05
Copper (Cu)	<0.007	2.0
Iron (Fe)	<0.02	*
Lead (Pb)	<0.005	0.01
Manganese (Mn)	<0.002	*
Mercury (Hg)	<0.001	0.006
Nickel (Ni)	<0.002	0.07
Selenium (Se)	0.005	0.04
Zinc (Zn)	0.124	*

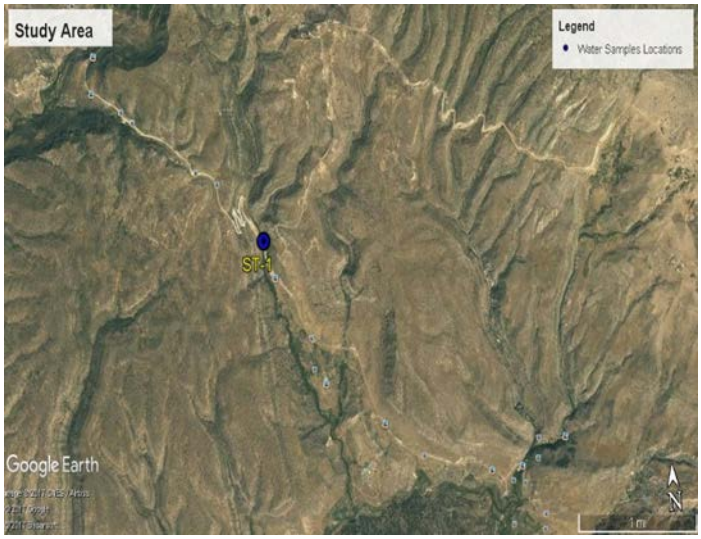
Note: The tested parameters of this site fall within the acceptable standard limits except for microbiology test.

Gavarke /SW05

BH team have not collected water samples from this location, there was no access road to the location, Weather was raining during survey, and the road has been covered totally with mud.

ST-1/SW06

The location is at Duhok governorate, close to main road of HKN permanent camp. The water source comes from spring water aquifer, the location surrounding by agricultural land. This location is considered a tourist area. The water is using for domestic purpose and irrigation.



ST1-P5	
Location Name	ST-1
Sample Code	SW06
GPS	38 S 349186 4085016
Sampling date	28-4-2018


SW06-1-P1


SW06-1-P2


SW06-1-P3


SW06-1- P4

Figure 29: SW06 Directions Photos

SW06 sample, field measurements

Parameters	Results	β WHO Guideline values
Air Temperature (ċ)	18.7	*
Water Temperature (ċ)	15.5	*
PH	8.20	*
Salinity (ppt)	ND	*
Electric Conductivity (µs/cm)	572	*
Dissolved Oxygen (mg/l)	11.9	*
Turbidity (NTU)	0.71	*

Water color	Transparent	*

Table 31: SW06 sample, lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Hardness	241	*
Total Dissolved Solid (TDS)	453	*
Nitrate (NO_3)	5.52	50
Chloride (Cl)	6.79	*
Sulphate (SO_4)	16.54	*
Calcium (Ca)	83.1	*
Magnesium (Mg)	31.1	*
Cyanide	<0.01	*

SW06 sample, microbiology test

Parameters	Conc. (MPN/100 ml)	β WHO Guideline values (MPN/100 ml)
Coliform	≥2400	0.0
E. coli	Presence	Absence

SW06 sample, heavy metals and hydrocarbons lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Petroleum Hydrocarbons (TPH)	<0.01	*
Antimony (Sb)	<0.002	0.02
Arsenic (As)	<0.002	0.01
Cadmium (Cd)	<0.001	0.003
Chromium (Cr)	<0.001	0.05
Copper (Cu)	<0.007	2.0
Iron (Fe)	<0.02	*
Lead (Pb)	<0.005	0.01
Manganese (Mn)	<0.002	*
Mercury (Hg)	<0.001	0.006
Nickel (Ni)	<0.002	0.07
Selenium (Se)	<0.003	0.04
Zinc (Zn)	0.168	*

Note: The tested parameters of this site fall within the acceptable standard limits except for microbiology test.

Chemanke/ SW07

This location is at Duhok governorate, at Chemanke village. The water source comes from spring water aquifer, the location surrounding by agricultural land. This location is considered a tourist area, there are several poultry fields around this location, and locals are using this water for domestic purpose. Weather was raining during samples collection. Grazing activities also has been noticed.

SW07-P5	
Location Name	Chemanke village
Sample Code	SW07
GPS	38 S 359554 4088908
Sampling date	28-4-2018

SW07-P1

SW07-P2

SW07-P3

SW07-P4

Figure 30: SW07 Directions Photos

SW07 sample, field measurements

Parameters	Results	β WHO Guideline values
Air Temperature (ċ)	15.4	*
Water Temperature (ċ)	13.0	*
PH	8.58	*
Salinity (ppt)	ND	*
Electric Conductivity (µs/cm)	388	*
Dissolved Oxygen (mg/l)	10.45	*
Turbidity (NTU)	11.3	*
Water color	Muddy	*

SW07 sample, lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Hardness	196	*
Total Dissolved Solid (TDS)	273	*
Nitrate (NO_3)	3.04	50
Chloride (Cl)	2.31	*
Sulphate (SO_4)	11.82	*

Calcium (Ca)	58.8	*
Magnesium (Mg)	13.0	*
Cyanide	<0.01	*

SW07 sample, microbiology test

Parameters	Conc. (MPN/100 ml)	β WHO Guideline values (MPN/100 ml)
Coliform	≥2400	0.0
E. coli	Presence	Absence

SW07 sample, heavy metals and hydrocarbons lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Petroleum Hydrocarbons (TPH)	<0.01	*
Antimony (Sb)	<0.002	0.02
Arsenic (As)	<0.001	0.01
Cadmium (Cd)	<0.001	0.003
Chromium (Cr)	<0.001	0.05
Copper (Cu)	<0.007	2.0
Iron (Fe)	<0.02	*
Lead (Pb)	<0.005	0.01
Manganese (Mn)	0.014	*
Mercury (Hg)	<0.001	0.006
Nickel (Ni)	0.002	0.07
Selenium (Se)	<0.003	0.04
Zinc (Zn)	0.215	*

Note: The tested parameters of this site fall within the acceptable standard limits except the microbiology results.

EST-1/SW08

This location is at Duhok governorate, around two km east of Chemanke village. The water source comes from a spring water aquifer, the location surrounding by agricultural land. This location is considered tourist area, there are several poultry fields around this location. BH team collected one sample from this location and one duplicate. Weather was raining during samples collection.

