Environmental and Social Impact Assessment

Timissit Exploration Project (Block 210)
Algeria, July 2015

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List of Acronyms

ABHS	Agency of the Sahara Hydrographic Basin (in French *Agence du Bassin Hydrographique Sahara*)
ACPP	Canadien Association of Oil Producers (in French *Association canadienne des producteurs pétroliers)*
AfDB	African Development Bank (in French *Groupe de la Banque africaine de Développement*)
ALNAFT	National Agency for Hydrocarbon Resources Valuation (agence National pour la Valorisation des Ressources en Hydrocarbures)
ANRH	National Agency of Hydraulic Resources (from French, Agence Nationale des Ressources Hydrauliques)
APC	Communal Popular Assembly (Assemblée Populaire Communale)
API	American Petroleum Institute
APW	Wilaya´s Popular Assembly (Assemblée Populaire Wilayale)
ARH	Hydrocarbons Regulation Authority (in French *Autorité de Régulation des Hydrocarbures*)
ASGA	Association of African Geological Surveys
BCP	Blowout Contingency Plan
BOP	Blow-out preventers
BP	Before Present
BTEX	Benzene, Toluene, Ethylbenzene and Xilene
C.F.P.A	Vocational Training Center (in French called *Centre de Formation Professionelle et d'Apprentissage*)
CAPP	Canadian Association of Petroleum Producers
CCEC	Board of Control for Classified Facilities (Commission de Contrôle des Établissements Classés de Wilaya)
CFT	Chemical Frac Tracer
CI	Intercalary Continental (from French, Continental Intercalaire)
CNRPH	National Centre of Research in Prehistory, Anthroplogy and History (in French, *Centre National de Recherches Préhistoriques, Anthropologiques et Historiques*)
CRAAG	Centre of Research in Astronomy, Astrophysics and Geophysics
CT	Terminal Complex (from French, Complexe Terminal)
DEM	Digital Elevation Model
DEW	Regional Directorates of the Environment (Directions de l´environnement de la Wilaya)
DGRE	Department of Water Resources (Département Général des Ressources en Eau)
DHW	Wilaya Hydraulic Directorate (from French, Direction Hydraulique de la Wilaya)
DPAT	Department of Planning and Regional Development *(in French Direction de la Planification et de l'Aménagement du Territoire)*
DPSB	Budget Monitoring and Preparation Directorate *(in French Direction de la Programmation et du Suivi*

	du Budget)
DTC Polio	Diphtérie-Tétanos-Coqueluche-Polio
EAM	Environmental, Assessment and Management
EAQG	European Air Quality Guideline
EDD	Industrial Risk Assessment (Étude de Danger)
EGSA	Etablissement de Gestion des Services Aéroportuaires d'Alger
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPH	Hospital (in French *Etablissements Publics Hospitaliers)*
EPSP	Health Centre (in French *Etablissements Public de Santé Hospitaliers)*
ERM	Environmental Resources Management
ESIA	Environmental and Social Impact Assessments
ESRI	Enviromental Systems Research Institute
FAO	Food and Agricultural Organization
FIT	Formation Integrity Tests
GHG	Greenhouse gas
GII	Gender Inequality Index
GIS	Geographic information system
GPD	Gross Domestic Product
GW	Gigawatts
HC	Hydrocarbons
HDPE	High Density Polyethylene
HSE	Health, Safety & Environment
IAGC	International Association of GeoChemistry
IGN	Institute National de l´Information Géographique et Forestiére
IUCN	International Union for the Conservation of Nature
KCl	Potassium Cloride
KPMG	Kynveld Peat Marwick Goerdeler (accounting firm)
LOT	leak-off tests
LSRP	Liquid Spill Response Plan

MATE	Ministry of Land Planning and the Environment (in French *Ministère de l´aménagement du Territoire et de l´Environnement*)
MEM	Ministry of Energy and Mining (in French *Ministère de l´Energie et des Mines*)
MOC	Management of Change
MP	Management Plan
MPN	Most Probable Number
MTBE	Methyl Tertiary Butyl Ethylene
NCDC	National Climate Data Center
NOAA	National Oceanic and Atmospheric Administration
NORM	Naturally Occurring Radioactive Material
NR	National Road
NTU	Nephelometric Turbidity Units
O&G	Oil and Gas
OBM	Oil-based muds
OECD	Organisation for Economic Co-operation and Development
OGP	International Association of Oil and Gas Producers
ONM	Meteorological National Office (from French, Office National de Météorologie)
ONS	Office for National Statistics (in French *Office Nationale des Statistiques*)
OSS	Sahara and Sahel Observatory (from French, L'Observatoire du Sahara et du Sahel)
P&A	Plug and Abandonment
PAC	Poly Aluminium Chloride
PCDP	Public Consultation and Disclosure Plan
PDAU	Development Plans and Urban Planning (in French *Plan de Développements et d'Aménagements Urbain*
PHPA	Partially Hydrolyzed PolyacrylAmide
PNUD	United Nations Development Program (in Franch *Programme des Nations Unis pour le développement*)
RA	Radioactive
RGPH	General Population and Housing Census (in French *Recensement Général de la Population et de l´Habitat)*
SAPP	Sodium Acid PyroPhosphate
SASS	North West Sahara Aquifer System (from French, Système d'Aquiferes du Sahara Septentrional)
SDS	Safety Data Sheet

SP	Pumping Station (in French *Station de Pompage)*
S-P-R	Source-Pathway-Receptor
STDs	Sexually Transmitted Diseases
TAC	Carbonate Trias Clay Aquifer
TAGI	Lower Triassic Clayey Sandstone Aquifer
TAGI	Lower Triasic Aquifere (in French *Trias Argilo-Greseux Inferieur*)
TAGS	Upper Triassic Clayey Sandstone Aquifer
TB	Tuberculosis
TBC	Tuberculosis
TCC	Thermtech Cuttings Cleaner
TCU	True Colour Units
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USGS	United States Geological Survey
USW	Urban Solid Waste
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compounds
WB	World Bank
WBM	Water-based muds
WGS	World Geodetic System
WHO	World Health Organisation
WTO	World Trade Organization
WWF	World Wildlife Foundation
ZHUN	New urban zone (in French : *La nouvelle Zone Urbaine)*

Non Technical Summary

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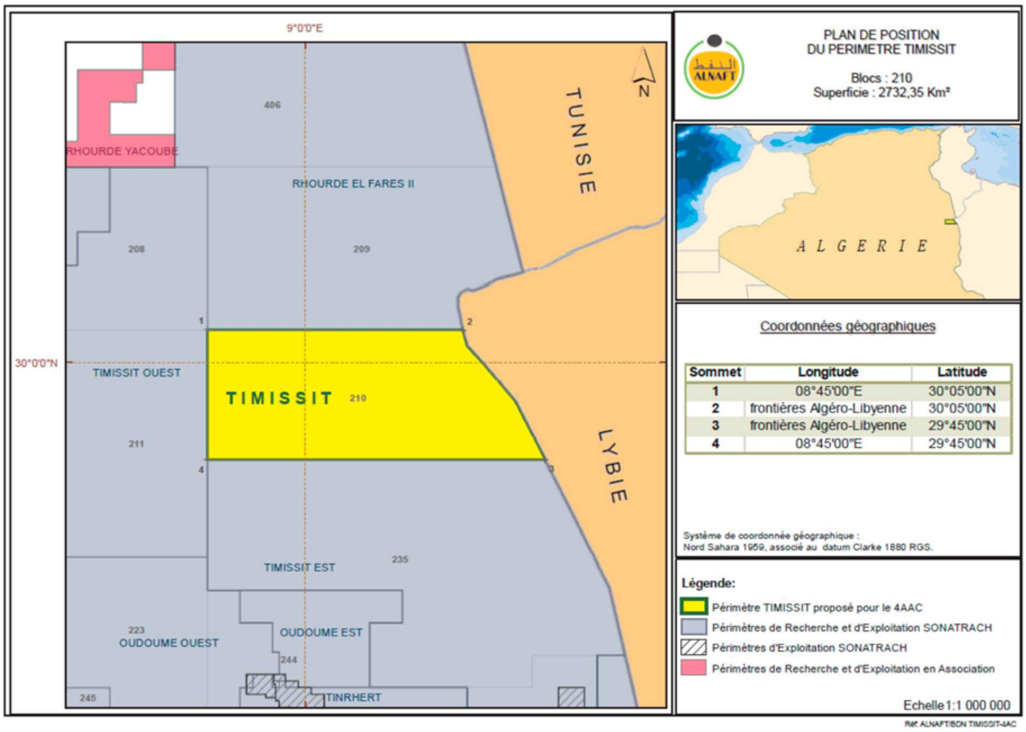
This Non-technical Summary (NTS) summarises the Environmental and Social Impact Assessment (ESIA) report, in order to inform readers of the main potential environmental and social impacts of the Project and how it is proposed to mitigate those potential impacts. A NTS cannot summarise all potential impacts or provide full detail of the issues which it summarises. Any reader wishing to learn more about a particular issue, or about how the Project proposes to mitigate any of the potential impacts referred to in the NTS, should read the relevant section of the ESIA (including the EMP and corresponding Annexes).

1 Introduction

This document is the Environmental and Social Impact Assessment ("ESIA") of an exploration campaign. The campaign is divided into three successive phases (1 to 3) combining exploratory drilling, hydraulic stimulation and 3D seismic acquisition. The results of each phase will define whether the next phase is to be developed or not. A maximum of 550 km^2 of 3D seismic and 6 wells will be drilled and hydraulically stimulated, if all phases are fully developed. Seismic, drilling and hydraulic stimulation of the exploratory wells is scheduled for the period 2016 – 2022. This document has been prepared by Statoil and Environmental Resources Management (ERM) in collaboration with the Algeria-based consultancy BEXAM.

Figure 1: Project Location



2 Administrative and Regulatory Framework

This Environmental and Social Impact Assessment (ESIA) was developed in order to meet the Algerian legislative and regulatory requirements. It was also undertaken using international best practices and guidelines and in accordance with Statoil's responsible and sustainable development practice (i.e., environmental and social responsibility).

2.1 Algerian legislative and regulatory framework

The key regulatory authorities and institutions involved in the permitting approval processes that are of relevance for the Timissit project are:

- The Ministry of Land-Use Planning and the Environment (Ministère de l'Aménagement du Territoire et de l'Environnement [MATE]).
- The Ministry of Energy and Mining (Ministère de l'Energie et des Mines [MEM]) including the National Hydrocarbon Agencies:
    - The Hydrocarbons Regulation Authority (Autorité de Régulation des Hydrocarbures – ARH).
    - The National Agency for Hydrocarbon Resource Valuation (Agence National pour la Valorisation des Ressources en Hydrocarbures – ALNAFT).
- The Ministry of Water Resources (Ministère des Resources en Eau).
- The Board of Control for Classified Facilities (CCEC - Commission de Contrôle des Établissements Classés de Wilaya).

The Hydrocarbons Regulation Authority (ARH) leads the EIA approval process for all hydrocarbon-related activities although final approval is granted by the MATE. The ARH is also responsible for controlling and monitoring the management plans included in the approved EIAs, approving risk assessments and granting authorisation and concessions for hydrocarbon pipelines.

The 2005 **Hydrocarbon Law** (law 05-07, dated 28 April, 2005) defines the legal system for prospection, exploration, exploitation, transportation by pipeline, refining, hydrocarbon processing, marketing, storage, oil products and associated works and facilities. The 2013 Hydrocarbon Law (Law 13-01, dated 20th February 2013) introduces new provisions for activities related to unconventional oil and gas and offshore activities. In addition, it introduces new specific provisions on environmental matters, including:

- Water use: Article 53 of the 2013 Hydrocarbon Law establishes that ALNAFT will be involved in the procedure for granting water use authorisations for projects on unconventional resources.
- Flaring: Article 52 states that, although flaring is prohibited, it can, exceptionally, be performed for a limited period. This provision was later implemented by the release of Executive Decree 13-400.
- Risk assessment studies for hydrocarbon activities: Article 18 establishes that industrial risk assessment studies (in French Étude de danger – EDD) relating to hydrocarbon activities will be sent to ARH for approval.

Article 23b of Law 13-01 states that any exploitation activity using hydraulic fracturing techniques is subject to approval by the Council of Ministers.

The legal basis for **environmental protection** in Algeria is established in Law 03-10, dated 19th July, 2003, on the Protection of the Environment within the framework of Sustainable Development. Law 03-10 sets out the framework for protecting biological diversity, air quality, atmospheric emissions, water, soil, desert areas and cultural heritage. It also sets out the principles for environmental protection, which include amongst other things, the "precaution" principle and the "polluter pays" principle.

Table 1 provides a summary of the key permits required to date for conventional and unconventional oil and gas exploration projects in Algeria.

Table 1 Key permits required for exploration of oil and gas in Algeria

Approval and reference legislation	Competent authorities	Approval time by law	Relation with other permits
EIA for seismic and exploratory drilling Decree 07-175 and 08-312	ARH and MATE	Approx. 6 months	The applicant requires a “right to explore” licence. The EIA must be approved before seismic and drilling works begin.
Risk Assessment (EDD) Decree 05-19	ARH	Between approx. 60 and 130 days	None
Exploitation authorisation for classified facilities Decree 06-198 and 07-144 (including a list of classified facilities).	MATE, Wali and President of the pertinent Communal Popular Assembly	3 months for the preliminary permit. The exploitation permit is delivered 3 months after notification of construction completion.	Construction of classified facilities is subject to the approval of the construction permit. *Note: Exploitation authorisation for classified facilities is only required if the exploration project includes the construction and operation of a classified facility (for instance the construction of an explosives storage area).*
Concession for the use of water reserves from fossil and weakly renewable aquifers (including well construction, stimulation and exploitation). Decree 10-318	Wilaya Directorate of Water Resources and ALNAFT (the latter only in the case of unconventional resource projects).	6 months (maximum).	None

Source: ERM, 2015

According to the 2005 Hydrocarbon Law and Article 18 of the 2013 Hydrocarbon Law, hydrocarbon-related activities such as those planned for the Timissit project, are subject to the performance of an EIA. The main regulatory text for Environmental Impact Assessment in Algeria is Executive Decree 07-145 dated 19th May, 2007, relating to environmental impact studies and impact notes.

As mentioned above, both Decree 08-312 and the 2013 Hydrocarbon Law state that all EIAs related to the hydrocarbon sector shall be submitted to the ARH. However, the MATE is the sole authority in charge of issuing EIA approvals.

Article 7 of Decree 08-312 states that in the case of any additional activities not included in the initial EIA, such as the drilling of new exploratory wells, new seismic work or the construction of new facilities, the initial environmental impact study will have to be updated, and then resubmitted by the contracting party or operator, for approval by the ARH.

According to Executive Decree 15-09 of 14th January, 2015, a risk assessment is required for all facilities and work related to hydrocarbon activities (including exploration and exploitation activities, storage, transport by pipelines, petroleum product distribution, refineries and transformation of hydrocarbons). The risk assessment must be approved before any work commences.

2.2 International best practice and guidelines

Table 2 below presents international good practices and guidelines that complement Algerian legislation for environmental and social aspects relevant to the project activities. Specific guidelines on unconventional gas activities have also been identified and presented to provide international guidance for the project. Guidelines on unconventional gas activities that have been identified include those developed by the American Petroleum Institute (API) and the Canadian Association of Petroleum Producers (CAPP).

Table 2 Main International Guidelines Applicable to the Project

Topic	International Guideline	Description
Air Quality	Air Quality Guidelines for Europe, WHO, Second Edition 2000 (WHO, 2000)	Air quality set by Algerian regulations does not cover all the potential contaminants that could be expected in the atmosphere. For carbon monoxide (CO), hydrogen sulphide (H_2S), lead, benzene, and photochemical oxidants like O_3, international ambient air quality standards, limits and guidelines could be used as a reference.
	WHO Guidelines for Air Quality, (WHO, 2005)	
	Environmental Air Emissions and Ambient Air Quality of the IFC (IFC, 2007)	
Noise	General EHS guidelines, IFC/WB 30th April, 2007 (WB, 2007a)	The national standards include limits for residential and other sensitive areas (i.e., hospitals), but not industrial areas. In addition, they have been revoked, but not replaced; consequently the World Bank standards can be used as reference values for identifying and assessing impacts until new threshold limit values are published.
	Guidelines for Community Noise, World Health Organisation (WHO), 1999	
Wastewater Discharge	General EHS guidelines, IFC/WB 30th April, 2007 (WB, 2007a)	For some pollutants not covered in Algerian legislation, such as chlorides and sulphides, international standards can be used as reference values. Algerian legislation does not set standards for groundwater quality. Therefore, the IFC Guidelines (2007) can be used as reference standards.
Soils	Ontario Standards (2011)	Algerian legislation does not set standards for soil pollution. The Ontario Standards (2011) can be used as a reference.
Unconventional resources	American Petroleum Institute (API) Guidelines	API has specific guidelines for hydraulic fracturing operations: Well Construction and Integrity; Water Management Associated with Hydraulic Fracturing; Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing; and Environmental Protection for Onshore Oil and Gas Production, Operations and Leases.
	Canadian Association of Petroleum Producers (CAPP) guidelines	The CAPP has developed seven operating practices for hydraulic fracturing: Fracturing Fluid Additive Disclosure, Fracturing Fluid Additive Risk Assessment and Management, Baseline Groundwater Testing, Wellbore Construction and Quality Assurance, Water Sourcing, Measurement and Reuse, Fluid Transport, Handling, Storage and Disposal, and Anomalous Induced Seismicity.

Source: ERM, 2015

2.3 Statoil Internal Standards and Procedures

As part of its corporate principles developed a Health, Safety and Environment (HSE) policy, Statoil sets out its commitments in terms of HSE Performance, which are aligned with the IFC and other International Standards of reference. Statoil strives to ensure safe operations that protect people, the environment, communities and material assets, to use natural resources efficiently and to provide energy that supports sustainable development.

3 Project Description

In the 2014 Algerian licensing round, Statoil, together with Sonatrach and Shell, was awarded the Timissit license, an unconventional liquid-rich gas license. The Timissit license, Block 210, covers a total area of 2732 km^2. The license is located in the Berkine Basin in the southeastern part of Algeria, and borders Libya to the east.

Statoil is proposing an exploration programme in the Timissit license area, Block 210. The exploration programme will include at least one phase. The activities may extend for another two phases, depending on the results of the first. The planned activities will combine 3D seismic and drilling activities

Table 3 Activities planned for the exploration campaign, presented below, summarises the activities planned for the exploration campaign (i.e., Phase 1, Phase 2 and Phase 3) assuming all phases are finally developed.

Table 3 Activities planned for the exploration campaign

Activities	Phase 1	Phase 2	Phase 3
Seismic acquisition	3D seismic, 350 km^2	3D seismic, 100 km^2	3D seismic, 100 km^2
Exploration wells	2 vertical wells	2 vertical wells 1 horizontal well	1 horizontal well
Water wells	3	3	1
Start	Jan 2015	2018	2020
Finish	Jan 2018	2019	2021

Source: ERM, 2015

3.1 Drilling, Stimulation and testing Operations

There are a total of 6 wells planned for the three exploration phases in the Timissit Licence. The exact locations of these wells are not yet known. Phase 1 of the exploration campaign will consist of two vertical wells, whereas Phases 2 and 3 will also include horizontal wells. Potentially all wells could be hydraulically stimulated and tested but this cannot be confirmed at this stage of the project definition.

During drilling operations drilling mud will be pumped through the drill string down to the drill bit. Water-based muds (WMB) are the choice for all wells. However the use of oil-based muds (OMB) in the deep/horzontal sections of certain wells cannot yet be disregarded. OMB would only be used for to technical and safety reasons and would be utilised in the horizontal section of the well and in the target formation, and only after the freshwater aquifers have been protected with a larger-diameter casing. In this way the oil-based mud will not come into contact with freshwater aquifers.

Hydraulic stimulation consists of pumping fluid down the well bore. Injection is carried out under sufficiently high pressure conditions to create small fractures in the hydrocarbon-bearing rock. The proppant agent, injected along with the stimulation fluid, becomes lodged within the fractures, holding them open and creating paths that allow the hydrocarbons to be produced and flow into the wellbore from the reservoir formations.

Stimulation activity design depends on local geology and the nature of the reservoir. Hydraulic stimulation operations determine the kind of completion, number of stages, type of stimulation fluid, volume, flow and the different additives required to ensure the correct geometry of the fractures within the target. Water is the most common base fluid, also known as carrier fluid, to which proppant and chemicals are added to enhance the fluid properties. Hydraulic stimulation fluid typically consists of about 90% water, 9% proppant, generally sand, and a blend of chemicals comprising around 1%.

Figure 2 shows a Statoil well in the USA being hydraulically stimulated.

Figure 2 Ongoing stimulation job

Water supply for civil works, drilling operations, and stimulation and testing will be provided via a water bore drilled in the vicinity of the well site. Average water consumption per well for drilling operations is estimated to be 795 m^3 for vertical wells and 954 m^3 for horizontal well. However, volumes may vary based on drilling rig specifications and well bore conditions

The construction of roads and airstrips is required to create sustainable access to the proposed drilling locations, camps, etc. Heavy equipment, such as drilling rigs, trucks, vibros and supporting equipment will be transported to the site by road.

Any wells drilled will ultimately be decommissioned through P&A operations that will prevent the migration of hydrocarbons and/or brine between different reservoirs, isolate the freshwater aquifers, and prevent aquifer contamination. The P&A will be performed in accordance with Algerian Legislation, Statoil requirements, and industry best practice.

3.2 Seismic operations

The Project plans to acquire 350 km² of 3D seismic in the first exploration phase. An additional 100 km² is planned for the second/third exploration phase. The seismic campaigns will involve deploying recording equipment to conduct vibroseis operations along a grid pattern within the 3D seismic operations area. Furthermore a grid of upholes will be drilled in this area to determine the seismic velocities in the upper unconsolidated layers.

Seismic data will be acquired using the vibroseis technique that involves sending vibration signals into the ground. Vibrator trucks will drive along the identified seismic lines in the final grid pattern.

The seismic campaign will include the drilling of up to 80 upholes spaced evenly across the 3D seismic area. The upholes are drilled through unconsolidated material until they hit a firm layer. The purpose of uphole drilling is to provide information about the top layers of the ground. The upholes will be drilled down to a depth of typically 50–100 m.

Figure 3: A vibration point

The location of the seismic base camp has not yet been identified, and will be chosen by the seismic contractor. However, the camp is expected to be located in the centre of the programme area, close to the airstrip. The seismic camp will be designed to house approximately 200-250 people

3.3 Project Alternatives

Statoil has been considering different alternatives for site locations, additives for the drilling and stimulation fluid, water sourcing and waste handling, as part of the Project design. The results of the assessment, which integrates environmental, physical and archaeological information, have led to the Project description presented in this Environmental and Social Impact Assessment report. However, the project is still potentially subject to refinements that better incorporate the sensitivities of the License Area and technical requirements. Any relevant changes to the current definition will be evaluated and, if needed, an updated ESIA will be prepared.

4 Description of the Baseline Environment

The Timissit Licence (hereinafter, referred to as the Study Area), is located on the edge of the Berkine basin, the westernmost extension of the larger Ghadames Basin in Northern Sahara. Figure 1 shows the location of the Timissit license, which lies on the eastern border of Algeria, with Libya. The border with Tunisia is located approximately 20 km to the northeast.

The Study Area falls completely within Illizi Wilaya, around 50 km south of Ouargla Wilaya

4.1.1 Physical Environment

The Study Area is characterised by a hot and arid climate. Rainfall recorded at the In Amenas meteorological station (averaged over a period from 2003 to 2013) is very irregular with a yearly average rainfall of approximately 19.4 mm over the period.

The Study Area is located in a remote area, free from noise-emitting activities with the exception of those associated to vehicular transport along the existing roads, and other anthropogenic activities such as farming, livestock rearing and construction activities.

The most significant groundwater resource in the Ghadames basin (where the Study Area is located) is the SASS (Système d'Aquifères du Sahara Septentrional). This is a large aquifer system that extends over an area of more than 1,000,000 km^2, comprising approximately 700,000 m^2 in Algeria, 80,000 m^2 in Tunisia and 250,000 m^2 in Libya.

4.1.2 Biological Environment

The Study Area falls within a transition zone dominated by the presence of a desert plateau in the south and the Grand Erg Oriental in the north (a massive sand dune field that extends over a large proportion of the Algerian Sahara, from the city of Ouargla in the west, to Tunisia and Libya in the east). The region is characterized by a year-round water deficit, as rainfall is very scarce and irregular. As a result, dry periods may extend over several months, or even years, with the associated evapotranspiration influencing the ecological communities by reducing the already scarce water resources.

Most of the existing **vegetation** consists of small and medium-sized species, typically with no trees, except in areas with human influence, where palm trees and ornamental acacias can be seen. As observed during the field survey, vegetation is present throughout the Study Area, though in most cases in very low densities and largely concentrated in patches in those areas more favourable to plant growth, like oued beds and sabkhas. A total of 53 different plant species were recorded during the field survey, including two species protected under Decree 12-03 and Decree 93-285, *Ephedra alata* ssp*. alenda* and *Helianthemum lippii* var.*sessiliflorum* respectively.

Fauna in the Sahara relies on the scarce vegetation. As a result, many small animal species (e.g., rodents, beetles, and arachnids) have the same clumped distribution pattern as the plants, and all animals in the desert environment are present at very low densities. 29 mammal species are expected to be present within the Study Area. Animals tend to be more vulnerable than plants because they rely on plants or even on the other, scarce, animals for survival. Because of this, the natural vulnerability of desert fauna is markedly higher than in other environments. This is especially true for the top predators such as foxes and jackals, as well as big herbivores.

There are no protected or designated areas within the Study Area; the closest is located more than 280 km away.

4.1.3 Human Environment

The Study Area is located within the Daïra of In Amenas and the Debdeb Commune. The Study Area is dry and barren. The only settlement within the Study Area is Debdeb. The only two other inhabited places close to the Study Area are the small settlements of Meriksene and Timeroualine located 21 km and 35 km to the north and south of Debdeb respectively. Outside Debdeb, the Study Area is largely uninhabited. The largest settlement is Debdeb itself, with over 3,600 inhabitants, representing 85% of the population in the commune.

During the field survey performed in 2015, no signs of nomadic activities were identified in the Study Area. Local authorities consulted during the meetings reported that the area was not frequented by nomads.

The In Amenas commune, adjacent to the southern part of Debdeb Commune, is mainly characterised by oil and gas activities which provide jobs for the majority of the local community. During the field survey performed in 2015, it was observed that the main economic activities and livelihoods in the Debdeb Commune are agriculture, pastoralism, quarrying activities, and informal trading.

The total agricultural surface area in use in Debdeb Commune is 149 ha which is negligible if we consider that the total surface of Debdeb commune is about 32,000 km². All the agricultural land is found in the surroundings of the three settlements in the commune, at a maximum distance of 2-3 km in the case of Debdeb and 150-200 m in the cases of Timeroualine and Meriksene. The Study Area is mostly undeveloped economically. Industrial land use includes quarrying areas, abandoned oil and gas exploration facilities, an operational Sonatrach camp located in the proximity of Debded, and hydrocarbon transport (i.e., pipelines), as well as an abandoned airstrip.

According to the results of the field survey, 11 water wells are located within the Study Area, which comprise artesian and traditional wells and which are mainly used for drinking and irrigation. These water wells are sourced mainly from the Continental Intercalaire aquifer, which is located, in this region, from approximately 550 m below the surface. The water level in these wells ranges from approximately 1.55 to 3.5 m below the surface, and the depth of the wells extends from approximately 600 m to 750 m below the surface

4.1.4 Cultural Heritage

Based on the desk-based study and site survey performed in the Study Area, the key archaeological sensitivities include traces of prehistoric settlements (flint tools, pottery, grinding stones and ostrich shells) around the edges of sabkhas/palaeolakes, prehistoric funerary monuments (groups of stone tumuli, typically on the edge of rocky high ground overlooking historic cross-desert routes), and traces of the ancient/medieval use of cross-desert routes, including surviving paths, wells, Islamic graves and desert mosques.

The remains of the prehistoric settlement that certainly used to exist within this region have been substantially degraded by illicit surface collection in recent decades. In contrast, it appears that the other two categories of sites have probably largely survived up to the present. On this basis, three areas of elevated heritage sensitivity within the Statoil exploration area were identified, these are a located along the edge of the Great Erg leading to Ghadames, on the margin of some topographic features where experience suggests prehistoric cemeteries and wells are most likely to be found, and the Oued Meriksene corridor on the eastern side of the area.

4.1.5 Past Oil and Gas activities

During the field survey, signs of previous activity were observed within the limits of the block. Most of these are related to past O&G activities, however, in some cases, such as the presence of general waste and debris, the origin could not be confirmed.

Observations of past activities are typically indicated by the presence of waste and areas of general garbage from base camps, decommissioned drilling sites, areas where earthworks occurred, old seismic lines, and abandoned camps.

5 Evaluation of Impacts and Mitigation Measures

5.1 Introduction and Impact identification

Impacts are assessed according to their significance and the implementation of the preventive and mitigation measures, resulting in residual impacts. The definition/identification of the impacts was based on the combination of the resources potentially being impacted (e.g. air, soils, fauna, groundwater, economy and livelihoods, infraestructures and services, cultural heritage, etc.) and the specific activities that the proposed exploration campaign entails.

The key project activities responsible for the potential occurrence of impacts can be summarized as follows:

Seismic Exploration

- Site preparation: seismic base camps
- Access and road construction
- Land occupation: presence of camps and seismic line clearance
- Use of vehicles and heavy machinery.
- Power generation and other ancillary activities
- Waste production and management
- Presence of workforce
- Line surveying
- Uphole drilling
- Closure of activities and demobilisation

Drilling, hydraulic stimulation and testing

- Site preparation: well pads and drilling base camps
- Access and road construction (additional)
- Land occupation: presence of camps and drilling rigs
- Use of vehicles and heavy machinery.
- Power generation and other ancillary activities
- Presence of workforce
- Waste production and management (excluding drilling waste and flow back water)
- Water abstraction and use
- Drilling and cementation
- Muds, cuttings and completion fluid generation and management.
- Hydraulic Stimulation
- Flowback water generation and management
- Well testing.
- Closure of activities and demobilisation

As indicated before, the evaluation of the impacts was carried out on the basis of the implementation of the proposed mitigation measures, which have taken into account the specific site conditions (baseline characteristics of the License Area) as well as compliance with the following principles:

- Compliance with relevant Algerian laws or regulations.
- Compliance with international environmental standards or guidelines (especially best practice from the US on stimulation operations).

Furthermore, an Environmental Management Plan (EMP) has been developed and will be implemented to establish measures, such as best practices and specific work procedures, to prevent, avoid, eliminate, minimise, or eventually offset/compensate the predicted adverse impacts. Relevant for the project is the fact that many of the most relevant preventive measures are already embedded in the project design.

5.2 Assessment of Potential Environmental & Social Impacts

5.2.1 Potential Impacts during Seismic Activities

During the seismic operations a large proportion of the potential impacts were evaluated as Negligible or Minor. The only impacts that have been defined as Moderate are those related to the potential interference with groundwater resources, natural landscape and potential disturbance of grazing areas.

The potential impact on the water resources and grazing activities are defined as Moderate due to the high sensibility of the resources being considered, water and grazing activities. On the contrary, the impact on the geomorphology and natural landscape was considered Moderate due to the potential line clearance requirements of the 3D seismic acquisition, which although they cannot be estimated yet, have the potential to be long lasting.

The impacts mentioned above will be managed through a wide range of preventive and mitigation measures. Those that are considered as most important are listed below:

- Minimization of earthworks through maximising the use of existing roads/airstrip/camps (e.g., policy of minimal clearance and bulldozing in accordance with the IAGC Environmental Guidelines for Worldwide Geophysical Operations)
- Proper maintenance of vehicles and machinery to avoid unnecessary or excess exhaust emissions. and implementation of safe fuel transfer protocols
- A field HSE Specialist will be incorporated into the seismic survey group to oversee all mitigation measures, carry out examination of areas that appear to be sensitive and evaluate its environmental vulnerability before the installation of seismic camp, access paths, roads or seismic lines.
- A one-track policy will prevail in all operations. Off-road driving is banned.
- Wherever possible previous survey line crossings of these features should be re-used to avoid additional disturbance.
- Uphole drilling sites will be located at a reasonable distance (>200 m) from any significant ephemeral water bodies and only water based bentonite fluid with no additives will be used wherever possible.
- There will be an Engagement Procedure with local communities integrated within the PCDP.

In addition several plans have been developed or will be developed prior to starting the operations on-site (see Section 6 EMP).

Finally it is also worth mentioning that the activities will also have a positive impact on the economy of the region and livelihoods through the local procurement of goods and services as well as through the short-term direct and indirect employment opportunities and the Long-term benefits of capacity enhancement.

5.2.2 Potential Impacts during Drilling and Hydraulic Stimulation activities

During the drilling, stimulation and testing activities most of the impacts were defined as Negligible or, in most cases, Minor. These evaluations are largely based on the fact that the project incorporates a large number of embedded mitigation measures and that site selection process (including but not limited to the drilling sites) will allow for the avoidance of areas deemed as sensitive.

There are several impacts that were considered as Moderate. These impacts are related to the socioeconomic environment and include: (1) the potential disturbance on grazing activities, (2) potential interference with infrastructures (increased pressure on roads and waste facilities), (3) potential competition on water resources and (4) potential increased traffic accidents due to increased traffic.

In addition to the above, it is also worth mentioning that, similarly to the seismic activities, the drilling, stimulation and flaring activities will have a positive impact on the economy of the region and livelihoods through the local procurement of goods and services as well as through the short-term direct and indirect employment opportunities and Long-term benefits of capacity enhancement.

The impacts mentioned above will be managed through a wide range of preventive and mitigation measures. In addition to those presented for the seismic works the following can be mentioned:

- International best practice will be followed, in accordance with Statoil's policies, which will include but will not be limited to the following: all waste pits will be lined, all waste pits will be located safe distances from sensitive receptors , the location of pits will be recorded and documented, properties of cuttings and flowback water will be determined to define corresponding treatment and final disposal, water based muds will be used, cuttings potentially infested with hydrocarbons will be either treated to reduce oil content below 1% and disposed at site or transported to a treatment facility.
- Flowback will be allowed to evaporate on site with outstanding fluids transported to a disposal facility.
- The additives for drilling muds and stimulation fluids will be subject to screening process to evaluate (and minimize) HSE risks.
- Statoil will work together with the local government, communities and herders to better understand the use of the airstrip access track and other existing roads/tracks expected to be used during the drilling activities.
- Maintenance works will be performed on the unpaved accesses used by machinery. Once works are completed, these accesses will be left in a good state of preservation and all affected services will be restored.
- As part of the operational Waste Management Plan, the chosen treatment for each waste will take into account the capacity of local treatment plants to prevent possible overpressure events and, therefore, any detrimental effect on the needs of the local population.
- If relevant and technically feasible, some produced water will be monitored throughout the project and the technical capability for reusing the water in subsequent drilling and stimulation phases will be considered.
- An assessment to confirm the absence of capable faults within the prospective drilling area will be carried out before the stimulation activities start.
- A Seismicity Monitoring Plan will be drawn up. The details of the monitoring system will be defined prior to commencement of stimulation activities, but a potential example of such type of plans is the system known as the "Traffic Light System", involving the installation of a network of seismographs (accelerometers) on the sites, and the definition of operational levels based on the intensity measured by the seismographs.

5.2.3 Accidental and Non-routine events (AE)

The use of heavy machinery, hazardous materials (e.g. diesel) and wastes always involves a certain level of risk. This risk is related to the potential occurrence of accidental events. Because these are situations that are not part of the project definition their evaluation has been performed using a risk approach, in which the probability of occurrence and the consequence of the potential scenario are combined.

The definition of the non-routine events was based on the standard current practice, which reflects the most typical risks as well as those concerns that the public may have with respect to the drilling and stimulation operations. The evaluation covered the occurrence of (1) a blow-out (loss of control of the well leading to a spill on the well pad surface) and (2) the potential contamination of the groundwater resources through accidental contact with drillings muds, stimulation fluids or wastes/raw materials from the surface of the well pad).

As presented in the summary table below, after the evaluation all scenarios have been ranked as having a Low risk magnitude with the exception of the risk to shallow aquifers from accidental spillage (e.g.fuel, oil or other hazardous substances), which was ranked as Medium, meaning that the risk must be acted upon but only if measures are not sufficient to reduce risks to ALARP (As Low As Reasonable Practical). In this case this impact is common to any other drilling site (conventional and unconventional) and the standard preventive measures such as, secondary containment and monitoring ensure risk are kept to ALARP.

5.3 Assessment Summary of Accidental and Non Routine Events Impacts during the Drilling and Hydraulic Stimulation activities

Table 5.1 Risk Magnitude Rating summary for Accidental and Non Routine Events

Accidental and Non Routine Events		Risk Magnitude Rating	
Blow-out	**AE1**	**Low**	
Groundwater contamination	**AE2**		
Accidental spillage of raw materials (fuels, oils and additives) and waste at the well site surface impacting shallow groundwater quality	**AE2.1**	**Medium** (hazardous substances)	**Low** (drilling & stim. additives)
Contact of drilling fluids with aquifers due to well construction and integrity issues during drilling	**AE2.2**	**Low**	
Contact of stimulation fluids with aquifers due to loss of well integrity during hydraulic stimulation	**AE2.3**	**Low**	
Contact of stimulation fluids with aquifers due to induced fractures/seismicity	**AE2.4**	**Low**	

Risk Rating	**Low**	**Medium**	**High**

For the scenarios presented above most of the key mitigation and preventive measures are embedded in the project definition and are aligned with the best practice in the industry and the United States. A selection of these measures is presented below:

- Use of blow-out preventers (BOP) and inspection of the pressure control systems and the blow-out preventer (BOP) systems; Hydrostatic and function testing of BOP's as per Algerian regulatory or API Standards, whichever is more stringent.
- Staff with the appropriate training in control of wells during drilling activities.
- Hydrostatic testing of the casing strings.
- Testing the integrity of the exposed formation at the casing shoe prior to drilling to greater depth. Commonly known as formation integrity tests (FIT) or leak-off tests (LOT).
- The selection of hydraulic stimulation additives considers their environmental profile in addition to their technical behaviour, through the Statoil HSE screening tool, described in detail in the Chemical Management Plan, Appendix of the EMP),
- Groundwater samples will be collected from several sampling points, as part of the monitoring programme described in the EMP.

6 Environmental Management Plan

The purpose of the Environmental Management Plan (EMP) is to describe the measures for preventing and managing the environmental risks associated with the Project activities according to the in-force legislation and regulations on environmental matters. The EMP was prepared in accordance with Algerian Legal Requirements, international and Statoil internal procedures as well as best industry practices, and will be applicable to all project phases.

The EMP is a collection of Plans, Programmes and Procedures and it is intended as a working document that will require periodic reviewing and updating. In an attempt to go beyond the outlines for each plan, to be developed in a further stage of the project, Statoil has developed detailed framework plans and procedures for the key challenges, such as:

- Liquid Spill Response Plan
- Waste Management Plan

- Water Management Plan
- Plan for Oversight and Monitoring of Environmental Impacts
- Plan for Environmental Information and Awareness
- Chemical Management Plan
- Environmental Audit plan
- Procedure for Management of Change and
- Procedure for Archaeological Chance Findings

These plans and procedures have been developed, as far as possible, considering the current project design and local conditions. These documents will be continuously updated as further project information becomes available, and the final documents will be issued prior to awareness training sessions and the commencement of the operation.

The EMP also includes outlines of additional plans and programmes that will be prepared prior to training and the start of operations, which are:

- Plan for Prevention and Control of Pollution
- Plan for Intervention in Case of Pollution
- Plan for Management of Contaminated Sites and Soil
- Plan for Management of Liquid and Gaseous Waste
- Borrow Pit (quarry) Management Plan
- Programme for the Shutting Down and Restoration of Site

The EMP also includes a section that outlines the overall roles and responsibilities of those involved in the planning and implementation of the proposed exploration campaign.

Chapter 1 - Introduction

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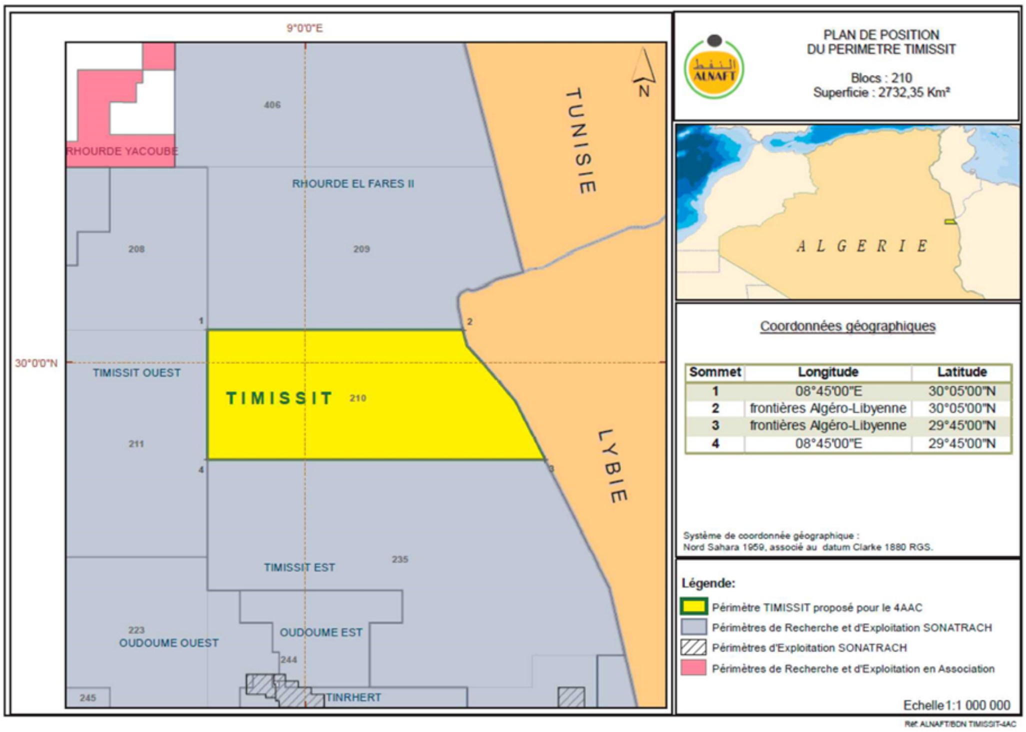
1 Introduction

1.1 Background

In the Algerian license round 2014, Statoil (Company), together with Sonatrach and Shell (Partners), was awarded the Timissit license, an unconventional liquid-rich gas license. The Timissit license is situated by the Libyan border on the edge of the Berkine basin.

Statoil is the operator of the license with a 30 % share, Sonatrach and Shell with respectively 51% and 19% shares.

Statoil intends to carry out a programme of 350 km^2 + 100 km^2 of 3D seismic acquisition and exploration drilling of minimum two, and up to six, exploration wells within the Timissit license area. Drilling and hydraulic stimulation of the exploratory wells is scheduled for the period 2016 – 2022. The seismic acquisition is scheduled to commence in 2017.



In keeping with Statoil's responsible and sustainable development practice (i.e. environmental and social responsibility) an Environmental and Social Impact Assessment (ESIA) is developed for the mentioned operations. This meets Algerian legislative requirements and will contain additional components in keeping with Statoil corporate requirements and International Standards & Best Practices.

1.2 Structure of the ESIA report

The ESIA report is prefaced by a Non-Technical Summary. The remainder of the report is set out as follows:

- Chapter 1 is this Introduction that gives an overview of the plan and present Statoil and the contractors used for developing of this report
- Chapter 2 provides the policy, legal and administrative framework for the project;
- Chapter 3 describes the main features of the drilling and stimulation programme and the seismic operations;
- Chapter 4 provides an overview of the environmental and social baseline;

- Chapter 5 sets out the scoping process, describes the potentially most significant environmental and social impacts, provides mitigation and management measures to manage these impacts and summarises residual significance;
- Chapter 6 describes the environmental management plans including an overview of plans, programs and procedures that have been developed and what the project plan to develop before start operations

The ESIA also contains the following Annexes:

- Annex to Chapter 1 Introduction:
  - Annex A.1: MATE's approval of BEXAM as contractor for performing ESIA
- Annexes to Chapter 4:
  - Annex C.1: Map and Summary Field Table Activities
  - Annex C.2: Noise measurement
  - Annex C.3: Soil Samples Certificate
  - Annex C.4: Water Sample Certificates
  - Annex C.5: Geomorphological Description
  - Annex C.6: Soil and Lithology Description
- Annexes to Chapter 6:
  - Annex D.1 Liquid spill response plan
    - D.1.1 Liquid Spill Modelling Initial Analyses
  - Annex D.2 Waste Management Plan
    - D.2.1 Existing Waste Facilities
    - D.2.2 Waste Management Summary Tables
  - Annex D.3 Plan for Mitigation actions and monitoring
  - Annex D.4 Water management Plan
    - D.4.1 List of Water Wells
    - D.4.2 Water Forecast Assumptions
    - D.4.3 Groundwater Sampling Methodology
  - Annex D.5 Plan for Environmental information and awareness
  - Annex D.6 Chemical management Plan
  - Annex D.7 Environmental Audit Plan
  - Annex D.8 Procedure for Management of Change
  - Annex D.9 Procedure for Archaeological Findings

1.3 Presentation of Statoil

Statoil is an international energy company with operations in 37 countries. Building on more than 40 years of experience from oil and gas production on the Norwegian continental shelf, we are committed to accommodating the world's energy needs in a responsible manner, applying technology and creating innovative business solutions. We are headquartered in Stavanger, Norway with approximately 23,000 employees worldwide, and are listed on the New York and Oslo stock exchanges.

The way we work is as important as the goals we achieve. We believe that competitive returns for our shareholders are best achieved through a values-based performance culture, stringent ethical requirements and a code of conduct which promotes personal integrity.

Safe and efficient operations are our first priority. We have won great renown for our technical safety monitoring system and our safe behaviour programme. We are convinced that all accidents can be avoided, and our goal is always to achieve zero personal injuries. We emphasise continuous work for an improved HSE performance in all our activities.

We focus on contributing to sustainable development via our core activities in the countries in which we operate. We are committed to openness and anti-corruption work, and to respect for human rights and employee rights. That applies both to our own activities and to those parts of the value chain over which we have significant influence.

Statoil has been in Algeria since 2003, when we open our office in Alger. We operate, in a joint venture, the In Salah dry gas and In Amenas gas and condensate fields together with BP and Sonatrach.

Timissit is Statoil's first operatorship license in Algeria.

1.4 Contractors that have supported Statoil in the ESIA development

1.4.1 Environmental Resources Management (ERM) - main contractor

ERM is one of Statoil's frame agreement companies. With more than 4,500 staff operating in 40 countries, ERM is a leading global provider of environmental, health, safety, risk, and social consulting services.

ERM is in a good position to perform the services required by Statoil in relation to the ESIA because of their experience working for more than 12 years in Algeria, their particular knowledge of the regulatory framework in the country, their experience working with Statoil, Shell and Sonatrach, their expertise in unconventional gas projects and the credentials of their Algerian associates.

Key areas of ERM's experience:

- Direct experience working for SONATRACH.
- Experience with Statoil: ERM has a track record with Statoil (UK, Gulf of Mexico, Tanzania, Italy), on a number of similar environmental studies (ESIA, environmental field surveys, regulatory support etc.). The team for this project has also direct experience working for Statoil in Algeria (Hassi Mouina Block) in 2005 and 2006 and for Joint Ventures of BP, Statoil and Sonatrach (In Salah Gas and In Amenas).
- ERM's experience in social and environmental studies in Algeria. The company is familiar with in-country complexities/challenges and existing regulations in conventional and non-conventional resources.
- ERM has gained a broad experience in unconventional gas projects across the globe. Since 2011, ERM has been deeply involved in several unconventional gas projects in North Africa (Algeria, Tunisia, and Morocco) including: permitting strategies, ESIAs, stakeholder engagement, support to operators in project design (e.g. Site selection criteria), water management studies, among others.
- ERM has a worldwide experience in Water Management Plans, Waste Management Plan and Spill modelling and response planning.
- ERM quality management system is certified under EN-ISO-9001. They also hold a certification on ISO 14001 and OSHAS 18001.

1.4.2 Local consultancy BEXAM – ERM's subcontractor

- BEXAM is an Algerian environmental consultancy with whom ERM's team has worked in the past on a wide range of oil and gas projects in Algeria. Over the course of recent years they have built up a good working relationship.
- Since 18th April 2009, BEXAM has been included in the list of approved contractors for the development of ESIAs in Algeria developed by the Ministry of Environment and Land Planning (Ministère de l'Aménagement du Territoire, de l'Environnement, [MATE]), *see Annex A.1.*
- BEXAM is familiar with SONATRACH's operations.

- The company has also extensive experience with Algerian laws, codes and regulations.
- BEXAM has been involved in the ESIA field data collection, support in review of legislation, support in obtaining and reporting baseline data.

Chapter 2 - Administrative and Regulatory Framework

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2 Administrative and Regulatory Framework

2.1 Introduction

This chapter describes the administrative and legal context of the Timissit licence area (an unconventional liquid-rich shale gas license) and presents a review of the Algerian legislation and standards applicable to the seismic and drilling activities required for the proposed exploration project. Some activities are not yet covered by Algerian regulations, in which case the relevant international standards and directives have been used as guidance references. In addition, Statoil's own applicable policies and guidelines have been included.

In line with the above this report is structured as follows:

- ***Section 2.2 Administrative and Institutional Framework***: provides an overview of the national, regional and local administrative framework as well as the key regulatory authorities and institutions for the Timissit exploration project.
- ***Section 2.3 Algerian Legislative Framework***: presents a review of the relevant national and international legislation directly applicable to, or considered of interest for, the different project activities; as well as the key permits required for hydrocarbon exploration and international guidelines of interest.
- ***Section 2.4 International Guidelines and Standards of Reference for the Timissit Exploration Project:*** summarises the international conventions of interest for the project that have been ratified or signed by Algeria as well as international best practices and guidelines relevant for the project including best practices specific for unconventional hydrocarbon activities.
- ***Section 2.5 Statoil Internal Standards and Procedures***: presents the key Statoil environmental standards relevant to the project activities.

For the purpose of the study, the Algerian Official Gazette has been closely monitored to ensure the most up-to-date legal texts published have been taken into account. The most recent access to the Algerian Official Gazette was on 4th May, 2015, and the latest bulletin available was released on 26th April, 2015.

2.2 Administrative and Institutional Framework

2.2.1 Overview of National, Regional and Local Framework

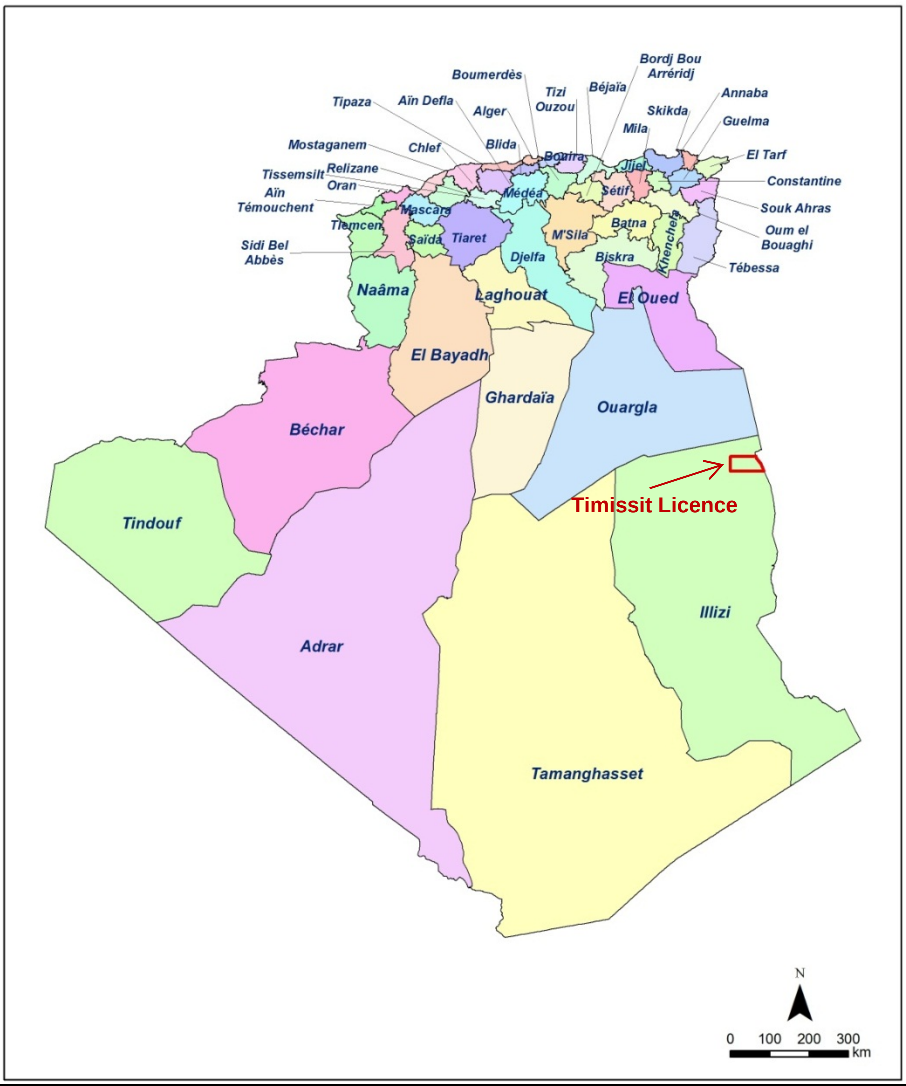
Algeria is divided into administrative regions (*Wilayas*) as shown in Figure 2.1 below. Each region is administered by a Wali (Regional Governor), designated by the President of the Democratic Republic of Algeria, and a Wilaya's Popular Assembly (*Assemblée Populaire Wilayale – APW*), elected by the people. The roles of the Wali and the Wilaya's Popular Assembly in the permitting approval processes applicable to oil and gas activities are described in Section 2.2.6 below.

The second level of administration involves the districts (*Daïras*) while the third level is represented by the Municipalities (*Baladiyahs*; in French *Commune*), governed by the Communal Popular Assembly (*Assemblée Populaire Communale-APC*), elected by the population.

Currently, Algeria has 48 regions (*Wilayas*), 553 districts (*Daïras*), and 1,541 municipalities (*Baladiyahs* or *Communes*). The Timissit license is located within the Illizi Wilaya,the In Amenas Daïra and the Commune of Debdeb. On 24th May, 2015, during the preparation of the present report, the Council of Ministers approved the creation of a new administration division under the Wilaya. Specifically, ten administrative districts (*circonscriptions*) have been created in the Wilayas of

Adrar, Biskra, Béchar, Tamanrasset, Ouargla, Illizi, El Oued and Ghardaïa. Each circonscription group one or more Daïras and several Communes. According to Presidential Decree 15-140 establishing the creation of these new administrative districts[1], the Timissit license is not affected by this new administrative division.

Figure 2.1 shows the location of the Timissit license with respect to the current (May 2015) boundaries of the Wilaya.



Source: ERM, 2015 from: http://www.d-maps.com/carte.php?&num_car=34318&lang=en

Figure 2.1 Regions of Algeria and location of Timissit license (in red)

2.2.2 Key regulatory authorities and institutions for the Timissit project

In addition to the national, regional and local representatives described above, below are the key regulatory authorities and institutions involved in the permitting approval processes that are of relevance for the Timissit project:

- The **Ministry of Land-Use Planning and the Environment** (*Ministère de l'Aménagement du Territoire et de l'Environnement [MATE]*).
    - o Wilaya Directorate of the Environment (*Direction de l'environnement*).

[1] In addition, Executive Decree 15-141 describes the internal organization of the new administrative bodies.

- The **Ministry of Energy and Mining** (*Ministère de l'énergie et des mines [MEM]*) including the National Hydrocarbon Agencies:
  - The **Hydrocarbons Regulation Authority** (*Autorité de Régulation des Hydrocarbures – ARH*).
  - The **National Agency for Hydrocarbon Resources Valuation** (*Agence National pour la Valorisation des Ressources en Hydrocarbures – ALNAFT*).
- The **Ministry of Water Resources** (*Ministère des resources en eau*).
  - Wilaya Directorate of Water Resources (*Direction des resources en eau*).
  - Agency of the Sahara Hydrographic basin (*Agence du Bassin Hydrographique Sahara*).
- The **Board of Control for Classified Facilities** (*CCEC - Commission de Contrôle des Établissements Classés de Wilaya*).

The Ministries (MATE, MEM and the Ministry of Water Resources) are supported at regional level by the regional offices or Directorates operating in each wilaya. The aforementioned authorities are described in the subsequent subsections.

2.2.3 Ministry of Land-Use Planning and Environment (MATE)

According to the Executive Decree 07-351 of 18 November 2007, the MATE is the institution responsible for environmental protection in Algeria.

The MATE is organised into two General Directorates and six Directorates. The relevant authority within the MATE for hydrocarbon activities is the General Directorate of the Environment and Sustainable Development, which has the following responsibilities:

- To propose national environmental policies.
- To propose and develop legislation aimed at protecting the environment.
- To propose and develop research studies concerning pollution identification and nuisance prevention, both in the natural and urban environments.
- To ensure the control and monitoring of the environment.
- To issue authorisations regarding the environment (for instance, authorisation for industrial wastewater discharges into public sewerage systems or treatment plants).
- To examine, analyse and grant final approval on environmental impact assessments, industrial risk studies, and environmental audits (Directorate of Assessment of Environmental Studies).
- To promote environmental awareness and education through actions and activities.
- To contribute to public health protection and life quality enhancement.

Furthermore, decentralised directorates are included within each Wilaya of the country, the Regional Directorates of the Environment (*Directions de l'environnement de la Wilaya*). These Regional Directorates are responsible for:

- To ensure, together with other regional authorities, the application of environmental regulation.
- To prevent all forms of pollution and environmental degradation, and preserve biodiversity.
- To disseminate educational materials related to the environment.
- To provide advice on authorising the transport of dangerous substances.

The Regional Directorate of relevance for the Timissit project is the Directorate of the Environment of the Illizi Wilaya.

2.2.4 Ministry of Energy and Mining (MEM)

The MEM is responsible for the development and implementation of government policies and strategies for the exploration, production and commercialisation of hydrocarbons, mining and electricity resources.

Executive Decree 07-267 sets out the organisation and the competences of the MEM. The main responsibilities of this ministry that are relevant for oil and gas activities include:

- Implementing laws and regulations for the oil and gas sector and the valorisation and use of natural resources (hydrocarbons and mining resources).
- Implementing international cooperation programmes related to energy and mines.
- Ensuring the application of international conventions related to energy and mines.
- Helping prepare the national programmes for seawater desalinization, electrification and public distribution of natural gas.
- Defining and controlling the implementation of industrial policies and strategies.
- Proposing measures for developing industrial activities and research and development.
- Participating in studies related to land planning and sustainable development.
- Promulgating and regulating standards, industrial protection and controls.

Furthermore, decentralised directorates are included within each Wilaya of the country, the Regional Directorates of the Energy and Mining (*Directions de de l'énergie et des mines de la Wilaya*). These Regional Directorates have the following responsibilities:

- To ensure, together with other regional authorities, the application of regulation published by the MEM.
- To control equipment in order to ensure industrial security.

The National Hydrocarbon Agencies ARH and ALNAFT, pertaining to the MEM are presented in separate sub-sections below.

2.2.4.1 Hydrocarbon Regulation Authority (ARH)

The ARH (*Autorité de Régulation des Hydrocarbures*) is an independent agency, under the authority of the MEM, created according to *Law 05-07 on Hydrocarbons* (modified by *Law 13-01*). It is responsible for administrative and regulatory activities in the hydrocarbon sector, including the following responsibilities:

- Coordinating the Environmental Impact Assessments (EIAs) and risk assessment (in French *Étude de danger*) approval processes for all hydrocarbon-related activities.
- Technical regulations applicable to hydrocarbon activities..
- Compliance with standards based on the best international practices.
- Monitoring and enforcing Algerian regulations concerning HSE and management of major risks.
- Managing the chemical products used in both conventional and unconventional projects as well as establishing site remediation and clean-up requirements.
- Regulation of the national hydrocarbon product market.
- Regulations related to tariffs and the principle of third-party access to pipeline transport and storage infrastructures.
- Reference terms for the construction of pipeline transport facilities and storage facilities.
- Analysis of permit requests for pipeline transport infrastructures; and submission of their recommendations to the ministry in charge of hydrocarbons as well as compliance control.
- Management of equalisation funds and tariff compensation for hydrocarbons transport.

The ARH leads the EIA approval process for all hydrocarbon-related activities although final approval is granted by the MATE (see Section 2.3.4.1 for further details on the EIA approval process). The ARH is also responsible for controlling and monitoring the management plans included in the approved EIAs, approving risk assessments and grating authorisation and concessions for hydrocarbons pipelines. Different types of equipment, materials and devices for oil and gas projects are as well subject to ARH control and approval process.

2.2.4.2 National Agency for Hydrocarbon Resources Valorisation (ALNAFT)

The ALNAFT (in French *Agence Nationale pour la Valorisation des Ressources en Hydrocarbures)* was created according to *Law 05-07 on Hydrocarbons* (modified by *Law 13-01*) and is under the responsibility of the MEM. ALNAFT's responsibilities are set out in Law 13-01. These include the following responsibilities relevant for the Timissit project:

- Coordinating, together with the relevant Wilaya's Directorate of Water Resources, the authorisation for the use of water from the hydraulic public domain in case of unconventional gas/oil projects.
- Granting the authorisation for exceptional flaring.
- Awarding exploration and exploitation contracts to investors through an open bidding process and providing information on investment opportunities.
- Promoting Research & Exploitation Investments.
- Managing and updating of databases on hydrocarbon exploration and utilisation, under the responsibility of the MEM.
- Issuing Prospection Authorisations.
- Monitoring the payment of various taxes related to oil, land occupation, flaring activities and water use.
- Concluding contracts for exploration and exploitation.
- Determining/collecting royalties.

According to Article 53 of Law 13-01, in case of unconventional gas/oil projects the authorisation for the use of water from the hydraulic public domain is granted by the relevant Wilaya's Directorate of Water Resources in coordination with ALNAFT. ALNAFT also grants the authorization for exceptional flaring and is in charge of examining and approving Field Development Plans.

2.2.5 Ministry of Water Resources

The organisation of the Ministry of Water Resources is established by the Executive Decree 2000-325 of 25 October 2000. Its main responsibilities that are of relevance for the Timissit project include:

- Managing and evaluating water resources. In particular, it is responsible for the management of public water service infrastructure.
- Participating in the development of the national policy in the field of water resources.
- Monitoring and controlling the implementation of national policies in accordance with the laws and regulations.
- Ensuring the rational use of water resources and their economy.
- Implementing maintenance and prevention with respect to hydraulic assets.

Furthermore, decentralised directorates are included within each Wilaya, the Regional Directorates of Water Resources (*Directions de Ressources en eau de la Wilaya*). The Regional Directorate of relevance for the Timissit project is the *Directorate of Water Resources of the Illizi Wilaya*. These Regional Directorates are responsible for:

- Ensuring the protection and preservation of public water resources and their rational use.
- Contributing to the development of conventional (surface and groundwater resources) and non-conventional water resources (treated wastewater and desalinated water) and their mobilisation.
- Ensuring the implementation and monitoring of regulations in the field of infrastructure development, operation and maintenance for the drinking water supply, sanitation and agricultural water.
- Collecting and analysing data on research, exploitation, production, storage and distribution of water for domestic, agricultural or industrial purposes.
- Maintaining a record of water points in the Wilaya's territory and following up studies and surveys that contribute to a better understanding of surface and groundwater resources.
- *Providing authorisations related to water resources* (e.g., authorisation for water extraction, or water use concessions).

The Ministry of Water Resources is consulted during the EIA approval process and other water related authorisations while the decentralised directorates within each Wilaya, the Directorates of Water Resources (*Directions des resources en eau*), are responsible for granting water resource-related permits. Besides, the Agency of the Sahara Hydrographic basin is also involved in the authorisation process for the use of water from the Sahara Basin, where the project is located, and is in charge of collecting the taxes for the water extracted from the Sahara Basin for hydrocarbon related activities (including the water injection in drilling wells).

2.2.6 Regional authorities

This section presents the main regional authorities involved in the permitting processes for oil and gas projects: the Wali, the Wilaya's Popular Assembly, the Communal Popular Assemblies and the Board of Control for Classified Facilities.

2.2.6.1 Wali and the Wilaya's Popular Assembly

As previously mentioned, the Wilaya is headed by a Wali and a Wilaya's Popular Assembly. The responsibilities of both authorities are described below.

Wali

The main responsibilities of the Wali relating to health, safety and the environment are detailed below:

- Ensuring public order, in particular in relation to health and safety, hygiene and security at a regional level.
- Interpreting and applying national legislation at the regional level (the Wali can make decisions that are applicable at the regional level), promulgating local orders[2] ("*Arrêtés*" or "Decisions").
- Ensuring that the legislative and regulatory aspects of environmental protection are enforced.
- Approving and implementing emergency response plans concerned with industrial accidents and natural disasters.
- Authorising or rejecting waste water discharges to local sewage networks.
- Acting in relation to the management of industrial zones.

[2] Local orders are mainly related to authorisation approvals/refusals and very specific decisions towards a project, community management (waste collection, lighting, noise, etc.) or decisions regarding expropriation for public interest. It should be noted that all the issues concerning hydrocarbon activities are consulted and endorsed at national level. However, regular contact with the authorities is highly recommended at all levels (national, regional and local) in order to ensure compliance with any formal or informal requirements that could arise as unconventional/shale gas projects in Algeria progress.

- Providing several authorisations related to the exploration and development of oil and gas projects (e.g., exploitation of 2nd category of classified facilities).
- Making EIA public and managing public consultation process.

Wilaya's Popular Assembly

The organisation of the Wilaya's Popular Assembly (APW) is defined by Law 90-09 of 7th April, 1990. It is responsible for taking actions on economic, social and cultural development, land planning, environmental protection and the promotion of specific vocations within the Wilaya. The president of the APW is elected by its members. The Wali participates in the APW meetings.

In the context of the oil and gas sector, the president of the APW is in charge of granting authorisations for the construction and operation of inert waste treatment facilities.

2.2.6.2 Communal Popular Assemblies

The organisation of the Communal Popular Assemblies (APC) is defined by Law 11-10 of 22nd June, 2011. Amongst other things, it is responsible for preserving cultural heritage and protecting the environment.
In the context of the oil and gas sector, the president of the APC is in charge of granting authorisations for the exploitation of 3rd and 4th level classified facilities and construction permits. In addition, the president of the APC is also in the commission in charge of approving emergency response plans.

2.2.6.3 Board of Control for Classified Facilities

The CCEC is the body within each Wilaya that is in charge of ensuring compliance with the regulations governing classified facilities and examining the requests (application dossier) for creating classified facilities. The list of classified facilities is established by Decree 07-144 (refer to Section 2.3.4.3 for further details).

The composition, organisation and functioning of the Board of Control for Classified Facilities (Commission de surveillance de contrôle des installations classées, CCEC) is defined by the Executive Decree 06-198.

2.3 Algerian Legislative Framework

2.3.1 Overview

This section presents the legal basis for hydrocarbon activities in Algeria established by Laws 05-07 and 13-01 and the environmental legal framework in Algeria, including a detailed description of the Environmental Impact Assessment (EIA) approval process and the key permits required for hydrocarbon activities (i.e., EIA, Risk Assessment and Exploitation permit for classified facilities).

In addition, this section presents a summary of the applicable Algerian regulations on air quality, atmospheric emissions, ambient noise, water quality, wastewater discharge, soils, waste, dangerous substances, flora and fauna, protected areas, and archaeology and cultural heritage. For those aspects not yet covered by Algerian legislation, international guidelines have been considered as a reference for the purpose of the impact assessment.

2.3.2 The Hydrocarbon Laws

Law 05-07, dated 28 April, 2005, hereinafter the 2005 Hydrocarbon Law, defines the legal system for prospection, exploration, exploitation, transportation by pipeline, refining, hydrocarbon processing, marketing, storage, oil products and associated works and facilities. It also defines the institutional framework that enables the implementation of the aforementioned activities and the rights and obligations of the parties performing any of these activities. The 2005 Hydrocarbon Law was modified and completed by Ordinance 06-10 of 29th July, 2006 and Law 13-01, dated 20th February 2013, hereinafter the 2013 Hydrocarbon Law.

The 2005 Hydrocarbon Law established two new independent national agencies: ARH and ALNAFT (see Sections 2.2.4.1 and 2.2.4.2 respectively); and obliges any hydrocarbon project to perform an EIA and submit it for approval to the ARH. Further details on the EIA approval process are included in Section 2.3.4.1.

The 2013 Hydrocarbon Law introduces new provisions for activities related to unconventional oil and gas and offshore activities. In addition, it introduces new specific provisions on environmental matters, including:

- *Water use*: Article 53 of the 2013 Hydrocarbon Law establishes that ALNAFT will be involved in the procedure for granting water use authorisations for projects on unconventional resources.
- *Flaring:* Article 52 states that, although flaring is prohibited, it can, exceptionally, be performed for a limited period. This provision was later implemented by the release of Executive Decree 13-400 (further details are included in Section 2.3.5.2).
- *Risk Assessment studies for hydrocarbon activities*: Article 18 establishes that industrial risk assessment studies (in French *Étude de danger* – EDD) relating to hydrocarbon activities will be sent to ARH for approval. This provision was later implemented by Executive Decree 15-09 published in January 2015, further details are included in Section 2.3.4.2.

Furthermore, Article 23b of Law 13-01 states that any exploitation activity using hydraulic fracturing techniques is subject to approval by the Council of Ministers.

Although the 2013 Hydrocarbon Law is the first regulation related to unconventional resources, specific provisions for hydraulic stimulation activities had previously been included in Executive Decree 94-43, which was created for developing the provisions set in article 14 of Law 86-14. This Decree establishes the rules governing the protection of hydrocarbon deposits and associated aquifers for exploration (Title II) and development phases (Title III). This same decree also sets specific provisions for drilling activities, including casing requirements, the use of safety valves (Title IV) and specific requirements for temporary and permanent well abandonment (Title V). It is worth noting that Law 86-14, under which Executive Decree 94-43 was created, was revoked by Article 114 of the 2005 Hydrocarbon Law. However, because it has not been replaced so far, it is still used as a reference.

2.3.3 The Environmental Regulatory Framework

The legal basis for environmental protection in Algeria is established in Law 03-10, dated 19th July, 2003, on the Protection of the Environment within the framework of Sustainable Development. Law 03-10 sets out the framework for protecting biological diversity, air quality, atmospheric emissions, water, soil, desert areas and cultural heritage. It also sets out the principles for environmental protection, which include amongst other things, the “precaution” principle and the “polluter pays” principle.

The most important applicable decrees deriving from Law 03-10 and which concern the environmental approval processes for oil and gas exploration and development are the following:

- *Executive Decree 07-145*, dated 19th May, 2007. It determines the scope and content of an EIA (see Section 2.3.4.1 for further details).
- *Executive Decree 08-312* dated 5th October, 2008, establishes the terms governing the ARH's approval of EIAs for hydrocarbon-related activities and completes the documentation required by Decree 07-145 for hydrocarbon projects (see Section 2.3.4.1 for further details).
- *Executive Decree 06-198* dated 31st May, 2006, defines the environmental protection regulations applicable to classified facilities and states that all classified facilities require an exploitation authorisation (see Section 2.3.4.3 for further details).
- *Executive Decree 07-144* dated 22nd May, 2007, describes the nomenclature for classified facilities and activities which are polluting or dangerous to the environment (see Section 2.3.4.3 for further details).

Furthermore, as previously mentioned, the 2013 Hydrocarbon Law introduces specific provisions to support research on unconventional resources and production, some of them regarding environmental matters (see Section 2.3.2).

2.3.4 Key Permits Required For Hydrocarbon Exploration

The following table provides a summary of the key permits required to date for conventional and unconventional oil and gas exploration projects in Algeria.

Table 2.1 Key permits required for exploration of oil and gas in Algeria

Approval and reference legislation	Competent authorities	Approval time by law	Relation with other permits	Reference section
EIA for seismic and exploratory drilling Decree 07-175 and 08-312	ARH and MATE	Approx. 6 months	The applicant's "right to explore" licence is required. EIA must be approved before seismic and drilling works begin.	Section 2.3.4.1
Risk Assessment (EDD) Decree 05-19	ARH	Between approx. 60 and 130 days	None	Section 2.3.4.2
Exploitation authorisation for classified facilities Decree 06-198 and 07-144 (including a list of classified facilities).	MATE, Wali and President of the pertinent Communal Popular Assembly	3 months for the preliminary permit. The exploitation permit is delivered 3 months after notification of construction completion.	Construction of classified facilities is subject to the approval of the construction permit. *Note: Exploitation authorisation for classified facilities is only required if the exploration project includes the construction and operation of a classified facility (for instance the construction of an explosives storage area).*	Section 2.3.4.3

Approval and reference legislation	Competent authorities	Approval time by law	Relation with other permits	Reference section
Concession for the use of water reserves from fossil and weakly renewable aquifers (including well construction, stimulation and exploitation). Decree 10-318	Wilaya Directorate of Water Resources and ALNAFT (the latter only in the case of unconventional resource projects).	6 months (maximum).	None	Section 2.3.4.4

Source: ERM, 2015

2.3.4.1 Environmental Impact Assessment (EIA)

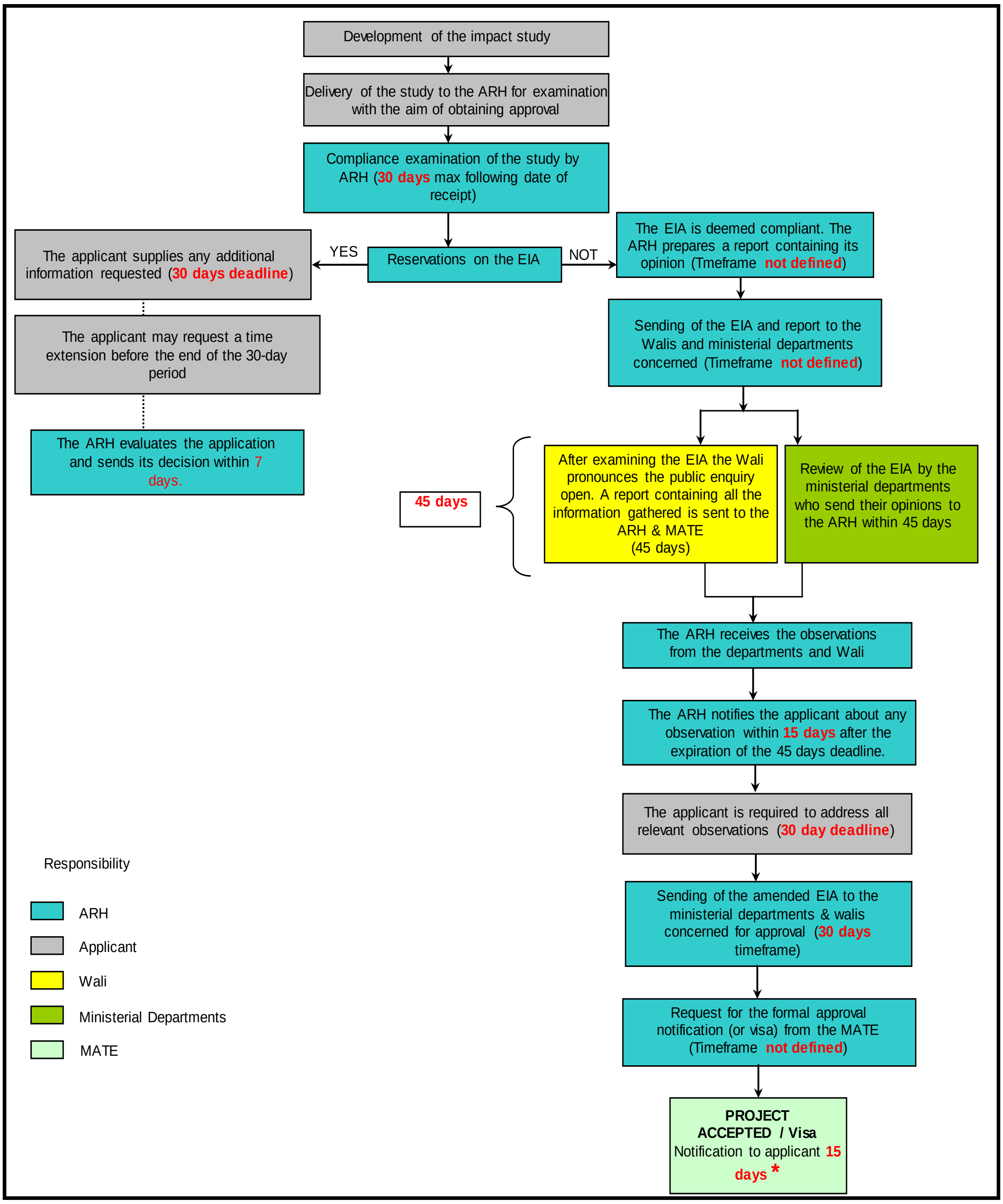
According to the 2005 Hydrocarbon Law and Article 18 of the 2013 Hydrocarbon Law, hydrocarbon-related activities such as those planned for the Timissit project, are subject to the performance of an EIA.

The main regulatory text for Environmental Impact Assessment in Algeria is Executive Decree 07-145 dated 19 May, 2007, relating to environmental impact studies and impact notes. This decree determines the scope, content and methods for obtaining approval of environmental impact studies and impact notes for the activities listed in its Annexes I and II respectively. However, for hydrocarbon-related activities the conditions governing the approval of environmental impact studies are set out in Executive Decree 08-312 dated 5 October 2008.

Both Decree 08-312 and the 2013 Hydrocarbon Law (Art. 18) state that all EIAs related to the hydrocarbon sector shall be submitted to the ARH, instead of sending it to the Wali as stipulated in Executive Decree 07-145 for non-hydrocarbon related activities in Algeria. However, the MATE is the sole authority in charge of issuing EIA approvals.

Figure 2.2 illustrates the approval process for hydrocarbon-related impact studies according to Executive Decree 08-312 and Executive Decree 07-145, including the timing. It should be noted that the regulation does not define whether the timing is in calendar days or working days

Figure 2.2 Flow Diagram of Impact Study Approval Process, Algeria



** The time available for the MATE to send the formal approval notification (visa) to the ARH is not specified in Decree 08-312 and therefore is outside the 15-day period.*

Source: ERM based on Decrees 07-145 and 08-312.

After the ARH has reviewed the EIA and the operator has addressed any reservations expressed, the ARH submits the EIA to the Wali. The Wali opens a public enquiry according to the requirements of Executive Decree 07-145, with the aim of inviting all individuals or legal entities to express their opinion on the planned project and its foreseeable impact on the environment. The decree opening the public enquiry is brought to the public's knowledge by means of a notice displayed at the Wilaya headquarters, in the municipalities (Communes) concerned and on the sites affected by the project, as well as published in the national newspapers. Once the enquiry is open, anyone can ask to consult the EIA through an application made to the Wali. The public enquiry lasts no more than one month from the date of posting.

The Ministerial Departments and Walis are required to present a report containing the opinion of the technical departments and the results of the public enquiry to the ARH and the MATE within 45 days of the reception of the EIA (the public enquiry is included within this time frame). After this deadline, the environmental impact study is deemed accepted.

In the event that the ministerial departments and Walis issue relevant observations, the ARH notifies the applicant within 15 days of the expiry of the 45-day deadline mentioned previously. The applicant has to address all reservations and send the duly amended impact study to the ARH in no more than 30 days from the date of notification. The ARH then sends it to the ministerial departments and Walis concerned[3] for approval, who must in turn provide their recommendation on the EIA submitted. According to Article 18 of Decree 08-312, after this time the amended EIA is considered to be approved.

If the ministerial departments and Walis do not notify the ARH within 30 days, the ARH makes a request for the formal approval notification (or visa) from the MATE.

It should be noted that the time available for the MATE to send the formal approval notification (visa) to the ARH is not specified in Decree 08-312. However, once the approval notification has been received from the MATE, the ARH must notify the applicant within 15 days.

According to ERM's previous experience, the approval time for an EIA is estimated at around six months for conventional projects, assuming minor comments are provided by the different consulted parties.

<u>EIA scope of work according to National Law</u>

Pursuant to Law 03-10, Article 6 of Executive Decree 07-145 and Article 6 of Executive Decree 08-312 (establishing the terms governing the approval of environmental impact studies for hydrocarbon activities), an EIA must contain at least the following:

- Presentation/introduction of the project developer (name, experience, etc.) and an introduction to expert technical service providers;
- Presentation of the company performing the study;
- Description of the limits of the study area, and the study goals and objectives;
- Description of the regulatory and administrative context linked to the project activity (category of classified facilities, contract, concession. etc.);
- Presentation of the different potential project alternatives with an explanation and justification of the economic, technological and environmental choices made, as well as the economic and social costs of non-completion of the project;
- Description of the site's initial conditions, its present environmental status, especially regarding its natural resources and biodiversity, in addition to the terrestrial, marine and hydraulic resources that may be affected by the planned activity;
- Detailed description of the different project phases, construction, exploitation, post-exploitation phase;
- Estimation of the type and quantity of waste, emissions, and potential damage in the various phases of the project.
- Assessment of the project's foreseeable short, medium and long-term direct and indirect impact on the environment (air, water, soil, organic environment, etc.), cultural heritage, socioeconomic conditions and public

[3] According to Article 14 of Executive Decree 08-312, the Ministerial Departments and Walis concerned for the approval process are: the Ministry of Defence, Ministries of the Interior, Water Resources, Forestry, Agriculture, Mining, Environment, Construction, Public Works, Culture, Tourism, Finance, Transport, Information Technologies and Communication, and the Wali or Walis of the Wilayas concerned by the project.

health, including any potential emissions and nuisances during the different phases of project activities, given the particularities of hydrocarbons and, in particular, the following:

- Research work into hydrocarbons - their extraction, treatment, storage, pipeline transportation, refining and transformation;
- Petroleum product loading/unloading operations;
- Excavations and modifications to the geological structures traversed and associated aquifers, due to drilling and exploration operations.
- Analysis of cumulative impacts;
- Description of measures planned by the applicant to eliminate, reduce and/or compensate for damage resulting from the different project phases, as well as the financial resources to be allocated to them. These include measures for eliminating, reducing or compensating for environmental impact linked to the generation of:
- Mud from drilling, hydrocarbon storage, oil removal facilities, and desludging facilities;
- Residual domestic and industrial water, notably oily or ballast water;
- Flaring or venting;
- Atmospheric pollutants, notably volatile organic compounds (VOCs);
- Special or hazardous waste.
- Details of the environmental management plan[4]. This shall necessarily comprise a description of the programme in place for monitoring the prevention and management measures implemented by the applicant with a view to eliminating, reducing and/or compensating for harmful environmental impacts. The environmental management plan must comprise, in particular:
- A pollution prevention and control plan (leakages, spills, atmospheric discharge, etc.) during the construction, exploitation and abandonment phases;
- A response plan in case of pollution;
- A waste management plan;
- A contaminated soil and site management plan;
- A liquid and gaseous discharge management plan;
- An environmental impact monitoring and follow-up programme;
- A plan for optimum use of natural resources;
- A chemical management plan;
    - An environmental awareness and information plan;
    - An environmental audit programme;
    - A site abandonment and renovation plan.
- The project's technical provisions for reducing impacts, during project design and exploitation; cost estimates and financial arrangements made by the developer to cater for these costs;
- The technical and financial aspects of the dismantling/decommissioning plan at the end of the project's life, and the financial arrangements made by the developer to cater for these costs;
- Any other document, information or study provided by the expert technical service providers to support the content of the EIA.

Although not specified by legislation the EIA should include an Executive Summary in both French and Arabic.

According to article 7 of Executive Decree 08-312, the environmental impact study on the hydrocarbon exploitation activities must focus on all facilities and activities undertaken within the exploration or exploitation perimeter, especially:

- Research drillings and statigraphic drillings.
- Seismic operations;

[4] Instruction nº2 issued by ARH to Sonatrach dated 26th April 2011 provides the minimum content to be covered by each of the management plans to be included in the EIA, as listed above.

- Construction of settlements.
- Construction of access roads.

Note: according to Articles 7 of Decree 08-312, should any additional activities not be included in the **initial EIA, such as the drilling of new exploratory wells, new seismic work or the construction of new facilities,** the initial environmental impact study will have to be updated, and then submitted again by the contracting party or operator for approval by the ARH.

2.3.4.2 Risk Assessment for oil and gas activities

According to Executive Decree 15-09 of 14th January, 2015, a risk assessment is required for all facilities and work related to hydrocarbon activities (including exploration and exploitation activities, storage, transport by pipelines, petroleum product distribution, refineries and transformation of hydrocarbons). The risk assessment must be approved before any work commences.

The risk assessment must be updated by the operator and resubmitted for approval by the ARH at least every five years. Any modification to the area of the “hydrocarbon” activities, the size of the facilities, the planned processing and/or the production capacity of any technological processes, is subject to the Operator submitting a new risk assessment for approval by the ARH.

The specific risk assessment approval process for oil and gas activities, as well as their content, is set out in Decree 15-09.

2.3.4.3 Classified facilities

Executive Decree 06-198 defines the environmental protection regulations applicable to classified facilities, which require an exploitation authorisation before its construction and operation.

Classified facilities are listed in Annex of Executive Decree 07-144. They are divided into four categories, depending on the approval authority. 1st, 2nd and 3rd categories are subject to authorisation by the Ministry of Energy and Mining (MEM), Wali or President of the Communal Popular Assembly respectively. Classified facilities 4th category are subject to a declaration from the President of the Communal Popular Assembly.

Examples of classified facilities include: explosive storage areas (Nº 1411 - 1st, 2nd or 3rd category, depending on the storage quantity), gasometers, compressed and inflammable gas tanks within an enclosed space (Nº 1511 – 1st, 2nd or 3rd category, depending on the gas storage capacity) and gas pipelines (Nº 1514 – 1st category).

The exploitation authorisation for classified facilities must be preceded by an approved EIA and risk assessment (further information on both studies can be found in sections 2.3.4.1 and 2.3.4.2 respectively).

It should be noted that the proposed exploration project does not include any of the classified facilities listed in Executive Decree 07-144. However, should the project envisage the construction and operation of an explosive storage area, an exploitation permit for classified facilities will be required.

2.3.4.4 Water well construction and water abstraction

Executive Decree 10-318 determines the approval procedure for concessions to use water reserves from fossil and weakly renewable aquifers. This concession approval also provides the well construction approval.

The application must include the documentation included in article 3 of Executive Decree 10-318 and the technical specifications form (*cahier de charges*) included in the annex of the same decree.

During their review of the documentation provided, the Wilaya Directorate of Water Resources undertakes a technical visit to the proposed location of the water wells to verify the site conditions of the planned water wells and water resource use.

Article 53 of 2013 Hydrocarbon Law (Law 13-01) establishes that in the case of unconventional resource projects the water use concession is granted by the Wilaya Directorate of Water Resources in coordination with ALNAFT.

The volume of water used shall be reported to the Directorate of Water Resources of the Wilaya and a tariff shall be paid.

2.3.5 Applicable Algerian Regulations and Reference Values of International Standards

The purpose of this section is to summarise the in force Algerian legislation on air quality, atmospheric emissions, noise, water quality, wastewater discharge, soils, waste management, dangerous substances, fauna, flora and protected areas, archaeology and cultural heritage, land use planning, protective perimeters and local content. For aspects not covered by Algerian legislation, the most relevant international standards have been used as guidance references in the project's impact assessment (e.g., Ontario standards for soil remediation) considering the nature of the project activities.

2.3.5.1 Air Quality

The main regulatory text in terms of air quality is Executive Decree 06-02 of 7th January 2006. This Decree defines the limit values, alert thresholds and air quality objectives for nitrogen dioxide, sulphur dioxide, ozone and particulate matter, as defined in Table 2.2.

Table 2.2 Algerian Air Quality guidelines

Parameter	Quality objective (1) ($\mu g /Nm^3$)1	Limit value (2) ($\mu g / Nm^3$)	Information level(3) ($\mu g / Nm^3$)	Alert threshold(4) ($\mu g / Nm^3$)
NO_2	135	200[2]	400	600
SO_2	150	350[3]	350	600
O_3	110	200	180	360
Particles	50	80	- (5)	- (5)

Notes:

(1) Quality objective: The concentration, in a certain period of time, of the chemical contaminants of concern, established on the basis of state-of-the-art technical knowledge that should be implemented in order to avoid or prevent the noxious effects of these contaminants on human health and the environment.

(2) Limit value: The maximum critical concentration of contaminants in the atmosphere, as established on the basis of scientific knowledge.

(3) Information level: The concentration of the contaminants that could cause limited and temporary effects on the health of particularly sensitive receptors, considering short-term exposure.

(4) Alert threshold: The concentration of the contaminants that could cause a risk for human health or the environment, considering short-term exposure.

(5) Established, based on local physical and chemical characteristics, by both MATET and the ministry in charge of the activity

Source: ERM based on Executive Decree 06-02

Numerical standards for air quality in Algeria do not cover all the potential contaminants that could be expected in the atmosphere. For reference purposes a compilation of international ambient air quality standards, limits and guidelines for selected parameters is presented in Table 2.3.

Table 2.3 Air Quality guidelines based on International Standards

Parameter	Agency	Type	Concentration ($\mu g / m^3$)	Averaging Time
Nitrogen oxides such as NO_2	IFC/ WB/ WHO	AQG	200 40	1 hour Annual
Hydrogen Sulphide (H_2S)	WHO[1]	AQG[2]	7 [3] 150	30 minutes 24 hours
Carbon Monoxide (CO)	WHO[1]	AQG [2]	100 mg/m^3 60 mg/m^3 30 mg/m^3 10 mg/m^3	15 minutes 30 minutes 1 hour 8 hours
Sulphur Dioxide (SO_2)	WHO IFC/ WB	AQG [4]	500 20	10 minutes 24 hours
		AQG [5]	500 (guideline) 20 (guideline) 125 (Interim target-1) 50 (Interim target-2)	10 minutes 24 hours [6]
Particulates (PM_{10})	WHO	AQG [4]	50 20	24 hours Annual
	IFC/ WB	AQG [5]	50 (guideline) 150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 20 (guideline) 70 (Interim target-1) 50 (Interim target-2) 30 (Interim target-3)	24 hours [6] Annual [24]
Particulate Matter ($PM_{2.5}$)	WHO	AQG	25 10	24 hours Annual
	IFC/ WB	AQG	25 (guideline) 75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) 10 (guideline) 35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3)	24 hours[24] Annual[24]
Lead (Pb)	WHO	AQG[2]	0.5	Annual
Photochemical Oxidants: Ozone (O_3)	WHO	AQG	100	8 hours daily maximum

Parameter	Agency	Type	Concentration ($\mu g / m^3$)	Averaging Time
	IFC/ WB	AQG	100 (guideline) 160 (Interim target-1)	8 hours daily maximum(6)
Benzene	WHO(1)	AQG (2)	6×10^{-6} (7)	Lifetime (8)

Notes:
(1) Carbon monoxide, benzene and hydrogen sulphide were not included in the WHO Air Quality Guidelines 2005. As a result, the 2000 WHO guidelines per European Air Quality Guideline for those pollutants remain in effect.
(2) European Air Quality Guideline (EAQG) of the WHO
(3) Recommended concentration to avoid odour nuisance.
(4) Guidelines set in World Health Organisation (WHO). Air Quality Guidelines. Global Update 2005.
(5) Values set in Table 1.1.1 of IFC Environmental, Health and Safety General Guidelines.
(6) IFC/ WB provides interim targets in recognition of the need for a staged approach to achieving the recommended guidelines
(7) Benzene concentration at an air concentration of 1 µg/m3 is 6 x 10-6 µg/m3
(8) Excess risk of dying from cancer following a lifetime exposure

Source:

World Health Organisation (WHO). Air Quality Guidelines Global Update, 2005

World Health Organisation (WHO). European Air Quality Guideline (2000)

2.3.5.2 Atmospheric Emissions

The framework for protecting the atmosphere in terms of atmospheric emissions is set out in Articles 44 to 47 of Law 03-10. Law 03-10 establishes that all facilities and vehicles must be constructed, exploited and used with the aim of avoiding and reducing atmospheric pollution. In the case that atmospheric pollution causes any damage, all necessary measures must be implemented in order to remove or reduce it.

Executive Decree 06-138 of 15th April, 2006, which develops article 47 of Law 03-10, is aimed at regulating and controlling atmospheric emissions of air pollutants from fixed sources and industrial facilities[5]. Annex I of Executive Decree 06-138 provides emission limit values (ELVs) for air pollutants and Annex II provides specific emission limit values for a number of fixed industrial facilities (e.g., refineries and transformation of hydrocarbon products). The proposed activities to be performed as part of the Timissit exploration project are not included in any of the categories of Annex II. Therefore, the limit values applicable to the project are those included in Annex I and presented in Table 2.4.

Table 2.4 Air emission limit values

Pollutant	Maximum Value (mg/Nm3)
SO_x (in terms of SO_2)	300
NO_x (in terms of NO_2)	300
VOCs	150
Total dust	50

Source: ERM based on Executive Decree 06-138

In addition, article 7 of Executive Decree 06-138 establishes that if atmospheric emissions are exceeded (according to the limit values shown in Table 2.4) the operator must reduce emissions by stopping or reducing the activity.

Finally, article 10 of Executive Decree 06-138 of 15th April, 2006, sets out that, for any facility not considered as a "classified facility[6]" (see Section 2.3.4.3) air emission information and associated reduction measures must be provided to

[5] It is worth noting that the Executive Decree 06-138 does not provide a definition of "fixed sources" and "industrial facilities".
[6] Exploratory drilling does not appear on the list of classified facilities included in Executive Decree 06-198. However, explosive storage areas are considered classified facilities (number 1411) according to Executive Decree 06-198.

the relevant authority. Article 11 establishes that for any facility (classified or not) that generates atmospheric emissions, analyses must be performed and the results provided to the relevant control services.

Regarding atmospheric emissions from motor vehicles, Executive Decree 03-410 provides threshold limits for emissions of CO, burned hydrocarbons (HC), NO_x and particulate matter by various motor vehicle types. Table 2.5 provides the limit values to be respected for all motor vehicle types.

Table 2.5 Air emission limit values for motor vehicles for conformity control

Type of vehicle*	Maximum Value (mg/Nm3)
Vehicles for goods transport ≤ 3.5 tonnes**	
Petrol/LPG/CNG engines	
CO (g/KM)	5.5
HC (g/KM)	0.31
NO_x (g/KM)	0.25
Particles (g/KM)	-
Diesel engines	
CO (g/KM)	1
HC (g/KM)	1
NO_x (g/KM)	0.9
Particles (g/KM)	0.15
Special vehicles***	
Diesel engines	
CO (g/KM)	6
HC (g/KM)	1.3
NO_x (g/KM)	9.2
Particles (g/KM)	0.9

Note:
**Executive Decree 03-410 includes limit values for nine type of vehicles. However, this table only include the limits for those vehicles that may be used for the Timissit project.*
*** For special vehicles, Executive Decree 03-410 only provides limit values for diesel engine vehicles.*
**** For goods transportation vehicles, Executive Decree 03-410 only provides limit values for vehicles ≤ 3.5 tonnes.*
Source: ERM, based on Executive Decree 03-410

In addition to the limit values to be respected for the conformity control, Executive Decree 03-410 establishes the maximum percentage of CO that all vehicles must comply with in their periodic technical controls:

- Vehicles equipped with an emissions treatment system (catalyser):
  - 0.5% in idle.
  - 0.3 % in accelerated idle, with an air/fuel relation of between 0.97 and 1.03.
- Vehicles not equipped with an emissions treatment system (catalyser): 4.5%

Pursuant to Article 52 of Law 05-07 modified by Law 13-01 gas flaring is prohibited and its use limited to exceptional cases and subject to an authorisation from ALNAFT. The procedure for granting this authorisation is established by Executive Decree 13-400. .

Executive Decree 13-110 of 17th March, 2013 regulates the use of substances that deplete the ozone layer. It prohibits the importation of ozone-depleting substances and lists products that contain those substances.

2.3.5.3 Ambient Noise

Noise standards in Algeria are set in Decree 93-184. This decree has, however, been revoked by Law 03-10 (Article 113), but has not yet been replaced. Algerian noise levels set in Decree 93-184 refer to residential areas and zones near sensitive receptors (hospitals, schools) (see Table 2.6.)

Table 2.6 Maximum Permissible Noise Levels (dB)

	6am - 10pm	10pm - 6am
Zone I: Inhabited zones and roads	70	45
Zone II: Hospitals, educational establishments, resting areas	45	40

Source: ERM based on Decree 93-184

Further noise limits are defined by the WHO Guidelines for Community Noise (1999). These limits, which have been considered in the IFC General EHS Guidelines (2007), are presented in Table 2.7 below. As can be seen, the IFC daytime standard for residential areas is more stringent than the Algerian standard. However, the levels in the hospital and educational areas are more stringent in the Algerian standards.

Table 2.7 IFC Maximum Permissible Noise Levels (dB)

Receptor	7am – 10pm	10pm – 7am
Residential (1); institutional; Education	55 dBA	45 dBA
Industrial (2); commercial (3)	70 dBA	70 dBA

Notes:
(1) A residential zone is an area where more than 50% of the properties are used for accommodation. This includes schools, hospitals, and mosques.
(2) An industrial zone is an area where more than 50% of the properties are used for manufacturing facilities.
(3) A commercial zone is an area where more than 50% of the properties are shops, offices, garages, and trading premises.

Source: IFC Environmental, Health and Safety (EHS) Guidelines, 2007.

Article 9 of Decree 93-184 sets out that some equipment, such as heavy plant machinery or compressors, have to be equipped with sound-insulation systems when they are used less than 50 m from residential areas or work places.

Executive Decree 03-410 establishes the noise threshold limits for motor vehicles. Table 2.8 includes noise limit thresholds for different types of vehicles.

Table 2.8 Noise limit values for motor vehicles

Type of vehicles	Vehicles subject to conformity control dB (A)	Vehicles subject to period technical control dB (A)
Vehicles for the transport of goods ≤ 3.5 tonnes	77	80
Vehicles for the transport of goods > 3.5 tonnes		
P < 75 KW	77	-
75 KW ≤ P < 150 KW	78	85
P ≥ 150 KW	80	-
Special vehicles	90	90

Source: ERM based on Decree 03-410

2.3.5.4 Water Resources

Law 05-12 on water, modified by Ordinance 09-02, sets out the general framework for the use, management and sustainable development of water resources, including the water authorisation regime.

It is worth noting that Executive Decree 94-43 establishes the rules for conserving reservoirs and the protection of associated aquifers. This decree was revoked by Law 05-07. However, it has not yet been replaced and therefore its statements are still being used as the reference.

Algerian legislation does not set limit values for groundwater and surface water quality. The values provided by Executive Decree 14-96 updating Executive Decree 11-125 for drinking water are the basis for assessing the groundwater and surface water quality. For those parameters not included in the Algerian standards, the WHO Guidelines for drinking water quality will be used as reference. These standards are summarised in Table 2.9.

Table 2.9 Algerian and WHO drinking water quality limit values

	Algerian Standards		WHO Guidelines	
Parameters	**Value**	**Unit**	**Value**	**Unit**
Natural Characteristics				
Turbidity	5	NTU	-- (1)	
Temperature	25	ºC	-	
Conductivity	2800	µS/cm	-	
Hardness (expressed as $CaCO_3$)	500	mg/l	-	
pH value	≥ 6,5 and ≤ 9	pH	-- (2)	
Chemical Characteristics				
Arsenic	10	µg/l	0.01	mg/l
Boron	- Conventional waters: 1 - Desalinated or demineralised waters: 1.3	mg/l	-	-
Chromium	50	µg/l	0.05	mg/l
Lead	10	µg/l	0.01	mg/l
Mercury	6	µg/l	0.006 (3)	mg/l
Selenium	10	µg/l	0.04	mg/l
Aluminium	0.2	mg/l	--	
Chloride	0.07	mg/l	--	
Iron	0.3	mg/l	--	
Potassium	12	mg/l		
Sodium	200	mg/l	--	
Sulphate $(SO_4)^{2-}$ (2)	400	mg/l	-- (4)	
Calcium	200	mg/l	--	
Barium	0.7	mg/l	0.7	mg/l
Benzene	0.01	µg/l	-	
Toluene	700	µg/l	-	
Ethylbenzene	300	µg/l	-	
Xylene	500	µg/l	-	
Biological Characteristics				
Enteroccoccus	0	n/100 ml	0	n/100 ml
E. coli	0	n/100 ml	0	n/100 ml

Notes:

(1) No health-based guideline values for turbidity have been proposed by the WHO for drinking water. However, to ensure the effectiveness of disinfection, turbidity should be no more than 1 NTU and preferably much lower. Large, well-run municipal supplies should be able to achieve less than 0.5 NTU before disinfection at all times and should be able to average 0.2 NTU or less. (WHO, 2011)

(2) The optimum pH required will vary in different supplies according to the composition of the water and the nature of the construction materials used in the distribution system, but it is usually in the range of 6.5–8.5 (WHO, 2011)

(3) For inorganic mercury

(4) No health-based guidelines are proposed for sulphate. However, because of the gastrointestinal effects resulting from ingestion of drinking-water containing high sulphate levels, it is recommended that health authorities be notified of sources of drinking water that contain sulphate concentrations exceeding 500 mg/litre.

Abbreviations:

mg/l: milligrams per litre

ml: millilitres

NTU: Nephelometric Turbidity Units

TCU: True Colour Units

Source: ERM based on Executive Decree 14-96 and Guidelines for Drinking-water Quality. Fourth edition. (WHO, 2011)

It should be noted that the supply of water for human consumption by portable tanks is subject to authorisation, according to the terms and conditions established in Executive Decree 08-195 of 6th July, 2008.

Ordinance No. 09-02 prohibits the extraction of alluvial materials by any means, especially through the installation of sand pits in the beds of wadis when they present the degradation risks set forth in Article 15 of Law No. 05-12. However, outside prohibited areas, extraction of alluvial materials may be permitted when limited in duration, accompanied by specifications and subject to an impact assessment as established by the in force laws and regulations. An inventory of wadis or sections of wadis affected by this prohibition has been completed by the Ministry of Water Resources and an Intersectorial Commission.

Other regulatory texts related to water resources are listed below:

- Executive Decree 08-148 of 21st May, 2008, fixing the authorisation regime for the use of water resources;
- Executive Decree 10-318 setting the approval procedure for a water-use concession from fossil or weakly renewable aquifers. Since the Timissit project is located within the Sahara Basin, groundwater extraction and use will be subject to this authorisation;
- Executive Decree 07-399 of 23rd December, 2007, related to the protection perimeters of water resources.

2.3.5.5 Wastewater discharge

Wastewater discharge is regulated by Algerian Water Code Law 05-12 and Environmental Framework Law 03-10.

Pursuant to the provisions of article 10 of Law 03-10, the allowable limits of industrial wastewater discharge effluents are set out by Decree 06-141 and completed by Order of 6th January, 2013. Decree 06-141 sets general limit values as well as specific limits for a number of facilities. The activities to be performed in the Timissit exploration project are not included within any of the categories listed. Therefore, the limit values applicable to the project are the general limit values, as presented in Table 2.10.

Table 2.10 Industrial effluent discharge limits

Parameter	Units	Algerian Standards: Max. values	Algerian Standards: Max. values for existing installations	International Standards (IFC, 2007): Values (1)
Temperature	°C	30	30	≤ 3 (2)
pH	-	6.5-8.5	6.5-8.5	6-9
TSS	mg/l	35	40	35
BOD5	mg/l	35	40	25
COD	mg/l	120	130	125
Kjeldahl nitrogen	mg/l	30	40	
Total phosphorous	mg/l	10	15	
Cyanide	mg/l	0.1	0.15	
Aluminium	mg/l	3	5	
Bioaccumulative toxic substances	mg/l	0.005	0.01	
Fluorine and fluorine compounds	mg/l	15	20	
Phenols	mg/l	0.3	0.5	0.5
Cadmium	mg/l	0.2	0.25	
Total chromium	mg/l	0.5	0.75	
Iron	mg/l	3	5	
Manganese	mg/l	1	1.5	
Mercury	mg/l	0.01	0.05	
Nickel	mg/l	0.5	0.75	
Lead	mg/l	0.5	0.75	
Copper	mg/l	0.5	1	
Zinc	mg/l	3	5	
Oil and grease	mg/l	20	30	
Hydrocarbons	mg/l	10	15	10
Chlorinated Organic Compounds	mg/l	5	7	
Tin	mg/l	2	2.5	

Notes:

(1) Indicative Values for Produced Water Discharges

(2) The effluent should result in a temperature increase of no more than 3°C at the edge of the zone where the initial mixing and dilution take place. Where the zone is not defined, apply a distance of 100 metres from the point of discharge, provided there are no sensitive ecosystems within this range

Source: ERM based on Executive Decree 06-141 and IFC Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development, 2007 (IFC, 2007b)

The Order of 6th January, 2013, sets the maximum limit values for effluent discharges, spillages and the disposal of substances of any nature not presenting toxicity risks or nuisance in the hydraulic public domain. The limit values for non-toxic effluent discharge into the hydraulic public domain, as established by the Order of 6th January, 2013, are presented in Table 2.11.

Table 2.11 Non-toxic effluent discharge limits

Parameter	Units	Maximum limit values
Physical parameters		
Decantable materials	mg/l	0.3
Nitrate NO_3	mg/l	50
Nitrite NO_2	mg/l	0.1
Chloride Cl	mg/l	700
Available chlorine Cl_2	mg/l	1
Chlorine dioxide ClO_2	mg/l	0.5
Sulphate SO_4	mg/l	400
Magnesium Mg	mg/l	300
Potassium K	mg/l	50
Sodium Na	mg/l	300
Calcium Ca	mg/l	500
Sulphide S	mg/l	1
Chemical parameters		
Antimony Sb	mg/l	0.3
Selenium Se	mg/l	1
Titanium Ti	mg/l	0.01
Pesticides and PCB	mg/l	0.001
Phenols, phenolic compounds	mg/l	0.3
Chlorine-containing solvent	mg/l	0
Anionic detergent (ABS)	mg/l	0.5
Boron B	mg/l	2
Molybdenum Mo	mg/l	0.5
Cobalt Co	mg/l	2
Available bromine Br_2	mg/l	0.05
Barium Ba	mg/l	1
Silver Ag	mg/l	0.1
Arsenic As	mg/l	0.1
Beryllium Be	mg/l	0.05
Hexavalent chromium Cr^{6+}	mg/l	0.1
Trivalent chromium Cr^{3+}	mg/l	0.5
Biological parameters		
Faecal streptococci	Per 100 ml	1000
Faecal coliform bacteria	Per 100 ml	2000
Salmonella	Per 5000 ml	Absence
Vibrio cholerae	Per 5000 ml	Absence

Source: ERM based on Order of 6 January 2013

In addition, the IFC has established standards for domestic wastewater discharge, as presented in Table 2.12.

Table 2.12 Domestic wastewater discharge limits

Parameter	Maximum value
pH	6-9
BOD	30 mg/l
COD	125 mg/l
Total Nitrogen	10 mg/l
Total Phosphorus	2 mg/l
Oil and Grease	10 mg/l
Total Suspended Solids	50 mg/l
Total Coliform Bacteria	400 MPN/100 ml (1)(2)

Notes:

(1) Not applicable to centralised, municipal, wastewater treatment systems which are included in the Environmental, Health and Safety Guidelines for Water and Sanitation.

(2) MPN = Most Probable Number

Source: ERM based on IFC Environmental, Health, and Safety General Guidelines, 2007 (IFC, 2007a)

2.3.5.6 Soils

There is currently no regulation in Algeria related to soil pollution. Considering the nature of the project (oil and gas activities) the values provided by the Ontario Standards (2011) will be used as reference standards for assessing any potential impacts. The Ontario Standards provide specific reference values for different hydrocarbon chains (instead of only total hydrocarbons, TPH). Since TPH is expected to be the principal compound of interest for this project, the Ontario Standards are considered the most appropriate. These standards, although not legal values in Algeria, are commonly used by the oil and gas industry and regulators as a reference.

Table 2.13 Soil pollution limits based on the Ontario Standards

Parameter	Agricultural or other property use (µg/g)	Residential/parkland/ institutional property use (µg/g)	Industrial/commercial/ community property use (µg/g)
Barium	390	390	670
Antimony	7.5	7.5	(50) 40
Copper	(180) 140	(180) 140	(300) 230
Lead	45	120	120
Mercury	(1.8) 0.25	(1.8) 0.27	(20) 3.9
Molybdenum	6.9	6.9	40
Selenium	2.4	2.4	5.5
Cadmium	1	1.2	1.9
Nickel	(130) 100	(130) 100	(340) 270
Zinc	340	340	340
Arsenic	11	18	18
Total chromium	160	160	160
Petroleum hydrocarbons F1 * (C6-C10)	(65) 55	(65) 55	(65) 55
Petroleum hydrocarbons F2 (C10-C16)	(150) 98	(150) 98	(250) 230
Petroleum hydrocarbons F3 (C16-C135)	(1300) 300	(1300) 300	(2500) 1700
Petroleum hydrocarbons F4 (C35-C40)	(5600) 2800	(5600) 2800	(6600) 3300

Notes:
**The F1 fraction does not include BTEX, however, the proponent has the choice as to whether or not to subtract BTEX from the analytical result.*

Source: ERM based on the Ontario Standards (2011).

2.3.5.7 Waste

The legislative framework regulating waste management in Algeria is provided by Law 01-19 of 12th December, 2001[7]. Waste is defined as "all residues of production, transformation, or use and all substances, materials, products, abandoned objects, or those destined for abandonment" (Article 89, Law 01-19).

Law 01-19 sets out the following principles for waste management, control and disposal:

- Prevention and reduction of the production and noxiousness of wastes.
- Organisation of waste sorting, collection, transport and treatment.
- Waste valorisation for its reuse and recycling.
- Ecologically rational treatment.
- Inform and raise awareness among citizens related to the risks of wastes and their impact on health and the environment; as well as on measures taken to prevent, reduce and offset those risks.

[7] This law does not apply to radioactive wastes, gas effluents, wastewater, declassified explosives, aircraft wreckage and wrecks.

According to article 5 of Law 01-19, wastes are classified into three categories: special wastes[8] (including special hazardous wastes[9]), domestic wastes, and inert wastes[10]. This classification is further developed by Executive Decree 06-104, the annexes of which provide a list of inert and domestic wastes (Annex II) and a list of special wastes, including hazardous special wastes (Annex III). For instance, muds and other drilling waste containing freshwater are considered inert waste; while muds and other drilling waste containing hydrocarbons[11] are considered special hazardous wastes. It has to be noted that the mix of special hazardous waste and other types of waste is forbidden.

Law 01-19 states that special wastes, including special hazardous wastes, can only be treated in facilities approved by the MATE. The development and exploitation of waste treatment facilities and the conditions of acceptance of waste in these facilities are included in Executive Decree 04-410. The collection of special waste and its transport is also subject to a prior agreement by the MATE (Executive Decrees 09-19 and 04-409), and to its labelling in accordance with the Interministerial Order of 2nd September, 2013.