SW08-P5	
Location Name	EST-1
Sample Code	(SW08)
GPS	38 S 361398 4087990
Sampling date	28-4-2018

SW08-1-P1

SW08-1-P2

SW08-1-P3

SW08-1-P4

Figure 31: SW08- Directions Photos

SW08 and SW08A (Duplicate) samples, Field measurements

Parameters	Results	Duplicate	β WHO Guideline values
Air Temperature (ċ)	15.3	15.3	*
Water Temperature (ċ)	12.9	12.9	*
PH	8.37	8.40	*
Salinity (ppt)	0.0	0.0	*
Electric Conductivity (µs/cm)	402	403	*
Dissolved Oxygen (mg/l)	10.36	10.11	*
Turbidity (NTU)	12.7	13.0	*
Water color	Muddy	Muddy	*

SW08 and SW08A (Duplicate) samples, lab analysis

Parameters	Conc. (mg/l)	Duplicate Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Hardness	211	217	*
Total Dissolved Solid (TDS)	345	352	*

Nitrate (NO_3)	4.05	4.1	50
Chloride (Cl)	3.8	3.66	*
Sulphate (SO_4)	15.23	14.74	*
Calcium (Ca)	62.9	63.3	*
Magnesium (Mg)	18.0	17.9	*
Cyanide	<0.01	<0.01	*

SW08 and SW08A (Duplicate) samples, Microbiology test

Parameters	Conc. (MPN/100 ml)	Duplicate Conc. (MPN/100 ml)	β WHO Guideline values (MPN/100 ml)
Coliform	≥2400	≥2400	0.0
E. coli	Presence	Presence	Absence

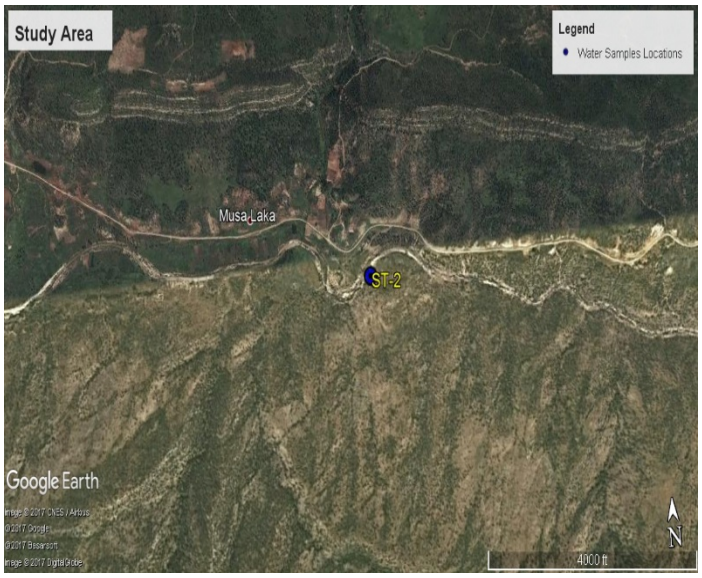
SW08 and SW08A (Duplicate) samples, heavy metals and hydrocarbons lab analysis

Parameters	Conc. (mg/l)	Duplicate Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Petroleum Hydrocarbons (TPH)	<0.01	<0.01	*
Antimony (Sb)	<0.002	<0.002	0.02
Arsenic (As)	<0.002	<0.002	0.01
Cadmium (Cd)	<0.001	<0.001	0.003
Chromium (Cr)	<0.001	<0.001	0.05
Copper (Cu)	<0.007	<0.007	2.0
Iron (Fe)	<0.02	<0.02	*
Lead (Pb)	<0.005	<0.005	0.01
Manganese (Mn)	<0.002	<0.002	*
Mercury (Hg)	<0.001	<0.001	0.006
Nickel (Ni)	<0.002	<0.002	0.07
Selenium (Se)	<0.003	<0.003	0.04
Zinc (Zn)	0.146	0.146	*

Note: The tested parameters of this site fall within the acceptable standard limits except the microbiology results

ST-2/SW09

The location is at Duhok governorate. The water source comes from a spring water aquifer, the location surrounding by agricultural land. The water is using for domestic purpose and irrigation. Weather was raining during samples collection. Grazing activities also been noticed.



SW09-P5	
Location Name	ST-2
Sample Code	SW09
GPS	38 S 370910 4082103
Sampling date	28-4-2018

SW09-P1

SW09-P2

SW09-P3

SW09-P4

Figure 32: SW09 Directions Photos

SW09 sample, field measurements

Parameters	Results	β WHO Guideline values
Air Temperature (ċ)	14.0	*
Water Temperature (ċ)	13.2	*
PH	8.65	*
Salinity (ppt)	ND	*
Electric Conductivity (µs/cm)	433	*
Dissolved Oxygen (mg/l)	10.09	*
Turbidity (NTU)	27.0	*
Water color	muddy	*

SW09 sample, lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Hardness	260	*
Total Dissolved Solid (TDS)	560	*
Nitrate (NO_3)	8.9	50
Chloride (Cl)	6.6	*

Sulphate (SO_4)	32.85	*
Calcium (Ca)	61.3	*
Magnesium (Mg)	22.4	*
Cyanide	<0.01	*

SW09 sample, Microbiology test

Parameters	Conc. (MPN/100 ml)	β WHO Guideline values (MPN/100 ml)
Coliform	≥2400	0.0
E. coli	Presence	Absence

SW09 sample, heavy metals and hydrocarbons lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Petroleum Hydrocarbons (TPH)	<0.01	*
Antimony (Sb)	<0.002	0.02
Arsenic (As)	<0.002	0.01
Cadmium (Cd)	<0.001	0.003
Chromium (Cr)	<0.001	0.05
Copper (Cu)	<0.007	2.0
Iron (Fe)	<0.02	*
Lead (Pb)	<0.005	0.01
Manganese (Mn)	0.003	*
Mercury (Hg)	<0.001	0.006
Nickel (Ni)	<0.002	0.07
Selenium (Se)	0.003	0.04
Zinc (Zn)	0.155	*

Note:
The tested parameters of this site fall within the acceptable standard limits except for the microbiology results Field Blank.

Field blank sample, lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Hardness	260	*
Total Dissolved Solid (TDS)	560	*
Nitrate (NO_3)	3.1	50
Chloride (Cl)	3.6	*
Sulphate (SO_4)	24.0	*
Calcium (Ca)	1.1	*
Magnesium (Mg)	0.7	*
Cyanide	<0.01	*

Field Blank sample, Microbiology test

Parameters	Conc. (MPN/100 ml)	β WHO Guideline values

		(MPN/100 ml)
Coliform	0.0	0.0
E. coli	Absence	Absence

Field Blank sample, heavy metals and hydrocarbons lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Petroleum Hydrocarbons (TPH)	<0.01	*
Antimony (Sb)	<0.002	0.02
Arsenic (As)	<0.002	0.01
Cadmium (Cd)	<0.001	0.003
Chromium (Cr)	<0.001	0.05
Copper (Cu)	<0.007	2.0
Iron (Fe)	<0.02	*
Lead (Pb)	<0.005	0.01
Manganese (Mn)	<0.002	*
Mercury (Hg)	<0.001	0.006
Nickel (Ni)	<0.002	0.07
Selenium (Se)	<0.003	0.04
Zinc (Zn)	0.273	*