The management of domestic wastes is the responsibility of the Commune (in the case of this project the In Amenas Commune); and the inert wastes that are non-reusable have to be disposed of in specific places. A communal waste management plan for the management of domestic wastes has to be developed by the president of the Communal Popular Assembly (APC) according to the statements of Executive Decree 2007-205.

In addition to the above-mentioned regulation, the following Executive Decrees provide specifications for different types of waste:

- Executive Decree 02-372 relates to the management of packaging wastes. Article 8 states that the company in charge of this function will be responsible for the collection of packaging waste and its transfer to the appropriate unit for re-use, recycling or elimination, to be carried out in conformance with statutory specifications.
- Executive Decree 03-477 of 9th December, 2003, on the execution of a national special waste plan.
- Executive Decree 03-478 defines the terms governing the management of healthcare waste.
- Presidential Decree 05-119 relates to the management of radioactive wastes[12].
- Decree 05-315 establishing the terms governing the declaration of special hazardous waste.
- Executive Decree 09-19 of 20th January, 2009, establishing the regulation of special waste collection.

In addition, Executive Decree 93-162 regulates and controls the recovery and treatment of waste oils including methods for storage, transport, and recycling. This decree develops Law 83-03, revoked by Law 03-10. However, as it has not yet been replaced, it remains of relevance for the Timissit project.

No regulation has been identified related to the management of Natural Ocurring Radioactive Materials (NORM).

There are no relevant provisions relating to non-hazardous and domestic waste disposal from exploration and production operations. Instead, specific arrangements must be made with the local authorities and with Sonatrach on a case-by-case basis.

[8] Special wastes are defined as any waste that due to their nature and composition, cannot be collected, transported and treated in the same conditions as domestic and inert waste
[9] Special hazardous wastes are all defined as special wastes because of their constituents or characteristics, as the harmful substances they contain are likely to affect public health and / or the environment (Law 01-19)
[10] Inert wastes are defined as any waste from the operation of quarries and mines and demolition, construction or refurnish activities; that are not subject to any physical, chemical or biological modification.
[11] No details on the quantity of hydrocarbons are provided in the regulatory text.
[12] Radioactive waste is defined as material containing radioelements with concentrations or activity over the exemption limits and for which any use is expected. This exemption limit is not defined in the decree.

2.3.5.8 Dangerous Substances

Executive Decrees 03-451, modified by Decree 10-19, defines the safety rules applicable to hazardous chemical products[13] and gas pressure containers. Article 4 of Executive Decree 03-451 establishes that performing professional activity involving mainly hazardous substances is subject to prior authorisation. However, when the use of hazardous materials is exceptional, circumstantial or accessory, as is the case of the Timissit exploration project, this authorisation is not required. However, the activity does remain subject to the provisions set by the decree. For instance, Article 7 of Executive Decrees 03-451, states that personnel involved in the storage of highly hazardous substances have to be qualified by the Wilaya's Directorate of Mining and Industry.

The import of hazardous material and chemicals included in the list published by the Ministry of Energy and Mining[14] is subject to an authorisation granted by the Ministry of Energy and Mining.

The conditions for the packaging and labelling of dangerous substances are set out in Executive Decree 05-08. For their transport, Executive Decree 03-452 states that an authorisation granted by the Ministry of Transport is required; and provides the conditions for transport (labelling, packaging, etc.). Specific transport conditions are set by Interministerial Order of 2nd November, 2000, on the transport of inflammable substances.

Ministerial instruction R1 of 22nd September, 2003, regulates the management of industrial risks related to hazardous substances. It is based on two principles: monitoring, and precaution through the establishment of an EIA, risk assessment, exploitation authorisation, Internal Operational Plan and an Emergency Response Plan.

Presidential Decree 90-198 (modified by Presidential Decree 99-64) regulates, amongst other things, the storage, transport and use of explosive substances. Article 17 establishes that the implementation and exploitation of a store for explosive substances is subject to authorisation. This decree also states that a security study for the use of explosive substances has to be approved by the Department of Mines.

2.3.5.9 Fauna and Flora

The framework for protecting biological diversity (flora and fauna) is set out in Articles 40 to 43 of Law 03-10.

Executive Decrees 83-509 and 95-252 and Order 06-05 of 15th July, 2006, sets out the list of protected animal species. Among the main threatened species are: *Gazella dorcas* (Dorcas Gazelle), *Uromastix acanthinurus* (Spiny Tailed Lizard), *Varanus griseus* (Grey Monitor), *Vulpes (fennecus) zerda* (Fennec), *Chlamydotis undulata* (Houbara Bustard), and *Falco naumanni* (Lesser Kestrel).

Furthemore, Decree 12-235 of 24th May, 2012 sets out provisional list of protected non-domestic animal species and defines the conditions for the recovery of their populations, their habitat and the requirements of protection during periods or circumstances where they are particularly vulnerable. This list completes the lists established by Decrees 83-509 and 92-252.

Executive Decree 12-03 of 4th January, 2012, which develops Article 41 of Law 03-10, sets out in its annex the list of non-cultivated protected floral species. This includes species in danger of extinction and which are interesting from a genetic,

[13] Defined as any products or goods that put in jeopardy, damage public health and the environment and deteriorate property and infrastructures (Executive Decree 03-452).
[14] List available at: http://www.mem-algeria.org/francais/index.php?page=liste-des-matieres-et-produits-chimiques-dangereux. Last access 6th May 2015.

medical, agronomical, economic, cultural or scientific point of view. Among the main species protected are: *Acacia raddiana* and *Ephedra alata* ssp. *alenda*.

Other relevant regulatory texts on faunal and floral conservation include Executive Decree 08-412 of 24th December, 2008, fixing the protection measures for safeguarding the protected animal species and their habitats; and the Hunting Law 04-07, of 14th August, 2004.

2.3.5.10 Protected Areas

The legislative framework for protected areas is set out in articles 29 to 34 of Law 03-10. Article 29 establishes seven categories of protected areas, which have been modified by Law 11-02 of 17th February, 2011. Article 4 Law 11-02 classifies protected areas into seven categories:

- National parks (‘*parcs nationaux’*);
- Natural parks (‘*parcs naturel*s’);
- Strict natural reserves *(‘réserves naturelles intégrales’*);
- Natural reserves (‘*réserves naturelles’*);
- Habitat or species management reserves (‘*reserves de gestion des habitats ou des espèces’*);
- Natural sites (‘*sites naturels’*);
- Biological corridors (‘*corridor biologique’*).

Law 11-02 establishes that a management plan has to be developed for each type of area. According to article 33 of Law 03-10, the classification of certain areas can prohibit the performance of any activity that may damage the biodiversity and the characteristics of the areas; these activities include mining, industrial activities and the use of water.

There are no protected or designated areas within the Timissit license, the closest protected area being the Tassili N’Ajjer Cultural Park located more than 350 km to the south.

2.3.5.11 Archaeology and Cultural Heritage

The legal framework relating to Algerian cultural heritage (including archaeology) is provided in Law 98-04 of 17th June, 1998, that abrogates Ordinance 67-281. This law sets up restrictions and requirements for the collection, listing and conservation of archaeological remains, as well as for classifying cultural features into three main categories: movable cultural property (for example, archaeological excavations and investigations, artefacts, such as tools, pottery, inscriptions, coins, seals, jewels, traditional dress, weapons and funeral remains), immovable cultural property (historical monuments, archaeological sites and urban or rural units) and intangible cultural property (such as music, drama, skills, crafts, festivals, and so on.).

According to Article 7 of Law 98-04, the Ministry of Culture must draw up a general inventory of classified cultural property, which has to be updated every 10 years. However, to date no official inventory is publicly available in Algeria. Article 30 establishes that a plan for the protection and enhancement of archaeological sites and their protection area has to be developed.

Law 98-04 prohibits the removal of cultural heritage assets. Article 77 of Law 98-04 states that all archaeological findings have to be reported to the relevant local authorities, which have to inform the appropriate department of the Ministry of Culture. The Ministry of Culture can stop the work for a maximum of 6 months.

There is a review planned of Law 98-04 that will include measures for developing a new inventory of cultural sites and a preventive archaeological framework[15] .

2.3.5.12 Land Use Planning and Protective Perimeters

Land use planning

Law 87-03 of 27th January 1987, repealed by Law 01-20 of 12 December 2001, sets out the framework for land use planning and requires the competent authorities to ensure that land is used as judiciously as possible for economical activities, human resources and natural resources exploitation. To this end, land use planning is to take into account the development of economic activities such as hydrocarbon exploitation (Art 10) while considering environmental and cultural heritage protection (Art 24). Finally, Chapter III addresses land use planning tools and states that investments on a national or regional scale are subject to an impact assessment on economic, social and urban planning aspects (Art 50).

Law 01-20 of 12 December 2001 defines the objectives and instruments for land use planning in order to ensure balanced and sustainable development of the Algerian national territory. A national council on land use planning and sustainable development was created the composition of which, its missions and procedures are fixed by Executive Decree 05-416 of 25th October 2005.

Expropriation is regulated by Law 91-11 completed by Executive Decrees 93-186, 05-248, and 08-202. This law defines expropriation for public utility and sets the conditions for implementing it as well as determining the procedure and terms of the prior compensation, in order to be fair and equitable.

Protective perimeters

Other regulations and guidelines relevant for the project are safety distances and protective perimeters set by Sonatrach's HSE guidelines and by Decree 07-399 .

Sonatrach's HSE guidelines for upstream activities define safety distances from seismic activites (vibroises equipment) and drilling activities to various elements including: gas wells, water wells, high tension power lines, roads and tracks, populated areas/buildings/ well torches, processing facilities and gathering stations / pipes. The distances range from 15m to 1,000m depending on the element.

In order to ensure the quality of water resources, Decree 07-399 sets protection perimeters for any type of work related to water mobilisation, treatment and storage. This includes water intakes, groundwater wells, dams, surface water mobilisation intakes, water treatment plants, desalination plants, water storage areas, among other things. Decree 07-399 establishes that perimeters are to be set in a technical study approved by the Wilaya or Ministry of Water Resources (Ministère des Ressources en Eau). Decree 07-399 establishes that proposed protection perimeters have to be included in a technical study performed at the initiative of:

- The National Agency of Hydraulic Resources (*Agence Nationale des Ressources Hydrauliques*); for vulnerable areas of groundwater and oueds.
- Public and private entities in charge of the exploitation of water, mobilisation, treatment and storage facilities; for existing facilities.
- The Works Director or public or private person that performs water mobilisation, treatment or storage works; for works in project or under construction.

[15] http://www.aps.dz/culture/15811-patrimoine-culturel-la-loi-98-04-appel%C3%A9e-%C3%A0-%C3%AAtre-revue-ministre. Last access June 2015.

2.3.5.13 Local content

Instruction nº01 of 11th March, 2013, is aimed at promoting the development of employment in southern Wilayas. It determines that employment of locals from the Wilaya concerned must be prioritised, mainly for non-skilled positions. In this sense, employers have to notify an authorised recruitment agency or the Commune, of any vacancy and the employer has to ensure the training of non-skilled workers. This measure has to be included in the services contract.

This instruction also establishes that salaries cannot be lower than 80% of the salaries for similar positions.

2.4 International Guidelines and References Standards for the Timissit Exploration Project

2.4.1 Overview

This section summarises (1) international conventions that have been ratified or signed by Algeria and (2) the international best practices and guidelines relevant for the project, such as the guidelines developed by the IFC, the International Association of Oil and Gas Producers (OGP), and the American Petroleum Institute (API).

2.4.2 International conventions and multilateral agreements

In addition to its national laws, Algeria has ratified or signed a number of international agreements. The main international agreements and conventions applicable to the proposed project activities are listed below. The requirements of these conventions/agreements apply to the project activities in the laws/decrees transposing them into the Algerian legislation.

- Convention Relative to the Preservation of Fauna and Flora in their Natural State (London, 1933). Africa entered as a whole in this convention on 14th January, 1936.
- African Convention on the Conservation of Nature and Natural Resources (Algeria, 1968). Signed by Algeria on 15th September, 1968, and entered into force on 11th December, 1982.
- World Heritage Convention (Paris, 1972). This was ratified by Algeria on 24th June, 1974.
- Convention on Wetlands (Ramsar, 1971). Algeria accessed this Convention on 4th November, 1983.
- The Protocol on cooperation between North African States in the fight against desertification (Cairo, 1977).
- Vienna Convention on the Protection of the Ozone Layer (Vienna, 1985). Algeria acceded (but did not sign) the convention on 20th October, 1992.
- Montreal Protocol on Substances that Deplete the Ozone Layer (Montréal, 1989). Algeria acceded (but did not sign) the convention on 20th October, 1992.
- Charter of the Maghreb on the environment (Nouakchott, 1992).
- United Nations Framework Convention on Climate Change (New York, 1992). Algeria signed the convention on 13th June, 1992, and ratified it on 9th June, 1993.
- United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (Paris, 1994). Algeria signed this convention on 14th October, 1994, and ratified it on 22nd May, 1996.
- Convention on Biological Diversity (Río de Janeiro, 1992). Algeria signed this convention on 13th June, 1992 and ratified it on 14th August, 1995.
- Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (Basel, 1989). Algeria acceded (but did not sign) the convention on 15th September, 1998.
- UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage (Paris, 2003). Algeria signed this convention on 15th March, 2004, but has not ratified it.

- The Kyoto Protocol (Kyoto, 2002). Algeria ratified this convention on 16^{th} February, 2005, and it entered into force on 17^{th} May, 2005. Recently, Algeria accepted the Doha amendment of the Kyoto Protocol (presidential decree no. 15-119, 13^{th} May, 2015)
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn, 1979). Algeria has been part of this convention since 1^{st} December, 2005.
- Stockholm Convention on Persistent Organic Pollutants (Stockholm, 2001). Algeria signed this convention on 5^{th} September, 2001, and ratified it on 22^{nd} September, 2006.

In addition, Algeria has signed several bilateral agreements with different countries related to environmental protection. This includes Agreement reach between Algeria, Libya and Tunisia in 2002 for the North-Western Sahara Aquifer System (SASS) and the Cooperation Convention signed with Egypt in March 2015 in order to exchange experiences in the field of the environment. In April 2015, MATE announced a plan for France and Algeria to sign a Cooperation Convention for the protection of the environment and sustainable development.

2.4.3 International best practices and guidelines

Table 2.14 presents international good practices and guidelines that complete Algerian legislation for environmental and social aspects relevant to the project activities. Specific guidelines on unconventional gas activities have also been identified and presented to provide international guidance for the project. Guidelines on unconventional gas activities identified include those developed by the American Petroleum Institute (API) and the Canadian Association of Petroleum Producers (CAPP).

Table 2.14 Main International Guidelines Applicable to the Project

Topic	International Guideline	Description
Air Quality	Air Quality Guidelines for Europe, WHO, Second Edition 2000 (WHO, 2000) WHO Guidelines for Air Quality, (WHO, 2005) Environmental Air Emissions and Ambient Air Quality of the IFC (IFC, 2007)	Air quality set by Algerian regulations does not cover all the potential contaminants that could be expected in the atmosphere. For carbon monoxide (CO), hydrogen sulphide (H_2S), lead, benzene, and photochemical oxidants like O_3, international ambient air quality standards, limits and guidelines could be used as reference. See *Section 2.3.5.1.*
Noise	General EHS guidelines, IFC/WB 30^{th} April, 2007 (WB, 2007a) Guidelines for Community Noise, World Health Organisation (WHO), 1999	The national standards include limits for residential and other sensitive areas (i.e., hospitals), not for industrial areas. In addition, they have been revoked, but not replaced; consequently the World Bank standards can be used as reference values for the identification and assessment of impacts until new threshold limit values are published. See *Section 2.3.5.3.*
Wastewater Discharge	General EHS guidelines, IFC/WB April 30, 2007 (WB, 2007a)	For some pollutants not covered in Algerian legislation, such as chlorides and sulphides, international standards can be used as reference values. Algerian legislation does not set standards for groundwater quality. Therefore, the IFC Guidelines (2007) can be used as reference standards. See *Section 2.3.5.5.*

Topic	International Guideline	Description
Soils	Ontario Standards (2011)	Algerian legislation does not set standards for soil pollution. The Ontario Standards (2011) can be used as a reference. See *Section 2.3.5.6*.
Unconventional resources	American Petroleum Institute (API) Guidelines	API has specific guidelines for hydraulic fracturing operations: Well Construction and Integrity; Water Management Associated with Hydraulic Fracturing; Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing; and Environmental Protection for Onshore Oil and Gas Production, Operations and Leases. See *Section 2.4.3.1*.
	Canadian Association of Petroleum Producers (CAPP) guidelines	The CAPP has developed seven operating practices for hydraulic fracturing: Fracturing Fluid Additive Disclosure, Fracturing Fluid Additive Risk Assessment and Management, Baseline Groundwater Testing, Wellbore Construction and Quality Assurance, Water Sourcing, Measurement and Reuse, Fluid Transport, Handling, Storage and Disposal, and Anomalous Induced Seismicity. See *Section 2.4.3.1*.

2.4.3.1 Unconventional Gas Guidelines

American Petroleum Institute (API) Guidelines

The American Petroleum Institute (API) is the only national trade association that represents all aspects of America's oil and natural gas industry. It has more than 500 corporate members that come from all segments of the industry: producers, refiners, suppliers, pipeline operators and marine transporters, as well as service and supply companies that support all segments of the industry. API has specific guidelines for hydraulic fracturing operation, which includes the followings:

- API HF1 – Hydraulic Fracturing Operations – Well Construction and Integrity Guidelines, First edition, October 2009: This guide provides recommended practices that will help to ensure that shallow groundwater aquifers and the environment will be protected, while also enabling economically viable development of oil and natural gas resources.
- API HF2 – Water Management Associated with Hydraulic Fracturing, First edition, June 2010: The purpose of this guidance document is to identify and describe many of the current industry best practices used to minimize environmental and societal impacts associated with the acquisition, use, management, treatment, and disposal of water and other fluids associated with the process of hydraulic fracturing.
- API HF3 – Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing, First edition, January 2011: The purpose of this guidance document is to identify and describe practices currently used in the oil and natural gas industry to minimize surface environmental impacts—potential impacts on surface water, soils, wildlife, other surface ecosystems and nearby communities—associated with hydraulic fracturing operations.
- RP 51R – Environmental Protection for Onshore Oil and Gas Production, Operations and Leases, First Edition, July 2009: This standard provides environmentally sound practices, including reclamation guidelines, for domestic onshore oil and gas production operations.

Canadian Association of petroleum producers (CAPP) Guidelines for unconventional gas

Canadian Association of petroleum producers (CAPP) represents companies that explores for, develop and produce about 90 per cent of Canada's natural gas and crude oil. Its mission is to enhance the economic sustainability of the Canadian upstream petroleum industry in a safe and environmentally and socially responsible manner, through constructive engagement and communication with governments, the public and stakeholders in the communities in which we operate. CAPP has developed a set of Guiding Principles for Hydraulic Fracturing. To support these CAPP's Guiding Principles, seven Operating Practices have been developed in collaboration with CAPP member companies.

- Fracturing Fluid Additive Disclosure: It describes minimum requirements to disclosure of fracturing fluid additives.
- Fracturing Fluid Additive Risk Assessment and Management: It describes minimum requirements for the risk-based assessment and management of fracturing additives.
- Baseline Groundwater Testing: It describes minimum requirements for baseline testing of fresh (non-saline) groundwater.
- Wellbore Construction and Quality Assurance: This practice is to be utilized to ensure the effective design, installation and quality assurance in hydraulic fracturing operations.
- Water Sourcing, Measurement and Reuse: It describes minimum requirements for safeguarding water quantity through assessment and measurement of water sources, including recycled water.
- Fluid Transport, Handling, Storage and Disposal: This practice is to be utilized to direct the safe transport, handling, storage and disposal of fracturing fluids, produced water, flow back and fracturing fluid waste.
- Anomalous Induced Seismicity: Assessment, Monitoring, Mitigation and Response: This practice describe minimum requirement for assessing, monitoring, responding to and mitigating anomalous induced seismicity in shale gas, tight gas and tight oil development areas.

2.5 Statoil Internal Standards and Procedures

Statoil as part of its corporate principles has a Health, Safety and Environment (HSE) policy which sets out its commitments in terms of HSE Performance. Statoil strives to ensure safe operations that protect people, the environment, communities and material assets, to use natural resources efficiently and to provide energy that supports sustainable development.

Statoil has developed the principles established in its policy through several standards. The main applicable standards include the documents reported in the following list.

- *FR 11 Sustainability Management*: These standards aim to establish Statoil's sustainability function requirements. Sustainability at Statoil includes the following elements:
  - Balancing a reliable energy supply and climate impact
  - Aiming for outstanding resource efficiency
  - Preventing harm to the local environment
  - Creating lasting local values
  - Respecting human rights
  - Leading an open and transparent business model
- *GL0386 Guidelines for Impact Assessment in Projects*: This standard provides guidance for preparing impact assessments for the exploration, development, operation and abandonment phases of onshore and offshore oil and gas projects. These guidelines are based on the recommendations for social and environmental assessments in the IFC Performance Standards on Environmental and Social and Sustainability (January 2012) and associated guidance notes.
- *TR1009 Environmental Requirements for Onshore Plants*: These standards describe the corporate technical and professional environmental requirements for the design, operation and cessation of onshore plants and facilities.

They are based on international standards and practices, such as the IFC Performance Standard 3 Resource efficiency and Pollution prevention, World Bank Group Environmental, Health and Safety Guidelines, and UN Globally Harmonised System of Classification and Labelling of Chemicals. These standards set performance levels for different environmental aspects such as energy, air emissions, noise, wastewater discharge, chemical usage and discharge, spill prevention and waste handling. The most relevant requirements for the Timissit project are summarised below:

- Air emissions: This standard states that production flaring/continuous flaring for gas disposal is not acceptable, however flaring for safety reasons is acceptable. The corporate CO_2 intensity target for new shale gas development projects is 6 kg CO_2/boe exported over the expected lifetime of the plant.
- Noise: Statoil's noise limits standards are those established by the World Bank Environmental, Health, and Safety (EHS) Guidelines (refer to *Section 2.3.5.3*).
- Wastewater discharges:
  - Wastewater treatment alternatives include reuse, or treatment for recycling, re-injection to the reservoir to maintain pressure (upstream oil and gas production), injection to other geological formations for disposal, treatment (cleaning) and discharge to surface waters or the sea, and export of wastewater to authority-approved treatment facilities. Where previous measures are not practicable, water shall be treated (cleaned) and discharged into evaporation ponds.
  - Facilities and systems shall be designed, operated and maintained to avoid, where practicable, or minimise the use of fresh water in hydraulic fracturing operations.
  - Flow-back water and produced water should be cleaned and reused as hydraulic fracturing water.

Other Statoil standards that may be applicable to the Timissit project are listed below:

- SF121 Performance of HSE risk management.
- FR01 Exploration.
- TR2237 Performance Standards for Safety Systems and Barriers – onshore.
- SU602 Planing and implementing safe and sustainable waste management.

Chapter 3 - Project Description

Table of contents

3 Project Description

3.1 Introduction

Statoil is proposing to carry out an exploration programme in the Timissit license area, Block 210. The exploration programme includes minimum one phase. Activities may extend for another two phases, see Table 3.1. After each phase, based on the results of the investigations, Statoil will evaluate whether to:

- Continue the exploration activities to increase the understanding of the subsurface,
- finalise exploration activities and continue with a field development programme or
- finalise exploration activities and exit the Timissit license

The table presented below summarizes the activities planned for the exploration campaign (i.e. Phase 1, Phase 2 and Phase 3) assuming all phases are fully developed. As indicated the planned activities will combine 3D seismic and drilling activities. The results from Phase 1 will be used to identify areas for further exploration activities. Phases 2 and 3 of the exploratory campaign will be planned following the results of Phase 1.

Table 3.1 Overview of phases

Activities	Phase 1	Phase 2	Phase 3
Seismic acquisition	3D seismic, 350 km^2	3D seismic, 100 km^2	3D seismic, 100 km^2
Exploration wells	2 vertical wells	2 vertical wells 1 horizontal well	1 horizontal well
Water wells	3	3	1
Start	Jan 2015	2018	2020
Finish	Jan 2018	2019	2021

The sections presented below provide an overview of all the planned activities for the seismic and drilling operations for the first three phases. A number of specialized studies have been prepared by Statoil in advance in order to anticipate potential project risks at an early stage of the project and include the necessary preventive measures in project design, e.g. anticipate infrastructure for wastewater management in the project area and options analysis. These specialized studies have been used to feed this Project Description Chapter of the ESIA (project design) and also the Environmental Management Plan (EMP), ref *Chapter 6*.

These studies are documented in:

- Liquid Spill Response Plan, ref Annex D.1
- Waste Management Plan, ref Annex D.2
- Water Management Plan, ref Annex D.4

The Project description includes the conclusions/findings of these plans embedded in Project Design and when needed references within the chapter to these Plans have been included for further details on a specific aspect.

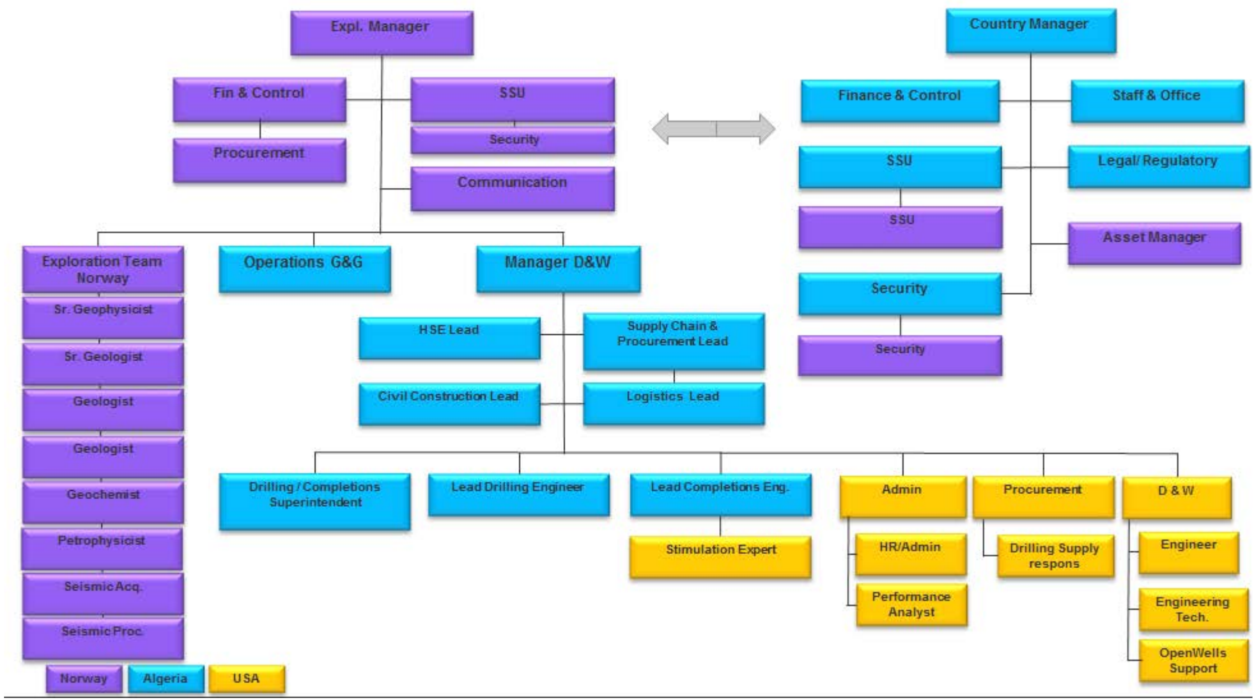
Potential significant changes in the described project activities will be managed according to the project's Procedure for Management of Change, see *Annex D.8 Procedure for Management of Change*. This procedure is important where, due to changes in the project definition, uncertainty on the potential impacts identified in this ESIA may occur. The system is defined for dealing with post-ESIA submission changes (e.g. changes to the drilling well location, technology used or selection of other footprint sites during exploration campaign) with the aim to manage any uncertainty.

3.1.1 Project organisation

Statoil's country office in Algiers and Country Manager is legally responsible for all Statoil's activities in Algeria. The company Statoil Sigma B. V. is the formal owner of all Timissit assets. Statoil's business area Exploration is on behalf of Statoil Algeria responsible for the exploration operations. Exploration has assigned US Onshore Drilling & Well department in Houston to undertake the Seismic and Exploration operations. US Onshore has experience with similar operations from USA and Australia.

Figure 3.1 shows how the Timissit project organisation looks like in the planning phase.

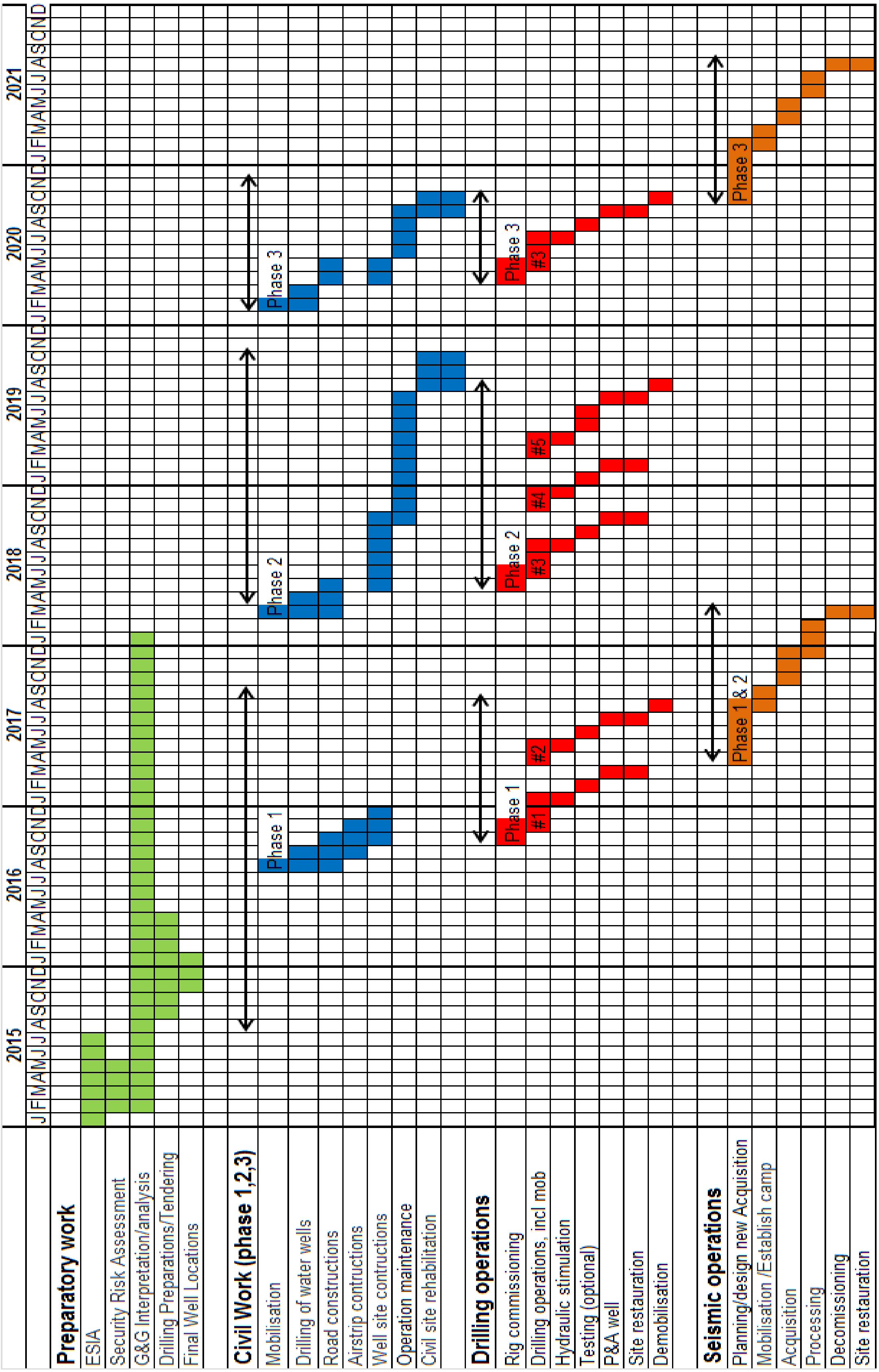
Figure 3.1 Timissit organisation – planning phase



3.1.2 Project schedule

Table 3.2 provides a detailed preliminary project schedule including the activities in each of the three Phases. Based on the plans site works would start around August 2016 and would be completed, including Phase 3, around September 2021. Tentative well locations for Phase 1 have been identified, as has the area for acquisition of 3D seismic data in phase 1 and 2. Identification of final well locations for all exploration phases and 3D seismic for phase 3 will be undertaken following internal evaluations and dialogue with Algerian authorities.

Table 3.2 Overall Project schedule Phase 1, 2, and 3

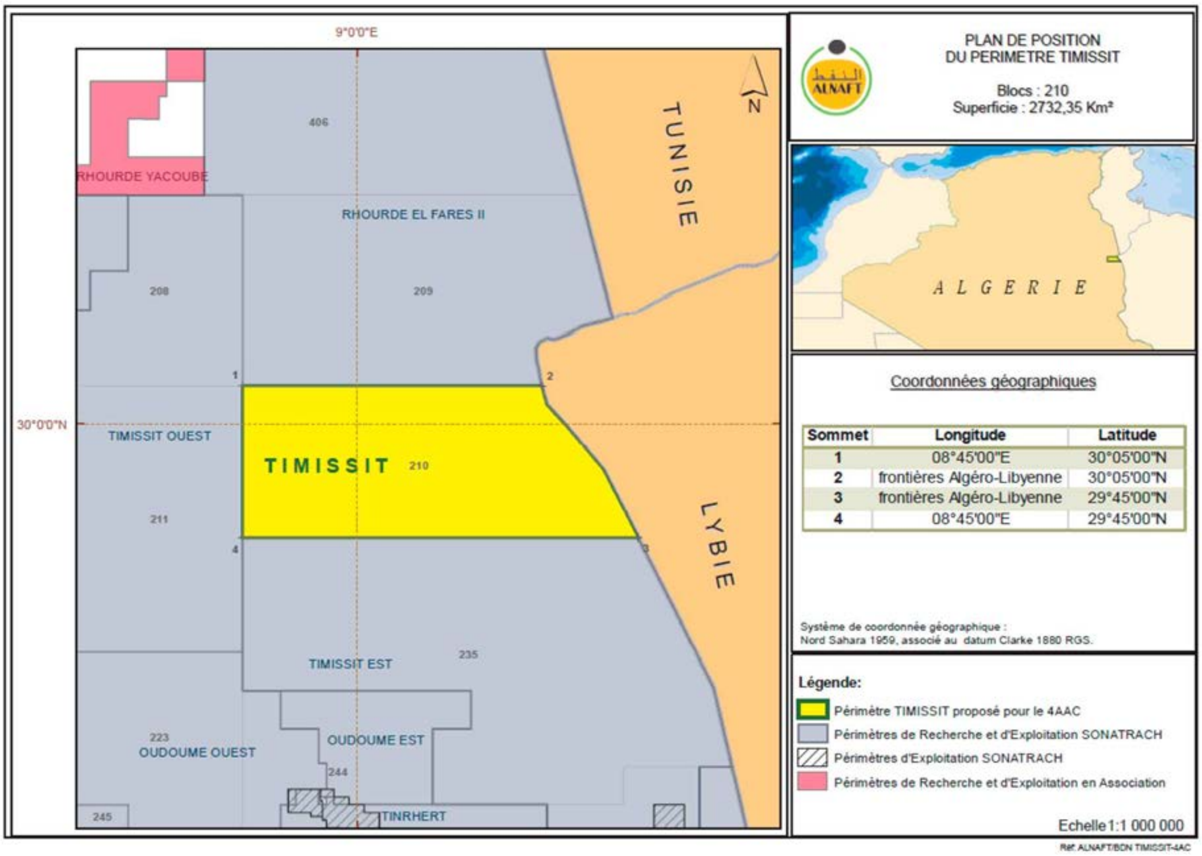


3.1.3 The Timissit License

The Timissit license, Block 210, covers a total area of 2732 km^2. The license is located in the Berkine Basin in the South Eastern part of Algeria, and borders Libya to the east (see Figure 3.2 below).

Chapter 4 Baseline presents the detailed description of the complete Block area for the environmental, physical, socioeconomic and cultural heritage features.

Figure 3.2 Timissit license, Block 210



3.1.4 Project's footprint

Tentative well locations for Phase 1 can be seen in the northern and southern areas of the license, and they are colour coded according to the geological formations they will explore. The 3D seismic campaign for phase 1 will take place inside the rectangular area marked with a black dotted line in the central area of the license.

Seismic activities for phase 2 are also identified at the map, marked with a green dotted line. For phase 3 the area for seismic operations is not identified yet. Well locations for phase 2 and 3 will depend on results from drilling and seismic operations in phase 1. Potential well locations would be typically located within or in the vicinity of the 3D seismic areas, however it cannot be discarded yet that they are located adjacent to these. In any case all wells would be located within the prospective drilling area.

Figure 3.3 Timissit project's footprints

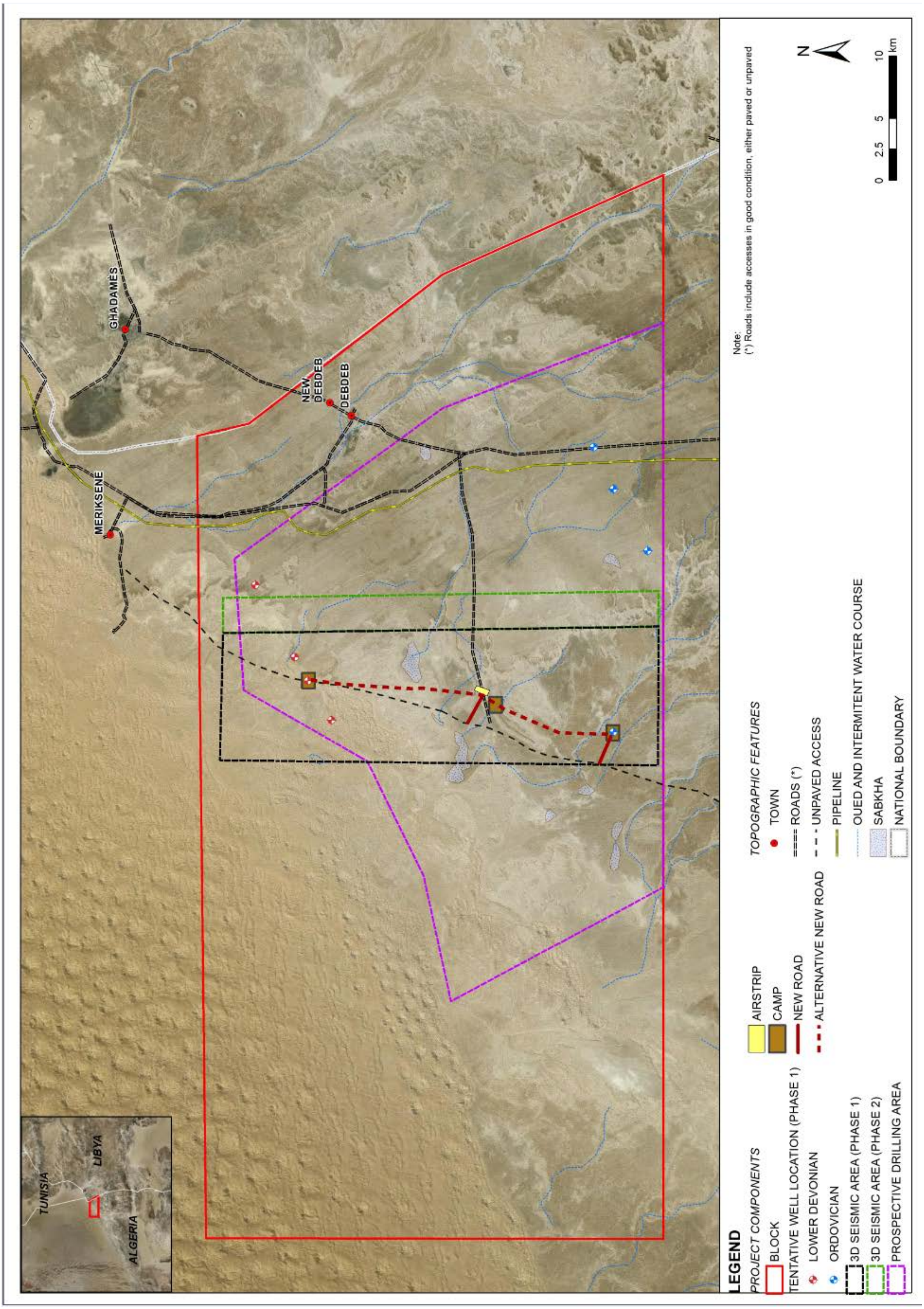


Table 3.3, below, summarizes the footprint areas considering all 3 phases are developed.

Table 3.3 Project's footprint considering Phase 1 to 3

ACTIVITIES	INFORMATION
1. Exploration drilling and stimulation:	
Prospective Drilling Area – all phases	1000 km^2
Number of well pads	6 maximum
Size of each camp/well pad	125,000 m^2
Coordinates for potential well locations Phase 1: Proposed co-ordinates of the Wells 1 Proposed co-ordinates of the Wells 2 Proposed co-ordinates of the Wells 3 Proposed co-ordinates of the Wells 4 Proposed co-ordinates of the Wells 5 Proposed co-ordinates of the Wells 6 Proposed co-ordinates of the Wells 7 Proposed co-ordinates of the Wells 8	 Lat: 29.79091, Long: 9.39489 Lat: 29.77668, Long: 9.359798 Lat: 29.75198, Long: 9.308264 Lat: 29.77708, Long: 9.157248 Lat: 30.03762, Long: 9.280604 Lat: 30.00908, Long: 9.220166 (Lat: 29.99926, Long: 9.200393) (Lat: 29.98241, Long: 9.167445)
Footprint Camps/Well pads:	0.75 km^2
2. Water wells:	
Number of water wells	7 maximum (one at each well pad in addition to one at central air strip)
Depth of water wells	Albian Sandstone: - 650-750 m in the area of the northern alternative exploration well locations - 500-600 m in the southern exploration well locations area
Footprint Water wells:	0.10 km2
3. Seismic acquisition:	
Area of seismic area Phase 1	350 km^2
Area of seismic area Phase 2	100 km^2
Area of seismic area Phase 3	100 km^2 (not outlined yet)
Area of camp	0,08 km^2
4. Roads:	
Length of roads to be developed	150 km
Footprint Roads:	3 km^2
5. Airstrips:	
Number of airstrips	1 (potential use of existing air strip to be determined)
Location (coordinated) for airstrips	Lat: 29^{0}52' 20'', Long: 9^{0}11'30''
Type of airstrip	Tuff / Gypsum Surface (locally sourced)
Facilities at airstrip	None
Footprint Airstrips:	0.25 km2

** Information based on well locations using WGS 1984 coordinate system in decimal degrees.*

3.1.5 Project Alternatives

3.1.5.1 Site location

Statoil will go through a multi-disciplinary process in order to identify the most suitable well locations. This process will be based on information and input from:

- Previous drilling operations in the license (the ONT1 well)
- Updated understanding of the geological characteristics of the license
- Available hydrogeological information
- Updated understanding of the terrain
- Security analysis
- Environmental, physical, archaeological and social baseline. Among other the following elements will be considered:
    - Presence of vegetation
    - Presence of archaeological elements
    - Topography of the site and substrate type (dunes, escarpments, oueds, plains, regs)

An equivalent assessment will be performed for the definition of other footprint elements that will be necessary for the program such as location of camps, definition of access roads, etc. The objective will be to incorporate these elements in the project refinement and to avoid unsuitable areas.

Through an integrated approach involving project partners, appropriate well locations and other footprint elements will be refined and disclosed to the Algerian authorities as required. Statoil will ensure that the environmental and social impact assessment undertaken for the project is appropriate to identify, analyse and avoid or mitigate environmental and social impacts relevant for the particular well locations and other footprint elements.

The desk investigations and field survey carried out for the preparation of this ESIA has provided relevant information for the tentative well locations and other footprint elements. However, if during the investigations new proposed well sites are significantly changed from the current footprint areas the Procedure for Management of Change (see *Annex D.8*) will be activated and potential impacts evaluated.

3.1.5.2 Drilling and stimulation fluid alternatives

Statoil designs all wells following a detailed well construction process which sets standards and requirements for all wells which Statoil drills. The requirements for the design of drilling and stimulation fluids are part of this process, throughout which multiple factors are evaluated leading to the design that is implemented.

Liquid drilling fluids can be broadly classified as water based mud (WBM) and oil based muds (OBM). Drilling engineers work with geologists and geophysicists in order to evaluate these alternative mud systems and decide upon the most applicable mud system for the specific well. Factors which are considered include the following:

- Geomechanics
- Well design
- Geological formation properties
- Subsurface formation pressures and temperatures
- Offset well analysis
- Well objectives
- Water quality and availability
- Well completion design

- Environmental classification of chemicals
- Safety of personnel handling chemicals

A wide variety of stimulation fluids are used throughout the world today. Statoil designs these fluids through an integrated approach between hydraulic stimulation experts, geologists, geophysicists, completion engineers, safety and environmental advisors, and reservoir engineers. 3D Hydraulic stimulation modelling is performed to evaluate various fluid systems and aid in the design process. The following factors will be considered when evaluating the stimulation fluids for wells in the Timissit license:

- Formation rock mechanical properties
- Formation fluid properties
- Formation pressure and temperature
- Core laboratory analysis (if available)
- Formation fluid analysis (if available)
- Previous experience on similar wells and/or similar formation characteristics
- Statoil best practices for unconventional reservoirs
- Well design
- Environmental classification of chemicals
- Safety of personnel handling chemicals

3.1.5.3 Water sourcing alternatives

The water source is an important criterion for the drilling and stimulation of oil and gas wells and is also a resource needed for seismic works, although at a much smaller scale. Water is used for civil works to construct and maintain well pads and roads, domestic supply for camp, and industrial supply for drilling and stimulation operations.

Statoil has considered a number of factors in order to evaluate and propose the water sourcing for the exploration campaign. The following factors have been considered:

- Social and environmental impact
- Water volume and flow rate requirements
- Distance between water source and well pad
- Distance of road to be constructed
- Local and regional hydrogeology
- Local and regional water use and management
- Local water wells
- Water source quality
- Water transportation
- Water reuse options

As a result of the investigations performed it has been concluded that the most reasonable water source is groundwater. This is basically due to the fact that the Timissit project area is remote and with very limited surface water. A summary of the potential quantities of water required for each of the three phases and specific tasks (seismic, drilling, stimulation, camps, civil works, etc.) is presented in Section 3.1.7.
The detailed analysis on the subsurface water supply is included in the Water Management Plan (*Annex D.4*).

3.1.5.4 Waste handling alternatives

Waste handling alternatives have been investigated taking into account both, (1) the nature of the wastes expected during the seismic, drilling and stimulation works and (2) the quantities of wastes expected.
These alternatives are included in *Annex D.2.2 Waste Management Summary Tables*.

3.1.6 Infrastructure

3.1.6.1 Roads

The construction of roads is required to create a sustainable access to the proposed drilling locations, camps, airstrips, etc. Heavy equipment, such as drilling rigs, trucks, vibros and supporting equipment will be transported to site by road.

As per all the footprint elements of the projects several elements are being considered to the road definition/location. These include: topography, ground condition, road material sources, type of road to be constructed, environmental and social factors (vegetation, presence of archaeological elements, landscape), and access to air strips. In addition, the length of road to be constructed is to be minimized while evaluating all other considerations. Existing roads and tracks will primarily be used and these will be upgraded to meet the required standard if necessary. Expected work activities for the road construction include the following:

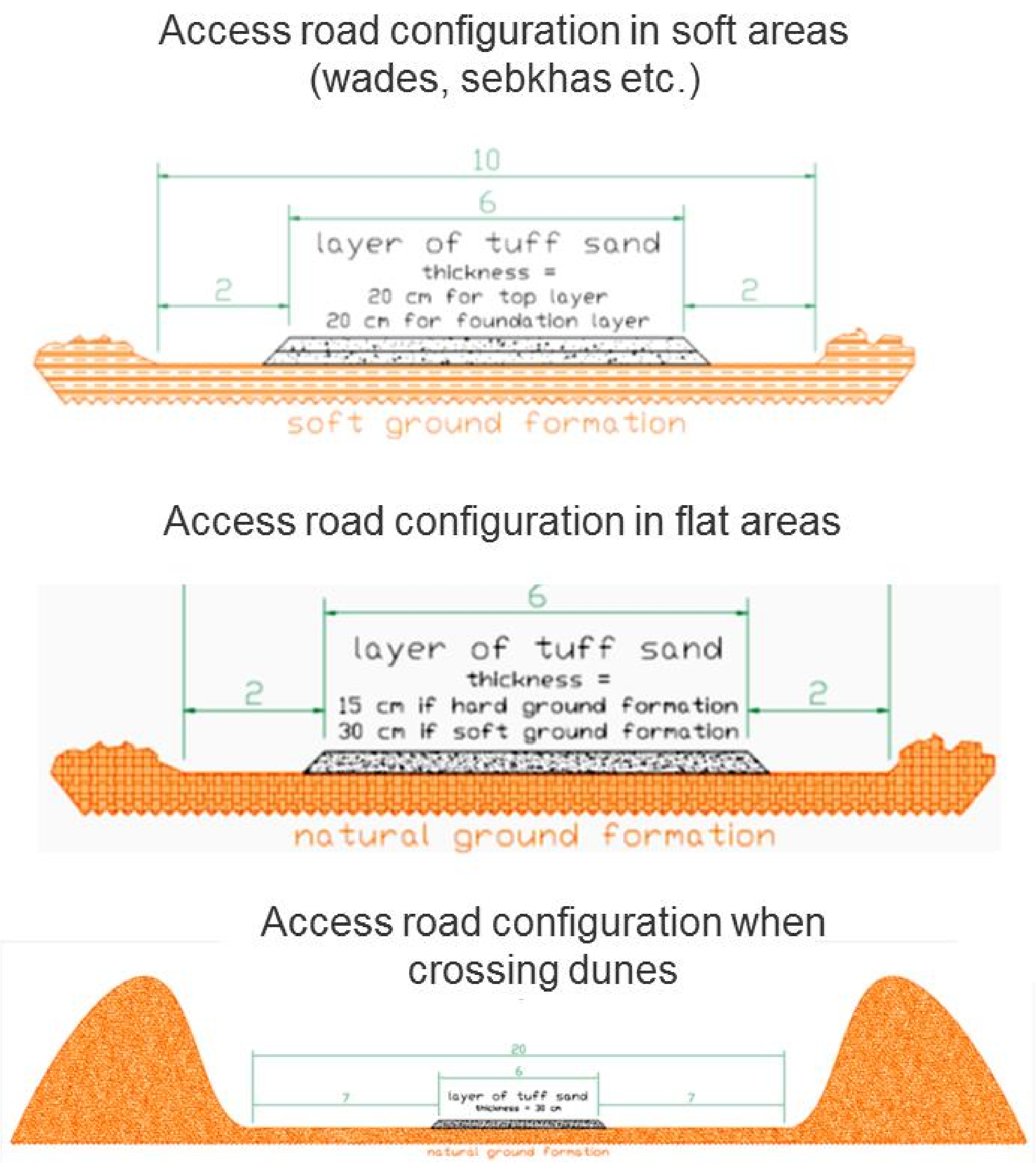
- Initial road grading
- Excavation
- Placement
- Compaction of road bed borrow material by either ditch cut techniques or the use of borrow pits
- Final compaction

Table 3.4 provides information about the road construction specifications, while Figure 3.4 shows different approaches to constructing roads on different ground conditions.

Table 3.4 Roads – technical specifications

Roads	Technical Specification
Width	10 – 20 m depending on terrain
Surface	Natural materials such as tuff/gypsum or gravel
Maintenance	Continuously throughout project lifetime consisting of grading, watering and rolling

Figure 3.4 Typical construction of roads on various grounds



Road construction and refurbishment activities will require the use of earth moving heavy equipment. For site preparation and set up activities, borrow material (gravel, tuff, gypsum and sandstone) and water will be required. The specific quarry locations and volume of borrow material must be based on local conditions. The estimated volume of borrow material required for road construction is on average 1800 m^3/km. Quarries will be constructed along the access roads and near the well pads to minimize transport distance during construction. A specific Plan for Management of Borrow pits (Quarries) will be developed for the management of these sites (see Chapter 6 EMP, section 6.4.5).

The proposed seismic and drilling operations will primarily be accessed from the N53 highway. The previously constructed ONT-1 access road, which is 20 km long, and an existing air strip is planned to be upgraded as part of the initial road construction. This site will be used as a central air strip and camp location for the license activities.

In Phase 1, the proposed southern and northern wells will be accessed from the ONT-1 Air Strip and Camp location. The proposed access can be seen in Figure 3.3. If possible, the existing track will be upgraded to access the northern and southern wells. This will reduce the need for opening more accesses and the construction of new roads, and subsequently impact of the project. Alternatively, if upon further detailed investigation it is not possible to upgrade the existing access then a new road will be constructed to the northern and southern wells, as depicted by the Alternative New Road with dashed red line in Figure 3.3. The road network is planned such that it can be expanded to meet the needs of both seismic and drilling operations throughout future project phases while mitigating the footprint of the roads. In this way roads that are used to access wells in the first phase of the project will be reused for drilling and seismic operations in subsequent years through construction of short road segments between the existing roads and newly constructed well pads.

Table 3.5

Road	Work Required	Approximate Distance
ONT-1 Access Road	Refurbishment and maintenance of existing road from N-53 to the ONT-1 Well Site	20 km
Southern Wells to ONT-1 Site Access Road	Construction and maintenance of new road and combined with possible refurbishment and maintenance of existing road.	20 km
Northern Wells to ONT-1 Site Access Road	Construction and maintenance of new road and combined with possible refurbishment and maintenance of existing road.	15 km
Well Pad Connecting Roads	Construction and maintenance of new road	Less than 10 km for each connecting road

3.1.6.2 Airstrips

Personnel and some materials will be transported to the sites by air. In addition, air strips are required for medevac support of both drilling and seismic operations. The current base case is to refurbish the airstrip at the ONT-1 site, and Table 3.6 provides typical relevant information regarding the airstrip. The construction of the airstrip will require levelling of the terrain and thus removal/refill of material as appropriate. If the refurbishment of the ONT-1 airstrip proves unfeasible a single air strip will be constructed.

Table 3.6 Airstrip – technical specifics

Air craft to be used	Small aircrafts with capacity approx. 20 – 25 passengers maximum
Length	1600 m
Width	Approximately 25 m
Surface	Natural material such as tuff, gravel or gypsum
Fuel storage and supply	There will be available fuel at the airstrip
Lighting	Emergency lighting will be available at the air strip
Emergency Fire Fighting Equipment	Emergency equipment will be available at the air strip.

The air strip will be refurbished at the ONT-1 location. Prior to commencing operations a detailed analysis will be conducted taking into account environmental, topographical, social, archaeological, meteorological, security, medical, and costs. All air strips will be located within the defined area of drilling and seismic interest.

3.1.7 Water sourcing and water consumption

The Albian (Cretaceous) sandstone of the Continental Intercalaire (CI) is considered to be the main fresh water aquifer within the Timissit license area. The Albian sandstone is expected within depth range 650-750 m in the area of the northern alternative exploration well locations and within depth range 500-600 m in the southern exploration well locations area. At these depths water delivery rates are expected to be high, tentatively in the 50-150 m^3/h range.

The Triassic sandstone (TAGI) is an alternative higher salinity (brackish) water source, which primarily is planned to be utilized if the project continues into the production phase, where large amounts of water is needed. The Triassic sandstone occurs at depths between 1800 and 2000 m within the northern part of the Timissit license where the sandstone is expected to be best developed (best flow capacity / permeability).

Water supply for civil works, drilling operations, and stimulation and testing will be provided via a water bore drilled in the vicinity of the well and camp site without the use of drilling muds. This water shall be fresh, however does not have to be potable quality.

One water well will be drilled in the proximity of each well pad. A second water well may be needed in certain cases where the distance of the road to be constructed and maintained requires a second well. This will be the exception and not the norm. Finally, a water well will be drilled in the vicinity of the ONT-1 access road to be used for road and air strip refurbishment and maintenance.

Water storage during the drilling operations will be in a water reserve pit and will be capable of storing a minimum of 1200 m^3 of water. The average drilling operations water consumption per well is estimated to be 795 m^3. However, volumes may vary based on drilling rig specifications, and well bore conditions. If the water bore is not on the well pad a small water storage pit will be developed at the water bore to provide a water storage buffer.

Further information regarding water is given in *Annex D.4 Water management Plan*.

Figure 3.5 Water Forecast Summary

Exploration Water Needs Summary

Length of Exploration Phase (years):	5
Total Number of Wells:	6
Total Water Usage (m3):	797.535

	2015/2016 (Phase 1)	2017 (Phase 1)	2018 (Phase 1)	2019 (Phase 2)	2020/2021 (Phase 3)
Vertical Wells to be completed	1	1	1	1	
Horizontal Wells to be completed	0	0		1	1
Vertical stimulation to be completed	1	1	1	1	0
Horizontal stimulation to be completed	0	0	0	13	13
Number Rigs	1	1	1	1	1

	Activity	m3	Quality	Metric	2015/2016	2017	2018	2019	2020/2021
Seismic	All seismic water needs	25	Fresh	per day	1500		1500		
Drilling	Drilling Ops water Needs	795	Fresh	per vertical well	795	795	795	795	0
		954	Fresh	per horizontal well	0	0	0	954	954
				Total Drilling Ops Water	795	795	795	1.749	954
	Expected volume of produced water	500	Saline	per vertical well (600 per horizontal well)	500	500	500	1.100	600
Hydraulic Stimulation	Hyd. Stimulation Ops Water	1589,9	Fresh or Slightly brackish	per stimulation	1.590	1.590	1.590	22.259	20.669
	Expected volume of flowback water	794,95	Brine	per stimulation	795	795	795	11.129	10.334
Camp	Camp water needs	75	Fresh	per well/per day	27.375	27.375	27.375	54.750	27.375
	Estimated grey/black water return	60	Grey/ Black	per well/per day	21.900	21.900	21.900	43.800	21.900
Civil Works	Well Pad Construction	6000	Fresh	per wellsite	6.000	6.000	6.000	12.000	6.000
	Airstrip Construction	2000	Fresh	per airstrip	2.000	2.000	2.000	4.000	2.000
	Misc. concrete mixing	125	Fresh	per wellsite	125	125	125	250	125
	Road Surfacing	14825	Fresh	per wellsite	14.825	14.825	14.825	29.650	14.825
	Road Maintenance	375	Fresh	per day/per well	71.250	71.250	71.250	150.000	78.750
	Total Civil Work			per year	94.200	94.200	94.200	195.900	101.700
Emergency Resp (Storage)	Emergency Response	50	Fresh	per event	50	50	50	100	50
			Total	**Total water demand per year (m3)**	124.010	124.010	124.010	274.758	150.748
				Average Water Demand per day (m3)	340	340	340	753	413
				Total water generated per year (m3)	23.195	23.195	23.195	56.029	32.834

3.2 Drilling, Stimulation and Testing Operations

3.2.1 Well Site Location

There are 6 wells being planned for the three exploration phases in the Timissit License. The wells in the first exploration phase will be drilled in the northern (1 well) and southern (1 well) areas of the license. Exact locations of these wells are not known yet, but tentative locations have been presented in Figure 3.2, which provide a good indication on the most probable sites. The exact location of the two exploration wells in Phase 1 will be known, following further refinement, towards the end of 2015.

Tentative locations for further exploration wells are not identified yet. However, results from the exploration campaign in Phase 1, including drilling, seismic, and potentially completion information, will provide essential data that will support the choice of well locations for Phases 2 and 3. In case the proposed drilling sites are significantly changed from the current footprint areas (which have been surveyed as part of this ESIA) the *Procedure for Management of Change (see Annex D.8)* will be activated and potential impacts evaluated. Typically where changes are considered relevant further baseline investigations and impacts assessments would be performed and potentially ESIA Addendums or updates prepared.

3.2.2 Well Site Preparation

A site is constructed at the chosen location to accommodate personnel, equipment and support services. The area of the well site will be levelled and capable of supporting the rig and associated equipment throughout the life of the well. Physical security measures will be installed based on a security risk assessment and detailed planning process.

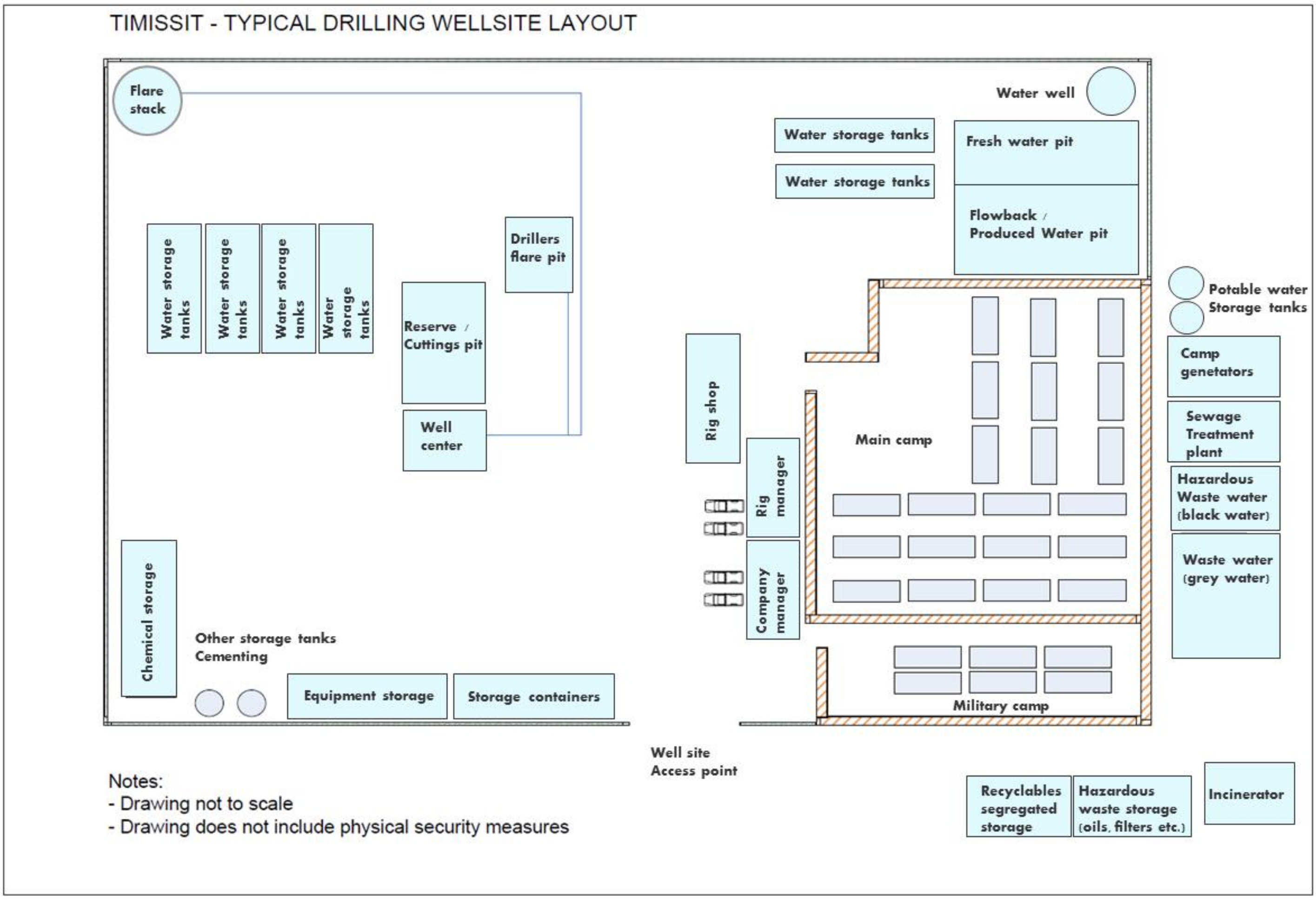
The area used for mud tanks, generators, mud storage, and fuel tanks will be built with a suitable alternative, such as ditching, to provide surface drainage from the work area to the pit. Land-based drilling rigs and support equipment are normally split into modules to make them easier to move. Once onsite, the rig and a self-contained support camp are then assembled.

The following measures will be taken for the design of the infrastructure:

- Build channels around the derrick area, mud pump zone, and mud tanks to collect the waste fluid and conduct it to the corral and to the waste pit;
- Provide drip pans or bunded areas to prevent any leakage of diesel into the soil in the diesel tanks area;
- Lined waste pits and the drilling water pond with a 2-mm high-density polyethylene liner to avoid infiltration of the fluids into the soil and the groundwater.

Typically each well site will consist of a concrete drilling pad, waste disposal facilities, mud storage facility and treatment units, temporary offices, and accommodation units, see Figure 3.6 below. It is important to note that this diagram does not include the physical security measures which will be installed based on the security risk assessment and detailed planning.

Figure 3.6 Typical well site layout



Site preparation and set up activities will include

- well site construction
- installation of base camps and associated infrastructure (such as a water network, sewage system, and power and utility cables)
- construction of internal access routes
- movements of vehicles, equipment, personnel and supplies
- movement and storage of construction materials
- storage and handling of fuels and chemicals

The proposed site layout is the most likely layout for vertical wells. However, horizontal wells planned during Phase 2 and 3 will require additional fresh water storage due to water volumes required for stimulation. Larger and potentially additional fresh water pits will be required. The most likely location of these pits is within the existing "maintenance road" on the NW and SW side of the site. Additional tanks may also be utilized for water storage along with the fresh water pits.

3.2.3 Drilling Vertical and Horizontal Wells

The well design and techniques used to drill wells for conventional and unconventional resources are equivalent, and therefore the wells to be drilled will not be different from those that have been drilled in the region.

Phase 1 of the exploration campaign will consist of two vertical wells, whereas phase 2 and 3 will also include horizontal wells. Certain wells will possibly be hydraulic stimulated and tested. The following Figures 3.7 and Figure 3.8 depict the general configuration for wells to be constructed in the license area. The figures represent the general design with respect to the current best knowledge regarding the geology and hydrogeology. If the prognosed formation depths and/or fresh water aquifer depths change significantly through further offset analysis and/or drilling results, the well design will be re-evaluated. This re-evaluation will determine if the preliminary well design continues to meet the well design requirements and environmental and social impacts are mitigated. If needed, the design will be updated to reflect the change in subsurface understanding.

Figure 3.7 Typical Vertical well configurations

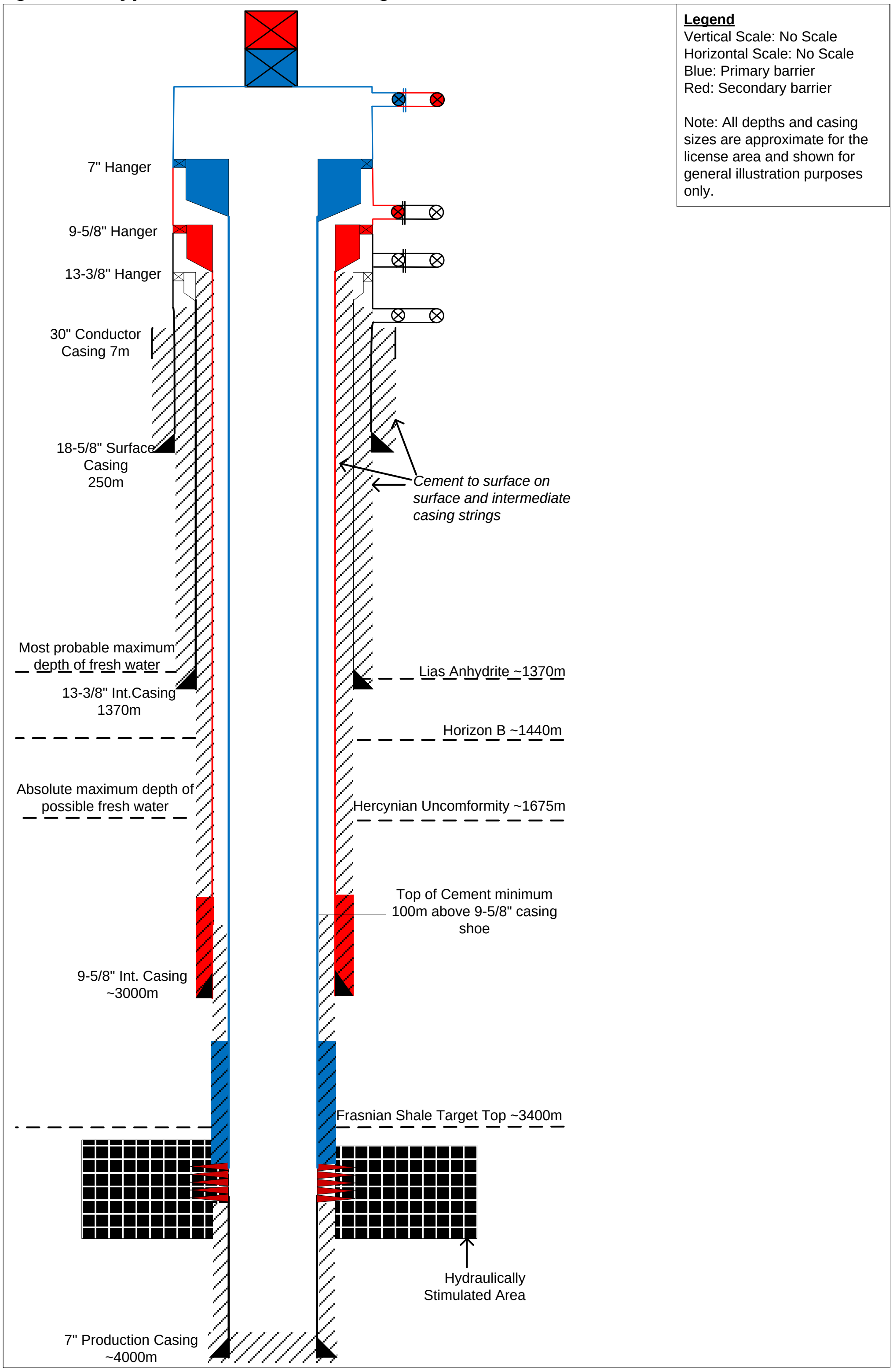
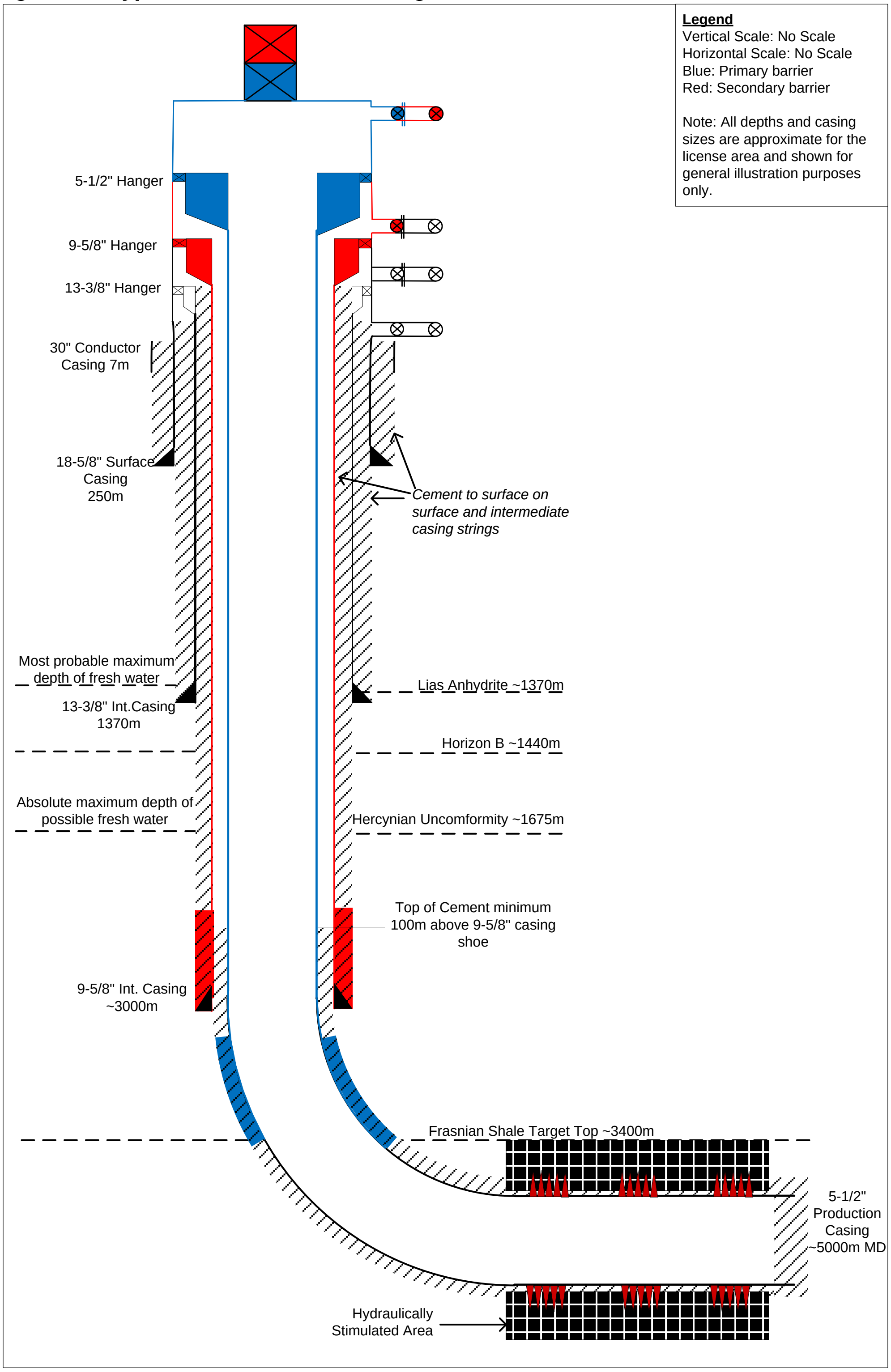


Figure 3.8 Typical Horizontal well configurations



The drilling contractor will drill with a land rig model with a minimum of 1,400 horsepower. Drilling operations will be conducted on a 24 hours per day basis. All drilling equipment will meet local regulatory, Statoil, and applicable API standards.

The drilling rig will be equipped with a minimum:

- Drilling mast that can safely handle minimum load of 1 million pounds.
- Drill string/BHA to drill to minimum required commitment including contingency.

- Top drive, to allow drilling with 30m lengths and minimize connections for personnel safety.
- Minimum 2 Mud pumps with a minimum of 5000 psi high pressure stand pipe mud pump system.
- Mud tank capacity to allow for 2 mud system simultaneously.
- Minimum 3 mud shale shakers to allow for safe distribution of cuttings return.
- A blow out preventer (BOP) and BOP control system with minimum of an annular preventer and 3 ram type preventers, with one of the ram type being a blind ram.
- A power system with emergency back-up system to run the top drive, draw work and mud pumps simultaneously.
- High quality drilling instrumentation and alarm systems.
- Tanks and fuel capacity to operate minimum 10 days.

The fuel tanks, engines or other fuel leak possibilities will be covered by secondary containment (i.e.: bund wall or liner). In addition, cement trucks, logging trucks and other large operational trucks will be parked on secondary containment to avoid spillage in the case of an engine leak.

3.2.3.1 Well Design and Operations

Statoil employs highly skilled engineers that work as part of a multi-disciplinary team to ensure the risks to the environment and society are minimized. Wells are designed and operations conducted in accordance with local regulatory requirements, Statoil requirements, API Standards and best practice from Statoil's operations in USA unconventional resource areas. Statoil places a very high priority on the integrity of the wells which it constructs following a detailed well construction process.

Phase 1 drilling operations will start with spudding of the surface hole using bentonite water-based mud. A blowout preventer (BOP) will not be installed at this stage as it is not normally installed until the surface casing is run and cemented. To avoid risk to groundwater because of high concentrations of potassium salts, casing will be used when drilling through potable aquifer zones, and cemented to surface to seal shallow aquifers and to provide well integrity of the well bore and structural support.

The well casing is an integral part of the design of the well. Casing design analysis is performed for all casing strings prior to finalizing the design of the well. Consideration is given to temperature, internal pressure, external pressure, and axial loads. Through this process casing is designed to meet minimum load criteria while considering all casing loads and the effect of casing wear. The casing design is performed using standard industry computer based software which has been specifically design for this purpose. Safety factors are included as part of the design, also known as minimum design factors, to ensure a competent design. The limits of the casing design will be stated clearly in the design documents and not exceeded during drilling, stimulation, or any other work performed on the well. In this way Statoil ensures that the well design safeguards the environment, local inhabitants, and personnel working on the well pad.

Following the installation of casing into the well cementing is performed. This is another critical activity and is designed with a great level of detail including computer based modelling during the design and laboratory analysis of the particular cement blend to be used. Cementing provides isolation between different subsurface formations, including those that contain fresh water. It also reduces casing corrosion and provides structural support for the casing. A state-of-the-art cement unit will be utilised following Statoil and industry best practices. This will secure the best quality cement slurry and reduce/optimise use of chemicals. To verify the integrity of the cement job, cement evaluation logs will be run. For all casing strings where the top of cement is not observed at surface a log will be performed to verify the integrity of the cement. Specifically, a cement evaluation log will be performed on the proposed 9-5/8" intermediate casing string and the production casing string prior to performing completion operations to provide assurance that the fresh water aquifers are isolated. Oilfield cements used on the Timissit wells are governed by API technical specifications.

Once the surface casing has been set and cemented to surface the blowout preventer's (BOP's) will be installed. The BOP system purpose is to prevent the uncontrolled flow of formation fluids into the well. The system is designed to detect flow into the well from subsurface formations and control this flow in a safe manner. The BOP's shall be tested upon installation to verify their performance capability. The system shall meet the minimum of local regulatory requirements or API Standard 53. The BOP will be pressure tested at the start of each well and at 21 day intervals or more frequently as per local regulations. The BOP will be function tested at the start of each well and at 7 day intervals or more frequently as per local regulations. Main Statoil and Drilling Contractor personnel will be trained and competent in supervision and performance of well control activities. The drilling unit will be equipped with sensors and alarms to monitor for potential well control situations. These systems will be tested regularly.

After the BOP's are installed and tested, the well will be displaced to a high quality mud system with fluid loss additives to help minimize any adverse impacts to potential groundwater resources. Aquifer zones will be cased off and cemented to surface to seal shallow aquifers and to provide well integrity of the well bore and structural support. Casing and cementing of the potable water aquifers eliminates the potential for these aquifers to be affected by fluid flow from other subsurface formations that may contain hydrocarbons or high salinity brines. Casing and cement are placed across all formations. In particular, casing and cement are placed below the Base of Fresh Water prior to penetrating the hydrocarbon bearing Frasnian formation, where casing and cement are placed once again (Figure 3.7 and 3.8).

After casing and cementing is performed the casing is pressure tested to verify the integrity of the casing string. Prior to drilling out the casing shoe a blow-out prevention drill is normally performed. The purpose of the drill is to ensure that all personnel understand their responsibilities and function in a safe and efficient manner. Once drilling commences, drilling fluid is continuously circulated down the drill pipe and back to the surface equipment, which balances underground hydrostatic pressure, cools the bit, prevents hole sloughing, and flushes out rock cuttings. Once the casing shoe is drilled out a leak-off test or formation integrity test (LOT/FIT) will be performed. A LOT or FIT is conducted to confirm the integrity of the casing cement job and establish a basis from which to calculate the Kick Tolerance for that hole section. During drilling, well control exercises will be performed on a regular basis.

A well position survey will be done minimum during every bit trip. A directional gyro survey or equivalent type, will be performed while drilling or during geological logging operation for each drilling section.

Intermediate casing strings will normally be set and cemented as needed based on the well design. In Timissit this should consist of two intermediate casing strings. The intermediate casing strings will be cemented to surface or with a top of cement above the previous casing shoe to ensure complete annular isolation of subsurface formations. To ensure good cement integrity, the casing will be centralized. If the casing is set through hydrocarbon filled formation the cement slurry will be gas block type slurry. The final well architecture will be adjusted throughout the design process to ensure that the well design and integrity safeguards people and the environment.

It is planned for the Timissit exploration campaign on Phase 1 that a water-based mud (WBM) formulation will be used. Using water-based mud will help minimize the adverse impacts to potential groundwater resources and reduce the environmental impact of the waste management. To avoid risk to groundwater because of high concentrations of potassium salts, casing will be used when drilling through potable aquifer zones.

A water-based bentonite mud (WBM) formulation will be used whenever possible. Appropriate mud formulation and drilling techniques will be used to minimize the potential for circulation losses and washout. Oil-based mud (OBM) is not expected to be used during the Timissit exploration Phase 1 Programme. In the event that a conventional oil-based mud system is utilized instead of a water-based mud system, a state-of-the-art solids/waste mud treatment system will be utilized which involves the processes described in Section 3.2.3.2 below.

During final design phase, volumes of cuttings, quantity of casing required and requirements for cement, muds, fluids etc. will be revised. A drilling database will be kept of drilling consumable items and materials consumed during the exploration programme and all wastes will be disposed of in accordance with the Waste Management Plan.

During Phase 2 and 3 where horizontal wells are planned to be drilled, a water-based mud (WBM) formulation will be used as well; however, for technical reasons oil-based mud (OBM) may be used for the horizontal well type. In this case several measures will be taken to minimize formation damage and waste production such as using additives with biodegradable and environmental friendly properties.

Statoil will have a contract with a specialised Well Control Company prior to commencing operations. This specialist company is involved in the development of the Blowout Contingency Plan (BCP) to mitigate risk of occurrence and impact mitigation. In the highly unlikely event that a blowout should occur they will assist the project team with equipment and personnel.

3.2.3.2 Mud Management and Methodology

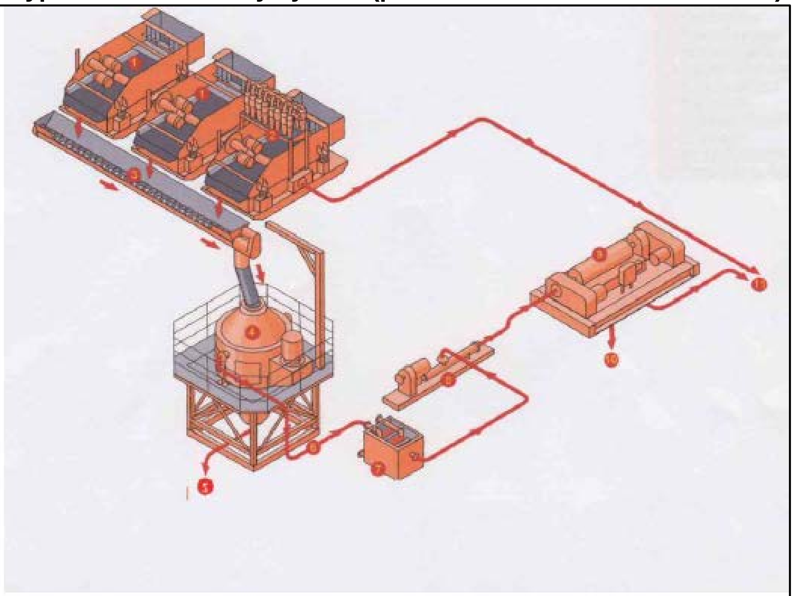
During drilling operations a fluid known as drilling mud is pumped through the drill string down to the drilling bit. Drilling mud is an essential element of modern drilling technology and is designed to perform several functions such as: (1) compensate the pressure in the well and prevents formation fluids from entering the well bore, (2) removing the cuttings from well, (3) lubricating and cooling the drill bit and string, and (4) depositing an impermeable cake on the wall of the well bore effectively sealing and stabilising the formations being drilled.

Mud will be pumped from the surface through the drill string, exit through nozzles in the drill bit, and return to the surface through the annular space between the drill string and the walls of the hole. As the drill bit grinds rocks into drill cuttings, these cuttings become entrained in the mud flow and are carried to the surface. In order to return the mud to the recirculating mud system and to make the solids easier to handle, the solids are separated from the mud. The first step in separating the cuttings from the mud involves circulating the mixture of mud and cuttings over shale shakers. The liquid mud (or drilling fluid) passes through the screens and is recirculated back into the mud system. The drill cuttings remain on top of the shale shaker screens (Figure 3.9.) through the vibratory movement of the shakers, the cuttings move down the screen and off the end of the shakers to a point where they can be collected and stored in a tank or pit for further treatment or management. Often, two series of shale shakers are used. The first series (primary shakers) use coarse screens to remove only the larger cuttings. The second series (secondary shakers) use fine mesh screens to remove smaller particles. The separated drill cuttings are coated with a large quantity of drilling mud roughly equal in volume to the cuttings.

Figure 3.9 Superimposed picture indicate shaker unit

The figure below represents a typical mud recovery system. The separated fine solids removed through the additional mechanical processing (unit 10 in the figure) are mixed with the larger drill cuttings removed by the shale shakers (unit 5 in the figure).

Figure 3.10 Typical mud recovery system (picture from the In-Amenas ESIA)



Legend:

1. *Shakers*
2. *Mud cleaner*
3. *Screw conveyor*
4. *Cutting dryer*
5. *Cuttings discharge*
6. *Recovered mud*
7. *Catch tank*
8. *Centrifuge feed pump*
9. *Centrifuge*
10. *Solids discharge*
11. *Clean mud to active*

The drilling mud handling equipment will comprise a minimum of two mud mixing units driven by mix pumps and a mud tank, and with total capacity volumes that will vary according to the rig type with a minimum of 361 m^3. Three shale shakers, a desander, a mud cleaner, and a centrifuge will be used to complete the separation of cuttings.

The water-based mud cuttings pit will be a minimum size of 500 m^3 capacity and will be lined.
Water-based mud does not generally contain hazardous components for the environment, except in rare cases, but if used this fluid will be kept in separate pits. If possible, the water based mud system will be utilised from well to well.

The proposed composition for the drilling mud has been designed according to site geological features. In line with the best industry practices, Statoil will refine the proposed composition through a detailed selection of additives, that is, selecting additives that have a better environmental performance. This process will also imply the minimization on the number and quantities of additives within mud composition.

If necessary, oil-based mud will be utilised in the horizontal section of the well and in the target formation and only after the fresh water aquifers are protected with larger diameter casing. As such the oil-based mud will not come into contact with fresh water aquifers.

In the unlikely event that oil-based muds are used, cuttings will be kept in a separate pit which will have a fluid-tight lining, as the content of synthetic oil in the OBM is considered hazardous to the environment. If oil-based mud is used, the management of OBM cuttings at the drilling site will be the following:

- OBM contaminated cuttings will be separated with a dedicated high-power shale shaker and transferred by a screw conveyor to a lined pit;
- Waste oil-based whole mud will be separated and transferred to a lined pit for treatment

Annex D.2 Waste Management Plan provides details on expected quantities of wastes as well as the proposed management procedures for all waste streams, including muds and cuttings.

3.2.3.3 Cuttings Disposal Methodology

The detailed methodology for treatment and disposal of drill cuttings will be finalized in the detailed design phase; however, in accordance with Statoil HSE management standards cuttings disposal will be driven by the following guidelines:

- Water will be reused or recycled to minimize water consumption.
- Pits associated with drilling and completion operations shall be constructed and guarded to prevent unauthorized access.
- Pits receiving possible environmentally harmful chemical will be lined to eliminate leaching, leakage or unauthorized discharge of contents into the surrounding environment.
- In order to manage the long-term liabilities associated with cuttings pit sites, the following procedures shall apply:
  - The locations of pits shall be recorded for positive identification at a future date, using coordinates from GPS and visual landmarks.
  - All pits will be located a safe distance from oasis, surface water and foggaras (>300m);
  - All pits will be located a safe distance from human settlements (>300m);
  - The pits will be of sufficient size to ensure they will not overflow in periods of heavy rainfall;
  - The closure process shall be planned to minimize potential environmental impacts;
  - A closure plan shall be developed and monitoring plans based on a risk assessment;
  - The closure and monitoring process shall be fully recorded and documented.
  - Water-based muds that have been determined to be benign, will be left to evaporate and then mixed with the excavated soil and left in the pit and covered over with top soil.

Annex D.5 Chemical Management Plan outlines the internal process of evaluating, selecting and managing chemicals in detail.

3.2.3.4 Anticipated volumes of discharge of mud and cuttings

During drilling the amounts of cuttings and Water Based Mud (WBM), shown in Table 3.7 are expected to be generated

Table 3.7 Estimated Mud and Cuttings volumes

	Classification	Volume (m^3)	Disposal Method
Phase 1 (2 wells)	Drilling mud (WBM)	1590	Evaporation
	Cuttings	1000	Buried
Phase 2 (3 wells)	Drilling mud (WBM)	2695	Evaporation
	Cuttings	1600	Buried
Phase 3 (1 well)	Drilling mud (WBM)	950	Evaporation
	Cuttings	600	Buried
Exploration Campaign Total Volume	Drilling mud (WBM)	5235	Evaporation
	Cuttings	3120	Buried

3.2.3.5 Geologic Well Evaluation

Well evaluation consists of a geological evaluation including the development of mud logging, petrophysical logging and coring programmes.

Mud logging is performed while drilling the intermediate and production hole sections. Mud logging consists of creating a detailed understanding of the formations being drilled through analysis of the cuttings which are circulated from the well. Specialists are contracted by Statoil who are highly skilled in this evaluation of cuttings and development of the log. This log is essential to ensure that the formations are as prognosed and that the well design remains suitable. This confirms the protection of the environment and safety of personnel through verifying the geologic prognosis used in the well design is accurate.

During the petrophysical logging programme, borehole measurements of different physical properties are made to help with the interpretation of lithology, porosity, pore-fluid content, and structural features. Some of these features, such as natural fractures, can be critical to production. As per standard practice in the industry radioactive sources are used as a way to estimate formation porosity. The geophysical logging programme is typically short, and the handling and storage procedures of the radioactive sources are always controlled. In the unlikely event that a logging tool is lodged in the well, all reasonable efforts will be taken to extract the tool.

Coring operations are conducted by drilling with a core head and specialized drill string that allow long formation samples to be retrieved from the well bore without damage to be analysed using standard industry tests. Coring operations are planned to be carried out to extract samples for the target zones and perform rock property tests to aid understanding of reservoir potential for mechanical integrity and stimulation design, and to remove uncertainty associated with the parameters required to make a proper evaluation of the potential for the existence of hydrocarbons and their mobility.

3.2.3.6 Drilling Chemicals

All Safety Data Sheets (SDS) shall be available for the chemicals to be used. The chemicals and the SDS will be subject to a thorough product screening and HSE risk assessment during the procurements process. The evaluation process, the HSE risk assessment, how to transport, store and use chemicals is described in *Annex D.6 Chemical Management Plan*. The chemicals listed in Table 3.8 are representative chemicals which are typically used, however may change dependent on the contractor and evolution of the well design.

For certain chemicals the Trade Names may be contractor specific. This is no way indicates the contractor to be utilized for this work. The contractors will be contracted in the first half of 2016 and the complete mud system design will be complete following contract award. The chemicals utilized will vary based on contractor which is awarded the contract for these services.

To ensure correct handling of chemicals a Chemical Awareness course will be mandatory for all site personnel directly involved with the drilling and well operations, ref *Annex D.5 Plan for Environmental information and awareness.*

Verification of safe management of chemicals will be conducted during the operations, ref *Annex D.7 Environmental Audit plan.*

Table 3.8 Typical Drilling Chemicals

Chemical Additive Trade Name	Typical Purpose	Typical Concentration Value	Typical Concentration Unit
Fresh water	Base Fluid	90-99.9	Vol. % of total
Bentonite	Viscosifier	15	ppb
Xantham Gum	Viscosifier	0,25	ppb
Soda ash	Alkalinity Control	0,25	ppb
KCl	Shale stabilization	4	Vol. % of total
Sodium Acrylate	Dispersant	N/A	Vol. % of total
Lignate	Dispersant	1	ppb
Sodium Chloride	Weight Material	N/A	ppb
Barite	Weight Material	N/A	ppb
PAC	Fluid Loss Control Agent	0,5	ppb
Starch	Fluid Loss Control Agent	0,5	ppb
Zinc Oxide	H_2S Scavanger	100	mg/gal
Organic LCM (Fibers and flakes)	Loss Circulation	10 - 20	ppb
SAPP	Bit Balling	10	ppb
Polycylate	Bit Balling	2	ppb
Soap Sticks	Bit Balling	Contingent	ppb
PHPA	Cuttings Encapsulation	1	ppb
Sulphonated asphalt	Shale stabilization	1	ppb
Class G Cement	Cement	50-90	Vol. % of total
Cellulose (halad)	Cement fluid control	0,5	Vol. % of total
Cellulose derivative	Cement free water control	0,05	Vol. % of total
Calcium Chloride	Cement accelerator	1,5	Vol. % of total

3.2.4 Hydraulic Stimulation and Testing

Shale formations are a subset of tight formations (low porosity and low permeability), which are made of fine-grained sedimentary rocks that formed from the compaction of finely layered silt and clay sized minerals. Unlike conventional formations, which are have adequate porosity and permeability to allow oil and/or gas resources to flow more or less freely to a well, in shale the hydrocarbons remain trapped within the very fine pores of the rock and must be released from the formation by hydraulic stimulation in order to be recovered.

Hydraulic stimulation is one of many well stimulation techniques used in the oil and gas industry to improve production. This technique consists of pumping fluid (comprised mostly by water and a propping agent or proppant, such as sand or ceramic materials) down the wellbore. Injection is carried out under sufficiently high pressure conditions to create small fractures in the hydrocarbon-bearing rock. The proppant agent, injected along with stimulation fluid, becomes lodged within the fractures, holding them open and creating paths that allow hydrocarbons to be produced and flow into the wellbore from the reservoir formations.

The design of stimulation activities depends on local geology and the nature of the reservoir. Hydraulic stimulation operations determine the kind of completion to carry out, number of stages, type of stimulation fluid, volume, pump rate and the different additives required to ensure a proper geometry of the fractures within the target objective.

Statoil may carry out stimulation and testing of the wells drilled in the Timissit license, in general known as Completion Operations. These operations will provide valuable data which can be used to determine the potential for hydrocarbon production in the Timissit license area.

The plan for the stimulation and testing operation will be designed in greater detail based on the drilling results. This will include, but not limited to, mud logging, gas detection, open hole logging and core analysis.

The subsequent sections of this Project Description address hydraulic stimulation water usage, additives, transport of fluids, storage of additives on site, and stimulation procedure. Flow testing will be described including a description of the procedure, expected flow back water volume and composition, storage of fluids on site, water management and disposal, and flaring characteristics.

Statoil will ultimately permanently plug and abandon the wells and carry out site remediation works. The timing of the permanent plug and abandonment is dependent on the testing results. In a proceeding section of this Project Description the procedures for permanent plug and abandonment are included. Statoil employs highly skilled and experienced engineers and consultants to ensure that the environmental and social impacts from its hydraulic stimulation and testing operations are as low as reasonably practicable. Statoil also employs stimulation experts specifically to ensure that the design of the hydraulic stimulation is in line with industry best practices and the vast experience Statoil has developed performing unconventional stimulation in the United States. Statoil acknowledges the importance of the sustainable development to secure its future and to ensure the ongoing relationship with all stakeholders.

In accordance with Statoil requirements and technical/operational standards the selection of all equipment and fluids (including chemicals and additives) used for stimulation and testing shall be based on risk assessments and HSE performance/evaluation, cost, effectiveness, capability and availability.

The site layout for completions operations will be similar to the layout for drilling operations. Minor changes may be incorporated into the site based on specific equipment requirements. In addition to the drilling equipment stimulation and testing equipment will be incorporated into the site plan.

3.2.4.1 Well Preparation for Stimulation

Well preparation prepares the well for the stimulation process, and generally includes the following three tasks:

- The quality of the cement behind the production casing/liner is analysed. The process ensures that the cement is of sufficient quality to isolate all potential hydrocarbon and potable water zones from communicating during the fracture stimulation treatment and ultimately the life of the well.
- Hydrostatic pressure testing of the casing is used to verify the pressure integrity of the wellbore.
- Installation of tubing and a packer, which provides a conduit to pump the hydraulic stimulation fluids. The detailed configuration of the tubulars through which the fluids are pumped changes based on well type, fluids, depth, and many other factors. However, all tubulars that will be exposed to stimulation fluids will have their hydraulic and mechanical integrity verified prior to proceeding with subsequent operations on the well.
- Diagnostic stimulation testing is performed to optimize the use of chemical additives and overall stimulation fluid volumes. This test includes creating access points through the casing and cement into the formation, pumping small volumes of water based fluid and monitoring the pressure after pumping has ceased. Efforts are made to reduce consumption of additives and fluids while maintaining a highly effective stimulation situation treatment. These datasets provide useful information to the final design of the hydraulic stimulation treatment.

3.2.4.2 Stimulation Design

The hydraulic stimulation treatment is performed following the wellbore preparation. Access to the target zone is achieved through creating holes in the casing/liner and cement. This can be achieved through numerous methods standard to the oil and gas industry. The tubular string, through which fluids will be pumped into the wellbore will be installed, if not already done so. The tubular through which the fluids are pumped is dependent on the well type (i.e.: vertical, horizontal, re-entry) and specific well design. All tubulars that will be exposed to stimulation fluids will have their hydraulic and mechanical integrity verified prior to proceeding with subsequent operations on the well. The hydraulic stimulation is pumped using surface high pressure pumping equipment to create fractures within the target formation and enable hydrocarbons to be produced. Dependent upon the geology and well design different fluid volumes and numbers of independent hydraulic stimulation treatments will be performed. In the proposed wells for Timissit the likely number of hydraulic stimulation treatments is as follows:

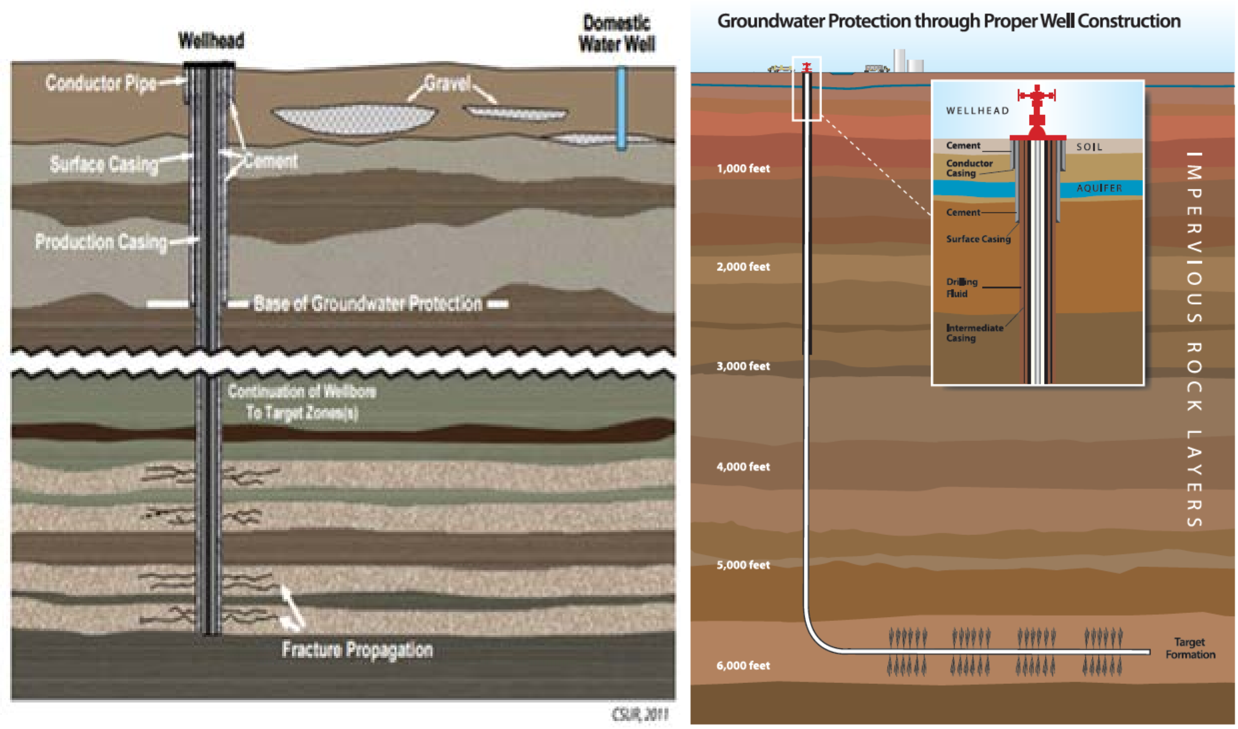
- Vertical wells: 2 stimulations
- Horizontal wells: 13 stimulations

The actual stimulation process is only part of the total time to complete the work. In general, one stimulation can easily be completed per day. As such, vertical well stimulation will last approximately two days and horizontal well stimulations will last approximately 13 days.

Currently, drilling and stimulating of different wells at the same time is not planned during the exploration phase of the project.

Fracture height growth is of high importance to be confident that there is no risk of the fracture connecting to fresh water aquifers. The aquifers are protected through proper well design and verification testing (i.e.: casing and cement). The fracture height in the target zone is contained within the geologic target zone and immediately adjacent formations. Computer modelling is performed as part of the fracture design process incorporating multiple data sets, including fluid properties, geologic interpretation, openhole wireline logs, core analysis, and diagnostic testing. The modelling aids in understanding the optimal fracturing job design and the probable fracture geometry, including maximum fracture height. The model is continuously updated throughout the design phase as further information is gathered up until the time of pumping the actual job. This verifies that there is no risk of impact on the potable water aquifers. Historical data from thousands of fractures shows no excessive height. Maximum hydraulic stimulated height growth is approximately 300 m, whereas the Frasnian target formation is at a depth of greater than 3200m. With the limited height growth and depth of the target formation it is not possible for the fracture to contact a fresh water aquifer in the Timissit area. A drawing of a typical vertical fractured well is included below which illustrates the protection of the freshwater aquifer from the fracture.

Figure 3.11 Hydraulic stimulation of vertical and horizontal wells



Left image: http://www.csur.com/resources/understanding-booklets Booklet name "Understanding Hydraulic Fracturing"
Right image: http://www.northeastern.edu/nuwriting/hydraulic-fracturing-in-the-marcellus-shale-region-of-the-u-s/

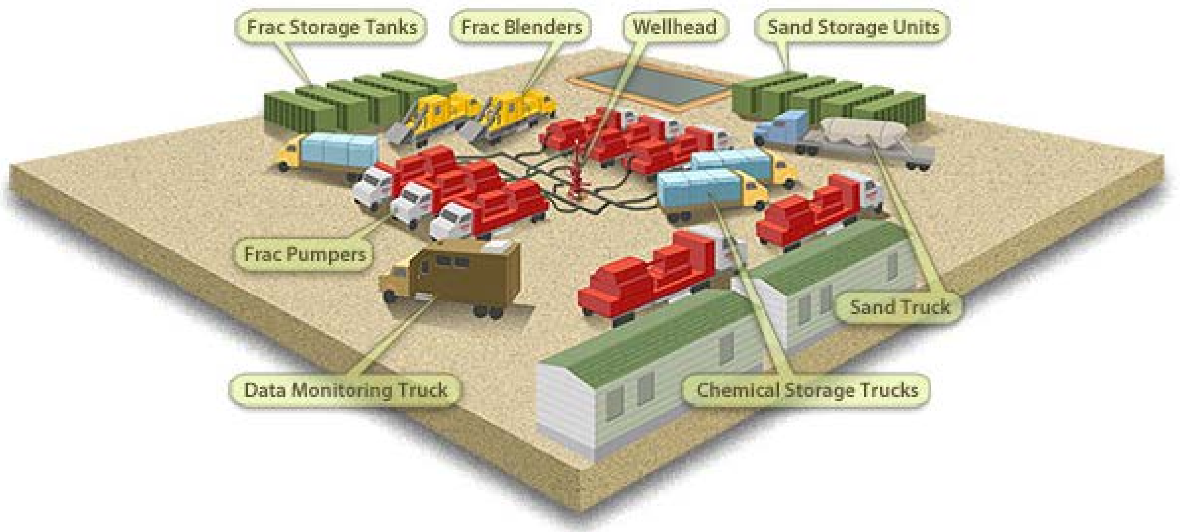
3.2.4.3 Stimulation Equipment and Operations

Hydraulic stimulation requires the use of specialized equipment to perform the operations safely. The key combination of these components forms what is commonly referred to as a hydraulic stimulation spread. The equipment, which is mobilized to site to perform this operation, and its purpose, is summarized below.

1. Stimulation Fluid Storage Tanks: Tanks which hold the base fluid to be used for the hydraulic stimulation, typically water.
2. Blenders: Combines the base fluid, chemicals and proppant to form the stimulation fluid.
3. Chemical Storage Tanks / Additive Unit: Used to store and supply chemical additives for the stimulation fluid.
4. High Pressure Pumps (Pumpers): Used to increase the pressure of the stimulation fluid being pumped down the well to enable stimulation of the target subsurface formation.
5. Sand Storage Units: Used to store proppant prior to being combined at the blender.
6. Sand Truck: Dependent upon the area sand may be delivered to location in specialized trucks or on flat top trailers in sacks.
7. Data Monitoring Van: Serves as a centralized location where experts remotely monitor data in real time and control each job.

A typical layout of a site during stimulation, without a drilling rig, is shown in the Figure 3.12 and 3.13 below.

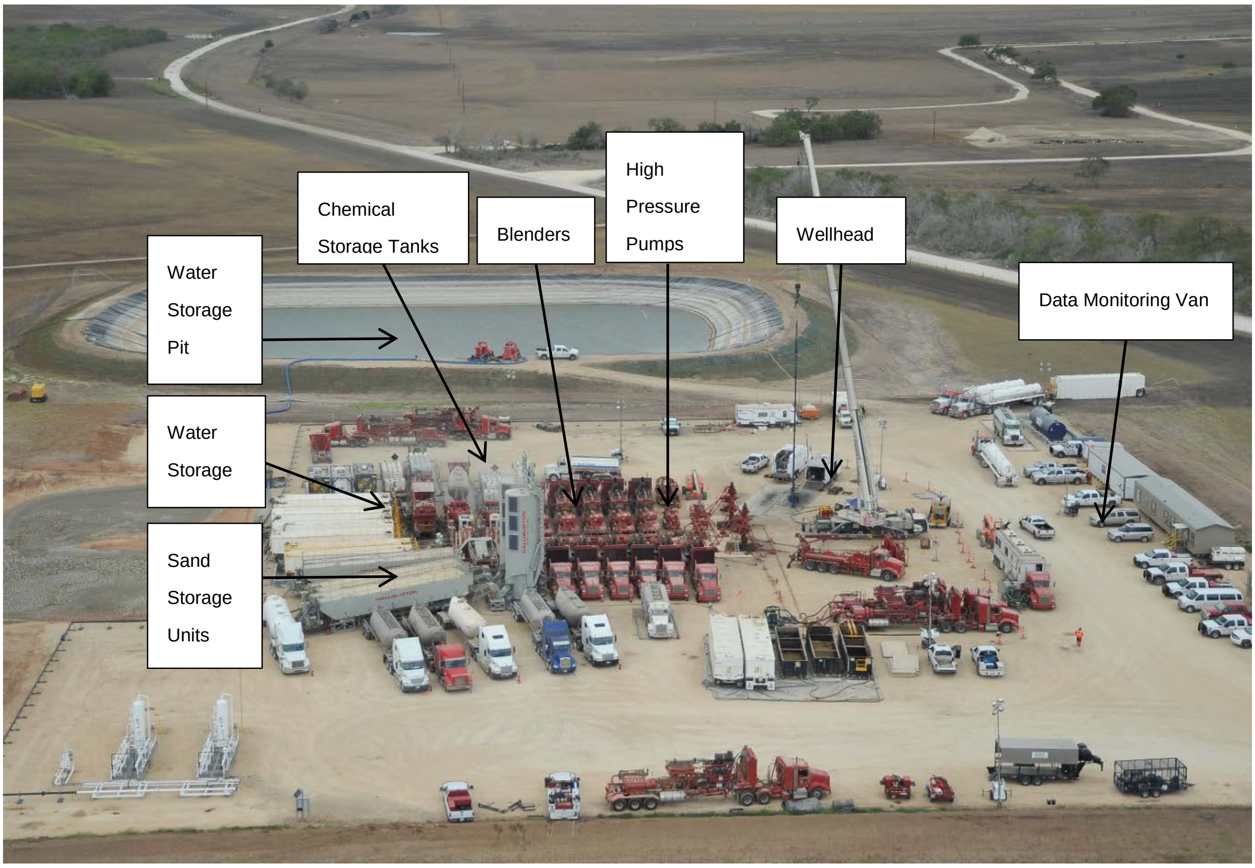
Figure 3.12 A typical layout of a site during stimulation



From http://fracfocus.ca/sites/all/themes/fracfocus_look/images/process.jpg

The following image is an actual picture of a hydraulic stimulation job being performed on a Statoil well in the USA.

Figure 3.13 Ongoing stimulation job



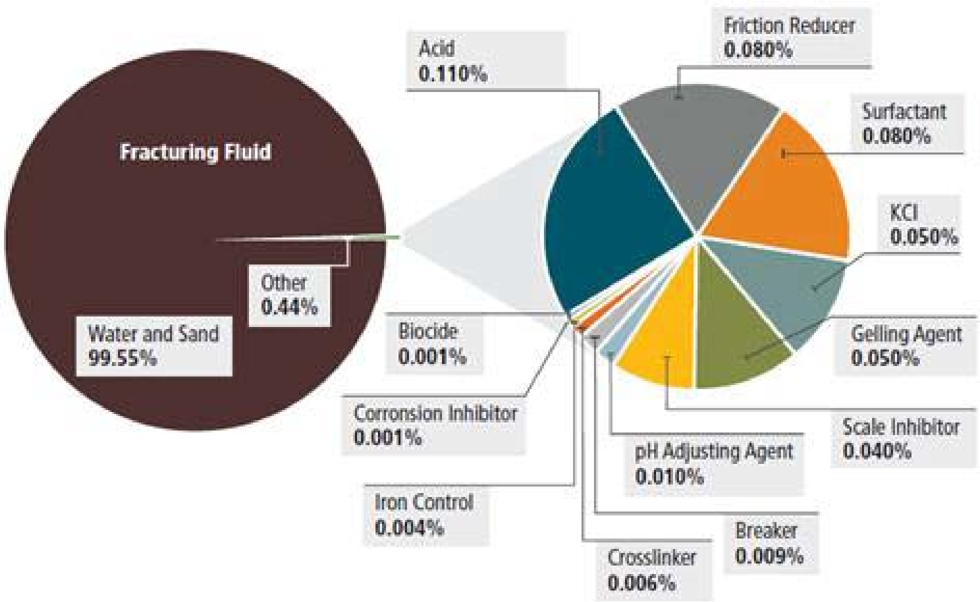
The process of hydraulic stimulation consists of combining the base fluid, chemicals, and proppant at the blender. The base fluid is provided to the blender from the storage tanks or pits used to store the fluid, chemicals are stored and provided to the blender from the chemical storage tanks, and the proppant/sand is delivered from the sand storage units.