Rinsate blank sample, lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Hardness	260	*
Total Dissolved Solid (TDS)	560	*
Nitrate (NO_3)	3.2	50
Chloride (Cl)	3.79	*
Sulphate (SO_4)	24.4	*
Calcium (Ca)	0.8	*
Magnesium (Mg)	0.5	*
Cyanide	<0.01	*

Rinsate Blank sample, Microbiology test

Parameters	Conc. (MPN/100 ml)	β WHO Guideline values (MPN/100 ml)
Coliform	0.0	0.0
E. coli	Absence	Absence

Rinsate Blank sample, Heavy metals and Hydrocarbons lab analysis

Parameters	Conc. (mg/l)	β WHO Guideline values (mg/l)
Total Petroleum Hydrocarbons (TPH)	<0.01	*
Antimony (Sb)	<0.002	0.02
Arsenic (As)	<0.002	0.01
Cadmium (Cd)	<0.001	0.003
Chromium (Cr)	<0.001	0.05

Copper (Cu)	<0.007	2.0
Iron (Fe)	<0.02	*
Lead (Pb)	<0.005	0.01
Manganese (Mn)	<0.002	*
Mercury (Hg)	<0.001	0.006
Nickel (Ni)	<0.002	0.07
Selenium (Se)	<0.003	0.04
Zinc (Zn)	0.235	*

Notes: [6] World Health Organization (WHO), Guideline values for chemicals that are of health significance in drinking-water Guideline.

*Chemicals for which guideline values have not been established. project facilities diagram with approximate sampling points for determining baseline data

Appendix 6. Analysis 1 – Swara Tika 2 and Swara Tika 4 wells

HKN Energy
ST-1, 2 and ST-4 Well
GTTS-File No.GTTSIQ-1708-01

Well: Comingled samples from ST-2 and ST-4
Cylinder No: D911770
Sampling Point: Separator Gas outlet line

Compositional Analysis of Surface Gas Sample in Cylinder No D911770

	Component	MW	Surface Gas	
		g/mol	Mole %	Weight %
H_2S	Hydrogen sulphide	34.08	10.914	14.076
CO_2	Carbon dioxide	44.01	6.619	11.024
N_2	Nitrogen	28.01	3.490	3.700
C_1	Methane	16.04	58.496	35.508
C_2	Ethane	30.07	8.458	9.624
C_3	Propane	44.10	5.394	9.002
iC_4	i-Butane	58.12	1.604	3.527
nC_4	n-Butane	58.12	2.292	5.041
iC_5	i-Pentane	72.15	1.085	2.963
nC_5	n-Pentane	72.15	0.644	1.759
C_6	Hexanes	84.00	0.379	1.204
C_7	Heptanes	96.00	0.269	0.977
C_8	Octanes	107.00	0.152	0.614
C_9	Nonanes	121.00	0.117	0.536
C_{10}	Decanes	134.00	0.075	0.382
C_{11+}	Undecanes+	147.00	0.011	0.062
	Total		100.00	100.00

Calculated Composition Properties	
C7+ Mole%	0.624
C7+ Molecular Weight (g mol-1)	26.42
Gas Average Molecular Weight (g mol-1)	108.87
Gas Gravity at ambient conditions	0.9125
Critical Temperature, K	252.39
Critical Pressure, psia	744.01
BTU/ft3 (gross-dry)	1195.57
BTU/ft3 (net-dry)	1094.30

Appendix 7. Gas composition analysis 2 – Swara Tika 1 well

HKN Energy
ST-1, 2 and ST-4 Well
GTTS-File No.GTTSIQ-1708-01

Well: ST-1

Cylinder No: D859657

Sampling Point: HP Separator Gas outlet line

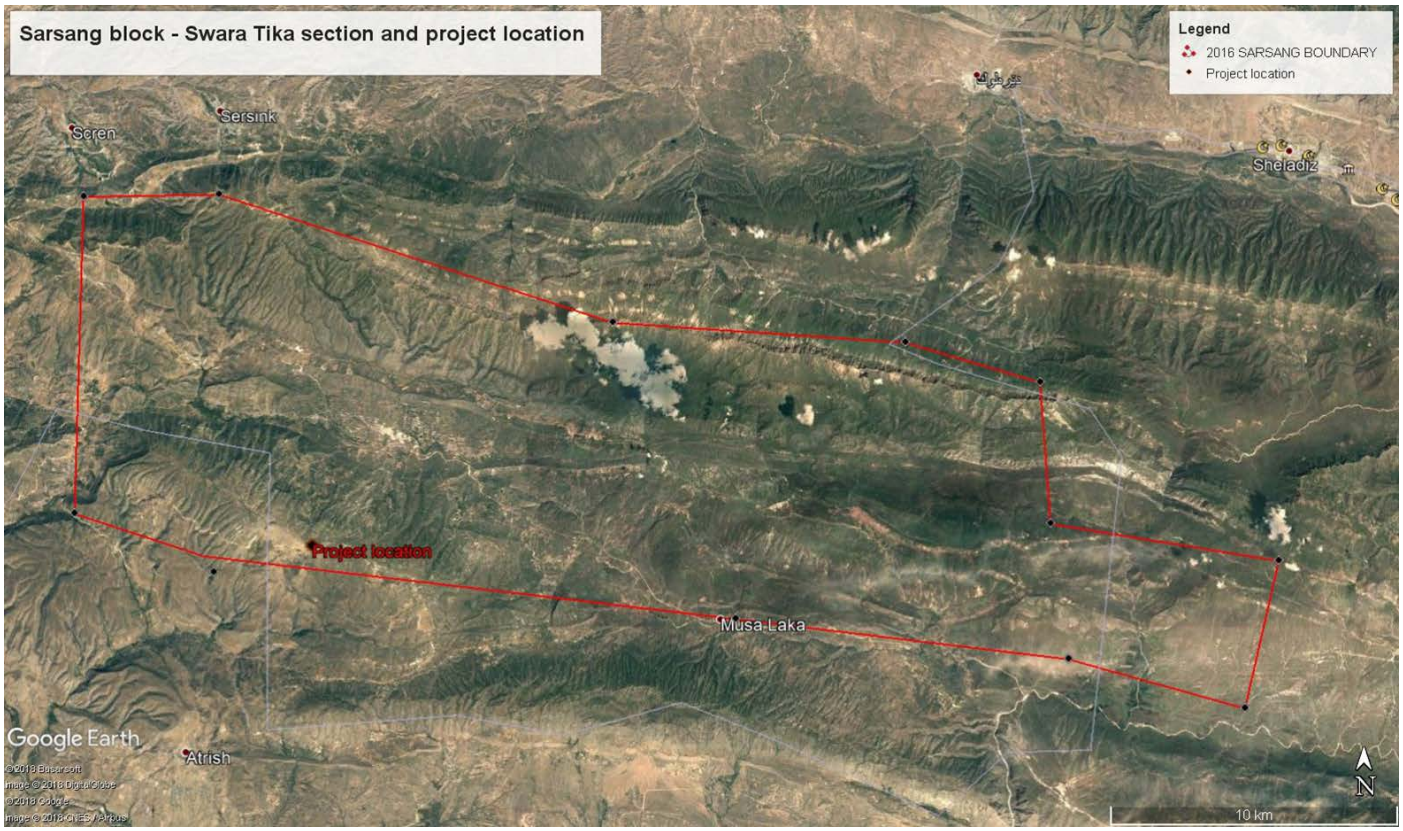
Compositional Analysis of Surface Gas Sample in Cylinder No D859657