Once the combination is complete at the blender the stimulation fluid mixture is transferred to the high pressure pumps through flexible hosing and pipes at low pressure. The high pressure pumps receive low pressure fluid from the blender and increase the pressure to that required for the hydraulic stimulation of the subsurface formation. The stimulation fluid discharged from the high pressure pumps travels through high pressure piping that is connected to the wellhead. From the wellhead the fluid travels down the well through tubulars that isolate all formations except for the specific formation being targeted for hydrocarbon production.

3.2.4.4 Stimulation Fluid

Water is the most common base fluid, also known as carrier fluid, to which proppant and chemicals are added to enhance the fluid properties. Hydraulic stimulation fluid consists typically of about 90% water, 9% proppant, typically sand, and a blend of chemicals comprising less than 1% (see Figure 3.14). The proppant stays in the formation to hold the fractures open which allows the oil or gas to flow to the wellbore and to the surface. The fluid used in the hydraulic stimulation flows back to the surface along with the oil or gas and normally, naturally occurring saline formation water. The recovery flow rate of flowback water is difficult to determine as it depends on the geologic formation properties. In addition, the total quantity of flowback water is difficult to determine for the same reason. In unconventional stimulation it is highly abnormal to recover all of the flowback water. Normally less than 50% of the flowback water is recovered over the life of the well.

Figure 3.14 Typical composition of Stimulation fluid (Source: Council of Canadian Academies, 2014)



From assessment on Environmental Impacts of Shale Gas Extraction in Canada.
http://www.scienceadvice.ca/en/assessments/completed/shale-gas.aspx

The stimulation treatments are planned taking sensitive resources, such as aquifers, into account. The target zones containing hydrocarbons are typically located much deeper than any aquifer, and in the Timissit licence the Frasnian target zone can be found at depths greater than 3200 m. The maximum height following of a stimulation treatment is approximately 300 m (the distance between the formation being stimulated and the deeper aquifer will be approximately 2000 m).

In order to ensure an effective and efficient stimulation treatment, chemicals will be added to the base stimulation fluids. These chemicals will serve many functions including increasing viscosity, limiting bacterial growth and preventing corrosion. The number and relative volume of chemical additives will depend on the specific conditions of a well, the characteristics of the water to be used and the formation being targeted. The stimulation fluids will typically consist of 99% water and 1% chemical additives. Table 3. lists chemicals which are typically used as an additive to well stimulations treatments.

There are different types of Hydraulic stimulation fluids, for unconventional exploration these are primarily slickwater, crosslinked gel, and a combination of the two (hybrid system). These fluids consist of primarily water, proppant, and chemical additives, including friction reducer and gels at very low concentrations. The fluid systems are designed based on the characteristics of target formation and reservoir fluids, makeup water source, and other considerations. Each fluid system has its advantages and disadvantages. The final decision is normally made based on multiple parameters including computer based modelling of the hydraulic stimulation.

Crosslinked Gel is a hydraulic stimulation fluid that uses gel designed to mitigate the proppant settling and placement concerns. Primary products include polymers, cross linkers, pH adjustment, bacteria-control chemicals and gel breakers. Target formation characteristics determine the need for other additives. Compared to slickwater, it can carry a higher concentration of proppant and for this reason provides greater fracture conductivity. It requires better quality water and is more sensitive to changes in the products and conditions. However, progress is being made to formulate gel systems using brackish and formation waters.

Slickwater is a type of hydraulic stimulation fluid that relies on a high volume of water and is pumped at a higher flow rate than crosslinked gels. The reason for this is that the carrying capacity of slickwater is generally much less for crosslinked gels. Water and sand make up over 98% of the fluid used for slickwater hydraulic stimulation. Because the chemical composition is less complex, it is less sensitive to water quality compared to crosslink fluids and is more tolerant of poor water quality.

A Hybrid System uses a combination of slickwater and crosslinked gel systems. The goal is to combine the advantages of slickwater and crosslinked gel systems. The volume of each fluid system varies depending on the design goals.

Proppants are sized inert particles which are mixed with fracturing fluids to keep fractures open after fracturing, allowing fluids to flow more freely to the wellbore. Proppants include naturally occurring sand as well as specially engineered resin-coated sand, ceramic beads, sintered bauxite, and other high-strength materials.

The water requirements for the vertical and horizontal wells in the Timissit licence are approximately 1600 m^3 and 21.000 m^3 respectively, see *Annex D.4 Water management Plan.*

All chemicals to be used are subject to a comprehensive risk assessment conducted by Statoil's chemical center, which evaluates their properties and assesses potential risks on human receptors and the environment. Those additives that are considered as not having the appropriate properties are discarded and will be substituted, see *Annex D.6 Chemical management Plan.*

3.2.4.5 Hydraulic Stimulation Chemicals

The transportation of all chemicals to be used for the hydraulic stimulation shall be performed in a manner that safeguards the environment and the personnel handling the chemicals and meets the local regulatory requirements. Safety Data Sheets (SDS), which contains comprehensive information about the chemical, will be available during transport and when the chemicals are on the site. The chemicals will be transported in containers properly designed for the chemical. In addition they will be transported, handled, and used in accordance with the relevant SDS. Chemicals stored on the well pad will be located inside secondary containment to protect the environment. The stimulation equipment, which was previously described, that handles chemicals will have secondary containment placed below it to contain potential leaks and safeguard the environment.

Figure 3.15: Secondary Containment

As indicated above, chemicals to be used during stimulation will be subject to a thorough product screening and HSE risk assessment during the procurements process. The evaluation process, the HSE risk assessment, how to transport, store and use chemicals is described in *Annex D.6 Chemical management plan.*

To ensure correct handling of chemicals a chemical course will be mandatory for all site personnel, see *Annex D.5 Plan for Environmental information and awareness.*

Verification of safe management of chemicals will be conducted during the operations, see *Annex D.7 Environmental Audit plan.*

A preliminary fluid composition is presented below. This composition is the result of the preliminary analysis of the formation and thus the fluid is considered adequate for stimulation activities within the target formation. Nevertheless, once detailed characteristics of the formation are known, the possibility of simplifying or enriching stimulation fluid will be assessed. The chemicals listed in Table 3.9 are representative chemicals which are used in this these types of formations, however may change dependent on the contractor and evolution of the stimulation design.

For certain chemicals the trade names may be contractor specific. This is no way indicates the contractor to be utilized for this work. The contractors will be contracted in the first half of 2016 and the preliminary stimulation design will be complete following contract award. The chemicals utilized will vary based on contractor which is awarded the contract for these services.

Once the contract is awarded, prior to drilling the exploration wells, a preliminary stimulation design will be developed based on offset well information and experience with similar formation types. Results from drilling the well, particularly openhole logs, are used to refine to stimulation design based on well specific measurements of the formation. In addition, laboratory analysis is performed on core samples which aids in the design. At this point the plan is very close to being finalized. Diagnostic testing is then performed prior pumping the actual stimulation job. Minor changes are made to optimize the treatment as more data becomes available. The job is then pumped based on the final plan.

Table 3.9 Stimulation chemicals

Chemical Additive Trade Name	Typical Purpose	Typical Concentration	
		Value	Unit
Fresh water	Base Fluid	90-99.9	Vol. % of total
KCl - Potassium Chloride	Clay Stabilization Agent	1	Vol. % of Total
FR-66	Friction Reducer	1	L/m^3
HAI OS	Hydrochloric Acid Inhibitor	10	L/m^3
BE-9	Bactericide	1	L/m^3
WG-36	Polysaccharide Fracturing Gelling Agent	3,59	kg/m^3
SP Breaker	Sodium Persulfate Breaker	0,6	kg/m^3
DCA-16001	Clay Stabilization Agent	2	L/m^3
100 Mesh Proppant	Proppant	1200	kg/m^3
30/50 Proppant	Proppant	1200	kg/m^3
20/40 Proppant	Proppant	1200	kg/m^3
DCA32002	Alcohol Based Surfactant	1	L/m^3
WG-11	Cross linker plus buffering agents	25	L/m^3
GasPerm 1000	Surfactant	10	L/m^3
Hydrochloric Acid	10-30% Hydrochloric Acid	500	L/m^3
Acetic Acid 60%	Iron Sequestrating Agent	20	L/m^3
FE-1A	Iron Sequestering Agent	20	L/m^3
FE-2A	Iron Sequestering Agent	5	L/m^3
Soda Ash	Acid neutralization, pH buffer	NA	NA

Success of the stimulation treatment is important information to acquire and several diagnostic methods can be used. This information will be used when planning new wells. Examples of diagnostic methods include radioactive (RA) and chemical frac tracers (CFT). RA tracers are stable naturally occurring isotopes and normally three are used; Scandium, Iridium, and Antimony. These isotopes are added to the stimulation proppant in very small quantities. After the stimulation treatment is complete the tracer remains in the target formation and an electric logging tool is run into the well to measure the fracturing proppant distribution.

CFT's are added at low concentrations to the fracturing fluids. They are then produced to surface during the well testing phase and the fluids analysed in a laboratory for presence of the CFT's. Other tracer technologies do exist and may be considered for this project. The final decision on the use and type of tracers will adhere to a risk based approach that emphasizes the mitigation of safety and environmental impact.

3.2.5 Well Testing

Well testing is performed to evaluate the productive potential of the target zones. Fluids produced will include formation water, stimulation fluids, condensate, and natural gas. The volume of fluids produced will be minimised while maintaining the effectiveness of the data.

The fluids will be separated into three fluid streams; condensate/oil, liquid water and natural gas. The three fluid streams will be managed independently.

- Natural gas will be flared using an flare stack designed specifically for this purpose. The flare stack will be designed in accordance with local regulatory requirements and industry best practices. The design will take into account gas flow rate, gas composition, gas temperature, gas pressure, dominant wind direction and speed, environmental, safety, and social requirements.
- Condensate/oil will be transported offsite by a licensed waste management contractor, transported to an oil processing facility, or burned on site using an effluent burner.
- Stimulation fluids and produced water will be stored on site in either lined earthen storage pits or above ground storage tanks. Fluids will be allowed to evaporate on site with outstanding fluids transported to a fluid disposal facility. Produced water quality will be monitored throughout the project and the technical capability for reuse of water will be considered to reduce the overall water use and disposal on the project.

3.2.6 Logistics

The drilling and completion operations will require a staffing of approximately 100-140 people divided into two crews. Two crews will allow 24 hour operations. Personnel will be predominately contractor employees in addition to a limited number of Statoil supervision employees. The military/security along with the camp staff will be approximately 80-120 personnel. Thus, the total of people engaged in the well pad operations is expected to be between 180 and 260. This will be dependent on the operation.

Appropriate accommodation will be located at each well site and include a workers' main camp and a military camp. The main camp is self-contained and provides workforce accommodation; catering facilities; communications; vehicle maintenance, parking areas; fuel handling and storage areas; and provision for the collection, treatment, and disposal of wastes. Camp location will be upwind of the rig, taking the prevalent wind direction into account, and take environmental and social sensitivities into account when being located. A catering company will be contracted to transport food and commodities to camp by air and/or refrigerated truck from the most appropriate markets.

Throughout the drilling and proposed stimulation and testing operations there will be a need for a number of vehicles to be made available to the operation. Table 3.10 categorises personnel and vehicles required. Note that not all personnel and vehicles are required at the well pad at all times.

Table 3.10 Number of vehicles and personnel required during the drilling and stimulation operations

Service / Company	Number of Vehicles	Number of Personnel
Statoil site supervision	1	2
Statoil Logistics	0	2
Statoil Engineer	0	2
Statoil HSE	1	2
Civil works supervisor	1	2
Civil works personnel	2	2
Flight Safety Coordinator	1	2
Stimulation Services	5	25
Cementing	2	6
Well Testing	4	10
Wireline Logging	2	6
Rig	5	40
Wellhead	1	2
Welding	1	2
Casing Cutting	1	2
Camp	2	10
Doctor	1	2

3.2.7 Waste management – drilling operations

3.2.7.1 Waste management in drilling operations

Waste generated during the drilling operations will primarily consist of drilling mud and cuttings, see Table 3.. Drill cuttings are transported out of the well with the drilling mud. As this mix reaches the surface, the solids will be separated from the fluid in order to return the mud to the recirculating mud system. A typical mud recovery system includes one or more shakers where the solids are being removed from the liquids. After completing the well mud and cuttings will be disposed of.

It is assumed that each vertical well approximately 800m^3 of water based mud and 500m^3 of cuttings will be produced. For horizontal wells volumes are anticipated to be higher, 950m^3 of mud and 600m^3 of cuttings respectively. The WBM and the cuttings will be placed in an evaporation pit. The pit will be lined with the appropriate lining to avoid any leakages into the ground, see *Annex D.2 Waste management plan*.

All pits will be located a safe distance from sensitive receptors such as human settlements, water sources and environmentally important areas. The pits will be guarded to prevent unauthorised access. Cuttings and the remains from the water based mud will, as long as it has been determined to be benign, be left in the pit and covered with top soil following completion of the drilling activities. The location of the pits will be recorded and documented to manage long term liabilities associated with the pit sites.

In case oil based muds have been used during the drilling operations, mud and cuttings will be managed separately from the WBM. Oil based muds will be recycled and reused on subsequent wells. Oil based muds and cuttings will be separated using a dedicated high-power shale shaker. Cuttings infested with hydrocarbons will either be treated by TCC at site to reduce oil content below 1 % and disposed at site, or transported to an external treatment site.

Table 3.11 Waste type and amount

Type of waste		Estimated quantity per vertical well drilled	Estimated quantity per horizontal well drilled
Domestic and assimilated waste	Food waste, litter, paper, cardboards	$150 m^3$	$150 m^3$
Special waste	Incinerator ashes	< 50 Ton	< 50 Ton
	Metallic drums, Scrap metal	$15 m^3$	$20 m^3$
	Drill cuttings (water based muds)	$500 m^3$	$600 m^3$
	Sludge from sewage treatment processes	Unknown	Unknown
Special Hazardous waste	Chemicals (solvents, others)	< 0.1 Tonnes	< 0.1 Tonnes
	Batteries (dry and acid-based)	400 Units (flashlights)	500 Units (flashlights)
	Aerosol cans	< 0.1 Tonnes	< 0.1 Tonnes
	Contaminated packaging	< 5 Tonnes	< 5 Tonnes
	Contaminated soil	Not expected	Not expected
	Electrical and electronic equipment	< 2 Tonnes	< 2 Tonnes
	Fluorescent lamps	< 0.1 Tonnes	< 0.1 Tonnes
	Used oil	0.15 Tonnes	0.25 Tonnes
	Oil filters	0.1 Tonnes	0.1 Tonnes
	Oily rags	0.1 Tonnes	0.1 Tonnes
	Refrigerants	< 1 Tonnes	< 1 Tonnes
	Cement slurries	approx. $20 m^3$ (From cement returns to pits)	Approx. $30m^3$ (From cement returns to pits)
	Drill cuttings (Oil-based muds)	not expected	not expected
	NORM	not expected	not expected
	Sludge from contaminated evaporation ponds	<20 m3	< 250 Tonnes
Hazardous wastewater	Potentially waste water from cleaning areas (e.g. rig)	<150m3	<150m3
	Sewage: grey water	$90 m^3$	$135 m^3$
	Sewage: black water	$795 m^3$	$950 m^3$
	Water-based muds	$795 m^3$	$950 m^3$
	Oil-based muds	not expected	not expected
	Condensate	$400 m^3$	$800 m^3$

	Flowback water	800 m^3	10000 m^3
Inert waste	Construction debris – Inert waste	<50Tonnes	<50Tonnes
Medical waste	Medical waste	<100kg	<100kg
Atmospheric emission	CO_2	up to 2000 Tonnes	up to 4000 Tonnes
	Noise	Up to 95 dbA	Up to 95 dbA
	Water evaporated from evaporation pit	500 m^3	600 m^3

3.2.7.2 *Waste management in well stimulation and testing*

Table 3.12 Additional waste in well stimulation and testing

	Product	Disposal Method	Estimated Volume	
			Vertical Well	Horizontal Well
Completions	Condensate	Offsite removal by licensed waste management contractor, transported to oil processing facility, or burned on site	400 m3	800 m3
	Gas	Flared	1000 E3M3	2000 E3M3
	Flowback Water	Fluids will be allowed to evaporate on site with outstanding fluids transported to a fluid disposal facility	800 m3	10000 m3
	Domestic and Assimilated waste	Partly offsite removal by licensed waste management contractor and partly incinerated and disposed at site. Recycle where possible	100 m3	150 m3

A complete overview of type and amount of waste generated during the drilling operations, and how these will be treated, is described in *Annex D.2 Waste management plan. Annex D.2.1 Waste facilities* describes relevant Waste facilities to be used for the different type of waste.

3.2.7.3 *Atmospheric emissions*

There are a number of potential sources of emissions to air including burning of fuel and incineration of wastes. Air quality in the survey area will also be degraded in the short term by dust clouds stirred up by vehicle movements. The greatest amount of emissions will come from burning of fuel by vehicles, generators and aircraft.

Diesel is the principal fuel for land transport and generators that will be used during the projects in the Block. Approximately 650 m3 of diesel fuel could be required per well for drilling a vertical well, accordingly 720 m2 diesel for drilling an horizontal well. Possible stimulation and testing would require ~ 260 m3 diesel for a vertical well and ~500 m3 for a horizontal well.. In additional there will be secondary consumption of fuel for civil works and flights down to the project area.

Fugitive emissions of fuel and oil vapours will also occur but these will not be relevant and basically associated to the use of fuel mainly. The nature of the proposed activities does not allow for potentially relevant fugitive emissions to be calculated at this time.

A quantitative estimate of CO_2 emissions generated by burning of fossil fuels is shown in Table 3.11.

3.2.8 Decommissioning

3.2.8.1 Final Plug and Abandonment (P&A) of Wells

Wells drilled will ultimately be decommissioned through P&A operations. These plans are not unique to unconventional wells but standard in the O&G industry. The detailed P&A operation will be specific to well type. Irrespective of the well type, the design of the P&A will prevent migration of hydrocarbons and/or brine between different reservoirs, provide isolation of fresh water aquifers, prevent aquifer contamination, and prevent migration of hydrocarbons or brines to surface. The P&A will be performed in accordance with Algerian Legislation, Statoil requirements, and industry best practice. The plug and abandonment will consist of the following steps.

- Verification of annular isolation and protection of fresh water aquifers: Annular isolation is achieved through the cementing process conducted during the drilling operations. Upon drilling the well steel casing is run to the bottom of the well and cement is pumped behind this casing to provide isolation between the subsurface formations and to surface. This is verified through electrical logging whereby the cement quality is evaluated and isolation verified. The logs will be provided to the regulatory authority for their review and approval prior to abandonment of the well.
- Setting and verification of cement for isolation of hydrocarbon bearing formations: The subsurface formations which may contain hydrocarbons are further isolated by setting cement plugs inside the casing strings, above and below the hydrocarbon bearing formation. This complements the cement that is on the outside of the casing strings and ensures that hydrocarbon zones are isolated and there will not be flow between these formations and other formations or flow to surface.
- Setting surface cement plug: A surface cement plug is required as the final barrier to isolate the well. A cement plug is placed within the inner most casing string which acts as a final barrier to flow from the well.
- Wellhead removal below ground level, whereby the wellhead is removed below ground level such that there is no part of the well remaining above the level of the ground.
- Finally, the location where the wellhead was is filled with cement and made level with the ground. A sign is installed to mark to well location.

The cement utilized for in oil and gas wells is specifically designed to withstand the pressure, temperature, and fluids over the long term. This cement will be tested by skilled professionals in a laboratory to ensure it meets the requirements for the specific well. Once the cement is placed in the well for abandonment it is verified through electric wireline logging, application of weight, and/or pressure testing.

Equipment used for the P&A will be either the equipment used for drilling and/or completions work.

3.2.8.2 *Camp Decommissioning and Site Restoration*

At the conclusion of Statoil's exploration activities in the Timissit license the well sites, access roads and camp locations will be reclaimed in accordance with Algerian legislation and international best practice. No permanent above ground infrastructure is planned to remain in place. However, it is planned for roads, air strips, and/or water wells to remain in place.. In coordination with the local Authorities, efforts will be made to work with the local inhabitants to hand over access roads, air strips and water wells in a way that positively impacts the local inhabitants. For instance for water wells an assessment will be made whether all infrastructure should remain in place for an operational well, or whether surface equipment might be removed, still enabling easy later commissioning.

This reclamation will include:

- Permanently securing the wellbore with cement and metal plugs sufficient to provide permanent barriers to isolate permeable formations (containing water or hydrocarbons).
- Removal and/or treatment of all fluids and cuttings
- All pits, berms, and other above ground structures constructed for the drilling of the well will be levelled and back-filled to restore the site to approximate pre-existing conditions
- Waste material will be disposed of in an environmentally responsible manner in accordance with *Annex D.2 Waste Management Plan*
- Photographic records will be acquired to document the reclamation

Equipment used for this operation will be similar in function and form to that used for the construction of the site.

Prior to operations a specific *Program for shutting down and restoration of site* will be developed, see *Chapter 6 EMP, section 6.4.6*.

3.3 Seismic operations

Statoil and partners plan to acquire 350 km^2 of 3D seismic in the first exploration phase. An additional 100 km^2 3D seismic is planned acquired during the second/third exploration phase.

The seismic campaigns will consist of the deployment of recording equipment to conduct vibroseis operations along a grid pattern with the 3D seismic operations area shown in Figure 3.3. Furthermore a grid of upholes will be drilled within this area to determine seismic velocities in the upper unconsolidated layers.

The seismic operations are planned to start in Q3 2017, and will be initiated by constructing the base camp for the seismic crew. The plan is to co-locate this camp with the Base de Vie established for the drilling campaign close to the airstrip in the centre of the survey area.

3.3.1 Areas of seismic interest

Acquisition of 3D seismic in Phase 1 will take place within a rectangular area in the middle of the license, see Figure 3.3. The exact grid pattern and uphole locations are not currently known, but this information will be available in due time before operations start. The final location of seismic grid and upholes will be shared and agreed with the Algerian authorities prior to start-up of any activity.

The results from the Phase 1 3D seismic campaign and the exploration wells will be used to determine the areas relevant for 3D seismic in the flowing phases. Area for seismic operation in for phase 2 is also identified, see map in Figure 3.3, marked with a green dotted line. For phase 3 the area for seismic operations is not identified yet.
The final location of 3D seismic acquisition for exploration phases 2 and 3 will be agreed with the Algerian authorities in due time.

3.3.2 Vibroseis and line clearance

The seismic lines will be laid out in a grid covering the 350 km^2 (35 km x 10 km) area to be surveyed. The lines will typically be located 300 – 600 m apart. and run the entire length and width of the survey area.

Seismic data will be acquired by using the vibroseis technique. Signals are sent into the ground using vibration techniques. First, a layout crew will deploy seismic recording equipment along pre-defined lines. A single (or a fleet of) vibrator trucks will drive along the identified seismic lines in the final grid pattern. It will stop every 35 – 70 m and lower a heavy plate to the ground surface. As the plate reaches the ground vibration starts and sends signals into the ground for 5-10 seconds. This is called a vibration point (see figure below). Signal range is 3 – 70 Hz. The signals will reflect off the various layers in the ground and the receiving signals are being picked up by recording devices.

Figure 3.16 Deployed recording equipment

Figure 3.17 A fleet of vibrator trucks

Figure 3.18 A vibration point

The vibration trucks determine the level of line clearance necessary. Ground work for clearing of lines will be minimised, and if possible avoided altogether. As long as the trucks can cross the surface without being stuck no clearance is necessary. Where there are non-passable sand dunes, line clearance will be required. The level of clearance required will be identified in the field.

In case there are pockets of vegetation “blocking” the seismic line, the audio cables will be put in place by hand. The vibrator trucks will find an alternative route around the vegetation pocket and continue vibroseis on the other side.

- The survey will be planned to avoid, or minimise disruption to, known significant wildlife breeding, nesting, migration and feeding patterns.
- Seismic lines will be aligned to avoid potentially sensitive areas e.g. wadis and dayas that support more extensive vegetation.
- The survey lines will be limited to a set working width and marked to prevent unnecessary off-road/line driving;
- Avoid the use of heavy earthmoving equipment where practicable.
- All vibrators will operate in accordance with the IAGC / Statoil / Sonatrach safe operating distances.
- A policy of minimal clearance and bulldozing will be implemented by the Contractor in accordance with the IAGC Environmental Guidelines for Worldwide Geophysical Operations and bulldozers will not be used on the reg.
- All foggaras, wells and other structures will be avoided by the seismic lines in accordance with the IAGC Environmental Guidelines for Worldwide Geophysical Operations.
- Should ephemeral streams and other hydrological features be encountered during the survey, they should be recorded and the survey lines planned to avoid crossing these features. Wherever possible previous survey line crossings of these features should be re-used to avoid additional disturbance.
- Planning of the survey should ensure that survey lines avoid passing through the foggaras, and known archaeological sites.
- The survey crew shall have received practical training in identifying archaeological sites prior to commencement of operations
- Guidelines for the management of archaeological finds will be implemented, see *Annex D9 Procedure for Archaeological Finds.*
- No waste will be left on the lines. All will be returned to camp facilities.

3.3.3 Uphole drilling

The seismic campaign will include drilling of up to 50 upholes spread evenly across the 3D seismic area. The upholes are drilled through unconsolidated material until they hit a firm layer. The purpose of uphole drilling is to provide information about the top layers of the ground. The upholes will be drilled down to a depth of typically 50 – 100 m, see Figure 3.19. A signal is generated on the surface (can typically drop a weight or use a sledge hammer to hit a plate of metal), and the signals generated are measured by sinking audio devices into the uphole.

Upholes will be drilled using mobile drilling rigs. The drilling mud will be produced on site, using water and bentonite, in a very small mud pit. When abandoning the site the upholes will be plugged, the mud pit emptied and backfilled before the surface will be brought back to the condition of the surroundings. Photographic records will be acquired to document how the location has been left.

The detailed location of the upholes can only be determined once the detailed seismic programme has been established, but a grid of upholes 2-4 km square is expected for this programme.

- Upholes will be planned, drilled and abandoned in a manner to avoid potential cross contamination of aquifers in the area.
- Only water based bentonite fluid with no additives will be used wherever possible.
- One will avoid locating upholes in areas adjacent to local community water wells/foggaras.
- Uphole drilling sites will be located at a reasonable distance (>200 m) from any significant ephemeral water bodies.
- All upholes will be located on GIS.
- Following completion of drilling the contents of mud pits should be allowed to evaporate before the pits are covered with at least 50 cm of clean soil and the landscape reinstated to its previous level.
- Photographic evidence of the state in which uphole locations are left will be acquired
- If there is in any way risk of cross contamination of aquifers the upholes will be will be plugged with cement

Figure 3.19 Typical uphole drilling site

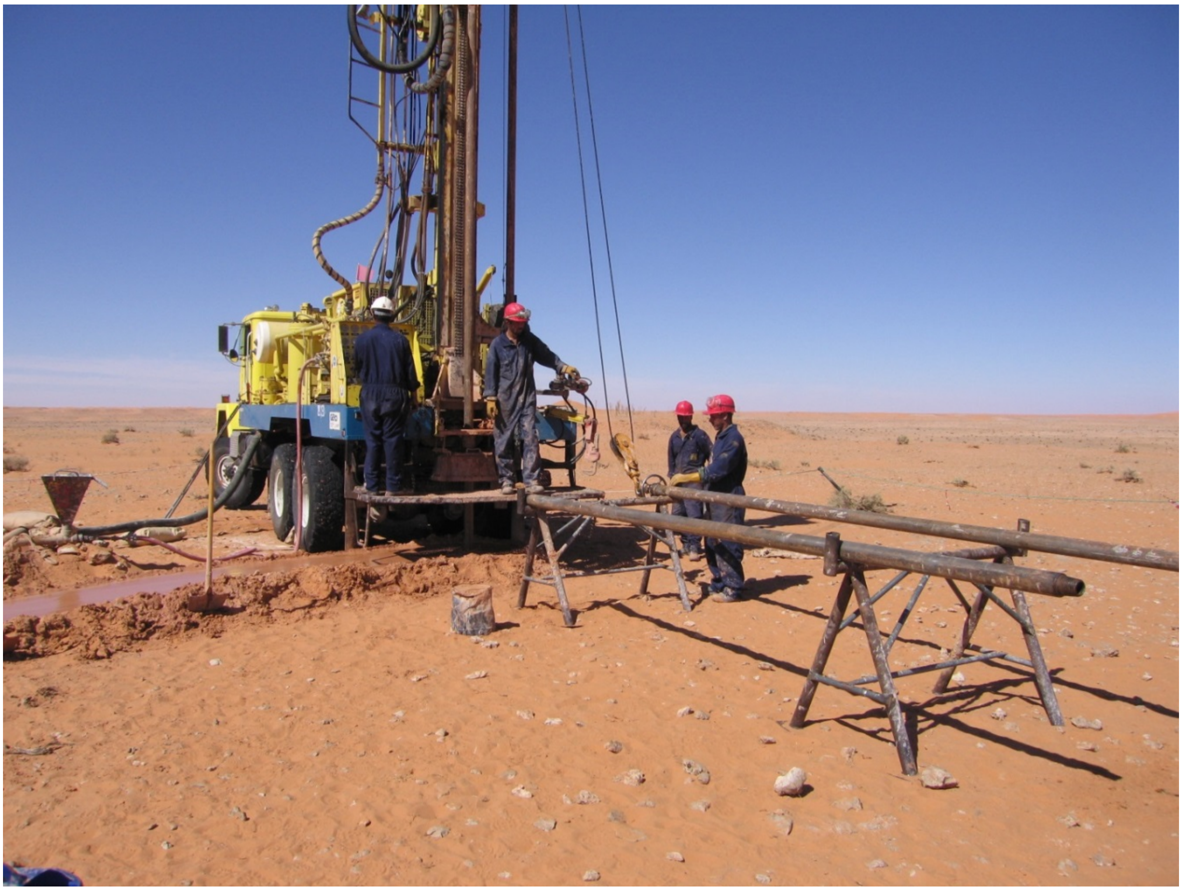


Table 3.13 Drilling of upholes

Number of upholes	Up to 50
Depths of upholes	50 – 100 m
Diameter of uphole	10 – 15 cm
Water need per well	1.0 – 2.5 m^3
Volume of cuttings produced per well	0.88 – 1.77 m^3

3.3.4 Seismic facilities and logistics

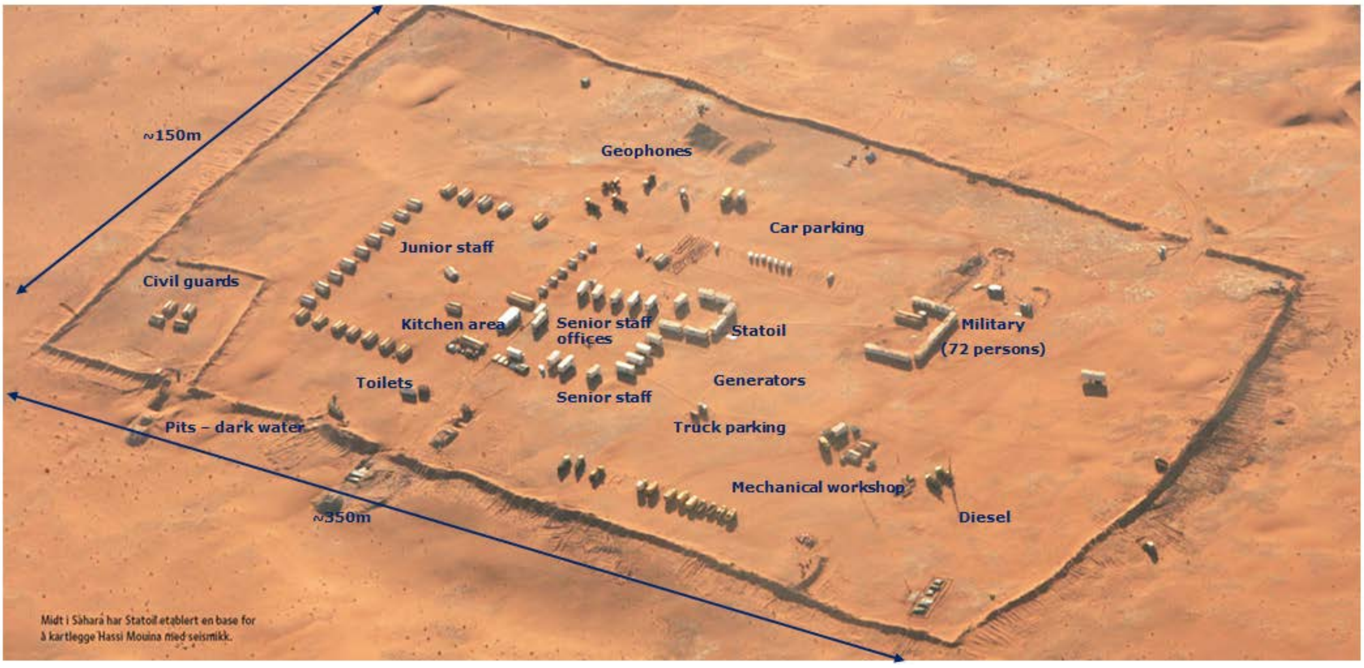
All transportation of personnel and equipment within the license area will take place on existing roads or in the terrain. No additional roads will be constructed as all vehicles will have off-road capabilities. Traffic will be routed through defined access routes from the seismic base camp to the survey areas, and it is likely that these access routes will follow the seismic lines. .

The location of the seismic base camp has not been identified, and will be chosen by the seismic contractor. However, the camp is expected to be located in the centre of the programme area, close to the airstrip. If a camp is established in this location for the drilling campaign, the facilities there will be re-used for seismic activities. However, it will have to be extended to accommodate the larger personnel contingent required for the seismic operation. The seismic camp will be designed to house approximately 200-250 people and will be 400 m x 200 m, see Figure 3.20.
The camp will have:

- Accommodation for senior staff, junior staff and guards
- Offices, kitchens, sanitary facilities, storage facilities, mechanical workshop
- Generators and power network
- Security fences/berms
- Water supply and waste water treatment
- Fuel station/facilities

Fly camps are not envisaged to be used for this operation given its limited areal extent.

Figure 3.20 Typical layout of seismic camp



In order to run the seismic campaign securely and efficiently a number of vehicles will be required to bring into the project, see Table 3.14. These vehicles will be transported by air or ground from Algiers/Hassi Mesaoud to be used in the project.

Table 3.14 Vehicles required as part of the seismic operations

Vehicles	Number
Vibrators	10 – 12
Off Road Vehicles	15
4x4 / 6x6 trucks	10
Uphole drilling rigs	2
Water trucks	2
Diesel tanker	1
Total	**40 – 42**

- Safe fuel transfer procedures will be developed and implemented by trained personnel.
- Oil and chemical spill clean-up materials must be provided for the containment and clean-up of minor spills. After cleaning up a spill it should be marked on a map for follow up inspection.
- Appropriate storage and bunding should be provided for oil and chemical containing areas.
- All spills and leaks will be reported promptly in accordance with the Statoil Notification of Incident Reporting System and the regulation's requirements.

The seismic campaign will have a limited requirement for provision of raw material over and above the normal provisions required for the camp of this size, see Table 3.15. It has been assumed that a local water source in Debdeb can provide the required quantity and quality of water to the seismic operations of the projects if the water from the wells drilled as part of the drilling campaign should turn out not to be potable. If it turns out that there are no appropriate water sources in Debdeb, Statoil will assess whether potable water shall be trucked from elsewhere (e.g. bottled). See *Annex D.4 Water management plan.*

Table 3.15 Raw materials required in the seismic campaign

Raw materials	Amount	Source
Daily water needs (Technical and potable water)	25 m^3	Trucked from local water source
Fuel need (two month survey period)	240 m^3	Transported from Hassi Mesaoud

3.3.5 Waste management – seismic operation

Waste can be divided into operational waste and camp waste. All domestic waste, such as food, paper, wood, plastic etc, will be incinerated on site or transported to appropriate recycling facilities if such exist. Other solid residues including but not limited to oil and fuel filters, mechanical parts, tyres, scrap metal, batteries and chemical wastes will be separated and stored on site until it is brought back to Hassi Mesaoud for recycling or destruction.

Table 3.16 Waste type and amount

Type of waste		Estimated quantity during a seismic survey campaign
Domestic and assimilated waste	Food waste, litter, paper, cardboards	2 kg/person/day
	Other Domestic and assimilated waste	$120m^3$
Special waste	Incinerator ashes	< 50 Ton
	Metallic drums, Scrap metal	500kg
Special Hazardous waste	Chemicals (solvents, others)	< 0.1 Tonnes
	Batteries (dry and acid-based)	400 Units (flashlights)
	Aerosol cans	< 0.1 Tonnes
	Contaminated packaging	< 5 Tonnes
	Contaminated soil	Not expected
	Electrical and electronic equipment	< 2 Tonnes
	Fluorescent lamps	< 0.1 Tonnes
	Used oil	0.15 Tonnes
	Oil filters	0.1 Tonnes
	Oily rags	0.1 Tonnes
	Refrigerants	< 1 Tonnes
Hazardous wastewater	Potentially waste water from cleaning areas (e.g. rig)	<150m3
	Sewage: grey water	$135\ m^3$
	Sewage: black water	$90\ m^3$
Inert waste	Construction debris – Inert waste	<50Tonnes
Medical waste	Medical waste	<100kg

Liquid wastes will be left on site or transported to an appropriate facility which can manage such wastes. Waste oils, fuels or other hazardous liquid wastes will be collected, stored and transported to Hassi Mesaoud for recycling or destruction.

Cuttings and bentonite based mud from the uphole drilling will be left in small evaporation pits on site. When the liquids have evaporated, the pits will be covered up and left according to Algerian and Statoil standards.
See also *Annex D.2 Waste management plan.*

3.3.6 Decommissioning

The decommissioning phase of the seismic operations will take approximately 3 weeks to complete, and it includes

- Plugging any remaining upholes (this is normally done straight after the well has been recorded).
- Camp removed and surface returned back to original state
- Photographic records will be acquired

- Mud and waste water pits to be cleaned out and covered up if appropriate

Prior to operations a specific *Program for shutting down and restoration of site* will be developed, see *Chapter 6 EMP, section 6.4.6*.

3.4 Health, Safety and Security

To prevent harm to people, community, environment and asset the Timissit project will be developed and operated in compliance with applicable Algerian regulations, Statoil's health, safety and security requirements and relevant conventions and codes, see *Chapter 2 Administrative and regulatory framework*.

The project's proactive approach to prevention of incidents a continuous risk assessment will characterize the project. Residual risks will be identified in an Emergency response analyses and actions to be taken if an incident occurs will be described in the Emergency response plans for Line 1 and line 2.
Annex D.1 Liquid Spill Response Plan (LSRP) will be part of these Emergency response plans.

Chapter 4 - Environmental and Social Baseline

Table of contents

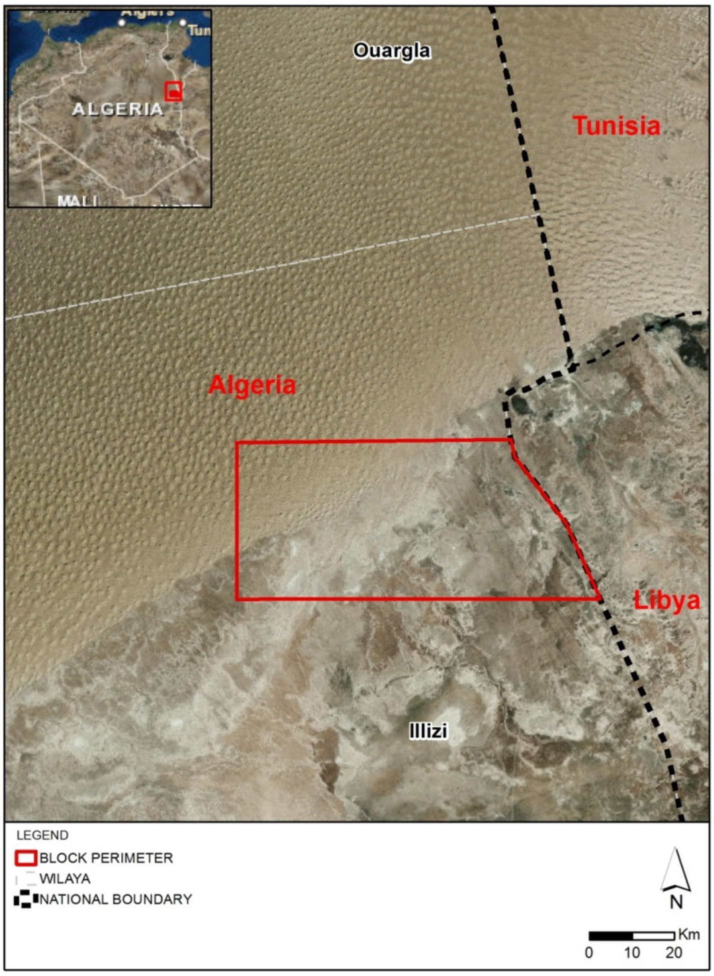
4 Environmental and Social Baseline

4.1 Introduction

The Timissit License (hereinafter, referred to as the Study Area), is located on the edge of the Berkine basin, the westernmost extension of the larger Ghadames Basin in Northern Sahara. Figure 4.1 shows the location of the Timissit license, which lies on the eastern border of Algeria, with Libya. The border with Tunisia is located approximately 20 km to the northeast.

The Study Area falls completely within the Wilaya of Illizi, some 50 km south of the Ouargla Wilaya.

Figure 4.1 Location of the Study Area



Source: ERM, 2015

The baseline conditions have been determined through a combination of desktop-based investigations, meetings with relevant Authorities and a site visit to the Study Area.

The desktop investigation included the gathering and review of available information for the area and the region. These sources of information included websites, desk-based studies, maps, satellite imagery and information gathered by ERM and BEXAM in previous assignments in the region (see *Section 7 References* for reference on bibliography).

In order to complement the desktop investigations, a field survey was undertaken in May 2015. The visit to the region was conducted by a team from Statoil and BEXAM consisting of archaeological, environmental, hydrogeological and social experts. The field visit combined meetings with regional and local Authorities and ground truthing of the Study Area.

Meetings with relevant Authorities were held to provide the Authorities with a short introduction to the project and the planned field activities and to request and gather potential relevant baseline information

A list of the specific meetings and activities carried out during the field survey is presented below:

- Meeting with the representatives of Illizi Wilaya, conducted in Illizi on 3, 4 and 11 May, including meetings with representatives from the following directorates:
    - Wilaya Hydraulic Directorate (*Direction de l´hydraulique de la Wilaya*).
    - Wilaya Agriculture Directorate (*Direction de l'agriculture de la Wilaya*).
    - Wilaya Planning and Statistics Directorate (*Direction de planification et statistique de la Wilaya*).
- Meeting with the Chief of In Amenas Daïra, conducted in In Amenas on 3 May.
- Meeting with the Mayor of Debded, conducted in Debded on 3 May.

Ground truthing activities in the field were undertaken to verify available information, identify additional areas of interest and sample soil and water.

A map with the specific sites visited during the field survey is presented in Annex C1, together with a table summarizing the specific field survey activities undertaken at every survey location. Specific sites of interest are referenced in the baseline, where relevant.

4.2 Physical Environment

4.2.1 Introduction

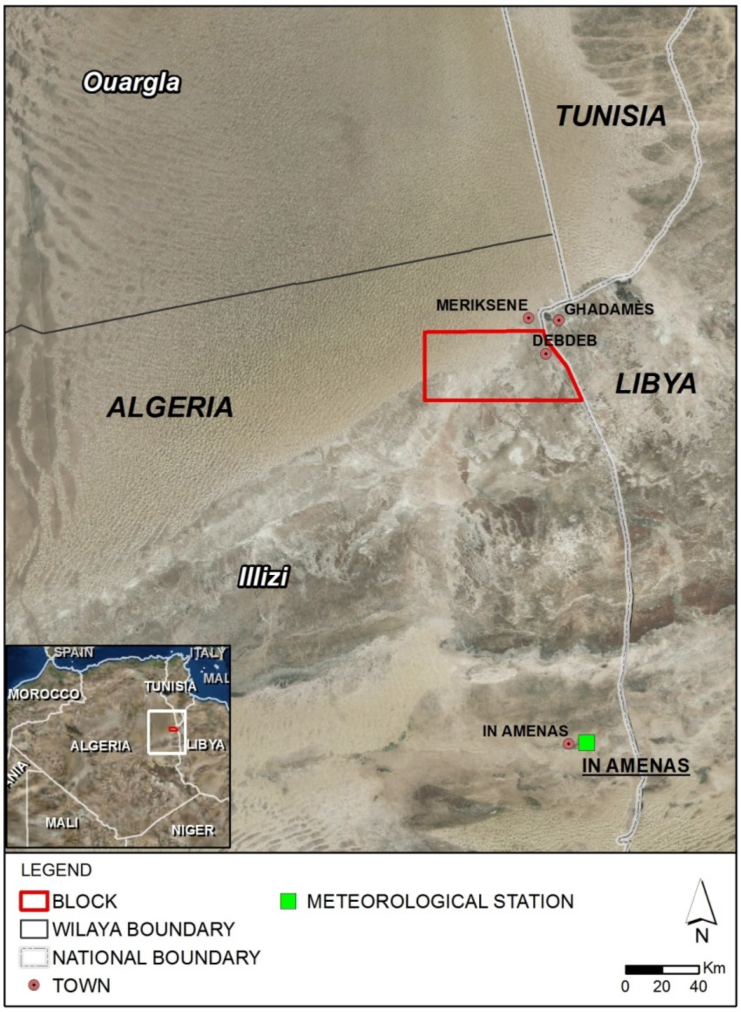
This section describes the existing physical conditions within the Study Area including climate, air quality and noise, geology, seismicity and naturally occurring radioactive material (NORM), geomorphology and topography, soils, hydrology and hydrogeology.

4.2.2 Climate

Algeria has a subtropical North African climate with considerable climatic variations between regions (north-south, east-west). For instance, rainfall is characterised by a decrease from north to south and from east to west. Northern Algeria is characterised by a Mediterranean climate with hot, dry summers and wet, cold winters while central Algeria, including the Study Area, has a desert climate (Sahara Desert). The general climate in this part of Algeria is extremely arid and characterised by high temperatures, rainfall of less than 100 mm and heavy or prolonged precipitation occurring only on rare occasions, particularly in the winter months.

The meteorological station in In Amenas is the station closest to the Study Area and climatic data from the station is being used to describe the conditions within the Study Area. The In Amenas meteorological station is located some 190 km southeast of the Study Area, see Figure 4.2.

Figure 4.2 Location of the selected meteorological station



Source: ERM, 2015

4.2.2.1 Temperature

The Study Area is characterised by a hot and arid climate. Table 4.1 presents the maximum, minimum and mean temperatures gathered at the In Amenas meteorological station over the last 10 years.

Table 4.1 Minimum, maximum and monthly mean temperatures (ºC) recorded at the In Amenas meteorological station (2005-2014)

Parameter	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Mean	11.24	13.57	19.06	24.51	29.03	32.57	33.65	33.03	30.51	24.61	17.76	12.21
Max.	32.22	36.11	37.22	41.11	43.89	46.11	46.11	46.11	42.22	38.89	33.89	31.11
Min.	-3.89	-2.22	0.56	6.11	12.22	17.22	20.00	20.00	17.22	7.78	2.78	-2.22

Source: NOAA's National Climatic Data Center (NCDC), 2015

4.2.2.2 Rainfall and relative humidity

A key characteristic of the rainfall in the Sahara desert is its annual variability, which consists of irregularly distributed rainfall events both during the year and from year to year. The number of days with precipitation pr year is generally low, averaging 15 days for In Amenas. The average monthly rainfall recorded at the In Amenas meteorological station (averaged over a period from 2003 to 2013) is presented in Table 4.2.

Table 4.2 Monthly average rainfall (mm) recorded at the In Amenas meteorological station (2003-2013)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2003	0	2	0	0	4	0	0	0	62	0	0	0
2004	0	0	25	0	0	0	0	0	0	0	0	6
2005	2	0	10	0	0	0	0	0	5	0	0	3
2006	0	1	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	16	0	0	0	0	0	0	0	2
2008	1	0	0	0	0	0	0	0	0	9	0	0
2009	2	0.2	1	0	0	0	0	0	7	1	0	0
2010	0	0.36	0	0	0.8	0.2	0	0	0	5.2	0	0
2011	0.2	7	3	3	0	0	0	3	0	13	0	0
2012	0	2	5	0.2	0	0	0	0	0	0.2	0.6	2
2013	0	0	0	0.9	0	0	0	0	5.4	0	1	1.1
Average 2003-2013	0.47	1.14	4	1.83	0.44	0.02	0	0.27	7.22	2.58	0.15	1.28

Source: Meteo Climat, 2015

Rainfall is very irregular with a yearly average rainfall of approximately 19.4 mm over the period 2003-2013. Rainfall is generally characterised by high intensity storm events, leading to streaming and erosion in degraded areas.

Table 4.3 shows the relative humidity data for the In Amenas meteorological station, recorded during the period from 2005 to 2014. Relative humidity stays below 50% which is characteristic of arid areas.

Table 4.3 Average relative humidity (%) recorded at the In Amenas meteorological station (2005-2014)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Mean	46.31	38.23	29.12	24.30	20.74	19.59	18.22	20.71	26.04	34.48	37.65	46.85

Source: NOAA's National Climatic Data Center (NCDC), 2015

4.2.2.3 Wind

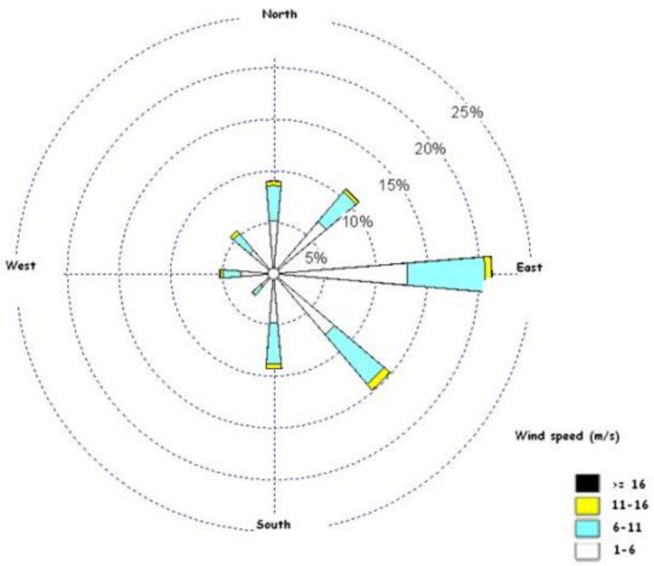
Wind plays an important role in the desert environment as it influences soil and sand erosion and hence determines the distribution of vegetation.

Most major deserts, including the Sahara, lie in areas crossed by the trade winds. The dry trade winds heat up as they move toward the Equator, dissipating cloud cover and allowing yet more sunlight to heat up the land.

Two spefic types of wind are considered relevant in Algeria: the Sirocco and the Gharbi. The Sirocco (also called *Chergui* or *Shehili*) is a hot, dry and dusty wind that comes from the Sahara Desert, where hot air rises and flows towards north. It is most common during the spring (between February and May), but can occur all year round. It arises from a low pressure system over the Mediterranean which moves towards the east allowing a southerly wind to blow from Africa. The dust carried by the Sirocco is known to spread as far as Northern Europe. The Gharbi is dry wind (Gharbi) that induces strong wind events during the winter, causing various sand accumulations (aeolian cover, dunes, etc.).

Figure 4.3 shows the wind rose for the In Amenas meteorological station. The predominant wind direction is east – west. Average wind speed measured 10 m above ground is estimated to 4 – 5 m/s in the Study Area (Renewable Energies Development Centre, 1999).

Figure 4.3 Wind rose for In Amenas climate station (1978-2007)



Source: Office Nationale de Météorologie, ONM.

4.2.2.4 Solar radiation

Figure 4.4 shows the number of sunshine and daylight hours per month registered at the In Amenas station. It can be observed that sunshine hours are similar to daylight hours, with minor differences of 3 hours. This results in a high yearly solar insolation average: about 3,500 h/year.

Figure 4.4 Sunshine and daylight hours at the In Amenas meteorological station

Source: World Climate Guide, 2015

4.2.3 Air Quality

No ambient air quality monitoring stations are known to exist within the Study Area and its surroundings. The Study Area can be considered to be located in a remote area, free of air emission activities with the exception of those associated to vehicular transport along the existing roads, and emission resulting from the settlements in the Study Area (Debded) or in the proximity of the Study Area. The closest oil and gas activities is EL Merck, located 90 km away, and it is not expected that the air quality in the Study Area is influenced by the activities in El Merck.

Since the Study Area is located in the Sahara desert, naturally high levels of dust and particulate matter can be expected on a seasonal basis.

The sensitive receptors are the settlements present in the Study Area , nomads, and sensitive ecological elements.

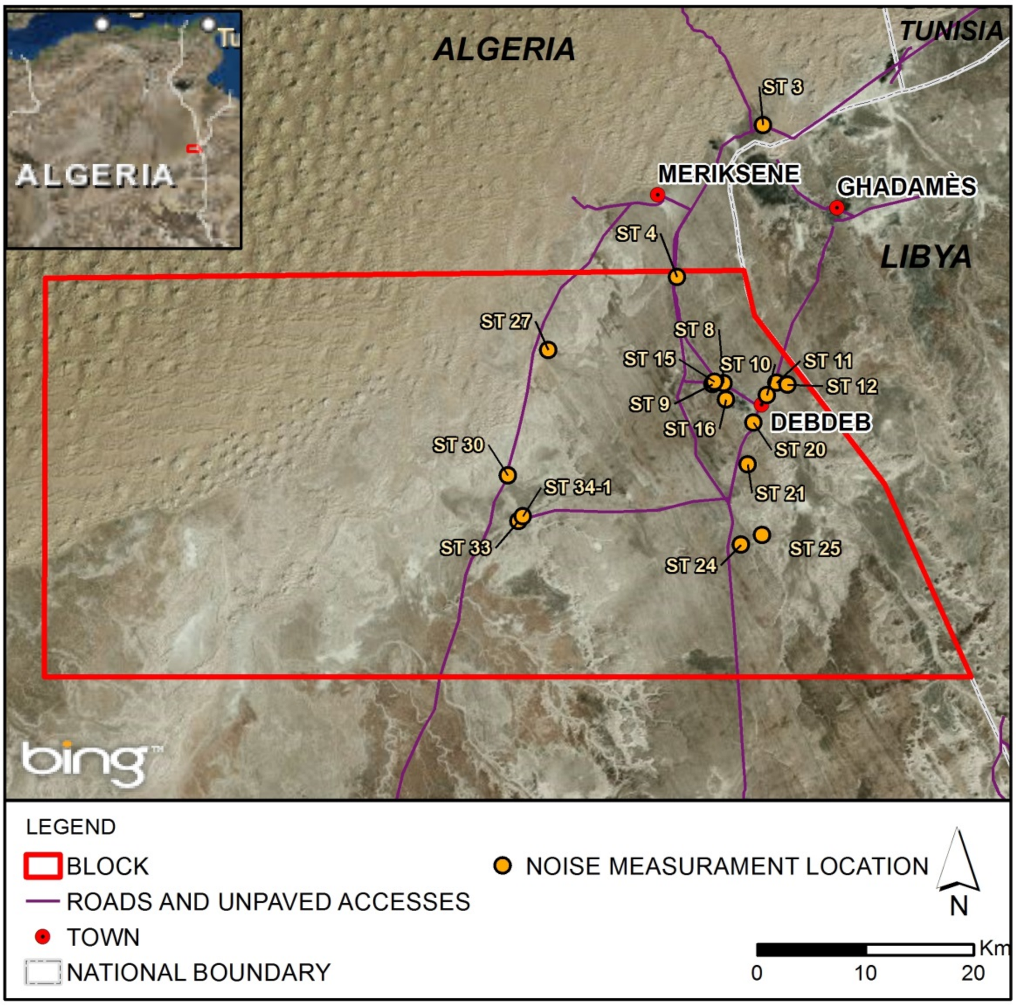
4.2.4 Noise Conditions

The Study Area is located in a remote area, free from noise emitting activities with the exception of those associated to vehicular transport along the existing roads, and other anthropogenic activities such as farming, livestock, rearing and construction activities.

According to data obtained for similar remote areas in the absence of human noise sources, the estimated noise level is approximately 40 dBA. A typical noise source in desert environments is sandstorms/strong winds. When they occur, the estimated noise level ranges from approximately 68 dBA to 80 dBA (as per noise measurements taken in similar areas during sandstorms).

Some noise measurements were carried out during the field survey conducted in May 2015, in order to provide an overview of noise conditions in the Study Area. Noise measurement locations within the Study Area are shown in Figure 4.5. The noise measurement results are included in Annex C.2.

Figure 4.5 Noise measurement locations in the Study Area



Source: ERM, 2015

4.2.5 Geology, Seismicity and NORM

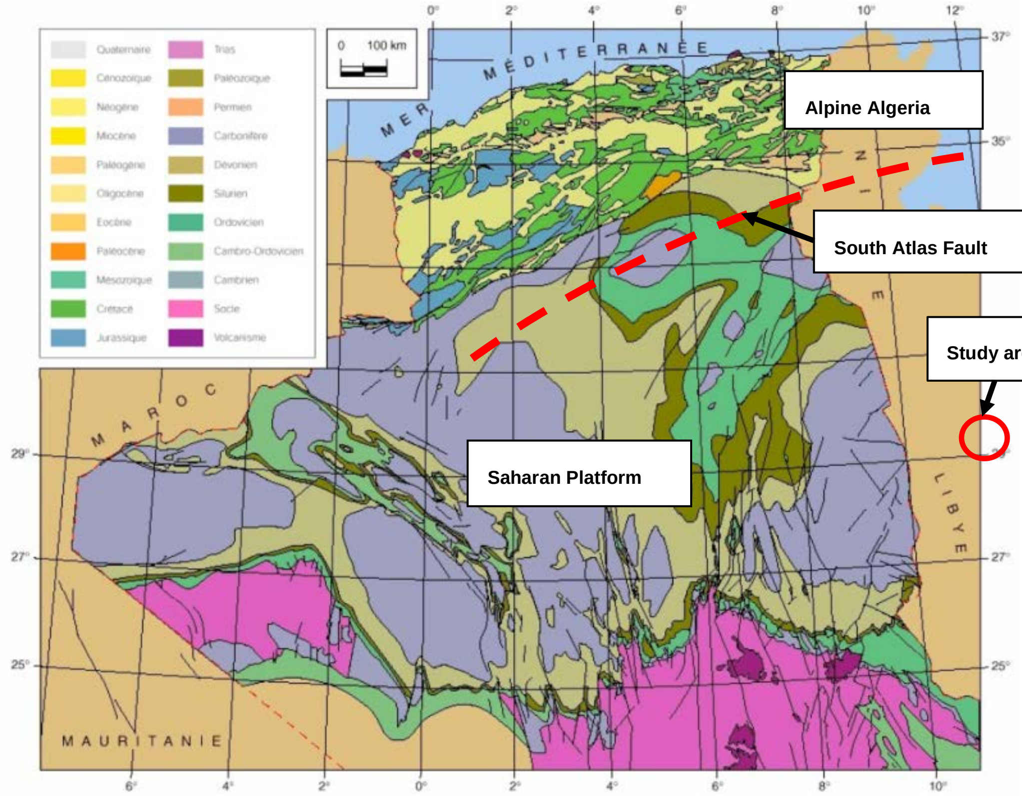
4.2.5.1 Geology

4.2.5.1.1 Regional context

The global geodynamic process of plate tectonics contributed to dividing Algeria into two distinct geological domains: “Alpine Algeria” in the north and the “Saharan Platform” in the south. The two major structural units are separated by the South Atlas fault (see Figure 4.6*)*.

As can be seen in Figure 4.6 the Study Area is located on the Saharan Platform.

Figure 4.6 Geological units in Algeria

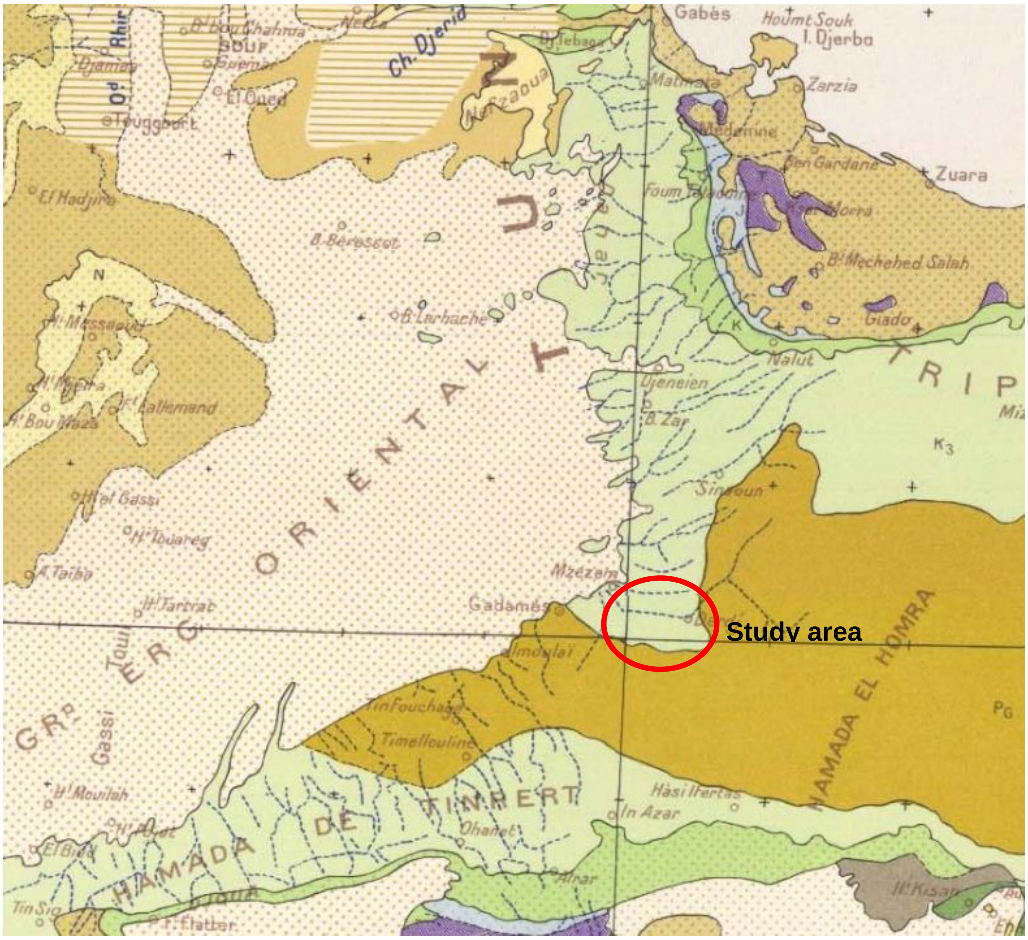


Source: Askri et al., 1995. Modified by ERM, 2015

The geology of the Saharan Platform is characterised by a succession of marine and continental events between the Cambrian and Tertiary periods that deposited sediments on a Precambrian basement. During the Palaeozoic these thick sediments were structured into a number of basins separated by geological highs (Askri et al., 1995).Various tectonic events have delineated the boundaries of the sedimentary basins within the Saharan Platform, each of which has its own more or less complete sedimentary column.

Figure 4.7 shows details of the surface geology in the Study Area. Sands and dunes from the Great Eastern Erg (*Grand Erg Oriental*) are found in the northwestern part of the Study Area, and Upper Cretaceous materials outcrop in the northeastern sector.

Figure 4.7 Surface geology in the Study Area



Legend (*only those elements located close to the Study Area, or within the Study Area, are included*):

Pg	PALÉOGÈNE. PALEOGENE.		Sables et dunes — Erg. Sands and dunes — Erg.	K_3	CRÉTACÉ supérieur. Upper CRETACEOUS.
K, K_{1-2}	CRÉTACÉ inférieur, moyen ou indifférencié. CRETACEOUS Lower, Middle or undifferenciated.	K	" Continental intercalaire " s. l.		

Cours d'eau intermittent. *Periodic watercourse.*

Source: Geological Map of Algeria. ASGA – UNESCO, 1963. Modified by ERM, 2015

4.2.5.1.2 Sub-regional context: Berkine Basin

The Saharan Platform comprises a series of sedimentary basins. The Study Area is located in the Berkine Basin, in the westernmost extension of the larger Ghadames Basin. The Ghadames Basin, covers approximately 350,000 km^2 of eastern Algeria and parts of Tunisia and Libya and contains over 6,000 metres of Palaeozoic and Mesozoic siliciclastic-dominated sediments (Echikh, 1998).

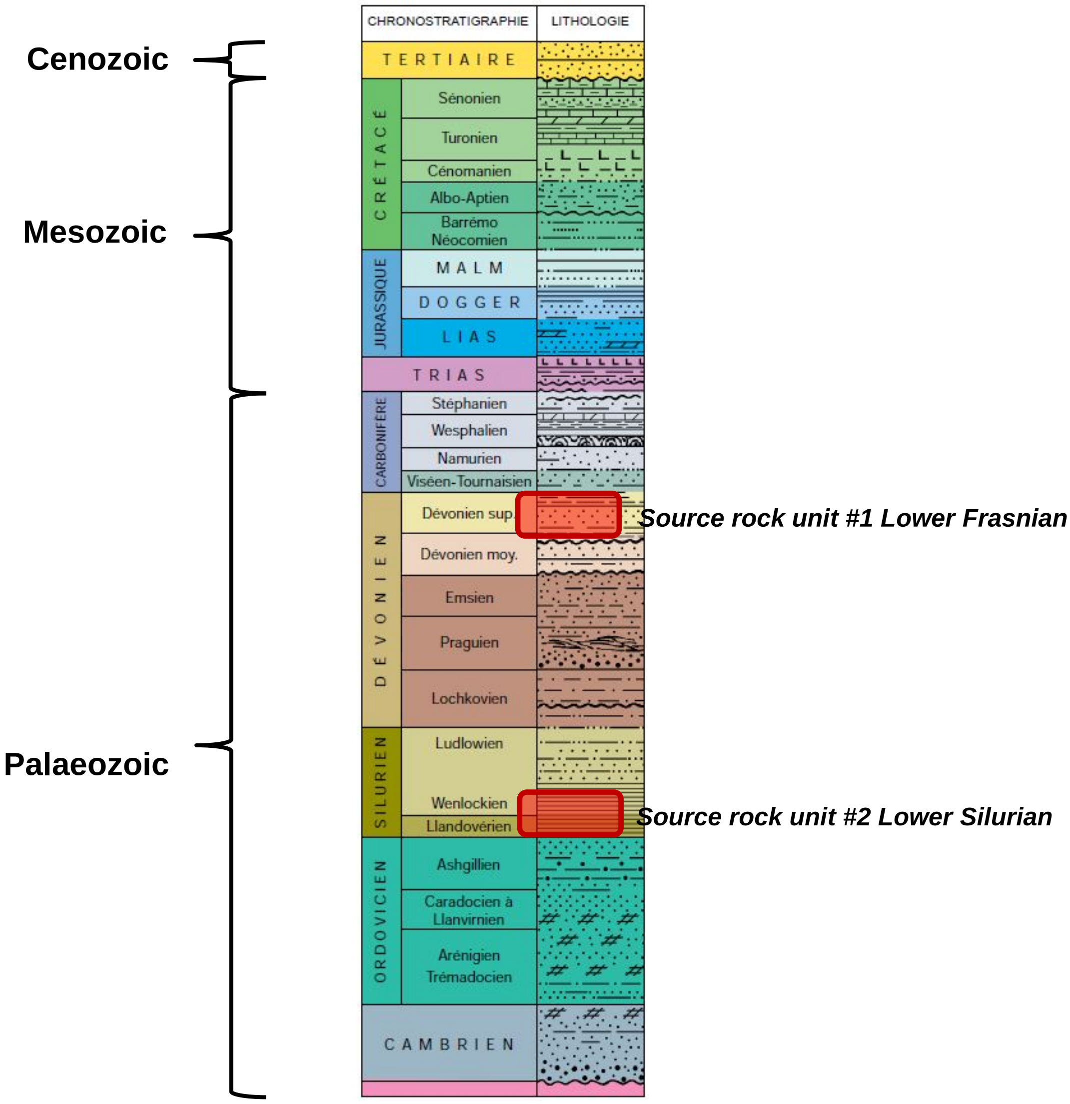
The Berkine Basin covers approximately 100,000 km^2.

4.2.5.1.3 Stratigraphy

Three different stratigraphies can be distinguished within the Saharan Platform, based on several factors including: formation thickness (1,000 to 8,000 m), lithology, tectonic deformation and subsidence. These stratigraphies are known as the Western province, Eastern province, and Triassic province.

The Study Area is located in the Eastern province, also known as the East Algerian Syncline. Figure 4.8 shows a stratigraphic column for the Eastern province.. The thin and discontinuous Quaternary deposits constitute the final phase of sedimentation.

Figure 4.8 Geological features within the Study Area



Source: Askri et al., 1995. Modified by ERM, 2015

The Ghadames Basin is a depression filled by sediments up to 6,000 m thick. Its Mesozoic formations are characterised by a thick succession of salts and anhydrites deposited in the northern and north-eastern parts of the basin.

4.2.5.1.4 Source rocks

The principal source rock units recognised within the different formations and which are capable of producing hydrocarbons in the Study Area are the following:

- Lower Silurian.
- Lower Frasnian.

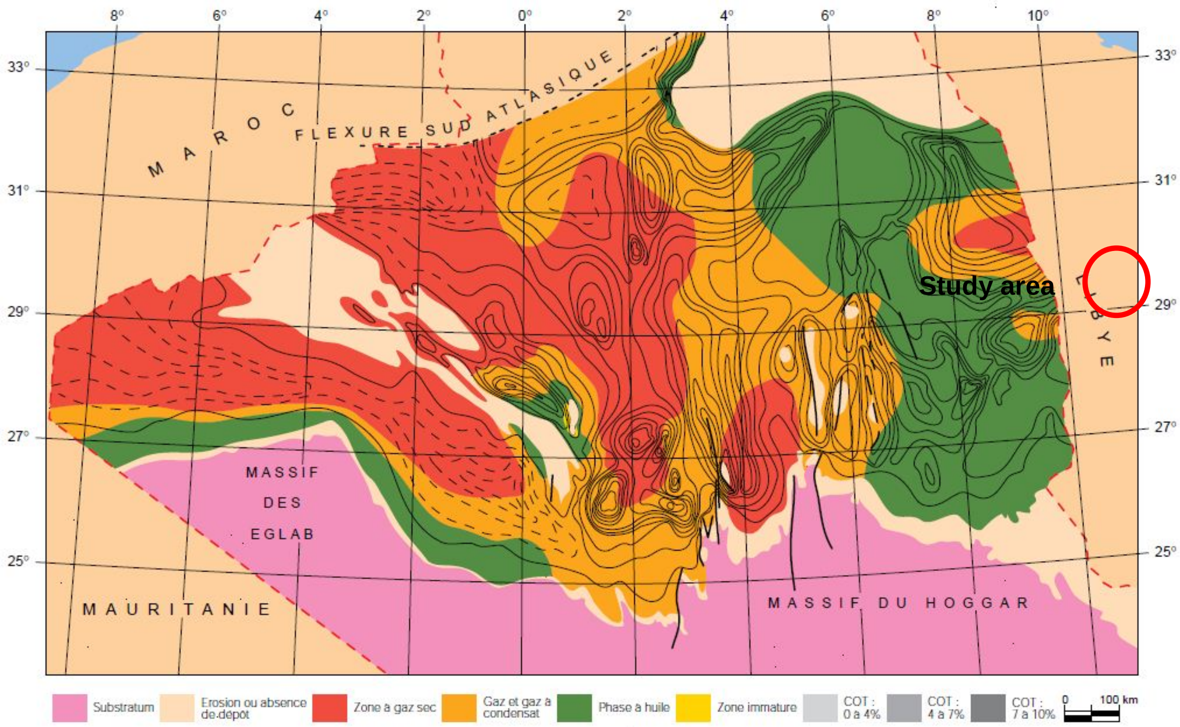
The **Lower Silurian** rocks comprise grey to black clays that are radioactive at the base. The distribution of this formation is shown in Figure 4.9. It can be seen that the Study Area is located in a region where condensate, gas (orange) and oil (green) are expected to be present associated to the Lower Silurian formation.

Radioactivity is mainly due to a high uranium concentration.

Thicknesses vary from 10 m to 100 m with the maximums located in the basins of Ahnet, Ghadames (where the Study Area is located), Illizi, Oued Mya, Mouydir, to the north of Timimoun Basin (Guern El Mor troighh) and in the Benoud and Sbaa troughs.

The total organic carbon (TOC) varies from 1 to 11% but reaches 20% in some cases. In the Study Area the TOC ranges between 0 and 4 %. The organic matter is of marine origin. The resulting source rock is of excellent quality and its hydrocarbon potential is often in excess of 60 kg hydrocarbon/t,.

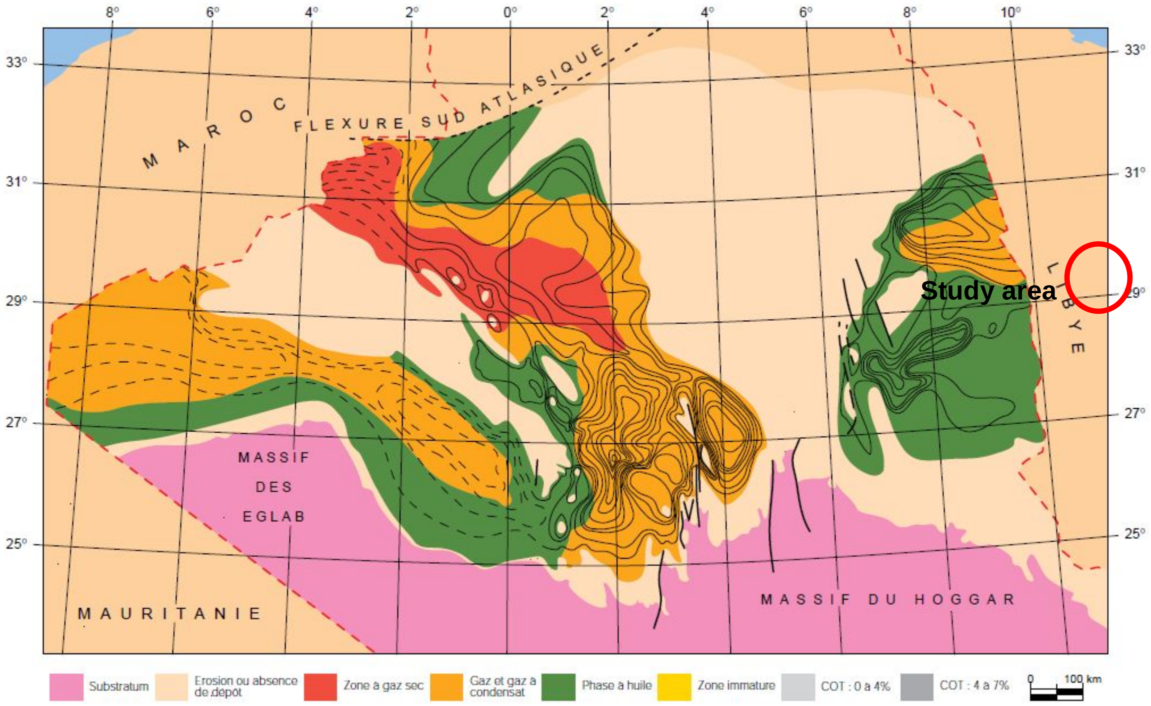
Figure 4.9 Distribution of Lower Silurian formation



Source: Askri et al., 1995. Modified by ERM, 2015

The **Lower Frasnian** formation resulted from a relatively calm period marked by a marine transgression over most of the Saharan Platform,.The distribution of this formation is shown in Figure 4.10.

Figure 4.10 Distribution of the Lower Silurian formation



Source: Askri et al., 1995. Modified by ERM, 2015

The Lower Frasnian formation has thicknesses varying from 10 m to 240 m, with the Ghadames basin being in excess of 100 m.

The Study Area is located in a region where condensate and gas (orange) and oil (green) are expected to be present in the Lower Frasnian formation. Total Organic Carbon (TOC) in the Lower Frasnian formation reaches some 10% with a potential of 52 kg hydrocarbon/ton.

The Lower Frasnian, like the Lower Silurian, comprises grey and black radioactive organic clays.

4.2.5.2 Tectonics and Seismicity

4.2.5.2.1 Seismicity

Northern Algeria is one of the most seismically active areas in the Mediterranean Basin, as a result of the collision between the African and Eurasian plates. The seismically active area occurs along the plate boundary zone which is located in the Tell Atlas of Algeria. The Study Area is located further south in an area with no significant seismic activity.

4.2.5.3 Naturally Occurring Radioactive Material (NORM)

Naturally occurring radioactive material (NORM) are readioactive materials naturally occurring in geological formations. NORM found in oil and gas operations is mainly caused by radium-226 and radium-228, daughter products of uranium-238 and thorium-232, which accumulate in barite scale.

The radium isotopes are soluble in brine and can be transported to the surface by produced water. Once they reach the surface, where the pressure and temperature drop, the isotopes can precipitate as scale in the production and processing equipment.

In order to gather information about presence of NORM materials in the target geological formation in the Study Area, samples must be taken from the geological formation itself for analysis.

4.2.6 Geomorphology and Topography

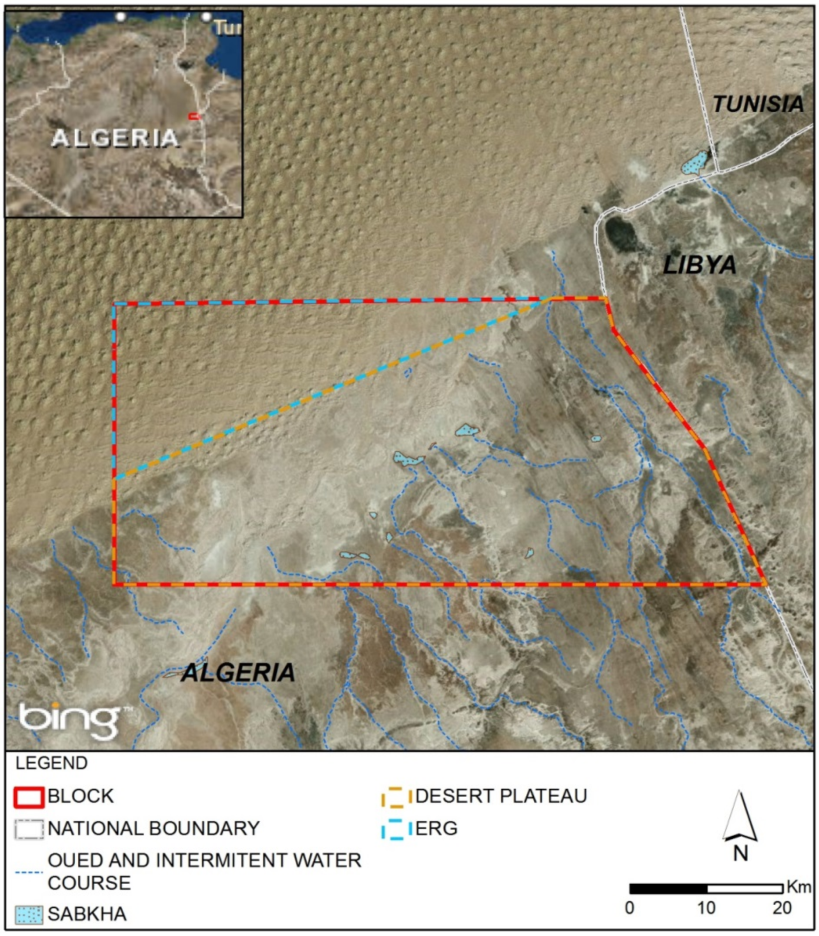
4.2.6.1 Geomorphology

The Sahara is the largest desert in the world and occupies approximately 10% of the African continent. The typical geomorphological features occurring in hot desserts include regs, ergs, hamadas, oueds[1], inselbergs, pediments, piedmont plains, and alluvial fans.

The Sahara consists primarily of several basins mostly isolated from the sea and lacking outward drainage.

Figure 4.11 shows the geomorphological elements specifically located in the Study Area, identified through satellite image analysis. It can be seen that there are two main geomorphological elements: the erg and the desert plateau, or hamada.

Figure 4.11 Geomorphological elements



Source: ERM, 2015

[1] Another term for “oued” is “wadi”. Both terms are synonyms, but the term “oued” is more frequent in Algeria.

4.2.6.1.1 Erg

The ergs (Arabic name for dune fields), or sand seas, are bodies of dunes of various sizes and shapes, ranging from the small crescent shaped and very mobile barkhans, to the huge fixed ghourds 50 to 200 m high, with the intermediate elb and silk.

The erg in the Study Area is part of the Great Eastern Erg (Grand Erg Oriental) that covers an approximate surface area of 1,200 km^2 in Algeria and Tunisia. It represents an approximate surface of 20% of the total Study Area surface, located in the north-west of the Study Area,.

Three main areas can be differentiated from the northwest corner to the centre of the Study Area:

- High and star dunes: in the northwest corner of the Study Area there is a higher density of dunes (high and star dunes). These landforms are characterised by arms that radiate out from a central pyramid-shaped mound. Star dunes grow upward instead of outward and are a result of multidirectional winds; they are among the tallest sand dunes.
- Linear dunes: these dunes are more separated and are not as high as the high and star dunes in the northwest corner. In the Study Area, the linear dunes are oriented west to east.

4.2.6.1.2 Desert Plateau

The desert plateau (also referred to as hamada) is a more or less flat structural surface covered by large flags of limestone, sandstone or basalt. They form rocky plateaus covered by irregular-sized, unequal rock fragments weathered out of the underlying parent rock. Hamadas have very little or no soil, because any fine particles formed during the weathering process are removed by deflation.

The hamada is the dominant geomorphological element in the Study Area. representing approximately 80% of the total Study Area). It is found across most of the Study Area, with the exception of the northwest, where the erg is located. The Hamada is locally referred as “Plateau of Tinrhert” or “Tinrhert Hamada”.

Some views of the hamada in the Study Area are shown in Figure 4.12.

Figure 4.12 Detailed view of the hamada in the Study Area

Source: BEXAM, 2015

The desert plateau or hamada is an area characterised by the heterogeneity of geomorphological elements on a very small scale. The following geomorphological features can be present in the Study Area:

- Regs: desert pavement areas covered by gravel and small stones coated with black-brown desert varnish (desert patina). These are the most typical landforms of hot deserts, and make up about 80% of the surface of the Sahara. A view of a typical reg is shown in Figure 4.13.

Figure 4.13 Detailed view of a reg in the Study Area

Source: BEXAM, 2015

- Sabkhas and dayas are differentiated based on the presence or absence of salts,.
    - Sabkhas: saline depressions, also called chotts. These are areas where temporal or permanent surface water storage takes place. They are closed endorheic depressions, with no natural drainage. During the field survey, sabkhas were observed in Wadi Oun Ahmed (ST 25), at Hassi Moulay (ST 30). Near the Study Area (ST2-2), is the Sabkha of Fort Saint, which is located to the NE of the triple border between Algeria, Tunisia and Libya, continuing along the edge of the Tunisian territory and covering an area of 20 ha, with permanent surface water (with a depth up to 8 m). Views of sabkhas in the Study Area are shown in Figure 4.14.

Figure 4.14 Detailed view of sabhkas in the Study Area

Source: BEXAM, 2015

-
    - Dayas: non-saline depressions. Dayas were not observed in the Study Area during the field survey, although they could be present in the proximity of the Study Area.

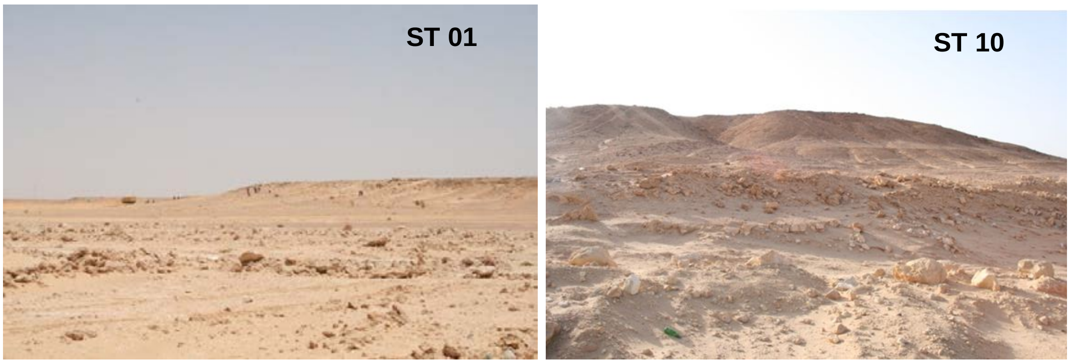
- Oueds (also referred to as wadis): river beds or valleys with ephemeral streams in desert areas. Oueds carry water during floods, which may be torrential and occur at irregular intervals. They usually have steep sides as a result of lateral flood erosion. Large oueds have broad flat beds covered by sand and/or gravel and rock fragments. During the field survey two main oueds were found: Wadi Meriksene and Oued Timeroualine. Both receive rain waters and occupy a considerable area. A view of the oueds is included in Figure 4.15 (ST-9 corresponds to the Wadi Meriksene. Oued Timeroualine was not visited). Further information about oueds is included in Section 4.2.8.

Figure 4.15 Detailed view of oueds in the Study Area

Source: BEXAM, 2015

- Escarpments: cliffs associated with rocky areas, generated by the faulting or fracturing of the rocky surface in areas with steep slopes. These are locally referred to as “garats”. A view of an escarpment is included in Figure 4.16.

Figure 4.16 Detailed view of an escarpment in the Study Area



Source: BEXAM, 2015

As detailed in the explanations above, during the field survey, geomorphological observations were made at the visited sites , whenever relevant. Annex C.5 summarises the main geomorphological observations. These locations are detailed in the field survey map (see Annex C1).

4.2.6.2 Topography

The altitude in the Study Area varies from 280 – 420 m above sea level. The highest areas are located in southeast. The gradient is very gentle, averaging some 0.25% between the lowest and highest elevations.

However, in the sand dune area, local slopes may be as much as 25º-30º, with changes in relief of up to 100 m, associated with the highest dunes. The dunes themselves can reach altitudes of 400 m above sea level.

4.2.7 Soils

The extreme climatic conditions in the Sahara Desert and the severe drought do not allow true soil forming activity, and only weakly developed soils are present, with very little organic matter.

The following types of soils are found in the Study Area:

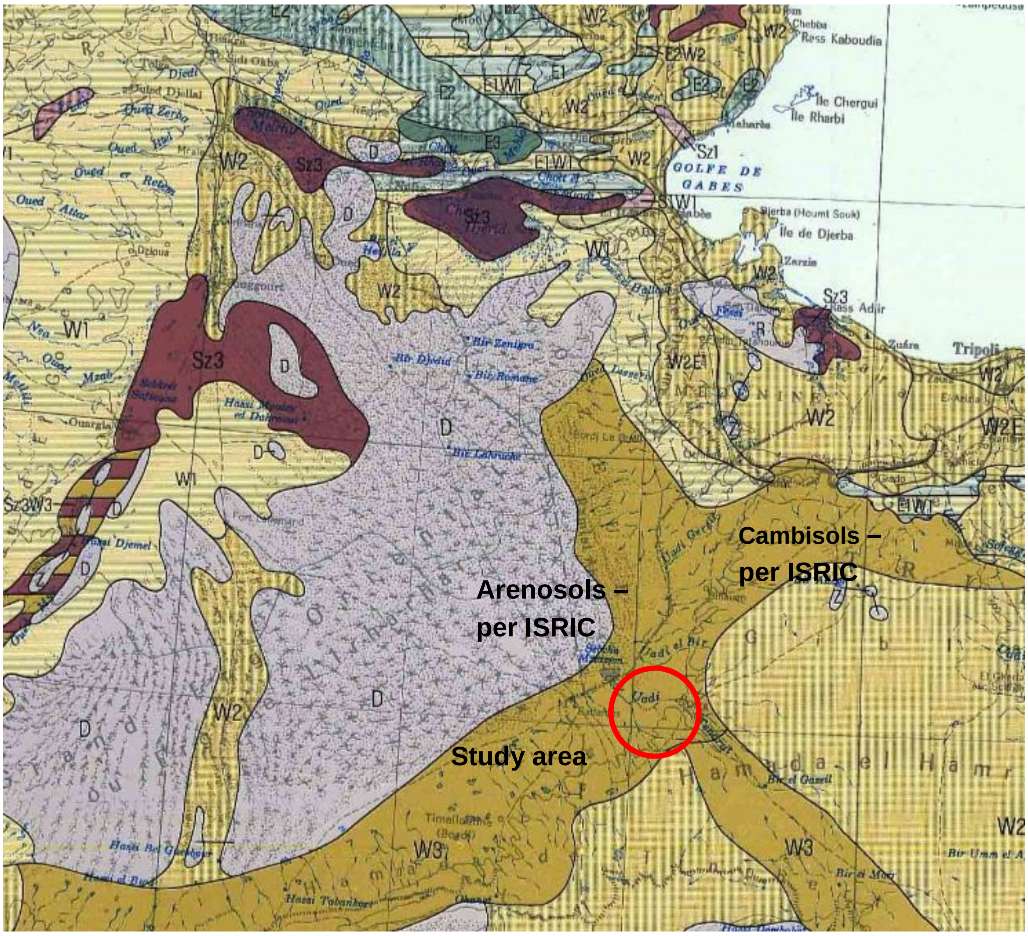
- Arenosols: sandy soils, formed in situ from the weathering of old, usually quartz-rich soil material or parent rock, and soils developed in recently deposited sands, such as occurs in deserts and on beaches. Their distribution is associated to erg distribution (Section 4.2.6.1.1).

- Cambisols substrate with incipient soil formation. Weak, mostly brownish discolouration and/or the formation of structure below the surface horizon evidences the start of soil formation. Their distribution is associated to hamada distribution (Section 4.2.6.1.2).

Soils types are directly related to soil degradation risk. Figure 4.17 shows the degradation risks of the soils present in the Study Area. Two different types of soil degradation risks are present in the Study Area:

- D: dunes, where no soil degradation risks are defined. The distribution of the dunes corresponds to the arenosol distribution.
- W3: where the risk of soil degradation resulting from wind erosion is very high (> 200 ton/ha/year). This distribution corresponds to the cambisol distribution.

Figure 4.17 Map of soils in North Africa

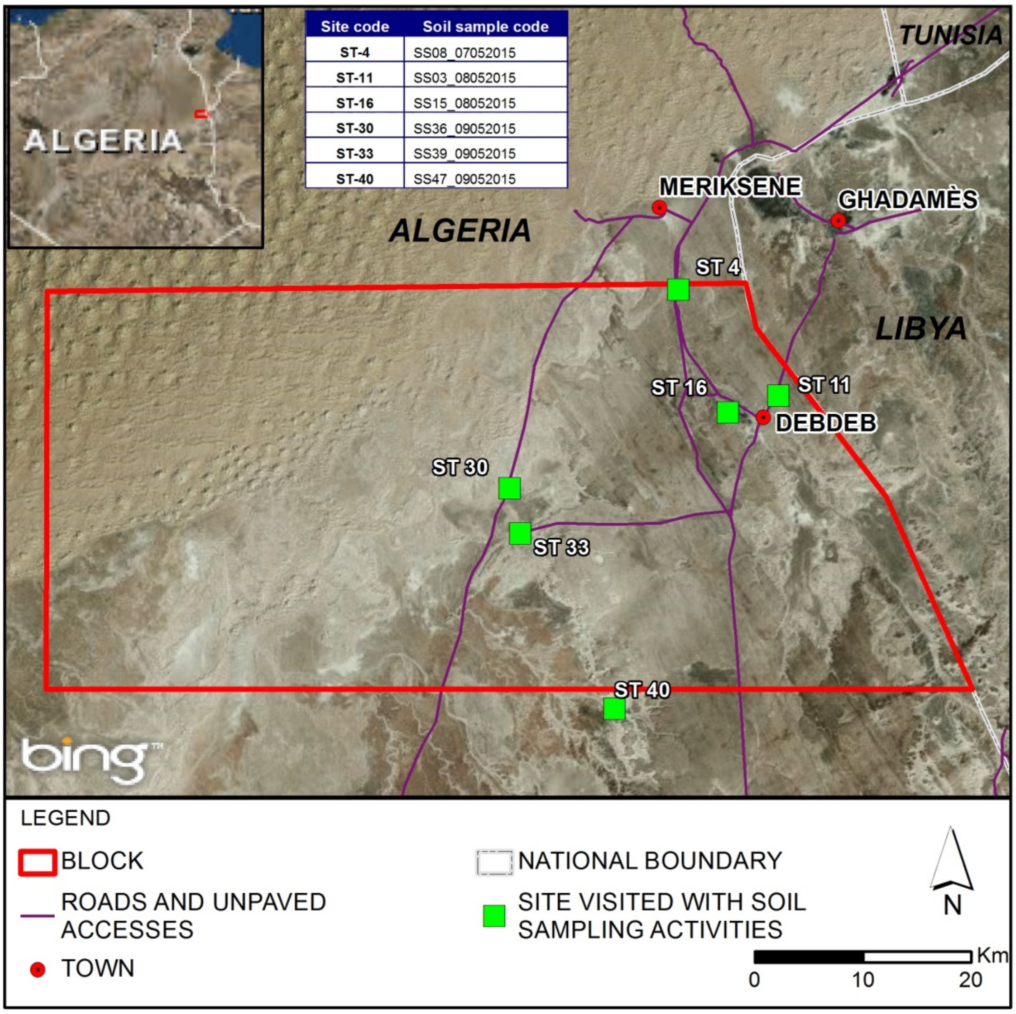


Source: Provisional Map of Soil Degradation Risks. Northwest Africa. FAO, UNEP & UNESCO, 1980

During the field survey, soil and lithological observations were made at the sites visited, when relevant. Annex C.6 summarises the main soil and lithological observations. Sites visted during the field surveywhere soil and lithology descriptions were taken, are included in the field survey map (see Annex C.1).

In addition to the above observations, soil sampling was carried out during the field survey in order to characterise the baseline conditions in the Study Area.
Analytical results of soil samples are included in Annex C.3. Soil sampling locations are shown in Figure 4.18.

Figure 4.18 Soil sampling locations



Source: ERM, 2015

Figure 4.19 shows the soil sampling activities undertaken during the field survey.

Figure 4.19 View of soil sampling activities during the field survey

Source: BEXAM, 2015

4.2.8 *Hydrology*

Rainfall in the Study Area is scarce and there are no permanent surface water bodies. Only oueds can be described as surface water features, although they are ephemeral stream beds, and water is only present after heavy rainfall (i.e.sudden but brief storms can trigger surface flows).

During the field survey, the presence of oueds was recorded at the sites visited, whenever relevant. Table 4.4 summarises the sites where oueds were observed and their characteristics.

Table 4.4 Observation of oueds in the field survey

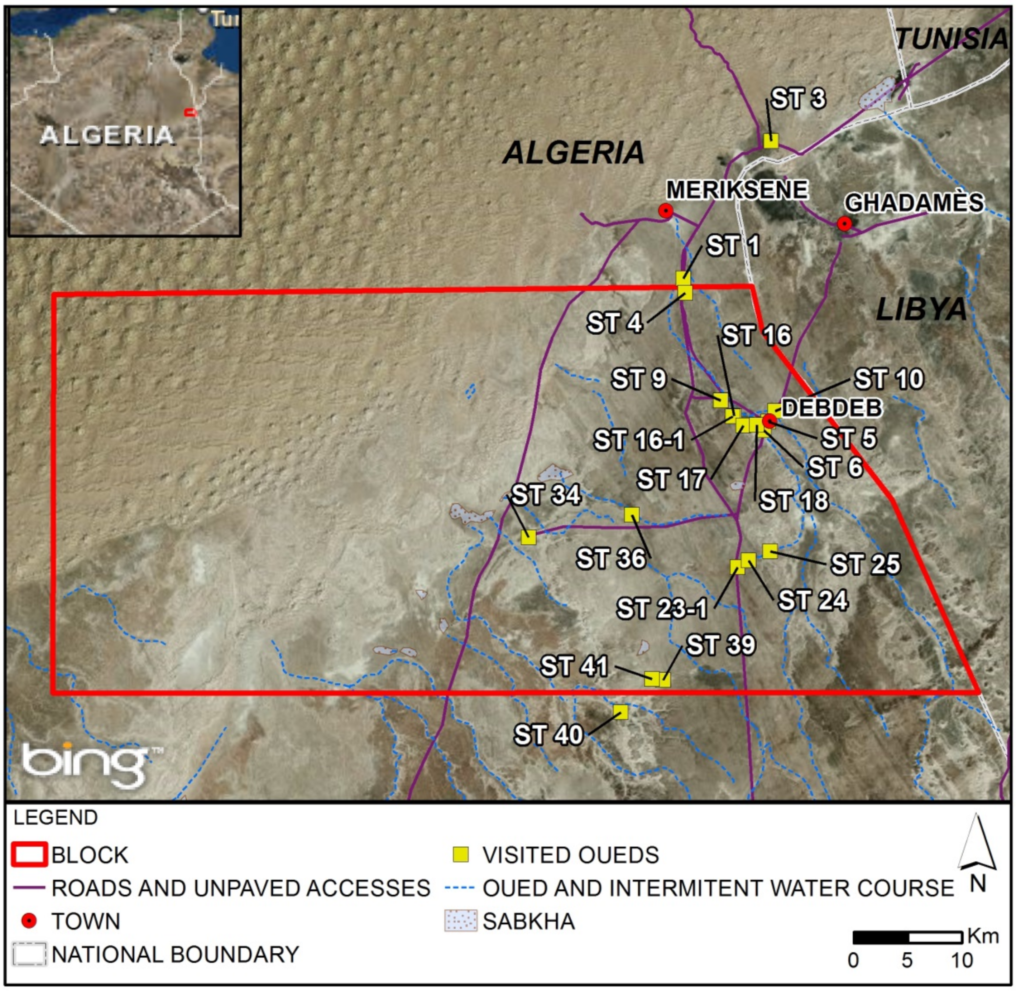
Site code	Characteristics	Site code	Characteristics
ST-1	Dry oued along the road	ST-18	Oued
ST-3	Little shallow oued	ST-23-1	Oued
ST-4	Little shallow oued that leads to anan artesian well	ST-24	Oued
ST-5	Oued crossing the city	ST-25	Oued
ST-6	Dry oued along the road	ST-34	Oued
ST-9	Oued	ST-36	Oued
ST-10	Fine oued alluvial	ST-39	Oued
ST-16	Oued	ST-40	Oued
ST-16-1	Oued	ST-41	Oued crossing the hamada
ST-17	Oued		

Source: BEXAM, 2015

Oueds in the Study Area are shown in Figure 4.20. Oueds are found within the desert plateau or hamadas. No oueds are found in the sand dune area (*Grand Erg Oriental*). The oueds are oriented southeast – northwest, towards the Grand Erg Oriental, following the relief in the area, which topographically decreases about 120 m along a distance of approximately 80 km within the Study Area (from the southeast corner to the sand dunes in SE-NW direction). Further information about oueds is included in Section 4.2.6.1.

Oueds typically terminate in low lying areas giving rise to evaporite-rich pans (indicated as “evaporites”). The oueds and pans support some sparse vegetation. Some photographs of oueds in the Study Area taken during the field survey are shown in Figure 4.15 (see Section 4.2.6.1).

Figure 4.20 Hydrological features within the Study Area



Source: ERM, 2015

4.2.9 Hydrogeology

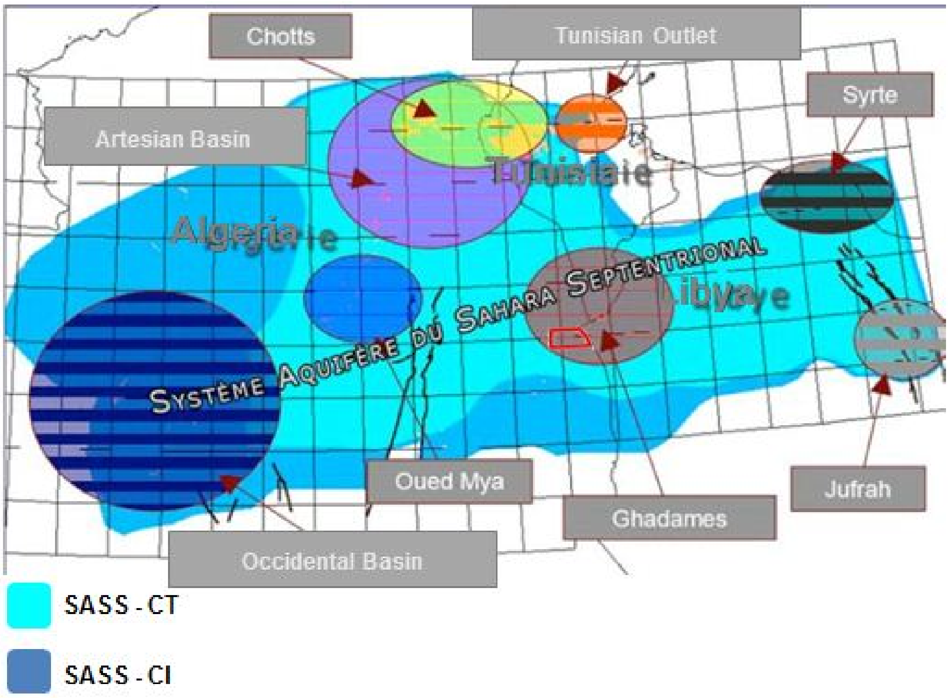
The most significant groundwater resource in the Ghadames basin (where the Study Area is located) is the SASS (*Système d'Aquifères du Sahara Septentrional*). This is a large aquifer system that extends over an area of more than 1,000,000 km^2, comprising approximately 700,000 m^2 in Algeria, 80,000 m^2 in Tunisia and 250,000 m^2 in Libya.

The SASS is a multi-layer aquifer found in Mio-Pliocene through to Triassic formations, although its vertical thickness varies across its geographical extent. It is principally comprised of three overlapping aquifers (from top to bottom):

- The Terminal Complex (CT, from the French name Complexe Terminal).
- The Turonian aquifer.
- The Continental Intercalaire (CI).

A recent study from the OSS (*Observatoire du Sahara et du Sahel* – Sahara and Sahel Observatory) proposed a hydrogeological zoning of the SASS by basins, as shown in Figure 4.21. The Study Area is located within the Ghadames Basin, which extends across parts of Algeria, Tunisia and Libya.

Figure 4.21 Location of monitoring wells (CI aquifer system) in the Study Area



Source: OSS, 2003 (modified by Sappa & Rossi, 2010)

Note: Principal basins within the overall extent of the SASS and their common name are shown in the grey highlighted boxes.

The Ghadames Basin is one of the primary sedimentary basins in the region. It is a wide synclinal basin and its lithology is comprised of two distinct deposits. The upper part, extending to the base of the Upper Cretaceous, is composed of limestone, dolomites, dolomitic limestone, marl and argillaceous sediments with some thin sandy, shaley, silty and gypsiferous beds (El Baruni, 2000). Some of these layers are frequently fractured and cavernous. These formations comprise the CT and Turonian aquifers. The second, deeper part of the lithology (from the Lower Cretaceous downward) is comprised of thick layers of granular sediments including Mesozoic and Palaeozoic sandstones with interbedded shale, clay and silt. Thin layers of limestone and gypsum (Triassic and Jurassic) are also present. The Lower Cretaceous-Jurassic-Triassic formations constitute the CI aquifer system.

In addition to the SASS there are two other aquifers systems found within the Ghadames Basin:

- Shallower aquifers, found primarily in Quaternary deposits. These are of lesser significance, in comparison with the SASS, due to their limited extent within the Ghadames Basin and their lower quality.
- Deeper aquifers than the SASS, represented by the Palaeozoic formations. These are also of lesser significance, in comparison with the SASS due to their depth within the Ghadames Basin.

Further detailed information about these aquifers (SASS, shallow aquifers and Palaeozoic formations) is included in the Annex D.4 - Water Management Plan.

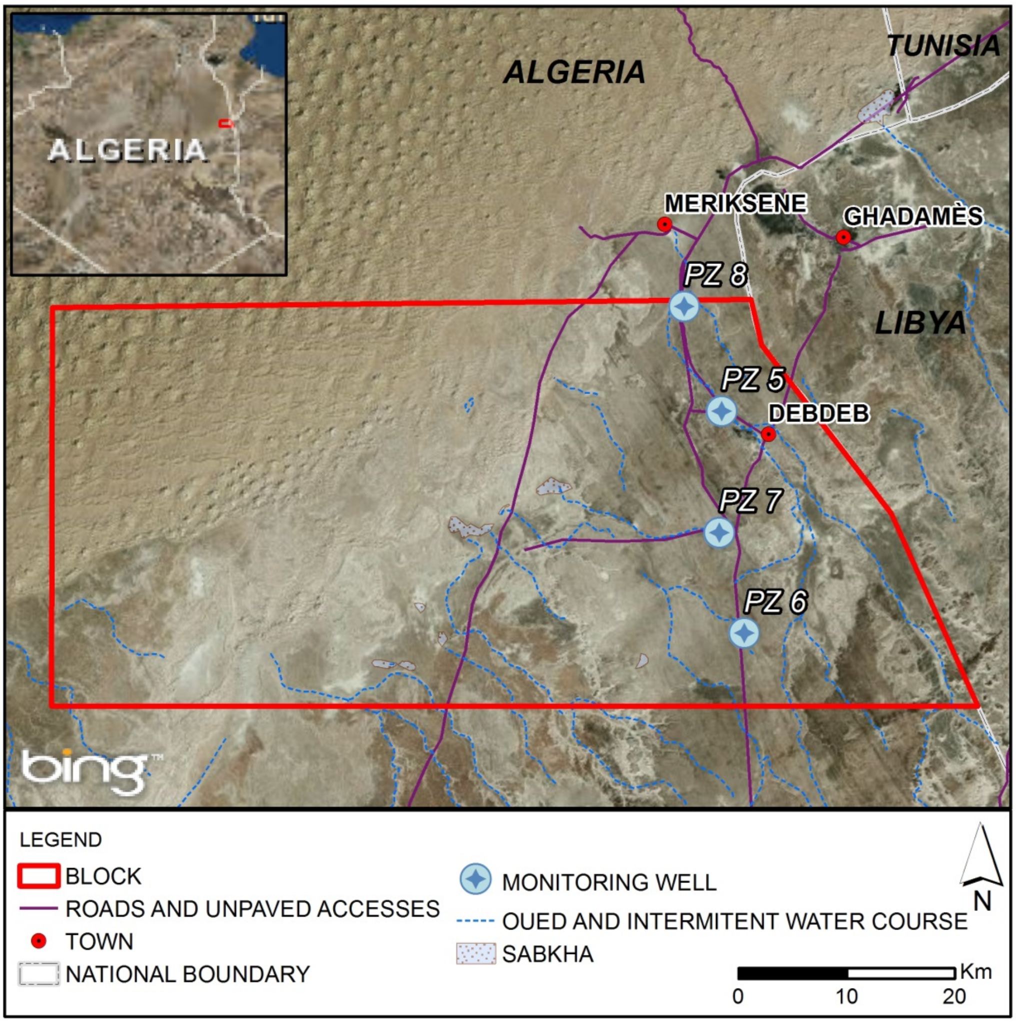
The primary aquifers being used in the Debded area are the Continental Intercalaire (CI) aquifer system – Albian and Barremian formations – and to a lesser extent, the Turonian aquifer. Drinking water is supplied specifically from the CI aquifer system (DHW of Illizi Wilaya).

In addition to the water wells included in the DHW inventory, a group of monitoring wells were installed by the ANRH[2] in 2004-2005 to measure the evolution of the water level in the CI aquifer system. A total of 8 monitoring wells were

[2] *Agence Nationale des Ressources Hydrauliques* (Hydraulique Resources National Agency)

installed along the border with Libya and Tunisia, spaced approximately 50 km apart. Four of these wells are located within the Study Area, as shown in Figure 4.22.

Figure 4.22 Location of monitoring wells (CI aquifer system) in the Study Area



Source: ERM, 2015

The main characteristics of the 4 wells are included in Table 4.5. The information available on the dry residue (roughly equivalent to salinity) shows that the salinity is above the maximum salinity concentration defined by the WHO for potable water (1.5 g/l).

Table 4.5 Monitoring wells (CI aquifer system) in the Study Area

Monitoring well	Well depth (m)	Water level (m)	Dry residue (g/l)
PZ-5	782	333.8	5.8
PZ-6	800	341.91	6.0
PZ-7	750	335.85	5.6
PZ-8	808	337	5.9

Source: BEXAM, 2015

Several shallow (<30 m), hand-dug wells were also identified during the field survey. These wells were not included in the DHW well inventory and they are reportedly used only for livestock (principally camels) and to a lesser extent for irrigation.

Groundwater sampling was carried out during the field survey in order to characterise the baseline conditions in the Study Area. Samples were collected from four of the shallow, hand-dug wells identified. Samples could not be collected from the deeper wells identified because of access issues. Table 4.6 shows the samples collected during the field survey.

Table 4.6 Groundwater samples collected in the field survey

Site code	Groundwater sample code	Description
ST-4	WELL8_07052015	Artesian well. Groundwater from the CI aquifer system. Water level at 1.7 m above ground level.
ST-19	WELL24_08052015	Irrigation well. Water level at 3.5 m depth.
ST-31	WELL37_09052015	Traditional well. Energy to the well is supplied by solar energy. Level of water could not be measured, since the well was being pumped at the moment of the site visit.
ST-40	WELL47_09052015	Traditional well.

Source: BEXAM, 2015

The analytical results for the water samples are included in Annex C.4.

Other wells observed during the field survey are included in Table 4.7.