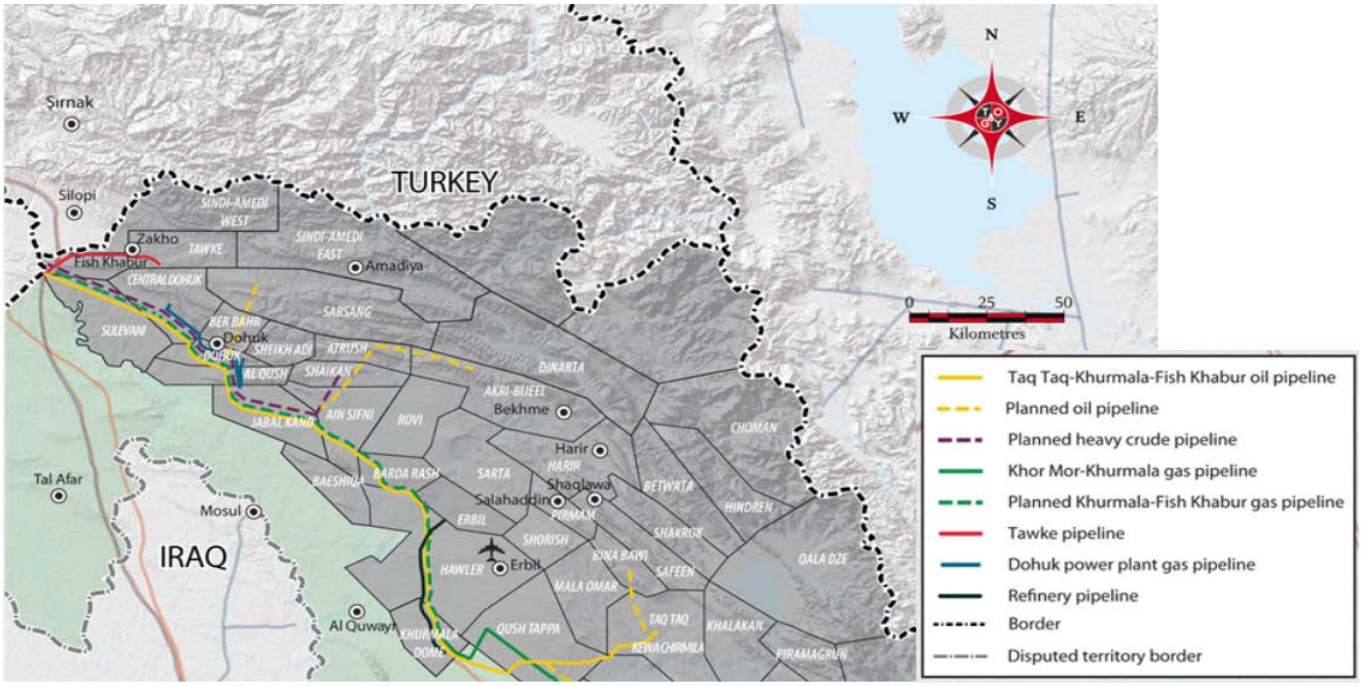
	Component	MW	Surface Gas	
		g/mol	Mole %	Weight %
H_2S	Hydrogen sulphide	34.08	3.817	5.386
CO_2	Carbon dioxide	44.01	2.455	4.473
N_2	Nitrogen	28.01	18.037	20.917
C_1	Methane	16.04	62.299	41.373
C_2	Ethane	30.07	4.124	5.134
C_3	Propane	44.10	3.473	6.342
iC_4	i-Butane	58.12	0.992	2.387
nC_4	n-Butane	58.12	2.114	5.088
iC_5	i-Pentane	72.15	0.952	2.844
nC_5	n-Pentane	72.15	0.879	2.625
C_6	Hexanes	84.00	0.411	1.431
C_7	Heptanes	96.00	0.192	0.762
C_8	Octanes	107.00	0.120	0.530
C_9	Nonanes	121.00	0.089	0.448
C_{10}	Decanes	134.00	0.039	0.215
C_{11+}	Undecanes+	147.00	0.008	0.046
	Total		100.00	100.00

Calculated Composition Properties	
C7+ Mole%	0.447
C7+ Molecular Weight (g mol-1)	24.15
Gas Average Molecular Weight (g mol-1)	108.10
Gas Gravity at ambient conditions	0.8340
Critical Temperature, K	214.86
Critical Pressure, psia	659.67
BTU/ft3 (gross-dry)	1031.48
BTU/ft3 (net-dry)	939.01

Note: 0.000 means less than 0.0005.

Appendix 8. Sarsang Block and KRG pipeline infrastructure plans





Appendix 9. Assessment of Impacts, Mitigation Measures and Residual Impacts

Civil works & General Operations									
Category	Event/Resources	Impact	Project activity	Severity	Duration	Likelihood	Impact rating	Mitigation	Residual rating
Physical disturbance (Land)	Vegetation clearance for new access roads and flowlines.	Loss of flora, displacement of fauna, loss of soil/sediment, stabilization increasing soil erosion, loss of livelihood	Site grading Surface preparation of pad areas Flare tower access track Production facility foundation Truck loading foundation area Storage tank foundations Excavation of pipeline and flowlines Access road construction Perimeter fencing on all access roads	Major	Short term	-	**M**	A 'single track' policy will be adhered to unless conditions dictate otherwise Journeys will be planned, controlled and minimized Stakeholders made aware of HKN's civil activities and footprint area expected to be covered Maximum use of project access roads previously constructed during the exploration	**L**

			Pit excavations Temporary camp set up Use of heavy lifting civils equipment, (mechanical diggers, dumper trucks and pickup trucks					phase of the project. Pre-survey the new access road and flowline route to avoid sensitive habitats. Limit clearance to within (or adjacent to) the road construction corridor. Avoid driving outside the working width of the access road. The area will be returned to original surface condition to reduce the potential for erosion and promote full recovery of the area's ecosystem at the end of	

								commercial production unless the Government takes over operations.	
Natural Resources	Use of fuel (for civils activities)	Depletion of resources resulting in reduction of fuel availability to local populations	Site grading Surface preparation of pad areas Flare tower access track Production facility foundation Truck loading foundation area Storage tank foundations Excavation of pipeline and flowlines Access road construction Perimeter fencing on all access roads Pit excavations	Minor effect	Short term	-	**L**	Prevent fuel theft by keeping stock within camp site boundaries. Prevention of spills through use of spill control procedures and fuel transfer procedures. Regular maintenance of vehicles, combustion engines and generators to the manufacturers' specifications.	**L**