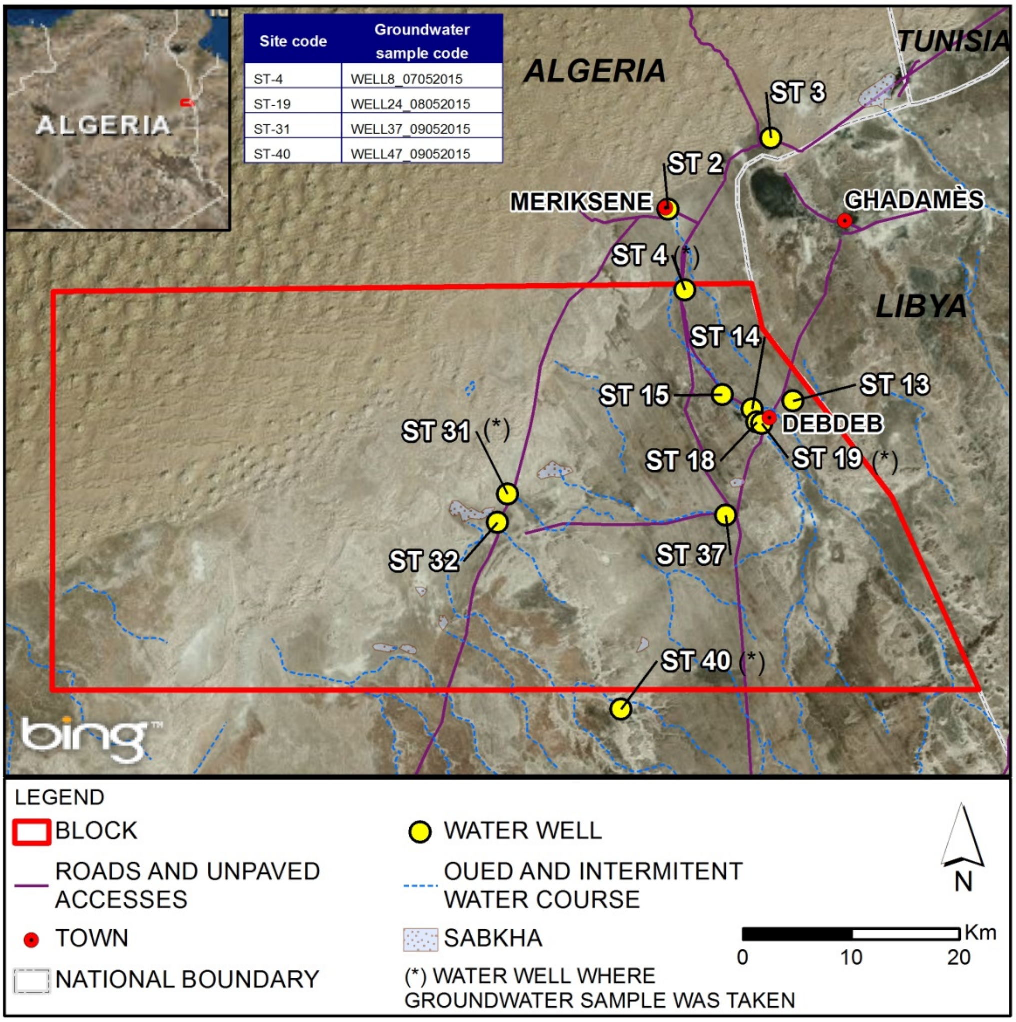
Table 4.7 Other wells observed during the field survey

Site code	Description
ST-2	Well extracting water from the CI aquifer system. Well depth is 600 m. The water level is connected to a water tower and to the village of Meriksene.
ST-3	Well extracting water from the CI aquifer system. Artesian well. Water level at 1.55 m depth. Groundwater flow: 3 l/s.
ST-13	Well not accessible.
ST-14	Well depth is 750 m.
ST-15	Artesian well. Water level at 0.7 m above ground level.
ST-18	Irrigation well.
ST-32	Closed well.
ST-37	Well.

Source: BEXAM, 2015

The locations of the wells described in Table 4.6 and Table 4.7 are shown in Figure 4.23. Water wells visited during the field survey are included in the field survey map (see Annex C.1).

Figure 4.23 Water wells visited during the field survey



Source: ERM, 2015

Figure 4.24 shows groundwater sampling activities during the field survey.

Figure 4.24 View of water sampling activities during the field survey

Source: BEXAM, 2015

4.3 Biological environment

4.3.1 Introduction

This section provides an overview of the main biological conditions (habitats, flora, fauna, and protected areas) existing within the Study Area (Timissit Permit). The data provided in this chapter has been obtained from available Algerian and international literature, as well as from the results of the field survey, which included several meetings with relevant regional and local authorities (see Section 1) and ground truthing/visit the Block.

4.3.2 Overview of the Ecology of the Study Area- Regional Context

The Study Area falls within a transition zone dominated by the presence of a desert plateau in the south and the Grand Erg Oriental in the north (a massive sand dune that extends over a large proportion of the Algerian Sahara, from the city of Ouargla in the west, to Tunisia and Libya in the east).

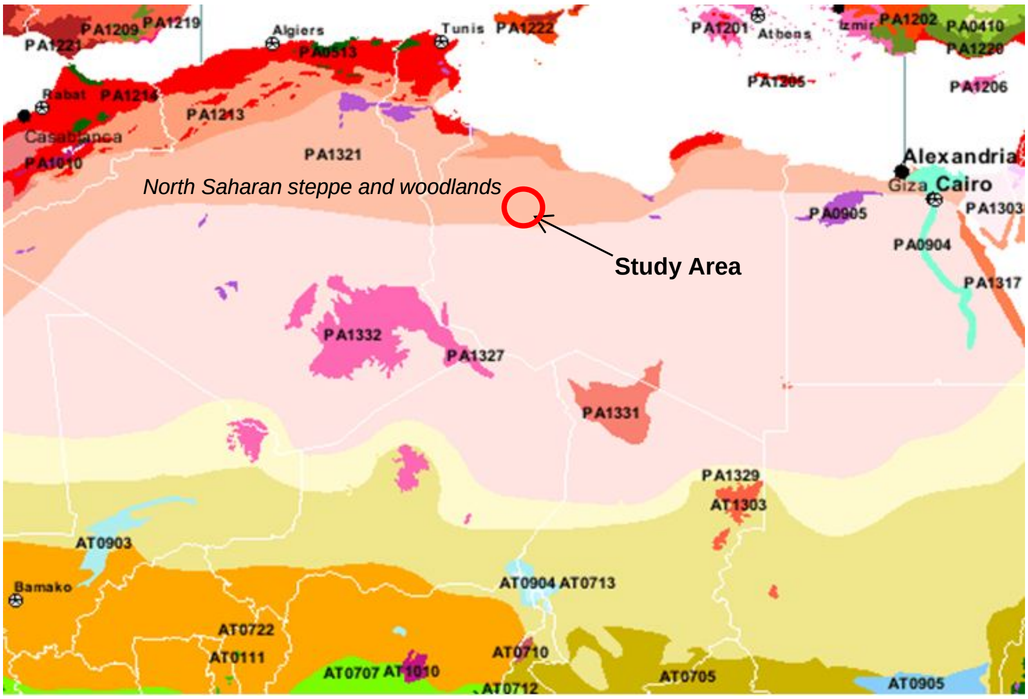
This region is characterised by a year-round water deficit, as rainfall is very scarce and irregular. As a result dry periods may extend over several months, or even years, with the associated evapotranspiration (Quinn, 2009) influencing the ecological communities by reducing the already scarce water resources.

According to the ecoregion map of northern Africa (see *Figure 4.2)*, the Study Area is located within the Desert Palearctic Ecoregion *PA1321 – North Saharan steppe and woodlands* and is part of the *Deserts and xeric shrublands biome.* The Study Area is actually located in the southernmost zone of this ecoregion and thus has a very strong desert component.

The Desert Palearctic Ecoregion extends across northern Africa and covers parts of Western Sahara, Mauritania, Morocco, Algeria, Tunisia, Libya, and Egypt. White (1983) defined the ecoregion as having 'regs, hamadas and oueds' and 'desert dunes with perennial vegetation'. Although these vegetation types cover the entire Sahara, the northern and southern habitats were delineated as distinct ecoregions due to distinct rainfall regimes and the presence of certain Mediterranean plant and vertebrate species in the north.

The floral diversity in the Sahara desert has been estimated to include only 500 species (Le Houérou, 1990) . Considering this figure and the huge extent of the Sahara, it can be considered a poor ecosystem (Ozenda, 1977) with very low diversity. It includes endemic species of both plants and animals, making it somewhat distinct from other Saharan ecoregions where endemism is very low.

Figure 4.25 Ecoregions of the Northern Africa and Study Area



Source: World Wildlife Fund (WWF), 2013. Northern Africa. Modified by ERM, 2015.

Note*: PA1321 is defined as the North Saharan steppe and woodlands ecoregion (http://worldwildlife.org/ecoregions/pa1321).

Given the harsh conditions imposed by the scarce rainfall, the species living in this desert environment need to be highly specialised for survival in these extreme hot and dry conditions. Plants tend to concentrate where the water availability and air humidity is higher, often clumped together. This is particularly true for shrubs with long life cycles that tend to concentrate in depressions such as oueds, sabkhas and dayas. Annual species such as grasses (mainly species of Graminidae) are, in contrast, able to occupy wider areas because they have much shorter life cycles and appear whenever the conditions are temporarily favourable (typically after periods of rain).

Animal species in desert environments generally rely on plants as sources of food (directly and indirectly), shade, water, and so on. Due to the relative scarcity of such resources in the Saharan environment, plants function as ‘attractors’ where microfauna, in particular, concentrates. The presence of these insects and other small arthropods contributes to making areas with plants also key food resource locations for many macro faunal species, as they tend to be attracted to the places with more vegetation abundance in order to feed. As a result, the fauna often displays the same clumped distribution pattern as the flora.

Some animal species, mainly carnivorous and large herbivorous mammals, are adapted to travelling long distances to visit different vegetated areas in order to obtain the resources they need, the limited nature of which determines animal density in desert regions.

Typically, the vegetation in the *Desert Palearctic Ecoregion PA1321*, where the Study Area is located, is characterised by tall shrubs (Retamas, jujubes, etc.) and trees (acacias, tamarisks, etc.), encountered in the main depressions and major dune systems (WWF, 2013). Vegetation species expected to be found in the Study Area as well as those directly observed in the field, are described in *Section 4.3.4*

The fauna of the ecoregion where the Study Area is located is characterised by a number of Saharan endemic mammals that are very locally distributed in the dune systems. These are mainly small mammals and include some endangered species such as the four-toed jerboa (*Allactaga tetradactyla*), the Dorcas gazelle (*Gazella dorcas*), which is also endemic to the Sahara, the mountain gazelle (*Gazella cuvieri*) which is endemic to the northern Sahara and Maghreb areas, and the slender-horned gazelle (*Gazella leptoceros*) (Kingdon, 1997).

The diversity of reptiles is moderately high, with a low number of endemic species, such as the Desert agama, *Agama mutabilis,* and the Natterers gecko, *Tropiocolotes nattereri*. Amphibian diversity is very poor given the lack of water resources and humid areas and no species of particular interest are expected. A complete description of the fauna potentially found within the Study Area and that was observed, including their protection status, is provided in *Section 4.3.5*

4.3.3 General Habitats in the Study Area

4.3.3.1 Introduction

In the absence of a comprehensive habitat map for Algeria, the main geomorphological elements of the Study Area have been adopted as the basis for defining the main habitat types and their distribution. These elements have been defined on the basis of the available satellite imagery (ESRI Imagery, 2007 and Google Earth Pro, 2015) and features defined on the IGN[3] Maps (*Carte International du Monde 1:1.000.000 Hassi Messaoud, NH-32, 1964*) and groundtruthed during the field survey in the Study Area.

The geomorphological units and their combination within the Timissit Study Area define the various local environmental conditions (e.g., microclimate, presence of surface water, substrate type, etc.) and therefore, to some extent, they determine (or favour) the combination of plants and animals that are found within different places of the Study Area.

As shown in Figure 4.26 below, based on the specific geomorphological features and the most common combination of features, the Study Area can be divided into two main areas: the hamada or desert plateau, and the Grand Erg. Each comprises different habitats, in addition to the human environments associated to human settlements:

- **Hamada or Desert Plateau**
  - Hamadas, regs and desert pavements.
  - Depressions: Sabkhas and non-saline depressions.
  - Oueds.
  - Escarpments.

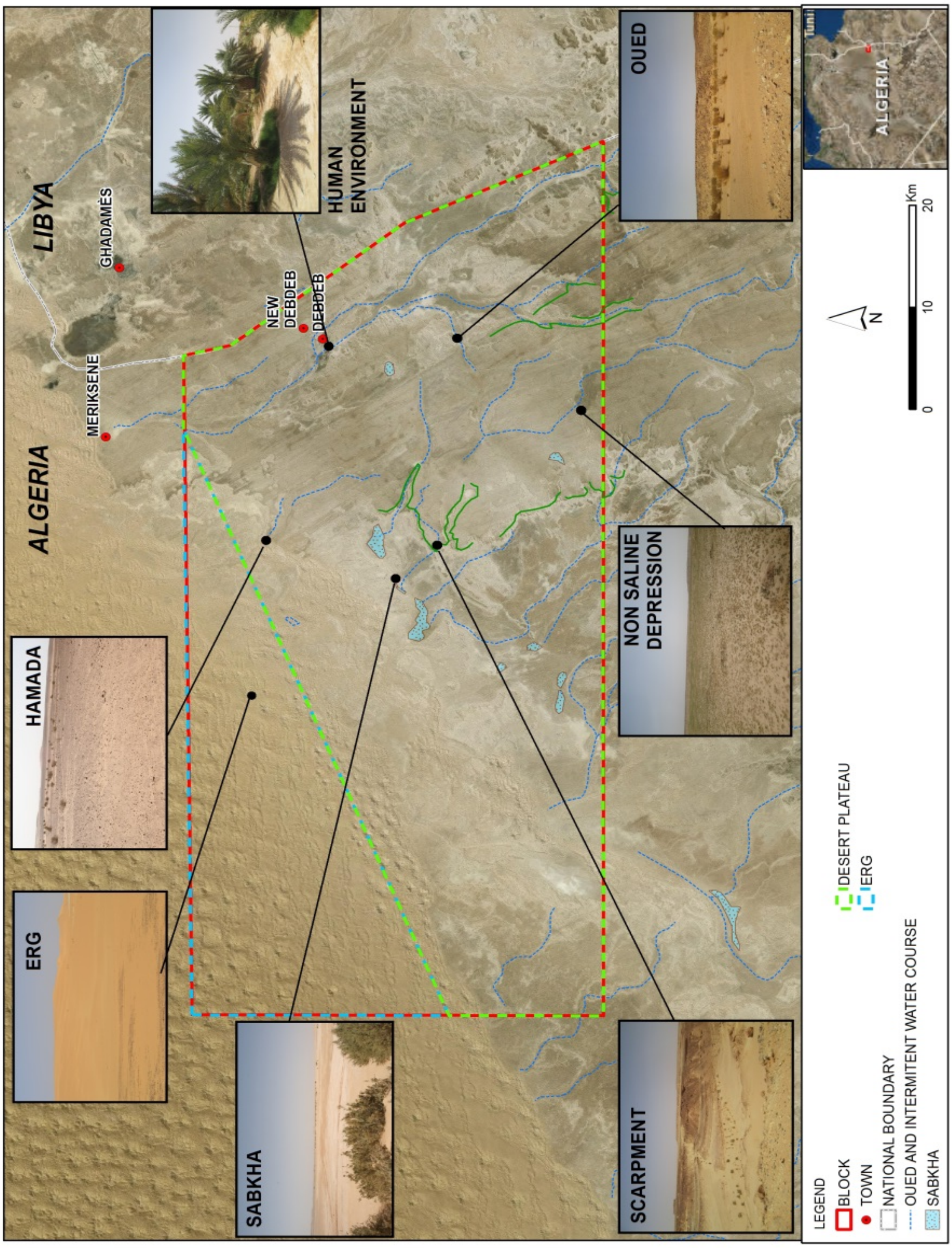
- **Ergs**
  - Sand dunes.
  - Interdune sand plains and depressions.

The field Survey performed in May 2015 (see Annex C.1 for the map showing field survey locations), in combination with the analysis of satellite images, has allowed to confirm that all the habitats listed above are present within the Study area. No other habitats have been recorded.

The hamada, or desert plateau, environments are predominant within the Study Area (75 % of the total surface of the Study Area approximately). The erg environments cover approximately 25 % of the Study Area and are localised in its northern zone. The combination of various habitats results in a relatively high diversity.

[3] *Institut National de l'information géographique et forestière, France.*

Figure 4.26 Distribution of extensive habitats in the Study Area: Hamada and erg



Source: ERM, 2015.

4.3.3.2 Hamada or Desert Plateau

The desert plateau in the Study Area, represented by the Tinrhert Plateau, or Hamada of Tinrhert, is located in the southernmost zone and constitutes the biggest portion of the Study Area (Figure 4.26). This geomorphological unit is mainly characterised by the absence of sand dunes and sand sheets, which leaves the desert plateau exposed revealing a variety of geomorphological elements, mainly dominated by the hamada (flat stony substrates) habitat.

Based on the analyses of the available satellite imagery (ESRI Imagery from 2007 and Google Earth Pro 2015) and the groundtruthing undertaken during the field survey, it has been confirmed that a number of other features are found within the hamada or desert plateau area. These include (1) small/local regs, (2) oueds, (3) escarpments, and (4) depressions (hosting sabkhas and non-saline depressions). These create varied local conditions in terms of substrate types and microhabitats within the hamada or desert plateau area.

A brief description of each of these environments is provided below.

4.3.3.2.1 Hamadas and regs

Regs and hamadas are generally flat, stony extensions with siliceous, calcareous or gypsum outcrops.

Regs are areas covered by desert pavement, gravel and small stones coated with black-brown desert varnish (desert patina). Hamadas are more or less flat structural surfaces covered by large flags of limestone, sandstone or basalt. They form a rocky plateau covered by irregular-sized, unequal rock fragments weathered out of the parent rock, on which they lie. Hamadas have very little or no soil, because the fine particles formed during the weathering process are removed by erosion (refer to *Section 2.5 Geomorphology and topography* for further details). In these areas rainfall flows rapidly off the surface towards depressions and oueds.

Within the Study Area, the hamada habitat covers a large proportion, and regs a minor portion, of the area. Examples of the typical desert pavement found are included in *Figure 4.27.*

During the field survey, 21 of the 42 stations visited, corresponded to a hamada environment. Most of them presented no vegetation cover at all and only within 10 hamada sites (ST-1, ST-11, ST-13, ST-21, ST-29, ST-32, ST-36, and ST-37. ST-39 and ST-41, see Annex C.1) flora species were recorded, including one station at the outskirts of Debdeb village.

The most representative flora species recorded within the hamada habitats are *Ammodaucus leucotrichis*, *Asteriscus pygmaeus*, *Ephedra alata ssp alenda*, *Helianthemun lippii*, *Retama raetam, Fagonia olivieri, Tamaris aphylla* and *Zygophyllum album*, all recorded in more than one hamada site.

Flora species diversity within the hamadas found in the Study Area is low, with less than 10 species, with the only exception of the hamada in the outskirts of Debdeb, probably due to the human influence and the associated water availability. In ST-36, ST-39 and ST-41, the species found were also associated to a small nearby oued or depressions rather than to the hamada.

The fauna associated with these hamadas and regs consists mainly of camels, dromedaries, hares, birds, and lizards. The only record of fauna within a hamada during the field survey was the presence of gazelle footprints at ST-39.

Only one reg was identified during the field survey, at ST-28 on the edge of the desert plateau and the Grand Erg Oriental. No fauna or flora was recorded at this site.

Figure 4.27 Examples of hamadas and regs found within the Study Area (ST-23 and ST-28)


Source: Bexam and ERM, 2015.

4.3.3.2.2 Oueds

Oueds (or wadis) are valleys with intermittent stream flow. Oueds typically carry water during floods, which may be torrential but ephemeral and occurring at irregular intervals. They often have steep-sided walls resulting from lateral flood erosion. The larger oueds have broad flat beds covered by sand and/or gravel and rock fragments. The size of the oueds is very variable and they range from small narrow incisions to very wide, long valleys (e.g., several kilometres). The term oued is also used for areas without ephemeral waters but which constitute elongated depressions or basins (refer to *Section 2.5 Geomorphology and Topography* for further details).

Oueds are one of the key geomorphological features in dry desert environments because they often support a good proportion of the vegetation present. As observed by satellite images and during the field survey, this is also the case of the Study Area. In addition to increased plant cover they also present higher biodiversity, supporting a larger number of floral species and faunal communities.

Within the Study Area there are several oueds along its southern part, over the desert plateau. No oueds have been identified in the Grand Erg. These oueds generally run from the southeast to the northwest and can reach considerable lengths, as is the case of the Oued Meriksene that crosses the Study Area entirely from South to North at its eastern edge and passes through the village of Debdeb. The oueds recorded in some cases finalize or cross through sabkhas (saline depressions) that are fed by them. This is the case of ST-9, ST-16 and ST-40.

Plant cover and species diversity is determined by the specific local conditions in each oued. This means that, within the same area, some oueds may have relatively dense plant cover while others have sparse vegetation.

Oueds can be important grazing habitats for the local herds, especially when herbaceous species are present. The main oued present within the Study Area is Meriksene Oued, located in the vicinity of the village of Debdeb and very important for the village's agricultural activities.

Ten of the field survey stations (ST-1.1, ST-3, ST-9, ST-16, ST-17, ST-20, ST-24, ST-25, ST-36 and ST-40) had an oued as the dominant feature (additional minor oueds were recorded, though associated to a sabkha in most cases), including one station (ST-3), where the oued was associated to an existing water well, In the case of the Oued Meriksene at ST-16 the presence of water is also almost constant as it is the place where the wastewater from Debdeb village are discharged. Except for ST-3 and ST-16, the oueds were dry at the moment of the field survey.

All these stations presented certain degree of vegetation, being very sparse at ST-17, ST-20, ST-24, ST-36 and ST-40 and quite dense at ST-9 and ST-16, both located at the Oued Meriksene. The most diverse vegetation was at ST-9, with 16 different plant species. At ST-40, despite the scarcity of the vegetation cover, diversity found was rather high with 14 different species. Generally, vegetation cover within the oueds visited in the Study Area is scarce and is higher close to the Debdeb village.

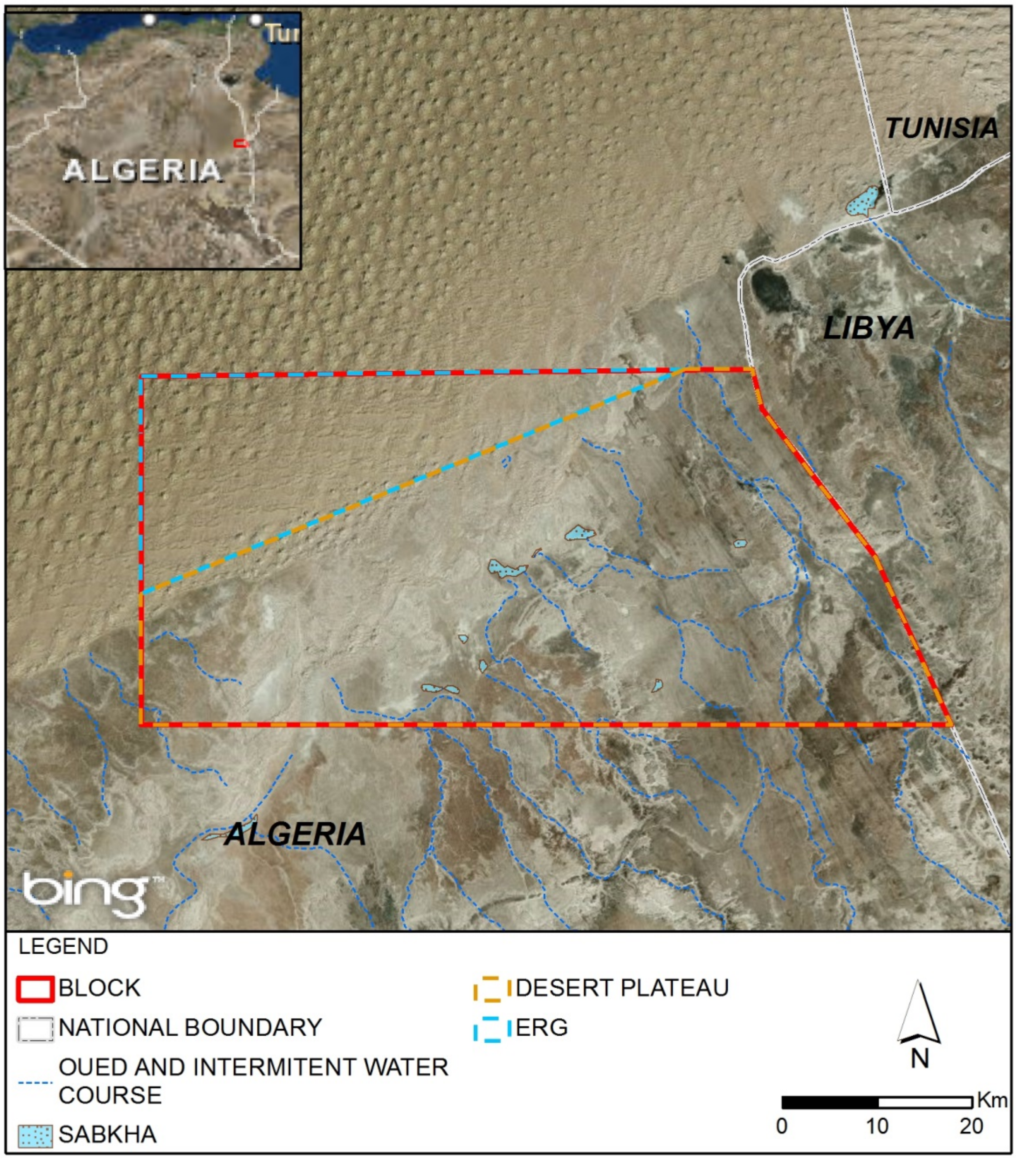
Vegetation in oued areas is very often located along the central axis of the oued, following the exact path the ephemeral stream flows down, as this is where water availability is maximised (see *Figure 4.28*). The plant species recorded within the oueds of the Study Area are characterized by the dominance of *Retama raetam*, *Tamaris aphylla*, both found at least at 4 different oued locations, and *Zygophyllumn album, Arthrophytum schmittianum* and *Pituranthos chloranthus*,found at 3 locations. Other species recorded include *Juncus maritimus*, *Imperata cylindrical* and *Faersetia aegyptiaca*.

With regards to the fauna, during the field survey, footprints of a hare and a jackal were recorded in one oued that crosses a sabkha at ST-16. In addition, Jackal bones were observed at the oued in ST-17. No other fauna sign was recorded within the oued habitats visited in the Study Area.

Figure 4.28 Examples of oueds found within the Study Area (ST-24 and ST-36)

Source: Bexam and ERM, 2015.

Figure 4.29 Location of the oueds and sabkhas found in the Study Area



Source: ERM, 2015.

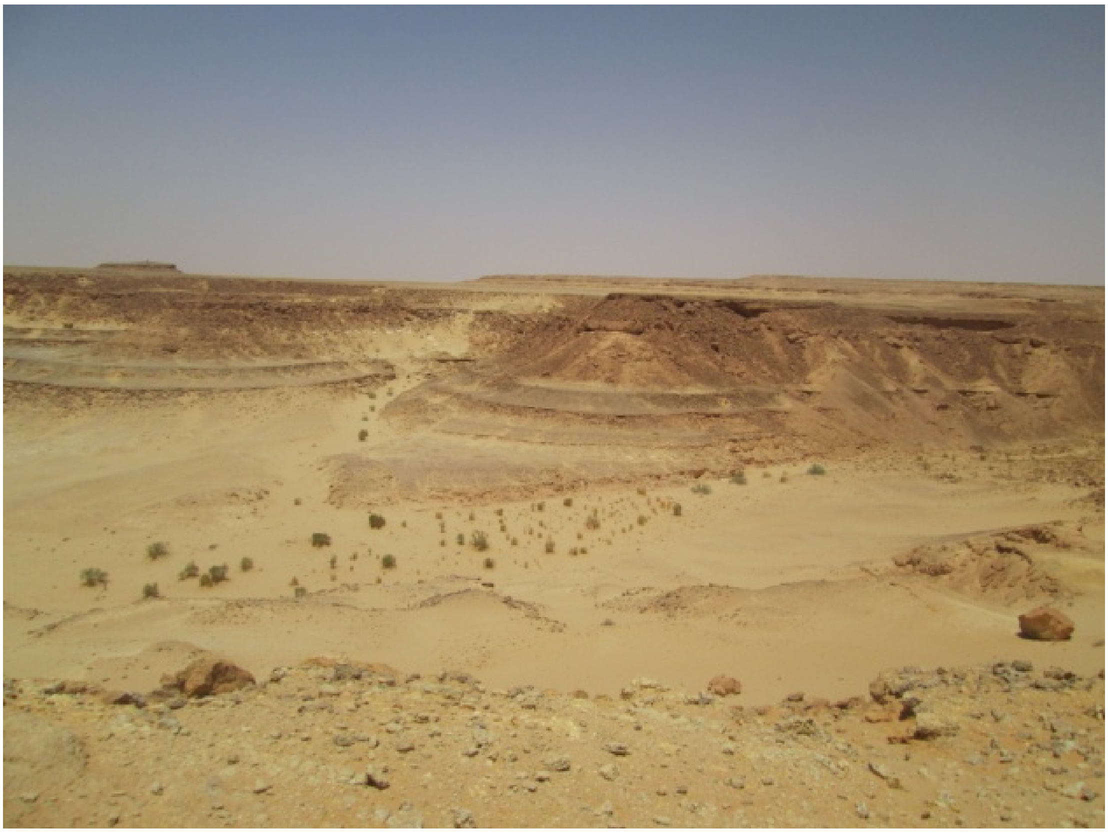
4.3.3.2.3 Escarpments

Rock escarpments in desert areas can be just a few metres high, associated with small oueds, which originate them through erosion, or they may attain remarkable heights (tens or hundreds of metres), associated with large geomorphological structures. Their main relevance, from an ecological point of view, is that these cliffs provide suitable areas for nesting birds (e.g., raptors) and a wide range of lizard species. Likewise, some plant species are also adapted to these harsh environments, although plant cover is generally very scarce.

This feature is common within the desert plateau areas. In the Study Area the escarpments identified are mainly associated to small oueds that have found their way by eroding the soil and leaving small elevations on their sides, though some of them are derived from the presence of mounds. All were relatively low.

No vegetation was observed associated to the garats in the Study Area, though the nearby oueds that through the erosion have originated these escarpments usually host some degree of vegetation as can be seen in Figure 4.30.

Figure 4.30 Examples of an escarpment found within the Study Area (ST-35)



Source: Bexam and ERM, 2015.

4.3.3.2.4 Sabkhas and non-saline depressions

Topographical depressions in the desert create environments that facilitate the establishment of plant communities and their associated fauna, as they may retain water for some time after periods of rainfall. The shallower water table also contributes to facilitating the presence of flora.

Depending on the characteristics of these depressions they are classified as sabkhas or non-saline depressions.

Sabkhas

Saline depressions within desert areas are known as sabkhas. They are areas where temporal or permanent surface water is stored. They are closed endorheic depressions, i.e. depressions with no natural drainage. Sedimentary deposits in sabkhas are mainly saline and gypsiferous.

Within the Study Area, sabkhas are a quite common feature within the desert plateau and appear usually associated with the presence of oueds that cross them. A total of 11 stations (ST-9, ST-14, ST-15, ST-16, ST-18, ST-22, ST-25, ST-27, ST-30, ST-31 and ST-40 – see Annex C.1) out of the 42 sites visited were located within a sabkha. Four of these stations were also dominated by the presence of an oued (ST-9, ST-16, ST-25 and ST-40).

In two of the stations (ST-14 and ST-18) there were water wells that contributed to the presence of green vegetation including palm trees in ST-14.

All the sabkhas visited during the field survey presented vegetation, with different degrees of density. None of the sabkhas held water at the moment of the field visit with the exception of the one associated to the wastewater discharges of the village of Debdeb, within the oued Meriksene.

The permanent vegetation in sabkhas is represented by chamaephyte (plants that bears hibernating buds on persistent shoots near the ground, but always above it) and halophyte (plants that grow on areas with high salt content) plants, which survive due to their proximity to the shallow groundwater and their tolerance of saline conditions. The dominant species found within the sabkhas of the Study Area include *Salsola vermiculata, Tamaris aphylla, Retama raetam, Pituranthos chloranthus* and *Zygophyllum album* , although 32 different species have been recorded.

Vegetation cover within sabkhas is generally low and on rare occasions will it reach more than 20%. Both plant density and diversity in neighbouring sabkhas can also be quite variable as is the case of the study area which presents sabkhas with very dense vegetation (ST-9, ST-14, ST-16, ST-18, ST-40), while others presented scarce and localized vegetation (ST-22, ST- 25 and ST-27), Well-developed sabkhas may cover large areas (several kilometres) and include a high proportion of woody vegetation, which is the basis for the animal and plant communities. This is the case of the sabkha associated to the oued Meriksene in the vicinity of Debdeb (represented by ST-9, ST-14, ST-15 and ST-16) showing a predominance of bushes that attain large dimensions.

Evaporation of the salt-rich water often results in a visible salty crust forming on the surface of sabkhas. This crust can trap moisture for long periods of time, even during the driest months of the year, contributing to maintaining the plant communities. Within the study area, however, these crusts were not observed widespread as the sabkhas recorded included a fine sandy layer and just few salty incrustations. Most of the sabkhas encountered had on the contrary gypsiferous and clayish substrates and presented dispersed salt deposits.

Regarding the fauna observed during the field survey, only footprints of hare and jackal (in a station where also an oued was located), together with the presence of dromedary herds, were recorded within the sabkhas visited in the Study Area.

Figure 4.31 Example of a sabkha within the Study Area (ST-30)

Source: Bexam and ERM, 2015.

Non-saline depressions

Non-saline depressions are morphologically similar to sabkhas but halophytic plants are not so dominant, given that the substrate is neither saline nor gypsiferous.

Plants generally found in non-saline depressions include *Anvillea radiata* and *Asteriscus graveolens*. Only one non-saline depression was recorded during the field survey. It is located in the southernmost part of the Study Area, at site ST-38 (see Annex C.1), and looked like a dry marshland, though it held no vegetation at the time of the field survey.

Figure 4.32 Detail of the non-saline depression found in the Study Area (ST-38)

Source: Bexam and ERM, 2015.

4.3.3.3 Ergs

Ergs, or sand seas, are dune bodies of various sizes and shapes, ranging from small, very mobile crescent-dunes to huge, fixed dunes 50 to 200 m high. Approximately 25% of the Study Area is located within the Grand Erg Oriental, covering the north west portion of the Study Area. Within this area large sand dunes and interdune sand plains and depressions are found.

4.3.3.3.1 Sand dunes

Star-shaped dunes are the most common feature within the portion of the Grand Erg Oriental located in the Study Area, dominant in the northwest corner of the block and in the southern edge of the Erg. According to the satellite images, between these star shaped dunes, there is an area dominated by dunes that seem to be mixed crescent and linear dunes, though in lower densities than the star-shaped ones. It is therefore a rather homogeneous environment.

The dunes are in most cases characterised by extremely low levels of plant cover due to the instability of the substrate, exposure to the elements and a lack of water and humidity. However, some vegetation can still be found on them, though it is generally limited to small patches of herbaceous plants located, in most cases, at the foot of the dunes or as patchy areas on their flanks.

In some cases, specific local conditions allow the presence of relatively abundant vegetation, although this is not expected to be a dominant feature within the erg of the Study Area. During the field survey the sand dunes were not visited and as such there are no records of actual vegetation in the area and the information gathered has been obtained by means of satellite images.

A view of the beginning of the dunes within the Study Area, corresponding to the edge of the erg and the desert plateau in ST-28 is shown in *Figure 4.33*.

Figure 4.33 Sand dunes within the Study Area

Source: Bexam and ERM, 2015.

Overall, dune vegetation has low species diversity but provides a niche for highly specialised plants and animals, including numerous rare and endangered species. Sometimes, small dunes originate because of the presence of vegetation, as plants trap sand and form small mounds (known as nebkhas) that may eventually grow and form dunes (see *Figure 4.34*).

Flora present within dune habitats is generally formed by psammophilous species such as *Cornulaca monacantha*, *Aristida pungens* and *Retama raetam*. The fauna potentially present in dune areas is dominated by invertebrates, lizards and snakes, though some small mammals like gerbils may also be present.

Figure 4.34 Example of a nhebka

Source: Bexam and ERM, 2015.

4.3.3.3.2 Interdune sand plains and depressions

Interdune areas and depressions found within the erg characteristically host most of the scarce vegetation present in the dune area, as in these zones, and particularly in the depressions, conditions can be more favourable for establishing plants. The increased soil stability, higher organic content in the soil, greater availability of water (from dew or collected in the subsurface after precipitation events), and the protection from wind are the main factors that allow the development of small patches of vegetation in these areas.

The distribution of plants on the sand plains and in the depressions is, however, very heterogeneous, following clumped distribution patterns. Where conditions are more favourable, significant plant cover may be found, including both herbaceous and woody plant species and very rarely exceeding 10% cover. These areas are, however, mainly devoid of vegetation.

A specific characteristic of some depressions is that, just as in the case of the sabkhas, they tend to accumulate salts and gypsum. However this phenomenon tends to be much more localized than in the sabkhas and large endorheic depressions.

The erg, located in the northeast of the Study Area (*Figure 3.*2) is, according to the satellite images analysed, covered by star dunes, linear and crescent dunes that include between them interdune areas and depressions. Because the presence of vegetation in the interdune areas and depressions depends mainly on the specific local site conditions, there may be significant variability in the Study Area, even within short distances and in the same type of landforms (i.e., different interdune areas may have significantly different plant cover, even if located close to one another).

Plant species that may be associated to interdune depressions include *Calligonum comosum*, *Cornulaca monacantha* and *Stipagrostis pungens*. This vegetation benefits from occasional water uptake and relatively rich soil, allowing it to maintain a fairly balanced condition. No interdune depressions were visited during the field survey, and therefore there are no records of the actual vegetation present.

Where plant communities are present, some fauna also may appear, including hares, camels, rats, birds, and lizards such as *Acanthodactylus maculatus* and *A. longipes*.

4.3.3.4 Human Environment

Historically human settlements within the wider region were associated with the oases. Although no natural oases are found in the Study Area the presence of the village of Debdeb, located at the eastern edge of the Study Area, and the associated agricultural land creates new opportunities for floral development. Typically vegetation is associated to water pools, waste water effluents, gardens/green areas or small agricultural plots. In the same way, fauna is linked to the areas where vegetation becomes established or where buildings and facilities provide opportunities for food and shelter. Similarly, landfills also provide opportunities for many species of fauna. In the study area orange and lemon trees were observed together with palm trees in ST-19, an agricultural area close to Debdeb where also vegetables were planted. Similarly in the vicinity of the village and the nearby roads, ornamental eucalyptus and acacias were recorded.

In the field survey in May 2015, dromedaries were recorded in the vicinity of Debdeb and close to water wells.

Figure 4.35 Example of a Palm Plantation in the vicinity of Debdeb (ST-19)

Source: Bexam and ERM, 2015.

4.3.4 Flora and Vegetation

The Study Area falls within the North African Saharan zone ecosystems and the presence of vegetation is strongly related to soil and water resources. Most of the existing vegetation consists of small and medium-sized species with the usual absence of trees, with the exception of the human environment habitats, where palm trees and ornamental acacias can be recorded. Flora in the North African Saharan zone is generally dominated by chamaephytes and hemicryptophytes (plants whose renewal buds remain at ground level during the period unfavorable to vegetation) (Ouled Belgacem, 2006). The presence of plants throughout the Saharan region is sporadic.

As observed during the field survey vegetation is present throughout the Study Area, though in most cases in very low densities and largely concentrated in patches on those areas more favourable to plant growth, like the oued beds and sabkhas. It has also been observed within the Hamada, though in lower densities and in localized spots On the other hand, when conditions are favourable, usually after rainfall, fast-growing herbaceous plants can quickly develop and occupy extensive areas as is the case expected in the non-saline depression recorded in the southern edge of the block. These species are highly adapted to desert environments and are typically able to complete their lifecycle and spread their seeds in just few weeks; the seeds lie dormant until the conditions are once again propitious. As a result their direct observation is difficult as they can only be observed during a short period after rainfall, which was not the case at the time of the field survey.

Vegetation in desert environments plays a key role within these ecosystems. Herbaceous species not only serve as a grazing resource, but also have an important dune-fixing function: this is fundamental for the shelter of local fauna (especially insects, reptiles, etc.). Sand fixation by herbaceous plants moreover modifies and prepares the environment for other plant species, which are more competitive when a minimum amount of organic matter is present and they can get a stable foothold. As a result, the sand fixation phenomenon contributes to the establishment of more complex communities

Shadowing by trees, bushes and herbaceous vegetation also has an important ecological function in maintaining lower temperatures and higher degree of humidity. This permits and facilitates the growth of seeds and young plants, which necessitate higher water concentrations in the soil substrate.

The vegetation is also a key factor in sustaining the local fauna and the traditional livestock activities, as the most important source of oued resources, and protection for a variety of animals. Due to the relative scarcity of such resources in the Sahara environment, plants function as ‘attractors’ where micro-fauna, in particular, concentrates.

As in other regions of the Sahara, the flora within the Study Area is poorly developed. The plants are concentrated mainly in the existing oueds and sabkhas, though always with a relatively low vegetation cover. A total of 53 different plant species were recorded during the field survey, including two species protected under Decree 12-03 and Decree 93-285, *Ephedra alata* ssp*. alenda* and *Helianthemum lippii var.sessiliflorum* respectively. *Helianthemum lippii var.sessiliflorum* has been recorded at three different stations (the Hamada part of ST-1, ST-21 and ST-39), all located in hamadas. *Ephedra alata* ssp*. alenda* (Oued Merksène at st-1, ST-21, ST-24, ST-27 and ST-36) was recorded at 5 different sites, four of them located in oueds and depressions and one within poorly vegetated hamada.

The two most widespread plant species found within the Study Area are *Tamaris aphylla* and *Retama raetam* that were recorded at 13 and 8 different stations respectively, though it must be noted that *Tamaris aphylla* has been also recorded as ornamental along the main route in the area, close to Debdeb. This species appears mainly in the form of bush and individuals of the size of a tree have only been observed in ST-32, close to a water well.

Among the 42 stations visited, vegetation was found at 28 of them, which indicates that despite a generally low vegetation cover, vegetation is widely distributed in the hamada area. The Grand Erg within the Study Area, where lower vegetation abundance is expected, was not visited.

As expected, the flora species recorded appeared mainly in oueds, sabkhas and associated to human presence, including the presence of water wells. Vegetation was recorded only in a few hamadas, and in some of those cases this was associated with a small ephemeral oued.

The stations that showed most biodiversity in terms of flora were ST-11, ST-9 and ST-40.

The ST-11 is located in a hamada terrain with a oued in the vicinity of Debdeb and holds 18 different flora species including some ornamental acacias. ST-9, located at the Oued Meriksene, 4 km northwest from Debdeb in a place where the oued crosses a sabkha, hosts 16 different species and presents a high density of vegetation (Figure 4.36). This site also presented some uncontrolled wastes. ST-40 contains 14 different species, though the vegetation cover is poor. This site, a sabkha, is characterised by the presence of a water well.

Figure 4.36 Vegetation encountered at ST-9

Source: Bexam and ERM, 2015.

Table 4.8 presents a selection of the main floral species expected to be present within the Study Area including those that have been recorded during the field survey as well as the number of sites where they were present (see precise locations in Annex C.1). The table should not be considered an exhaustive or complete list of flora for the Study Area but rather those species that, based on local expert knowledge, direct observation and the general literature on the region, are expected or found to be more common or ecologically relevant.

Table 4.8 Plant found and potentially present in the Study Area

Scientific name	Local name	Preferred Habitat	Algerian Legal Protection	Algerian Conservation Status	Abundance in Study Area	Observed during field survey
			Trees			
Acacia senegal	-	Oueds, along roads	-	Introduced species	Rare	Yes – two stations (ST-10 and ST-11, planted)
Phoenix dactylifera	Nakhla	Oases	-	Agricultural use	Unknown	Yes – two stations, ST-14 and ST-36
Phragmites communis	Qasba	Oases, oueds	-	Common	Common	Yes – one station (ST-11), associated to human uses
Rhus tripartitum	Djedari, Tahounek	Oueds (rocky areas)	-	Common	Rare	Yes – one station (ST-36)
Tamarix aphylla	Tlaïa, Ethel, tabarakat	Oueds	-	Common. Endemic	Rare	Yes – thirteen stations, including Hamada, oued and sabkha environments
			Bushes			
Agathophora alopecuroides	Kourtel	Regs	-	Common	Rare	
Anabasis articulata	Belbel	Oueds (stony and sandy)	-	Common	Common	
Antirrhinum ramosissimum	Chebreg	Regs	-	Common	Rare	
Aristida pungens = Stipagrostis pungens	Drinn	Ergs, dunes	-	Common	Common	
Arthrophytum scoparium	Remt	Regs	-	Common	Rare	
Arthrophytum schmittiatianum	Remt	Regs	-	Common. Saharan endemic.	Rare	Yes – three stations (ST-9, ST-40, ST-36)
Atriplex halimus	Gtef, Aramas	Sandy, silty and gypsophile soils	-	Common	Rare	Yes – one station, sabkha of ST-9
Calligonum comosum	Azel	Hamadas	-	Common	Common	Yes – at three stations (ST-3, ST-15, ST-20)
Cornulaca monacantha	Had, Tahara	Regs	-	Common	Common	
Echiochilon fruticosum	Djerda	Desert pavement, regs	-	Common	Common	
Eruca vesicaria ssp. *pennatifida*	Semna	Non saline depressions (dayas)	-	Rare	Rare	Yes – two stations (ST-1, ST-11)
Ephedra alata ssp. *alenda*	Alenda	Ergs, dunes	Decree n°12-03	Common	Common	Yes – five stations (ST-1, 27, ST-21, ST-24 and ST-36) in oueds and hamada.
Euphorbia calyptrata ssp. *involucrata*	Tahouh	Dunes and rocks (escarpments)	-	Common	Common	

Scientific name	Local name	Preferred Habitat	Algerian Legal Protection	Algerian Conservation Status	Abundance in Study Area	Observed during field survey
Euphorbia guyoniana	Halib eddaba	Dunes and rocks (escarpments)	-	Common	Common	
Fagonia bruguieri	Affessour	Desert pavement, regs	-	Common	Rare	Yes – one station (ST-1.1 oued Merksene)
Fagonia glutinosa	Ghegaa	Desert pavement, regs	-	Common	Common	Yes –at ST-40
Fagonia olivieri	-	Desert pavement, regs	-	Common. Endemic	Rare	Yes – two stations (ST-11 and ST-39)
Juncus maritimus	Semmar	Sabkhas	-	Common	Common	Yes – three stations (ST-1.1, ST-3 and ST-11)
Moltkia callosa	Aguinest	Ergs, dunes	-	Common. Endemic	Common	Yes – at ST-40
Moricandia arvensis	Gdem	Desert pavement	-	Rare	Rare	Yes – at ST-9
Oudneya Africana	Eulga	Hamada, regs	-	Rare. Endemic	Rare	Yes – at ST-1.1
Pergularia tomentosa	Sellkha, Tachkat	Desert pavement, regs	-	Common. Saharan endemic	Common	
Periploca laevigata	Sellouf, Halleb	Hamadas	-	Common	Rare	
Pithuranthos chloranthus	Quessou	Desert pavement with sand	-	Common	Rare	Yes – six stations (ST-1, ST-9, ST-21, ST-24, ST-25, ST-40) in oueds and hamadas
Pituranthos scoparius	Guezzah	Desert pavement, regs	-	Common	Common	
Pulicaria undulata	Améo	Regs, hamadas	-	Common	Rare	Yes – three stations (ST-21, ST-22 and ST-36) in hamadas and oueds
Retama raetam	Rtem	Ergs and oueds	-	Common	Common	Yes – eight stations (ST-1, ST-3, ST-4, ST-9, ST-11, ST-27, ST-36 and ST-40)
Reseda alphonsii ssp. *barbuitii*	Qaua elkherouf	Regs, hamadas	-	Rare. North African endemic	Rare	
Rhanterium adpressum	Arfadja	Desert pavement, regs	-	Rare. North African endemic	Rare	
Rhanterium suaveolens	Arfadja	Hamadas	-	Rare. North African endemic	Rare	
Salsola vermiculata	Rhessal	Sabkhas, regs	-	Common	Common	Yes – four stations (ST-1, ST-9, ST-22, ST-25)mainly associated to sabkhas
Solenostema argel	Arellachchem (targui)	Hamadas	-	Common. Endemic	Rare	
Traganum nudatum	Damran	Regs	-	Common	Rare	Yes at ST-3
Zilla spinosa	Zilla	Regs, hamadas	-	Common	Common	Yes – two stations (ST-1.1 and ST-39)
Ziziphus lotus ssp. *saharae*	Cedra, Tabakat	Non-saline depressions (dayas)	-	Common	Common	Yes at four stations (ST-1, ST-3, ST-9 and ST-41)
Zygophyllum album	Bou gribaa	Sabkhas	-	Common. Endemic	Common	Yes at ST-25

Scientific name	Local name	Preferred Habitat	Algerian Legal Protection	Algerian Conservation Status	Abundance in Study Area	Observed during field survey
Herbaceous						
Aeluropus littoralis	Aguerich	Sahbkas, silty soils	-	Common	Common	Yes at ST-4
Ammodaucus leucotricus	Senarya	Ergs, sandy areas	-	Common. Saharan endemic	Rare	Yes – at three stations (ST-11, ST-39 and ST-40)
Anacyclus cyrtolepidioides	Djerf	Desert pavement	-	Common. North African endemic	Common	Yes – at three stations (ST-9, ST-11 and ST-40)
Anastaticha hieriochuntica	Komchet Nabi	Regs, stony soils	-	Common	Rare	
Anvillea radiata	Horf, Ain el begra	Non-saline depressions	-	Common	Common	
Artemisia herba alba	Chih	Desert pavement	-	Rare	Rare	Yes at ST-1
Astericus pygmaeus	Nouggd, Nesrine	Regs, hamadas	-	Common	Common	Yes – at three stations (ST-11, ST-25 and ST-39)
Asteriscus graveolens	Negued, Tamayout	Desert pavement	-	Common	Common	
Astragalus cruciatus	Bou akifa	Regs		Common	Common	
Astragalus gyzensis	Foult ibel	Ergs, sandy areas	-	Common. Saharan endemic	Rare	Yes – at three stations (ST-9, ST-11 and ST-40)
Atractylis serratuloides	Chandar el djemel	Desert pavement	-	Common, Saharan endemic	Common	Yes – two stations, ST-11 and ST-25.
Bassia muricata	Rebbir, Ouhas	Oueds (sandy)	-	Rare	Rare	
Calendula aegyptiaca	Tamamaguerit 'targui)	Regs, hamadas	-	Rare	Rare	
Centaurium spicatum	Emend	Non-saline depressions (dayas)	-	Rare	Rare	
Colocynthis vulgaris	Hamdal, Alkad	Oueds (sandy)	-	Common	Common	
Crotalaria saharae	Afarfar	Oueds	-	Common. Saharan endemic	Common	Yes, at ST-3
Cymbopogon schoenanthus	Senboul el arab , tiberimt	Desert pavement	-	Rare	Rare	
Cyperus conglomeratus	Echoub	Ergs, sandy areas	-	Rare	Rare	Yes at ST-11
Echinocloa colona	Oulafa	Oases, depressions	-	Common	Common	
Fagonia glutinosa	Chegaa	Desert pavement	-	Common	Common	Yes, at ST-40
Farsetia aegyptiaca	Horaig, Ourtemes	Regs	-	Common	Common	Yes, at four stations (ST-1, ST-9, ST-11 and ST-40)
Helianthemum lippii var.sessiliflorum	Regig, Tahaouet	Desert pavement	Decree n°93-285	Common	Rare	Yes, at three stations, (ST-1, ST-21 and ST-39)

Scientific name	Local name	Preferred Habitat	Algerian Legal Protection	Algerian Conservation Status	Abundance in Study Area	Observed during field survey
Heliotropium undulatum	Medeb, Tahena	Desert pavement	-	Common	Common	Yes, at ST-40
Herniaria fontanesii	Ozzaima	Regs	-	Common	Rare	Yes, at ST-40
Hyoscyamus muticus ssp falezlez	Afalehlé	Regs and sandy areas	-	Common. Saharan endemic	Rare	Yes, at two stations (ST- 1.1 and ST-11)
Imperata cylindrica	Diss	Sandy oueds	-	Common	Common	Yes, at three stations (ST-3, ST-4 and ST-16)
Launea nudicaulis	Azim	Desert pavement	-	Common	Rare	Yes, at ST-9 and ST-25
Launea resedifoli	Azim	Desert pavement	-	Common	Rare	Yes, at ST-9
Marubium desertii	Djade, Telhert	Desert pavement	-	Common. Endemic	Common	
Matthiola livida	Bouerngu	Ergs	-	Rare. Endemic	Rare	Yes, at ST-40
Matricaria pubescens	Gartoufa, asensi	Oueds (sandy)	-	Rare. Endemic	Rare	Yes, at ST-3
Medicago minima	Hassaka	Ergs and regs	-	Common	Common	Yes, at ST-39
Paganum harmala	Harmel	Desert pavement, regs	-	Common	Common	Yes, at two stations (ST-1.1 and ST-9)
Pennisetum dichotomum	Bou rokba, hada	Sands and regs	-	Common	Rare	Yes, at ST-24
Plantago albicans	Heulma	Desert Pavement	-	Common	Common	Yes, at two stations (ST-11 and ST-25)
Polypogon monspeliensis	Sboul el far	Sabkhas	-	Common. Saharan endemic	Common	Yes, at ST-16
Pteranthus dichotomus	Derset vel adjoura	Desert pavement	-	Common	Common	Yes, at ST-11
Schismus barbatus	Rochina	Shabkas	-	Common. North African endemic	Common	
Scirpus holoschenus	Semmar	Non-saline depressions (dayas)	-	Common	Common	Yes, at ST-4
Silene villosa	-	Ergs	-	Common. Saharan endemic	Rare	
Spergularia diandra	Oudhen elfar	Sabkhas	-	Common	Common	Yes, at ST-9
Telephium spaerospermum	Degania	Regs, hamadas, escarpments	-	Rare	Rare	
Teucrium polium ssp. *geyrii*	Djaad, Timzourin	Desert pavement	-	Rare	Rare	
Trichodesma africana	Alkah	Hamadas, regs	-	Common	Rare	

Note : Abundance is estimated based on local expertise together with field survey observations.

Source: ERM, BEXAM, 2015

Table 4.9 Distribution of Plant species along the Study Area

	Station number																																									
Plant species	1	1.1	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	32	33	34	35	36	37	38	39	40	41
Trees																																										
Acacia senegal												X	X																													
Phoenix dactylifera															X					X																	X					
Phragmites communis												X																														
Rhus tripartitum																																					X					
Tamarix aphylla		X		X	X					X		X				X		X	X				X								X	X	X				X					
Bushes																																										
Agathophora alopecuroides																																										
Anabasis articulata																																										
Antirrhinum ramosissimum																																										
Aristida pungens = Stipagrostis pungens																																										
Arthrophytum scoparium																																										
Arthrophytum schmittianum										X																											X				X	
Atriplex halimus										X																																
Calligonum comosum				X												X					X																					
Cornulaca monacantha																																										
Echiochilon fruticosum																																										
Eruca vesicaria ssp. *pennatifida*	X											X																														
Ephedra alata ssp. *alenda*	X																					X			X			X									X					
Euphorbia calyptrata ssp. *involucrata*																																										
Euphorbia guyoniana																																										
Fagonia bruguieri		X																																								

	Station number																																									
Plant species	1	1.1	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	32	33	34	35	36	37	38	39	40	41
Fagonia glutinosa																																									X	
Fagonia olivieri												X																												X		
Juncus maritimus		X		X								X																														
Moltkia callosa																																									X	
Moricandia arvensis										X																																
Oudneya Africana		X																																								
Pergularia tomentosa																																										
Periploca laevigata																																										
Pithuranthos chloranthus	X									X												X			X	X															X	
Pituranthos scoparius																																										
Pulicaria undulata																						X	X														X					
Retama raetam	X			X	X					X		X																X									X				X	
Reseda alphonsii ssp. *barbuitii*																																										
Rhanterium adpressum																																										
Rhanterium suaveolens																																										
Salsola vermiculata	X									X													X			X																
Solenostema argel																																										
Traganum nudatum				X																																						
Zilla spinosa		X																																						X		
Ziziphus lotus ssp. *saharae*	X			X						X																																X
Zygophyllum album																										X																
Herbaceous																																										
Aeluropus littoralis					X																																					
Ammodaucus leucotricus												X																												X	X	

	Station number																																								
Plant species	1	1.1	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	32	33	34	35	36	37	38	39	40	41
Anacyclus cyrtolepidioides										X		X																													X	
Anastaticha hieriochuntica																																										
Anvillea radiata																																										
Artemisia herba alba	X																																									
Astericus pygmaeus												X														X														X		
Asteriscus graveolens																																										
Astragalus cruciatus																																										
Astragalus gyzensis										X		X																													X	
Atractylis serratuloides												X														X																
Bassia muricata																																										
Calendula aegyptiaca																																										
Centaurium spicatum																																										
Colocynthis vulgaris																																										
Crotalaria saharae				X																																						
Cymbopogon schoenanthus																																										
Cyperus conglomeratus												X																														
Echinocloa colona																																										
Fagonia glutinosa																																									X	
Farsetia aegyptiaca	X									X																															X	
Helianthemum lippii var.sessiliflorum	X																					X																		X		
Heliotropium undulatum																																									X	
Herniaria fontanesii																																									X	
Hyoscyamus muticus ssp falezlez	X											X																														
Imperata cylindrica				X	X												X																									

	Station number																																									
Plant species	1	1.1	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	32	33	34	35	36	37	38	39	40	41
Launea nudicaulis										X																X																
Launea resedifoli										X																																
Marubium desertii																																										
Matthiola livida																																									X	
Matricaria pubescens				X																																						
Medicago minima																																										
Paganum harmala		X								X																																
Pennisetum dichotomum																									X																	
Plantago albicans		X																								X																
Polypogon monspeliensis																	X																									
Pteranthus dichotomus												X																														
Schismus barbatus																																										
Scirpus holoschenus					X																																					
Silene villosa																																										
Spergularia diandra										X																																
Telephium spaerospermum																																										
Teucrium polium ssp. *geyrii*																																										
Trichodesma africana																																										
Unidentified species														X	X	X		X	X																			X				

Source: ERM, BEXAM, 2015

As indicated in the *Table 4.8* only two plant species recorded within the Study Area are protected by Algerian law, *Ephedra alata* spp*. alenda* under Decree n°12-03, focused on the protection of non-cultivated plant species, and *Helianthemum lippii* var. *sessiliflorum* under Decree n°93-285, related to the ratification by Algeria of the 1979 Bonn Convention on the conservation of migratory species due to its importance for the migrant herbivores.