Physical Disturbance (Land)	Soil compaction / destruction of cultural artefacts	Land compaction and earth works, from heavy vehicles during construction phase (drill site, camp, WPF & access roads)	Site grading Surface preparation of pad areas Flare tower access track Production facility foundation Truck loading foundation area Storage tank foundations Excavation of pipeline and flowlines Access road construction Perimeter fencing on all access roads Pit excavations Temporary camp set up Use of heavy lifting civils	Major	Short term	-	**M**	Limit soil disturbance /grading to areas within the area designated for the production facility, road / flowline corridors, camp and well sites. Where practical, retain and store the topsoil for use in site earthworks and/or reinstatement work later in the project. All known cultural sites will be avoided and plotted on construction maps. Project field workers will be made aware that any disturbance to,	**L**

			equipment, (mechanical diggers, dumper trucks and pickup trucks					defacement of, or removal of archaeological, historical, or sacred material will not be permitted. Any chance finds of cultural heritage will be reported to the EHS Department who will notify the appropriate authorities about the management processes to be followed.	
Air and Climate	Air Quality	Reduction in ambient air quality due to exhaust and vapor emissions, and dust generation. These emissions may contribute to	Site grading Surface preparation of pad areas Flare tower access track Production facility foundation	Major	Short term	-	**M**	Civil works and dust generating activities will not take place in windy conditions where excessive wind-blown sand could be generated	**L**

		climate change (CH4, CO2), acid effects (SOx, NOx) and short term localised impact on the air quality. Road construction may create dust in the air which may contribute to short term localised impact on the air and water quality.	Truck loading foundation area construction Storage tank Foundations construction Excavation of pipeline and flowlines Access road construction Perimeter fencing on all access roads Pit excavations Temporary camp set up Use of heavy lifting civils equipment, (mechanical diggers, dumper trucks and pickup trucks Diesel generators for power supply Transport of personnel and materials by road					Engine and equipment use will be minimized to only use equipment for its intention. Preference will be given to fuel-efficient generators and vehicles Appropriate procedure for fuel transfer to minimize vapor loss Use alternative energy where possible such as solar power Use low sulphur fuels if available in the local marketplace. Contractors are required to have maintenance programs in place ensuring	

								that construction equipment power generators and other prime movers are regularly serviced and maintained to the manufacturer's specifications. Traffic movements to be always optimized and management procedures to be followed, including speed restrictions (especially near any communities or dwellings). All vehicles will be required to cover loose loads of dust generating materials when on	

								driving on public roads. Employees working in dusty conditions must use appropriate PPE.	
Liquid Waste Discharges	Waste water discharge (Domestic and sanitary waste water)	Contamination of ground water, soil contamination, soil erosion and biological hazard		Major	Short-term	-	**M**	Wastewater will be disposed and treated in of aerated treatment system consisting of a pond with artificial aeration to promote the biological oxidation of wastewaters. The lagoons shall be monitored to ensure compliance with regulatory requirements	**L**

								Where lagoon is not accessible, septic tank system shall be in place and Gray/back water waste shall be removed by approved contractor.	
Ecology and biodiversity	Flora & Fauna	Disturbance of flora and fauna	Site grading Surface preparation of pad areas Flare tower access track Production facility foundation Truck loading foundation area Storage tank foundations Excavation of pipeline and flowlines	Major	Short term	Certain	**M**	Disturbance of vegetation will be avoided during access road construction by mapping out the project area Field staff will undergo training to ensure that personnel are aware of environmental sensitivities. Food storage and waste management procedures will be	**L**

			Access road construction Perimeter fencing on all access roads Pit excavations Temporary camp set up Use of heavy lifting civils equipment, (mechanical diggers, dumper trucks and pickup trucks Diesel generators for power supply					designed such that animals will not be attracted to camps. Areas which may attract fauna will be fenced off. Lights will be oriented towards specific work areas Night driving will not be undertaken except in emergency	
Water resources	Ground water	Increased demand in water resources	Camp operation All site preparations as mentioned above.	Localized	Short term	Certain	**L**	Minimize the demand for water by reusing and recycling, setting strict water conservation targets and by monitoring water consumption	**L**

Human environment	Local community disturbance	Nuisance due to increased traffic and land clearing and construction. Disturbance to public picnic areas and local farmers Accidents due to increased vehicle movements	Site grading Surface preparation of pad areas Flare tower access track Production facility foundation Truck loading foundation area Storage tank foundations Excavation of pipeline and flowlines Access road construction Perimeter fencing on all access roads Pit excavations Temporary camp set up Use of heavy lifting civils	Major	Short term	Certain	**M**	Community engagement will take place via local authorities to ensure that local people are aware of the project. Traffic disturbance during mobilization and demobilization will be minimized Deliveries and trips between communities and base camp will be minimized Speed limits will be strictly enforced Night driving will not be undertaken except in emergency All drivers will	**L**

			equipment, (mechanical diggers, dumper trucks and pickup trucks Diesel generators for power supply					undergo appropriate training	

Light	Light from ground transport movements	Disturbance to local populations, livestock and fauna	Lifecycle of civils project				**M**	Minimize road transport requirements by storing equipment on site when practical. Ensure personnel transfer is carried out during daylight hours where operationally practicable."	**L**
Human environment	Local community effect on project	Increase in business/trade	Procurement of supplies and equipment	-	-	-	**P**	Local trade will be encouraged	**P**
Human environment	Local community effect on project	Increased employment opportunity		-	-	-	**P**	Local employment will be encouraged	**P**
Human environment	Local community effect on project	Skills / technology transfer	Staffing	-	-	-	**P**	Local employment and training will be encouraged	**P**
Human environment	Local tourism	Disruption	Access road construction and excavation works	-	-	-	**M**	Local tourism will benefit from the use of improved access routes	**L**
Socio economic	Existing infrastructure	Damage to local economy	Procurement of local supplies	-	-	-	**M**	The workforce will be made aware of local	**L**

								infrastructure Buffer zones will be established around infrastructure where appropriate	
Waste	Food and solid waste disposal	Pests / rodents influx and seepage from poor waste management	General operations; Civils, drilling and production	Localized	Mid/Long term	-	**M**	Waste storage, handling and disposal (incineration, compaction and removal from site or burial - especially for biodegradable material) will be in accordance with HKN Waste Management Plan. Specifically, HKN will segregate all solid wastes at source to allow re-use, recycling, or disposal as appropriate for waste type:	**L**

								Food waste shall be segregated for incineration. Paper and cardboard waste will be segregated so that it can if possible be sent for recycling or be incinerated on site. All waste will be stored in designated waste storage areas (at camps, well site and camp site). Waste storage will be on hard standing in covered skips or bins which will be color coded for segregation. Any solid hazardous	

								waste (e.g. light bulbs, batteries etc.,) will be segregated and stored in covered containers until transported to approved waste management facilities. Special waste including waste from the medical room will be stored in dedicated biohazard waste storage containers which will be sealed and sent in dedicated approved vehicles to MNR approved hospital waste disposal facilities."	

Liquid Waste Discharges	Waste water discharge (produced water)	Contamination of ground water, soil contamination, soil erosion and biological hazard	Production facility	Localized	Long term	-	**M**	Produced water from HKN production has been historically low, and will be collected by waste management contractor, approved by the MNR.	**L**
Heritage	Archeological and cultural site	Disturbance	access roads preparation and site clearing works	-	-	-	**Negligible**	Archaeological and cultural sites will not be disturbed	**Negligible**

Drilling and testing phase									
Category	Event/Resources	Impact	Project activity	Severity	duration	Likelihood	Impact Rating	Mitigation	Residual rating
Land (disturbance)	Landscape Visual Physical presence Physical disturbance	Soil erosion Modification of natural drainage patters Open access to human activity (local community)	Rig mobilization Temporary Camp mobilization Surface hole drilling (spudding) Casing/cementing Well testing Rig demobilization Temporary camp set up and mob Diesel generator for power supply Temporary camp demobilization chemical and equipment storage	Major	Medium term	-	**M**	Planned journey management to minimize unnecessary movement and disturbance The workforce will undergo training in landscape sensitivity awareness A 'single track' policy will be adhered to unless conditions dictate otherwise Journeys will be planned, controlled and minimized Stakeholders made aware of HKN's civil activities and footprint area expected to be covered	**L**
Air and climate	Air quality	Flaring (during well testing) Well testing Site reclamation and abandonment	Rig mobilization Well testing Rig demobilization Temporary camp set up and mob	Major	Medium term	-	**M**	Heavy lifting works and dust generating activities will not take place in windy conditions where excessive wind-blown sand could be generated Engine and equipment use will be minimized to	**L**

		Reduction in ambient air quality due to exhaust and vapor emissions, and dust generation	Diesel generator for power supply Temporary camp demobilization					only use equipment for its intention. Preference will be given to fuel-efficient generators and vehicles Regular maintenance will be undertaken for all equipment in accordance to manufactures specifications Speed limits will be enforced to reduce dust levels and emissions output. Appropriate procedure for fuel transfer to minimize vapor loss Use alternative energy where possible such as solar power	
Solid waste storage/ management	Drill cuttings storage and disposal	Chemical hazards - salt, barite, other mud components leading to ground water, surface water and soils/sediments contamination	Drilling operations	Localized	Long term	-	**M**	HKN will apply stabilization/solidification process to drill cuttings by mixing with cement. If this method is not applied for any reason; Cuttings will be dried and buried on site in a dedicated high-density	**L**

								polyethylene (HDPE) lined pit The chemical content of the WBM cuttings is inert and poses little or no risk to the environment."	
Ecology and biodiversity	Flora Fauna	Disturbance of flora and fauna	Rig mobilization Surface hole drilling (spudding) Well testing Rig demobilization Temporary camp set up and mob Diesel generator for power supply Temporary camp demobilization	Minor	Medium term	-	**L**	Disturbance of vegetation will be avoided during access road construction by mapping out the project area Field staff will undergo training to ensure that personnel are aware of environmental sensitivities. Food storage and waste management procedures will be designed such that animals will not be attracted to camps. Areas which may attract fauna will be fenced off. Lights will be oriented towards specific work areas	**L**

								Night driving will not be undertaken except in emergency	
Water resources	Ground water	Increased demand in water resources	Site preparation including access road construction Camp operations Drilling operations	Major	Medium term	-	**M**	Minimize the demand for water by reusing and recycling, setting strict water. conservation targets and by monitoring water consumption	**L**
Human environment	Local community	Nuisance due to increased traffic and land clearing and construction. Accidents due to increased vehicle movements		Major	Medium term	-	**M**	Community engagement will take place via local authorities to ensure that local people are aware of the project. Traffic disturbance during mobilization and demobilization will be minimized Deliveries and trips between communities and base camp will be minimized Speed limits will be strictly enforced Night driving will not be undertaken	**L**

								Except in emergency All drivers will Undergo appropriate training	
		Increase in business/trade	Procurement of supplies and equipment	Positive	-	-	**P**	Local trade will be encouraged	**P**
		Increased employment opportunity		Positive	-	-	**P**	Local employment will be encouraged	**P**
		Skills / technology transfer		Positive	-	-	**P**	Local employment and training will be encouraged	**P**
Human environment	Local tourism	Disruption			-	-	**L**	Local tourism will benefit from the use of improved access routes	**L**
	Existing infrastructure	Damage to local economy		Localized effect	-	-	**M**	The workforce will be made aware of local infrastructure Buffer zones will be established around infrastructure where appropriate	**L**
Heritage	Archeological and cultural site	Disturbance		-	-	-	**Negligible**	Archaeological and cultural sites will not be disturbed	**Negligible**
	Noise and Vibration	Disturbance to fauna and livestock,	Noise and vibration from drilling activities				**M**	Power generators, prime movers, and other noise generating	**L**

		workers, and local populations						drilling/production equipment (e.g. draw works, pumps, compressors etc.,) must be equipped with silencers/mufflers where practical. Safety signage must be in place in noise-prone areas and as specified in local regulation. In such areas, appropriate hearing protection must be used. Conduct on-going noise monitoring to ensure mitigation effective	
Air and climate	Unplanned event The uncontrolled release of H2S has the potential to cause fatalities among the workforce, local fauna, and neighboring communities.	Uncontrolled gas release following a well blowout	-	Massive effect	-	Unlikely	**M**	Well program complies with internationally accepted oil and gas practices. Appropriate well control equipment and techniques are in place and are tested. All personnel (subcontractor and CONTRACTOR) should conduct well control drills at regular intervals and train all personnel in well control.	**L**

								Proper pre-well planning, drilling fluid logging, use of drilling fluid with sufficient density to balance the pressures in the wellbore; BOP system can be rapidly closed in the event of an uncontrolled influx of formation fluids and the well to be circulated to safety by venting the gas at the surface. All well tests are conducted to an approved schedule. The drilling rig and production sites will be fitted with gas alarms and the site will be fitted with emergency alarms. Design the production equipment with emergency shut down valves at appropriate locations, as recommended by good industry practice. Maintain technical integrity of all plant /equipment through	

								design, operation, condition monitoring, regular inspection and maintenance. Plan and risk assess any heavy lifting or other construction activities in and around live plant and ensure appropriate controls implemented. Drilling and production facilities will be fitted with gas alarms and the site will be fitted with emergency alarm. An emergency response plan and evacuation procedure at the site will be implemented and regularly tested.	

Well production facility and activities									
Category	Event/Resources	Impact	Project activity	Severity	Duration	Likelihood	Impact rating	Mitigation	Residual rating
Land	Landscape Visual Physical presence Physical disturbance	Soil erosion Modification of natural drainage patters Open access to human activity (local community)	Diesel for power generation Camp installation Production facility installation Well installation Storage tank installation Tanker loading facilities installation Flowline And pipeline installation pickup trucks for transportation personnel Oil trucking for export	Major	Long term	-	**M**	Planned journey management to minimize unnecessary movement and disturbance The workforce will undergo training in landscape sensitivity awareness Trucking activity and journey management will be on a designated route away from community settlements and sensitive ecological areas Journeys will be planned, controlled and minimized Stakeholders made aware of HKN's	**L**

								production activities and footprint area expected to be covered	
Liquid Waste Discharges	Spills from fuel storage tanks, well sampling equipment, include maintenance, tank filling operations, vehicle refueling	Impact on ground water quality and soils/sediment related to amount spilt					**M**	Locate the fuel storage tanks in bunded areas. Implement a Spill, Prevention, Countermeasure and Control Plan. Ensure all tank filling activities shall be conducted according to a tank filling procedure. Vehicle refueling, and maintenance will only occur in designated areas and over hard standing or portable drip trays. Place clearly marked spill kits	**L**

								adjacent to the refueling area. Post 'No Smoking' and other warning signage around the fuel / oil storage and refueling areas at production facility, camp and drilling sites. Install fire-fighting equipment at strategic places within the fueling station and in other areas of fire risk. Implement an Emergency Response Plan at the site and ensure all personnel are familiar with it.	
Light	Disturbance to local populations, livestock and fauna	Floodlights used at production facility, camps and active well sites					**M**	Ensure that local people are appropriately informed about what to expect and the duration	**L**

								construction, and ongoing production operations. Ensure lighting systems are designed, positioned and monitored for optimal utilization at night. Ensure light is directed downwards to minimize potential effects on local communities and nocturnal fauna.	
Air and climate	Air quality	Stack emissions - Release combustion products to the atmosphere. These emissions may contribute to climate change (CH4, CO2), acid	Gas flaring from production	Major	medium term	-	**M**	Ensure final flare location, height and design will meet regulatory air quality standards, based on the outputs of atmospheric emission modelling. Use of double pilot lighting	**L**

		effects (SOx, NOx) and short-term localized impact on the air quality.						system to prevent emission of un-combusted gas containing H2S. Flare management planning to ensure ambient air quality remain within safe levels for SO2 exposures. Monitoring program to ensure air quality remains within safe standards to inform when production and flaring needs to be choked back, if required. The WPF base case is to acquire production data during Phase 1, and feed into gas handling facility by 2021 in order to	

								completely utilize gas and eliminate flaring	
Ecology and biodiversity	Flora Fauna	Disturbance of flora and fauna	Camp installation Production facility installation Storage tank installation tanker loading facilities installation Flowline and pipeline installation Flaring pickup trucks for transportation Oil trucking for export	Localized effects	Long term	-	**M**	Disturbance of vegetation will be avoided during access road tanker movements Field staff will undergo training to ensure that personnel are aware of environmental sensitivities. Food storage and waste management procedures will be designed such that animals will not be attracted to camps. Areas which may attract fauna will be fenced off. Lights will be oriented towards specific work areas	**L**

								Night driving will not be undertaken except in emergency	
Water resources	Ground water	Increased demand in water resources	Camp operations	Localized effect	Long term	-	**M**	Minimize the demand for water by reusing and recycling, setting strict water conservation targets and by monitoring water consumption	**L**
Human environment	Local community	Nuisance due to increased traffic and land clearing and construction. Accidents due to increased vehicle/tanker movements		Localized effects	Long term	-	**M**	Community Engagement will take place via local authorities to ensure that local people are aware of the project. Deliveries and trips between communities and base camp will be minimized Speed limits will be strictly enforced	**L**

								Night driving will not be undertaken except in emergency All drivers will Undergo appropriate training	
		Increase in business/trade	Procurement of supplies and equipment	-	Long term	-	**P**	Local trade will be encouraged	**P**
		Increased employment opportunity	-	-	Long term	-	**P**	Local employment will be encouraged	**P**
		Skills / technology transfer		-	Long term	-	**P**	Local employment and training will be encouraged	**P**
	Existing infrastructure	Damage to local economy. Increased wear and tear and traffic on road infrastructure		Localized effect	Long term	-	**M**	The workforce will be made aware of local infrastructure Buffer zones will be established around infrastructure where appropriate	**L**

Air and climate	Air quality	Power generation Release combustion products to the atmosphere. These emissions may contribute to climate change (CH4, CO2), acid effects (SOx, NOx) and short term localised impact on the air quality.		Major	Long term	-	**H**	Use low sulphur fuels if available in the local marketplace. Contractors are required to have maintenance programs in place ensuring that generators and any other prime movers are regularly serviced and maintained to the manufacturer's specification. Employees working in dusty conditions must use appropriate PPE.	**M**
	Archeological and cultural site	Disturbance		-	-	-	Negligible	Archaeological and cultural sites will not be disturbed	Negligible
Air and climate	Crude oil storage operations – fugitive emissions.	Fugitive emissions of methane which contribute to climate change and					**M**	Gas vapors from the crude oil storage tank will be routed to the flare.	**L**

		ozone formation.						Each product loading arm must be fitted with a vapor sealing head so that they can be diverted into a vapor recovery system. All potential sources of fugitive emissions (e.g. valves, flanges, etc.,) will be part of the planned maintenance program, so subject to regular inspection and maintenance**.**	
Liquid Waste Discharges	Waste water discharge (produced water)	Contamination of ground water, soil contamination, soil erosion and biological hazard	Production facility	Localized	Long term	-	**M**	Produced water from HKN production has been historically low, and will be collected by waste management contractor, approved by the MNR.	**L**

General Health & Safety									
Category	Event/Resources	Impact	Project activity	Severity	Duration	Likelihood	Impact rating	Mitigation	Residual rating
Occupational Health & Safety	Unsafe working conditions	Injuries to workers and visitors	Drilling, Production and civil works				**H**	Ensure the implementation of contractor management plans and EHS Plans through regular audits. Undertake a risk assessment of each main operation (road construction, well site construction, drilling operations, flowline construction, production operations and decommissioning activities) and ensure that all high-risk activities identified are controlled through appropriate operational controls and procedures.	**L**

								Provide EHS induction for all personnel and visitors to drill sites; flowline locations and production facilities. Make the use of appropriate PPE in all activities mandatory. Ensure all safety signs, barriers and access controls are in place at all construction and operations sites. All operations will be conducted in compliance with CONTRACTOR EHS policies, Kurdish standards and/or internationally accepted practices for	

								similar environments. Only properly trained and authorized employees shall operate drilling equipment, construction machinery, or production facilities. All electrical equipment shall be properly installed, earthed and regularly inspected. CONTRACTOR shall implement spill prevention and emergency response A project Clinic will be provided with suitably qualified field medical staff, equipment and medication as appropriate,	

								including an ambulance. Adherence to an Emergency Response Plan, Evacuation Plan, and Medevac Plan.	
Occupational Health & Safety	Welfare	Standard of welfare	Drilling, Production and civil works				**L**	HKN and subcontractors to follow industry standards for personnel welfare.	**L**

References

1. Abawi S. A. and M.S. Hassan. 1990. Environmental Engineering, Water Analysis. Dar Al-Hikma Press.

2. Abdul-Aziz, M.H. 1982. Principles of Hydrology. King Saud University. First Edition. Riyadh, Saudi Arabia.

3. Abdul-Redah, K.A. 1984. Microbiological Water Pollution. Military Academic Press Training Directorate. Number 70.

4. Al-Lammi, A. A. 1986. An Ecological Study on the Phytoplankton in Some Marshes in Southern Iraq. Master of Science Thesis. University of Basrah. Basrah, Iraq.

5. Allen, S.E., H.M. Grimshaw, and J.A. Parkinson, J.A. 1974. Chemical Analysis of Ecological Materials. Blackwell Scientific Publication. Oxford, England.

6. Alloway, B. and D.C. Ayres. 1997. Chemical Principles of Environmental Pollution. Chapman & Hall. Second Edition. London, England.

7. Al-Mahdi, H.M. 1979. Report on Physiographical Division and Geomorphology of Iraq and the Nature of Erosion Effects. Unpublished Report.

8. Al-Muslih, R.M.A.1998. Bacteriological Study of Some Well Water in Iraq. Iraqi Journal of Science. Volume 27, Number 1 and 2.

9. Al-Saadi, H. A. 2006. Principles of Ecology and Pollution. Dar-Al Yazori Publication.

10. Al-Saadi, M.A.A. 2004. Study of Physical and Chemical Properties and Their Possible Pollution of Groundwater in Rahalia _ Al-Anbar. Unpublished Master of Science Thesis. University of Baghdad. Baghdad, Iraq.

11. American Public Health Association. 1975. Standard Methods for the Examination of Water and Waste Water. 14th Edition. Washington, D.C, United States.

12. Amnesty International. Human Rights in the Kurdistan Region of Iraq. 2009. Amnesty International, International Secretariat. United Kingdom.

13. Bartram J. and R. Balance. 1996. Water Quality Monitoring: A Practical Guide to the Design and Implementation of Fresh Water Quality Studies and Monitoring Programmes. United Nations Environment Programme and the World Health Organization. Chapman & Hall.

14. Berding F. 2002. Soil Management Consultancy. Food and Agriculture Organization of the United Nations, Agricultural Rehabilitation Programme, Mission Report. No. 1. Erbil, Iraq.

15. Buday, T. and Jassim, S.Z., 1987. The Regional Geology of Iraq: Tectonism, Magmatism and Metamorphism. GEOSURV. Volume II. Baghdad, Iraq.

16. Carter M.R and E.G. Gregorich E.G. 2008. Soil Sampling and Methods of Analysis. CRC Press, Taylor & Francis Group. 2nd Edition.

17. E&P Forum. 1993. Exploration and Production Waste Management Guidelines. Report number, 2.58/196. London, England.

18. E&P Forum and United Nations Environment Program. 2000. Environmental Management in Oil and Gas Exploration and Production: An Overview of Issues and Management Approaches. Joint E&P Forum/United Nations Environment Program Technical Publication. London, England.

19. E&P Forum. September 1994. Report No 2.59/197. Methods of Estimating Atmospheric Emissions From E&P Operations.

20.Ecomterica.August 2012.
Greenhouse Gases, CO2, CO2e, and Carbon: What Do All These Terms Mean? https://ecometrica.com/assets//GHGs-CO2-CO2e-and-Carbon-What-Do-These-Mean-v2.1.pdf

21. Environmental Protection Department, Water Contamination and Monitoring. 2001. Directorate of Health – Erbil Annual Report. Erbil, Kurdistan, Iraq.

22. Food and Agriculture Organization of the United Nations. 2003-2006. Agro-Meteorological Field Stations. Food and Agriculture Organization of the United Nations, Erbil Sector. Bulletins Number 1 to 12, Volumes 1 to 12. Iraq.

23. Gardy, S.Q. 2010. Geophysical Resistivity and Environmental Impact Assessment of Erbil Dumpsite Area, Iraqi Kurdistan Region. Master of Science Thesis, Department of Geology, Salahaddin University. Erbil, Iraq.

24. International Association of Oil and Gas Producers. 2004. Environmental Performance in the E&P Industry. Report, Number 372. London, England.

25. International Finance Corporation/World Bank Group. 2007. Environmental, Health, and Safety General Guidelines.

26. International Finance Corporation/World Bank Group. 2007. Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development.

27. International Labor Organization – Occupational Safety and Health. 2001. Guidelines on Occupational Safety & Health Management Systems.

28. Iraqi Meteorological Organization. 1989. Meteorological Atlas of Iraq.

29. Kahraman. 2006. Physical and Chemical Properties of Soil in Hawler Governorate. Unpublished Doctoral Thesis. Salahaddin University. Iraq.

30. Kurdistan Regional Government. 2007. Law Number 22 - Oil and Gas Law of The Kurdistan Region - Iraq.

31. Kurdistan Regional Government. 2008. Law Number 8 - The Law of Environmental Protection and Improvement of the Kurdistan Region - Iraq

32. Kurdistan Regional Government. 2010. Law Number 3 - The Law of Environmental Protection and Improvement Board in Iraqi Kurdistan Region - Iraq.

33. Kurdistan Region Statistics Office. n.d. Kurdistan Regional Government, Ministry of Planning. <http://www.krso.net>

34. Kurdistan Region Statistics Office. 2007. Population of Duhok. Official Correspondence from Kurdistan Region Statistics Office to Directorate of Health – Duhok. Kurdistan Regional Government, Ministry of Planning.

35. Kurdistan Regional Government. 2014. Instruction No.1 - Technical Guidelines on the Environmental Impact Assessment of Petroleum Operations in the in Kurdistan Region - Iraq.

36. United Nations Global Compact Office. 2005. United Nations Global Compact.

37. United Nations High Commissioner for Refugees. 2007. Governorate Assessment Report, Dohuk Governorate. < http://www.unhcr.org/471efbe22.pdf>

38. United States Environmental Protection Agency. 2011. National Ambient Air Quality Standards. Office of Air and Radiation. Washington, D.C., United States.

39. World Health Organization. 2005. Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulphur Dioxide. Geneva, Switzerland.

40. World Health Organization. 1999. Guidelines for Community Noise.

41. World Health Organization. 2008. Guidelines for Drinking Water Quality. 3rd Edition. Volume 1. Geneva, Switzerland.