4.3.5 Fauna

4.3.5.1 Introduction

Fauna along the Sahara rely on the scarce vegetation (as source of food, shade, habitat for prey, and so on). As a result, many small animal species (i.e., rodents, beetles, arachnids, etc.) have the same clumped distribution pattern as the plants, and all animals in the desert environment are present at very low densities.

During the field survey in May 2015, no relevant fauna species were observed, and only domesticated dromedaries were observed *in situ*. Three mammal species (jackal, hare and gazelle) were recorded by means of secondary traces (i.e. bones and footprints). These secondary observations were made in only 2 stations, both associated with dense vegetation in a sabkha or an oued. Dromedaries were recorded at three sites, including one close to the Debdeb village.

Animals tend to be more vulnerable than plants because they rely on plants or even on the other scarce animals. Because of this, the natural vulnerability of desert fauna is markedly higher than that in other environments. This is especially true for top predators such as foxes and jackals, and also for big herbivores.

As indicated in *Section 4.3.3*, several different habitats can be found within the Study Area. Although the species show a preference for certain habitat types, most of them can generally be found in a range of habitats, especially due to their mobility.

The following sections present a brief description of the main faunal species potentially found within the Study Area.

4.3.5.2 Mammals

The only observed mammals where the domesticated dromedaries, while three additional species were recorded by means of their traces. This was the case of the golden jackal (*Canis aureus*), whose bones and footprints were recorded at two different stations (ST-16 and ST-17, see Annex C.1), a hare (*Lepus capensis*) and a gazelle species (*Gazella* spp.), whose footprints were found at one station each (ST-16 and ST-39 respectively). The ST-16, where golden jackal and hare were recorded, is located at the end of an oued and close to agricultural lands and is characterised by the presence of water as it is the discharge point of the oued. This leads to the formation of a depression where water remains stagnant in a sort of small marshland. However only 2 plant species were recorded at the site.

Table 4.10 Table 4.1presents the 29 mammal species expected to be present within the Study Area. The table should not be considered as an exhaustive or complete list but rather those species that, based on local expert knowledge and the general literature on the region, are expected to be more common or ecologically relevant. This list is dominated by different species of gerbils and bats.

Figure 4.37 Jackal footprints at ST-16

Source: Bexam and ERM, 2015.

Table 4.10 Mammal species found and potentially present in the Study Area

Scientific name	Local name	English name	Preferred Habitat	Algerian Legal Protection	Algerian Conservation Status	IUCN Conservation Status	Potential abundance in Study Area	Observed during field survey
Acomys cahirinus seurati	Tajejert	Egyptian spiny mouse	Erg, oueds	-	Common	LC	Common	No
Canis aureus	Dib	Golden Jackal	Oueds and hamadas	-	Common	LC	Common	Footprints at STt-16; Bones at ST-17
Felis silvestris lybica	Qat elkhla	African wild cat	Oueds and hamadas	Decree n° 12-235	Very Rare	LC	Very rare	No
Gazella dorcas	Ghazal	Dorcas gazelle	Ergs, oueds, hamada, regs	Decree n° 83-509 Ordinance n° 06-05	Rare	VU	Rare	Gazelle footprints at ST-39. Species unknown
Gazella leptoceros	Rym	Rhim gazelle	Ergs, oueds, hamada	Decree n° 83-509 Ordinance n° 06-05	Rare	EN	Rare	Gazelle footprints at ST-39. Species unknown
Gerbillus campestris	Gerbouh	North African gerbil	Ergs, oueds	-	Common	LC	Common	No
Gerbillus gerbillus	Gerbouh	Lesser Egyptian gerbil	Ergs, oueds	-	Common	LC	Common	No
Gerbillus henleyi	Gerbouh	Pigmy gerbil	Ergs, oueds	-	Common	LC	Common	No
Gerbillus nanus(G. garamantis)	Gerbouh	Gerbil	Ergs, oueds	-	Common	LC	Common	No
Gerbillus pyramidumo	Gerbouh	Greater Egyptian gerbil	Ergs, oueds	-	Common	LC	Common	No
Gerbillus tarabuli	Gerbouh	Tarabul's gerbil	Ergs, oueds	-	Common	LC	Common	No
Jaculus jaculus	Eddawi	Egyptian Jerboa	Ergs, oueds	-	Common	LC	Common	No
Lepus capensis	Arnab	Brown hare	Hamadas, oueds	-	Common	LC	Common	Footprints at ST-16
Massoutiera mzabi	Telout	Mzab gundi	Ergs, oueds	Decree n° 12-235	Rare	LC	Rare	No
Meriones crassus	Akounder	Sundevald's jird	Ergs, oueds	-	Rare	LC	Rare	No
Meriones libycus	Akounder	Libyan jird	Ergs, oueds	-	Common	LC	Common	No
Pachyuromys duprasi	Gerbouh	Fat-tailed gerbil	Ergs and regs	-	Common	LC	Common	No
Paraechinus aethiopicus	Gunfoud	Desert hedgehog	Oueds and hamadas	Decree n° 12-235	Common	LC	Common	No
Pipistrellus deserti	Tir ellil	Desert pipistrelle	Oases and near human settlements	Decree n° 12-235	Common	LC	Common	No
Pipistrellus kuhlii	Tir Ellil	Kuhls pipistrelle	Oases and near human settlements	Decree n° 12-235	Common	LC	Common	No

Scientific name	Local name	English name	Preferred Habitat	Algerian Legal Protection	Algerian Conservation Status	IUCN Conservation Status	Potential abundance in Study Area	Observed during field survey
Procavia capensis	Akawka	Rock hyrax	Desert pavement	Decree n° 12-235	Very rare	LC	Very rare	No
Psammomys obesus	Far Assubkha	Fat sand rat	Desert pavement, sabkha	Decree n° 83-509	Common	LC	Rare	No
Rhinolophus clivosus	Tir Ellil	Horseshoe bat	Desert pavement	Decree n° 12-235	Very rare	LC	Very rare	No
Rhinopoma hardwickwii	Tir Ellil	Lesser mouse tailored bat	Oueds and desert pavement	Decree n° 12-235	Rare	LC	Rare	No
Tadarida aegyptiaca	Tir Ellil	Egyptian free tailed bat	Oueds, escarpments, desert pavement	Decree n° 12-235	Very rare	LC	Very rare	No
Taphozous nudiventris	Tir Ellil	Naked rumped tomb bat	Oueds	Decree n° 12-235	Very rare	LC	Very rare	No
Vulpes ruppellii	Zerdi	Rupell's Fox	Ergs, desert pavement	Decree n° 83-509	Common	LC	Rare	No
Vulpes zerda	Fnak	Fennec Fox	Ergs	Decree n° 83-509 Ordinance n° 06-05	Rare	LC	Rare	No

Note : LC : Least Concern ; VU : Vulnerable ; EN : Endangered.

Source: ERM, BEXAM, 2015

As can be seen in Table 4.10, ten species are potentially present in the area are protected by Decree nº 12-235 of May 24th, 2012, which establishes species protected by the Algerian authorities, and places them under protection and subject to specific conservation measures.

Similarly, three additional species, *Gazella Dorcas*, *G.leptoceros and Vulpes zerda* are assessed as endangered by Algerian authorities as revealed by the protection status given under and Ordinance nº 06-05 of 15th July 2006 on the protection and conservation of endangered animal species.

As previously indicated, and based on the rare observations of fauna traces in the field, mammal species when present within the Study Area are attracted to the oueds and sabkhas present in the desert plateau area, where they can find water and vegetation. This seems to apply specially to the oued Meriksene in the vicinity of Debdeb, as the discharge of wastewater ensures the permanent presence of water.

A short selection of mammal species of interest is presented below. The selection is based on those species that are either considered most relevant due to their conservation status or protection under Algerian legislation. The three species selected correspond to those included in the order 06-05 indicating an endangered status within Algeria. In addition to these species, the numerous bat species potentially present in the area, are considered also to play a key role in desert environments, though given their conservation status have not been considered for description.

Fennec fox ***(Vulpes zerda)***

The fennec fox is the smallest species of the *Canidae* family. It weighs approximately 2-3 kg and is approximately 50-60 cm long. It ranges throughout the deserts of Northern Africa from Morocco and Algeria, to Egypt and Sudan. The fennec fox is mainly found in sand dune habitats (ergs) and very often observed near oases. Like other foxes, the fennec fox stores extra food in its underground dens. It gets most of the water it needs from its food. The nocturnal fennec foxes gives birth once a year, in late winter or early spring. It is an omnivorous species and feeds on fruit, insects, lizards, birds and rodents. It is commonly trapped and sold commercially in northern Africa.

Dorcas gazelle ***(Gazella dorcas)***

Dorcas gazelle females are small and measure up to 62 cm in height whilst the males measure up to 67 cm tall. They are 90 to 110 cm long and weigh between 12 and 25 kg. Dorcas gazelles are found throughout the Sahara, with the exception of central Mauritania. They are active during the day except at midday when the heat is excessive and they usually stay in shaded places. Herds usually comprise small groups of 3 to 5 individuals. Dorcas gazelle populations are typically encountered near oueds, as well as on the savannah, dunes, and in rocky areas. The populations are threatened due to poaching and habitat degradation.

The beds of large, vegetated oueds form ecological corridors connecting the different Dorcas gazelle populations, ensuring their migration and genetic mixing. This is one of the most desert-adapted gazelle species, obtaining all its moisture from the plants it eats. It can withstand very high temperatures, although during hot weather it is primarily active at dawn, dusk, and throughout the night. Herds wander over large areas searching for food, and tend to congregate in areas where recent rainfall has stimulated plant growth.

Rhim gazelle ***(Gazella leptoceros)***

The Rhim gazelle present in Algeria belongs to one subspecies, *Gazella leptoceros loderi,* typically found in Western Sahara as opposed to *Gazella leptoceros leptoceros*, which is found in the western desert of southern Egypt and north-eastern parts of Libya. The Rhim Gazelle is mainly linked to ergs and large sand piles, which seem to be its main habitats. It is also linked to interdune depressions including vegetation comprising *Cornulaca monacantha* on which the gazelle feeds. It inhabits sandy and stony deserts with acacia groves and sandy depressions with sparse vegetation.

4.3.5.3 Birds

The number of birds in the region is likely to be low for most of the year as reflected by the scarcity of bird sightings during the field survey, though increasing somewhat during migratory periods, in autumn and spring. Many species make migratory flights mainly at night, and the birds rest by day. The crossing may be made in a single hop or in several shorter stages, the birds rest and possibly feed between each stage at more or less suitable sites (amongst which oases play a major role).

Recently, more intensive exploitation of the oases by men, and the creation of other green areas around oil fields in the desert, seems to have created new feeding and resting possibilities for migrant and overwintering birds. In autumn, migration occurs mainly between August and November, and in spring between February and May. Bird species crossing the Sahara Desert during winter originate from the region between western Europe and western Russia (Isenmann et al., 2005).

Table 4.11 presents a selection of bird species potentially present in the Study Area, including the three species observed while in the field. The table should not be considered an exhaustive or complete list but rather those species that, based on local expert knowledge and the general literature on the region, are expected to be most common or ecologically relevant.

Table 4.11 Avifauna species found and potentially present in the Study Area

Scientific name	Local name	English name	Preferred Habitat	Algerian Legal Protection	Algerian Conservation Status	IUCN Conservation Status	Potential abundance in Study Area	Bird behavior in Study Area	Observed during field survey
Alaemon alaudipes	Ati-ati	Hoopoe lark	Desert pavement	-	Common	LC	Rare	RB	No
Ammomanes deserti	Touidira	Desert lark	Desert pavement	-	Common	LC	Rare	RB	No
Anthus campestris	-	Tawny pipit	Unknown	-	Common	LC	Rare	MV	No
Athene noctua	Taouik	Little owl	Unknown	Decree n° 12-235	Rare	LC	Rare	MV	No
Bubo ascalaphus	Bouhan	Pharaoh Eagle-owl	Unknown		Common	LC	Rare	RB	No
Bucanetes githagineus	Tahrayt	Trumpeter finch	Unknown		Common	LC	Rare	RB	No
Buteo rufinus	-	Long-legged buzzard	Desert pavement, regs	Decree n° 12-235	Rare	LC	Rare	RB	No
Circus aeruginosus	-	Western marsh harier	Depressions	Decree n° 12-235	Common	LC	Rare	MV / W	No
Circus macrourus	-	Pallid harrier	Depressions	Decree n° 12-235	Rare	NT	Rare	MV	No
Columba livia	Tidebbirt	Rock dove	Unknown	-	Common	LC	Common	RB	Yes, close to Debdeb
Corvus ruficollis	Ghurab	Brown-necked raven	Oueds, depressions	-	Common	LC	Common	RB	No
Cursorius cursor	Seyellel-ibaraden	Cream-coloured coursor	Desert pavement, regs	-	Common	LC	Rare	RB	No
Delichon urbicum	Khotefa	Northern House-Martin	Unknown	-	Common	LC	Rare	MV	No
Emberiza striolata	Siboubou	House bunting	Unknown	-	Common	LC	Rare	RB	No
Falco biarmicus	Aloullem	Lanner falcon	Desert pavement, Hamada	Decree n° 12-235	Common	LC	Rare	RB	No
Falco tinnunculus	Aloullem	Kestrel	Desert pavement	Decree n° 12-235	Common	LC	Common	RB	No
Hieraetus pennatus	Elrougab	Booted Eagle	Unknown	Decree n° 12-235	Common		Rare	RB	No
Hirundo rustica	Khotefa	Barn swallow	Desert pavement	-	Common	LC	Common	MV	No
Lanius meridionalis	Srend	Southern grey shrike	Desert pavement	-	Common	LC	Common	RB	No
Lanius senator	-	Woodchat shrike	Desert pavement	-	Common	LC	Common	MV	No
Merops apiaster	-	European Bee-eater	Escarpments, oueds	Decree n° 12-235	Common	LC	Common	MV	No

Scientific name	Local name	English name	Preferred Habitat	Algerian Legal Protection	Algerian Conservation Status	IUCN Conservation Status	Potential abundance in Study Area	Bird behavior in Study Area	Observed during field survey
Milvus migrans	-	Black kite	Desert pavement	Decree n° 12-235	Common	LC	Common	MV	No
Monticola solitarius	-	Blue rock thrush	-	-	Common	LC	Common	W	No
Motacilla alba	-	Wihte wagtail	Oued, sabkha	-	Common	LC	Rare	MV	No
Motacilla flava	-	Yellow wagtail	Oued, sabkha	-	Common	LC	Rare	MV	No
Neophron percnopterus	Taghaldji	Egyptian vulture	Desert pavement, regs, hamadas	Decree n° 12-235	Commoon	LC	Common	MB	No
Oenanthe leucopyga	Moula moula	White-crowned black wheatear	Desert pavement, regs, hamadas	-	Common	LC	Common	RB	No
Oenanthe oenanthe	-	Northern Wheatear	Desert pavement, regs, hamadas	-	Common	LC	Common	MV	No
Otus scops	El hama	Eurasian scops owl	Desert pavement, regs, hamadas	Decree n° 12-235	Common	LC	Rare	MV	No
Passer simplex	Zaouch	African desert sparrow	Desert pavement, oueds	-	Common	LC	Common	RB	Yes,close to Debdeb)
Phoenicurus phoenicurus	-	Common redstart	Desert pavement, oueds	-	Rare	LC	Rare	MV	No
Phylloscopus bonelli	-	Bonelli's warbler	Desert pavement	-	Common	LC	Rare	MV	No
Phylloscopus collybita	-	Common chiffchaff	Desert pavement	-	Common	LC	Rare	MV	No
Pterocles coronatus	Tagdout	Crowned sandgrouse	Desert pavement, oueds	-	Common	LC	Rare	RB	No
Pterocles lichtensteinii	Tagdout	Lichstenstein's sandgrouse	Desert pavement, oueds	Decree n° 12-235	Common	LC	Rare	RB	No
Ptyonoprogne fuligula	Khotefa	Rock martin	Escarpments, oueds	-	Common	LC	Common	RB	No
Spilopelia senegalensis	Tadjeredjert	Palm dove	Oases, water sources (oueds, dayas)	-	Common	LC	Rare	RB	No
Streptopelia turtur	Tinkarrout	Turtle dove	Oases, depressions	-	Common	LC	Rare	MV	No
Sylvia cantillans	Sidden-izien	Subalpine warbler	Desert pavement, regs,	-	Common	LC	Common	MV	No

Scientific name	Local name	English name	Preferred Habitat	Algerian Legal Protection	Algerian Conservation Status	IUCN Conservation Status	Potential abundance in Study Area	Bird behavior in Study Area	Observed during field survey
			hamadas						
Sylvia Conspicillata	Sidden-izien	Spectacled warbler	Desert pavement, regs, hamadas	-	Common	LC	Common	WI	No
Sylvia deserticola	Sidden-izien	Tristam's warbler	Desert pavement, regs, hamadas	-	Common	LC	Common	RB	No
Sylvia hortensis	Sidden-izien	Orphean warbler	Desert pavement, regs, hamadas	-	Common	LC	Common	MV	No
Sylvia melanocephala	Sidden-izien	Sardinian warbler	Desert pavement, regs, hamadas	-	Common	LC	Common	WI	No
Turdoides fulvus	Etiyyeti	Fulvous charterer	Desert pavement, regs, hamadas	-	Common	LC	Common	RB	No
Tyto alba	El hama	Barn owl	Desert pavement, oueds	Decree n° 12-235	Common	LC	Rare	RB	No
Upupa epops	Hudhud	Hoopoe	Oases, depressions	Decree n° 12-235	Rare	LC	Rare	MV	No
Unidentified Raptor									Yes, flying over an oued

Note : IUCN Categories : LC : Least Concern

Bird Behaviour : RB : Resident Breeder ; MV : Migratory Visitor ; WI : Wintering ; MB ; Migratory Breeder.

Source: ERM, BEXAM, 2015

As reflected in Table 4.11, thirteen bird species potentially occurring within the Study Area are protected by the Algerian authorities under Decree nº 12-235 of May 24th, 2012, that establishes the list of protected species. None of the bird species potentially occurring in the Study Area is included in the list of endangered species within Algerian territory as set by Ordinance 06-05 of 15th July 2006.

Most of the species in the Study Area are described as resident breeders or migratory visitors to the area.

During the field survey in May 2015, birds were observed only in the vicinity of Debded. This included only species typically associated to the human presence as the desert sparrow (*Passer simplex*) and the dove (*Columbia livia*). In addition one unidentified raptor was observed flying over an oued.

4.3.5.4 Reptiles and amphibians

Herpetofauna (reptiles and amphibians) can play an important ecological role in maintaining the biological balance of natural ecosystems as they occupy key positions in many trophic chains, whether as predators of many species of insects and rodents, or as prey for other reptiles, raptors, and small carnivores (Nouira, 1996).

Amphibian presence within the Study Area is not expected as they require areas with high humidity and permanent surface water. In practical terms this means that they are basically limited to oases or irrigated areas as those located close to Debdeb village, including the discharge point of wastewater, and therefore are practically absent in the Study Area (i.e., potentially present only in certain areas linked to O&G activities such as water ponds, or to the village etc.).

Table 4.12 presents a summary of the herpetofauna potentially present in the Study Area. This summary is not to be considered an exhaustive list of reptiles and amphibians but a selection of the most representative species, based on local expert knowledge of the Study Area and the desktop analysis (i.e., considering the habitats present and species ranges in North Africa).

Table 4.12 Herpetofauna species found and potentially present in the Study Area

Scientific name	Local name	English name	Preferred Habitat	Algerian Legal Protection	Algerian Conservation Status	IUCN Conservation Status	Potential abundance in Study Area	Observed during field survey
Acanthodactylus scutellatus	Timkelkelt	Desert lizard	Oueds, depressions	-	Common	NE	Common	No
Agama agama	Emeterter	Common Agama	Oueds, depressions	-	Rare	NE	Rare	No
Agama impalearis	Emerterter	Bibron's agama	Oueds, depressions, hamada	Decree n° 12-235	Rare	LC	Rare	No
Cerastes cerastes	Um groon	Horned viper	Oueds, depressions	-	Common	NE	Common	No
Cerastes vipera	Tachelt	Sand Viper	Oueds, ergs	-	Rare	LC	Rare	No
Lythorynchus diadema	Seffeltes	Diademed sand-snake	Oueds, depressions	-	Rare	LC	Rare	No
Mesalina guttulata	-	Small spotted lizard	Oueds, regs, hamada	-	Common	NE	Unknown	No
Mesalina rubropunctata	-	Red spotted lizard	Gravel rocky areas (regs, scarpments)	-	Common	NE	Unknown	No
Psammophis schokeri	-	Schokari sand snake	Oueds, depressions	-	Rare	NE	Rare	No
Ptyodactylus hasselquistii	Emezerega	Fan-footed gecko	Oueds, reg, hamada	-	Common	NE	Unknown	No
Scincus scincus	Tahellemwit	Sandfish	Erg, oueds	Decree n° 12-235	Common	NE	Unknown	No
Stenodactylus petrii	-	Dune gecko	Oueds, reg, hamada	-	Rare	NE	Unknown	No
Stenodactylus stenodactylus	-	Elegant gecko	Oueds, reg, hamada	-	Common	NE	Unknown	No
Tarentola ephippiata hoggarensis	-	African wall gecko	Oueds, reg, hamada	-	Rare	NE	Unknown	No
Tarentola neglecta	-	Algerian Wall gecko	Oueds, reg, hamada	-	Rare	NE	Unknown	No
Trapelus mutabilis	Emerterter	Desert agama	Oueds, reg, hamada	Decree n° 12-235	Rare	NE	Unknown	No
Tropiocolotes steudneri	-	Algerian sand gecko	Oueds, reg, hamada		Rare	NE	Unknown	No
Tropiocolotes tripolitanus	-	Northern sand gecko	Oueds, reg, hamada	-	Common	LC	Unknown	No
Uromastyx acanthinurus	Dab	Spiny tailed lizard	Oueds	Decree n° 83-509 Ordinance n° 06-05	Common	NE	Rare	No
Uromastyx geyri	Dab	Geyr's spiny tailed lizard	Oueds, reg, hamada	Decree n° 12-235	Rare	NE	Unknown	No
Varanus griseus	Aghata	Desert monitor lizard	Hamadas, wadis, depressions	Decree n° 83-509	Common	NA	Rare	No

Source: ERM, BEXAM, 2015

Table 4.12 shows that the Algerian authorities consider five reptile species as protected under Decree nº 12-235 of May 24th, 2012, that establishes the list of protected species, and Decree 83-509 of 20th August, 1983. *Uromastyx acanthinurus* is also included in Ordinance o6-05 of 15th July 2006 that gathers the list of species assessed as endangered in Algerian territory.

No traces of reptile species were recorded during the field survey within the Study Area.

4.3.5.5 Invertebrates

The main invertebrate species potentially present are arthropods. They are relatively common and none are protected by the IUCN or Algerian law. Table 4.13 presents a selection of invertebrate species potentially present in the Study Area.

During the field survey, no invertebrate species were observed across the 42 stations visited.

Table 4.13 Selection of invertebrate species potentially present in the Study Area

Scientific name	English name
Anodroctonus amoreuxi	Fat tailed scorpion
Anodroctonus australis	Yellow fat tailed scorpion
Anodroctonus bicolor	Black fat tailed scorpion
Buthacus arenicola	Sahara Scorpion
Buthiscus bicalcaratus	Sand scorpion
Buthus tunetanus	Yellow scorpion
Eremiaphila sp.	Desert mantis
Laisius niger	Black ants
Orthochirus innesi	-
Pimelia deserta	Black ground beetle
Pimelia deresa	Darkling beetle
Scorpio maurus	Large clawed scorpion
Scolopendra sp.	Desert Centipede
Sympetrum striolatum	Common darter dragonfly
Trichodes apiarius	Bee-eating beetle

Source: ERM, BEXAM, 2015

4.3.6 Protected and Designated Areas

Algeria includes a range of different types of protected areas. Based on the United Nations List of Protected areas in Algeria (2014), these zones can be divided between nationally protected areas and internationally protected areas, as follows:

- Nationally protected areas, including Cultural Parks, Hunting Reserves, Marine Nature Reserves, National Parks and Nature Reserves.
- Internationally designated areas, including Ramsar sites, UNESCO-MAB Biosphere reserves, and World Heritage sites.

As presented in *Figure 4.38* there are no protected or designated areas within the Study Area. The closest protected or designated area (the Ahagghar Cultural Park) is located more than 280 km away (see Table 4.14).

Table 4.14 National protected and internationally designated areas in the proximity of the Study Area

Name of the area	Type of nationally protected areas	Type of internationally designated area	Associated surface area (km^2)	Distance to the Study Area (km)
Tassili N'Ajjer	Cultural Park	-	133,300	352.8
	-	World Heritage Site	72,000	352.8
	-	UNESCO-MAB Biosphere Reserve	72,000	352.8
Ahagghar	Cultural Park		528.560	287.1
Valley d'Iherir	-	Ramsar site	65	478.0
Chott Ain El Beida	-	Ramsar site	68.53	384.0
Chott Oum Raneb	-	Ramsar site	71.55	388.0
Chott Sidi Slimane	-	Ramsar site	6.16	591.9
Sebkhet el Melah	-	Ramsar site	189.4	561.76

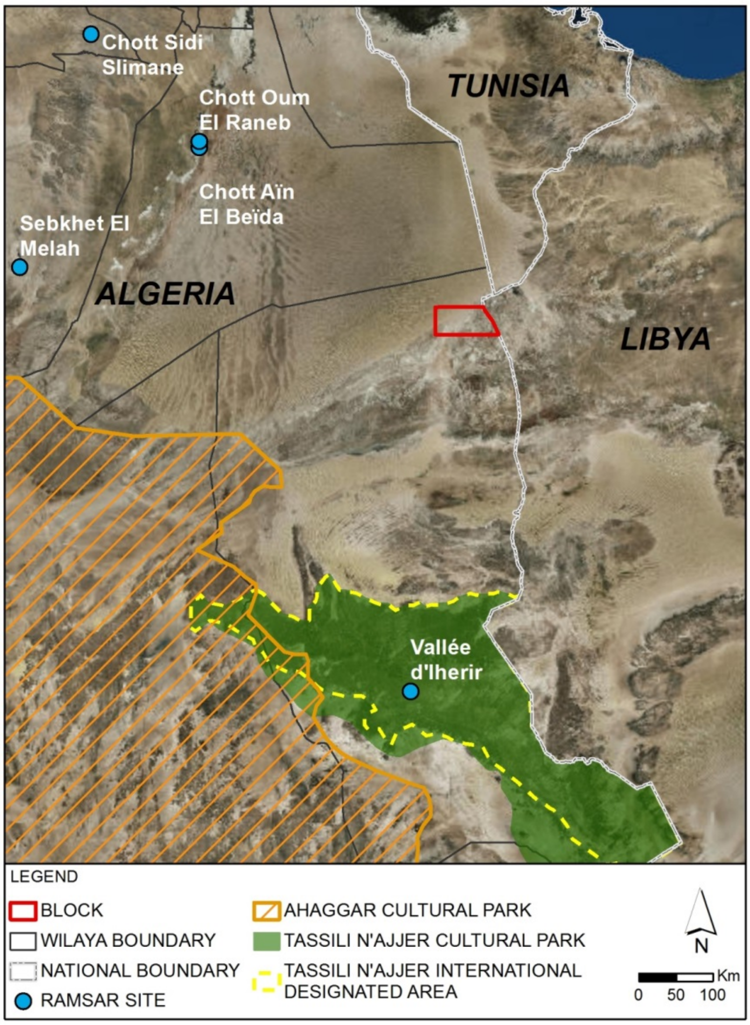
Tassili N'Ajjer is an internationally important site for its fauna and flora, but also due to its particular geology. It supports 28 nationally rare plants, one of which is *Cupressus dupreziana* (the Saharan Cypress). This is one of the 12 critically endangered plants selected by IUCN's Species Survival Commission. The entire region is also important for migratory birds. In addition, the site was designated a World Heritage Site in 1982 for the ensemble of rock engravings and paintings which are among the best examples of prehistoric art in the world.

The Ahaggar Cultural Park was also protected due to its wealth of geological and archaeological resources, as well as to preserve the flora and fauna of this sandstone massif and plateau. It is located at the southern edge of Algeria and includes three different biogeographical areas based on existing vegetation, making the flora of the park one of the most diverse in the Sahara.

The combination of the Ahaggar and the Tassili N'Ajjer Cultural Parks constitutes a geographical and geomorphological complex that, given its combined area, constitutes the largest protected area in Africa, and the second in the world.

Similarly, the Ramsar sites recorded are very important for the conservation of fauna and flora that relies on the water resources present in them for their survival.

Figure 4.38 Nationally and internationally designated areas in the vicinity of the Study Area



Source: ERM, 2015.

4.4 Socioeconomic environment

4.4.1 Overview and administration structure of the Study Area

This section provides an overview of the main socioeconomic features of the Study Area. The information in this section is presented at Wilaya (Illizi) and commune (Debdeb) level, with reference to other levels (i.e., national) where relevant.

The Illizi Wilaya is made up of 3 Daïras, In Amenas, Illizi and Djanet, and 6 Communes: Illizi, Djanet, Debdeb, Bordj Omar Driss, Bordj El Houas and In Amenas. The Study Area is located within the Illizi Wilaya, the Daïra of In Amenas and the commune of Debdeb (see Figure 4.39).

Illizi Wilaya is the third largest Wilaya in Algeria occupying a total area of 284,618 km^2, and representing 12 % of Algeria. Debdeb Commune covers a total area of 32,000 km^2 and represents 11.24% of Illizi Wilaya.

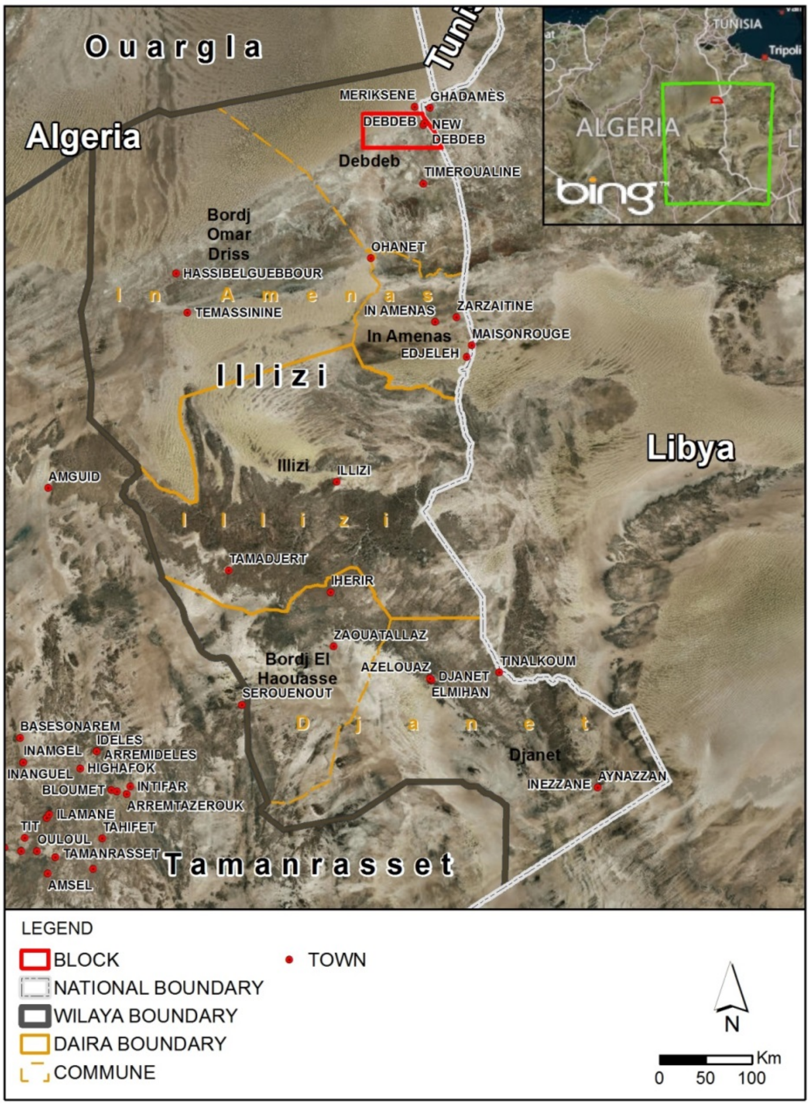
The Study Area is dry and barren. The only settlement within the Study Area is Debdeb (old and new). The only other two inhabited places close to the Study Area are the small settlements of Meriksene and Timeroualine located 21km and 35 km to the north and south of Debdeb respectively (see Figure 4.39). Illizi, the capital city of Illizi Wilaya, is located approximately 400 km to the south of the Study Area.

4.4.2 Data Sources and Assumptions

The data included in this section has been collected from the following sources:

- Secondary data: available literature, published information, and analysis of satellite imagery.
- Primary data to supplement and ground-truth secondary data: A nine day field visit to the Study Area was performed in May 2015. It included a visit to the Debdeb, Meriksene and Timeroualine settlements as well as a series of courtesy meetings with key authorities including the General Secretary of Illizi Wilaya, representatives from the key regional Directorates and the heads of In Amenas Daïra and Debdeb commune.

Figure 4.39 Locations of the Study Area, Daïras and Communes in Illizi Wilaya



Source: ERM 2015

During the field survey, two documents were provided by the authorities (Wilaya and APC [Communal Popular Assembly, in French *Assemblée Populaire Communale*]) that have been key in describing the socioeconomic baseline:

- **The APC Development Plan and Urban Planning** (in French *Plan de Développements et d'Aménagements Urbain* or PDAU) dated 2010 and referred to as ***Debdeb APC, 2010*** in this document. The report includes the most up-to-date information available at a commune level, which mainly dates from 2008.

- **The Directorate of Programming and Budget Monitoring 2014 Statistical Yearbook for Illizi Wilaya** (in French *Monographie de la Wilaya d'Illizi de la Direction de la Programmation et du Suivi du Budget* [DPSB]), published in February 2015 and referred as ***DPSB, 2015*** in this document. The report includes statistical information on the socioeconomic and cultural activities of each commune found in the Illizi Wilaya[4]. .

In summary, the statistical data included in this section is based on the 2010 Debdeb APC PDAU in the relevant sections, as well as on the 2014 Statistical Yearbook wherever data from the APC is missing.

4.4.3 Demographics

4.4.3.1 Population, age and gender

National and Wilaya Context

In 2013, the Algerian population numbered 39.1 million inhabitants (World Bank, 2015) and was mainly concentrated in the coastal regions. Algeria has a young and growing population. In 2013, almost 32% of the population was estimated to be under 14 years of age and the average annual growth rate was 2.07% (World Bank, 2015). In 2012, life expectancy at birth in Algeria was 73 years (UNDP, 2013). The majority of the Algerian population (80%) lives in urban areas (FAO, 2014).

The Illizi Wilaya is inhabited by approximately 52,000 people representing less than 0.2% of the total population, making Illizi the second least populated Wilaya in the country. The average population density in Illizi Wilaya is approximately 1.17 inhabitants per km² while the national average is estimated to be 16.08 inhabitants per km^2 (OECD, 2014).

Table 4.15 Demographics for the Illizi Wilaya, 2008*

	Population (inhabitants)	Pop. aged <15	Female pop. (%)	Pop. growth rate (%) between 1998 and 2008
Illizi Wilaya	52,331	43%	46%	4.5

Note: Last census in Algeria performed in 2008[5].

Source: DPSB, 2015

[4] The data presented in the 2014 Statistical Yearbook is based on the APC PDAU reports of each commune. However, it has been observed that the numerical data do not always match exactly between both documents (which could be due to typographic errors). Nevertheless, these numerical differences are not considered significant in presenting the baseline for the Study Area

[5] RGPH: *Recensement Général de la Population et de l''Habitat* 2008, ONS

The population figures for the six communes within Illizi Wilaya are presented in Table 4.16 . Approximately 60% of the total population in the Wilaya lives in the communes of Illizi and Djanet. The population in Debdeb Commune was 4,340 inhabitants in 2008 (DPSB, 2015) with a population density of 0.13 inhabitants per km².

Table 4.16 Population in the Daïras and Communes in Illizi Wilaya (2008*)

Daïra	Commune	Population (inhabitants)
In Amenas	**Debdeb**	**4,340****
	In Amenas	7,385
	Bordj Omar Driss	5,736
Illizi	Illizi	17,252
Djanet	Djanet	14,655
	Bordj El Haouas	2,963
Total		**52,331**

Notes:

* *Last census in Algeria performed in 2008.*

** *Population data in Debdeb Commune for 2008 varies in the official sources. The 2014 Statistical Yearbook of Illizi Wilaya considers 4,340 inhabitants (see Table 4.16) while the APC PDAU Report of Debdeb counts 4,238 inhabitants in the Commune in 2008 (see Table 4.17.) Source: DPSB, 2015*

The population growth rate in Ilizi Wilaya is higher than the national average. The population is expanding, due to a high birth rate, estimated to be 3.4% (DPSB, 2015), higher than the national rate of 2.5% (Office for National Statistics, ONS, 2013). However, the birth rate in the Commune of Debdeb was 1.8 % in 2014, lower than the regional and national rates.

Debdeb Commune and Study Area

As shown in Figure 4.40 there are three settlements within Debdeb Commune: Debdeb, Meriksene and Timeroualine. Only Debdeb falls within the Study Area. Meriksene, designated as secondary settlements, and Timeroualine, an area with dispersed settlements, are located 21 km and 35 km to the north and south of Debdeb respectively. Outside Debdeb, the Study Area is largely uninhabited.

As presented in Table 4.17 and Figure 4.41 below, the largest settlement is Debdeb with over 3,600 inhabitants, representing 85% of the population in the commune.

Debdeb, encompasses two zones: a new urban zone (in French : *La nouvelle Zone Urbaine* or ZHUN) and an “old” urban zone. The ZHUN is identified as the primary settlement, while the “old zone” is designated as a secondary settlement. The ZHUN was created as “old” Debdeb is situated in a zone potentially exposed to oued flooding. Consequently, the development of a new zone, 2 km further north in the direction of Libya, was proposed in 1986 in order to meet the requirements of the population. Today the “new Debdeb” occupies 31.83 hectares, and “old Debdeb”, 59.95 hectares. The new urban zone includes 285 new houses and also new utilities and infrastructure (e.g., water tanks, the APC headquarters and a vocational training centre) (BEXAM, 2015).

Table 4.17 Population in Debdeb Commune (2008)

Settlement	Population	% of Total
Debdeb (Old)	2,707	63.87%
Debdeb (New)	906	21.38%
Meriksene	346	8.17%
Timeroualine	259	6.11%
Other*	20	0.47%
Total Commune	4,238**	100%

Notes:

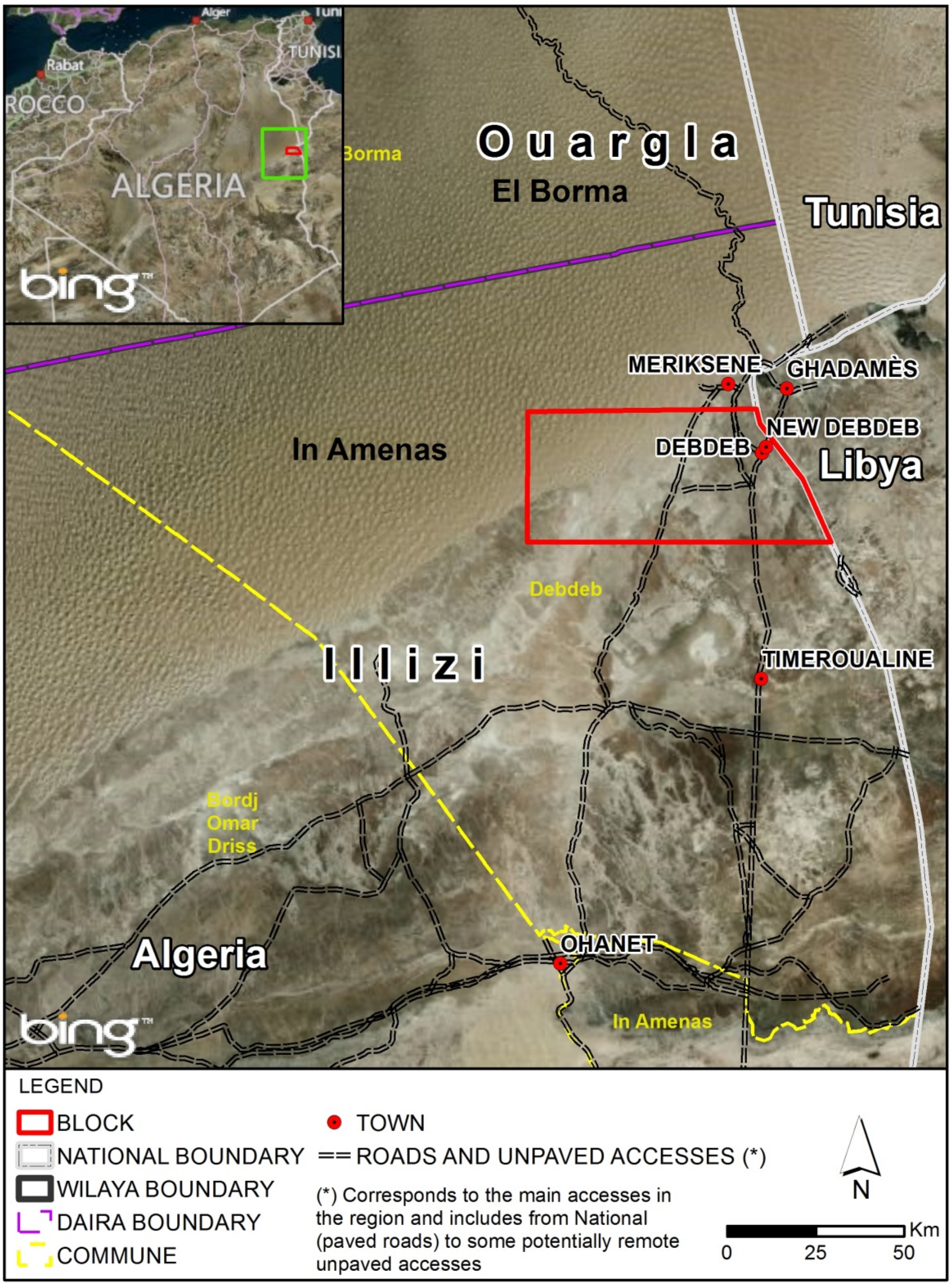
* *These are isolated houses near Meriksene and Debdeb.*

** *Population data in Debdeb Commune for 2008 varies in the official sources. The 2014 Statistical Yearbook of Illizi Wilaya considers 4,340 inhabitants (see Table 4.16) while the APC PDAU Report of Debdeb counts 4,238 inhabitants in the Commune in 2008 (see Table 4.17), Source: Debdeb APC, 2010.*

Figure 4.40 Meriksene (left) and Debdeb (right)

Source: BEXAM, 2015

Figure 4.41 Settlements in Debdeb Commune



Source: ERM, 2015

Table 4.18 includes a breakdown of the population in Debdeb Commune by age. Like the age structure of the whole country, the population in the Debdeb Commune is predominantly young. Approximately 53% of the total population was less than 19 years old in 2008, slightly higher than the average for the Wilaya of 47% in 2008 (ONS, 2008). The population in Debdeb Commune in 2008 comprised 47.85% women.

Table 4.18 Age Structure of the Population in Debdeb Commune in 2008

Age (years)	Men		Women		Total	
0-5	*334*	*7.89 %*	*326*	*7.70 %*	*660*	*15.59 %*
6-15	*610*	*14.4 %*	*555*	*13.09 %*	*1165*	*27.49 %*
16-19	*234*	*5.52 %*	*214*	*5.05 %*	*448*	*10.57 %*
20-59	*895*	*21.11 %*	*828*	*19.54 %*	*1723*	*40.65 %*
More than 60	*137*	*3.23 %*	*105*	*2.47 %*	*242*	*5.70 %*
	2,210	***52.15 %***	***2,028***	***47.85 %***	***4,238***	***100 %***

Source: Debdeb APC, 2010.

Gender

Gender-related policies have been adopted, the most striking example being the law on increasing the participation of women in elected assemblies to 30% (AfDB, OECD, UNDP, 2014). According to the 2014 Statistical Yearbook (DPSB, 2015), in the Debdeb Commune, 73% of the registered employed population are women (employed mainly by the administrative sector). Refer to Section 4.4.4.2 for further information on employment data.

4.4.3.2 Migration and Population Change

Over the last twenty years, a demographic pattern has become evident in the Wilayas located in the south of Algeria including Illizi: the population in the southern urban areas coexists between local inhabitants, Algerian migrants, settled Sub-Saharan migrants, and Sub-Saharan migrants in transit. This pattern is perceived as an urban development of the southern Wilayas. On the one hand, the Algerian migrants perceive this urban development as a possibility for enrichment. On the other hand the Sub-Saharan migrants perceive it as an opportunity to migrate to European countries (Cairn info, 2004)..

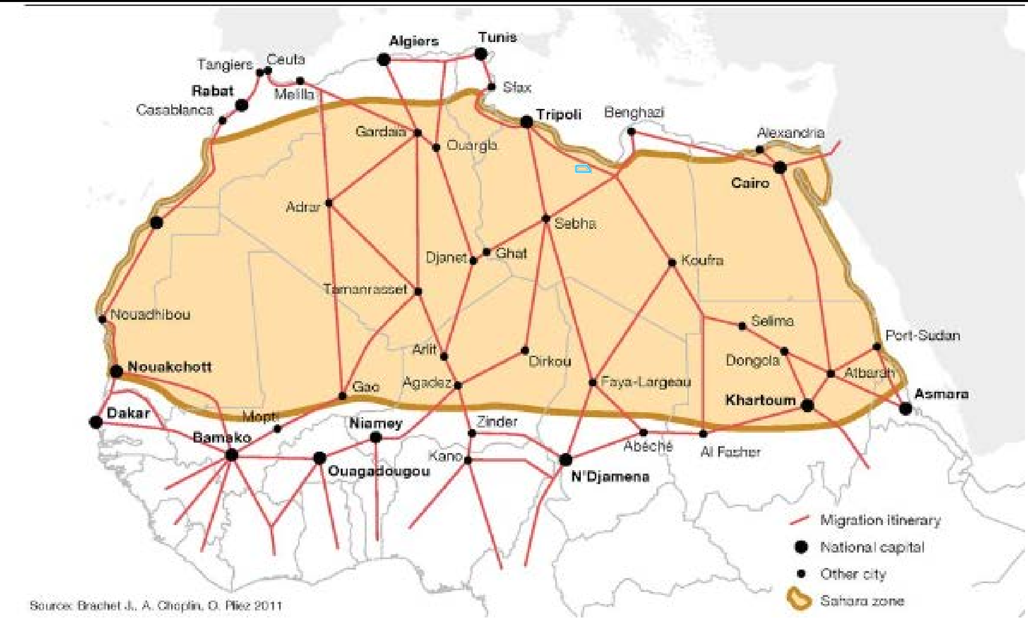
Urban development in the southern Wilayas has been encouraged by the development of infrastructure such as national roads, e.g., National Road 3 [NR-3] which connects Illizi Wilaya to the main towns in the south such as Touggourt, Ouargla and Hassi Messaoud. Thanks to these improvements in urban infrastructure, the national demographic census in 1998 showed the highest population growth rate in the south of Algeria. In Illizi Wilaya, the majority of people arrived from the south (63%), while 33% arrived from Algeria's northern Wilayas (Cairn info, 2004).

The Sub-Saharan migration, which started in the 70s, comprises the migration of Malians and Nigerians into the urban areas in the south of Algeria. Even though these migrants only stay temporarily in these towns, they still impact in the population increase as it is a constantly-maintained flow. The migrants select urban areas where they can benefit from a discreet welcome by the local population and where there is a need for workers (Cairn info, 2004).

During the field survey performed in 2015, some community members reported the occasional presence of Sub-Saharan migrants (mainly from Mali and Niger) that pass through Illizi Willaya as it is on the way from the frontier to other regions. Generally, these migrants do not settle down in the region but move on, looking for job opportunities. In addition, community members reported that some Libyans escaping from the civil war in Libya settled in Debdeb during the civil war. No conflicts between the local population and migrants were reported during the field survey.

Figure 4.42 shows the migration routes in North Africa and Algeria and demonstrates that the Study Area is not located along a known main migration route.

Figure 4.42 Migration Routes (Study Area in Blue)



Source: OECD, 2014

4.4.3.3 Language, Religion and Ethnicity

The official language of Algeria is Modern Standard Arabic, as specified in its constitution since 1963, and this is spoken by about 83% of the population (KPMG, 2013). Although French has no official status, it is still widely used in government, culture, media (newspapers) and education (taught from primary school), and it can be regarded as the *de facto* co-official language of Algeria. Other languages spoken in Algeria include Berber dialects such as Kabylie Berber (Tamazight), Chaouia Berber (Tachawit), Mzab Berber, and Touareg Berber (Tamahaq).

The majority of the population in Algeria (99%) is Arabised Berber or Arab-Berber. Nearly all Algerians (99% of the population) are Muslim, with almost all practicing Sunni Islam, with the exception of around 200,000 Ibadis in the M'zab Valley in Ghardaia Wilaya (located to the northwest of Illizi Wilaya, adjacent to Ouargla). The Algerian Sahara is inhabited by 3 main ethnic groups: Berbers (Sahandja, Touaregs and Mozabites), Maures (Arab-Berbers or Saharawi's), and Arabs (Châamba, Kountas and Maghrebins).

The population of Illizi Wilaya is principally Touareg, a Berber sub-group that itself can be further subdivided based on the region they live in (e.g. the Kel Ahaggar in the Hoggar region, and the Kel Ajjer in the Djanet region).

However, during the field survey performed in 2015,it was reported that the population in the Study Area is principally Châamba (Arab tribe mainly from Matlili, El Menia, Ouargla, El Oued and Occidental Erg) with a minority of Touareg. The main spoken language in the Study Area is Classical Arabic and only the population that has received an education speak French (BEXAM, Fieldwork 2015).

4.4.3.4 Nomadic populations

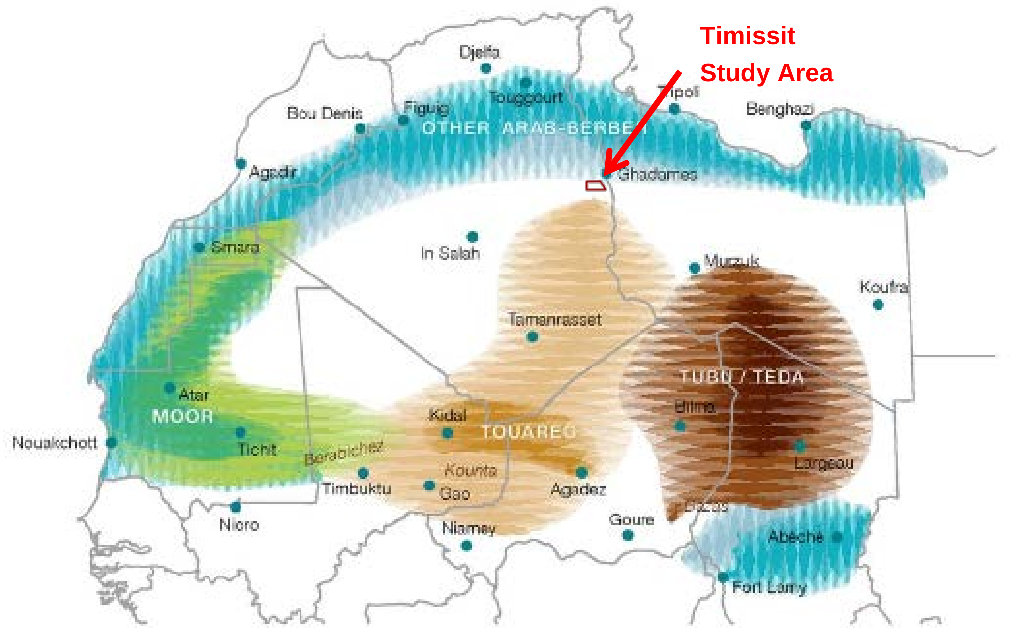
The geographic distribution of the major nomadic groups present in Algeria is presented Figure 4.43. The southern frontier of the Sahara Desert is where the desert nomads, the Touareg, the Châamba, and others, found refuge after the Arab arrival in the 7th century, and is where many of them still live.

According to the Tenth Session of 2011 of the United Nations' Permanent Forum on Indigenous Issues, the Touareg pastoralist nomads are considered Indigenous People[6]. Today, however, many Touaregs live in sedentary communities in the towns bordering the Sahara that were once the great trade centres of western Africa. There are about 65,500 Touaregs in Algeria, mainly concentrated in the south of the Hoggar, and around Tamanrasset and Djanet, to the south of the Study Area.

In general terms, the nomadic lifestyle is declining in the northern Sahara, and a large number of nomads have settled near water sources and small population centres. For instance, nomads represented less than 1% of the total population in 2008 (approximately 230,000 individuals), whereas they accounted for 10% at independence (OECD, 2014). It should be noted, however, that these census methods are not accurate, as they consist of consulting tribal leaders, which has the effect of narrowing the definition of nomadism to groups living in tents and uninvolved in agriculture. This excludes living a semi-nomadic lifestyle[7] which is the most common situation.

During the field survey performed in 2015, no signs of nomadic activities were identified in the Study Area. Local authorities consulted during the meetings reported that the area was not frequented by nomads.

Figure 4.43 Major nomadic groups in the Sahara (Study Area in red)



Source: OECD, 2014

6 Indigenous Peoples are culturally distinct societies and communities; the land on which they live and the natural resources on which they depend are inextricably linked to their identities, cultures and economies (OP 4.10 - Indigenous Peoples, World Bank, 2005).

7 Pure pastoral nomads rely for their subsistence upon their herd. Milk from camels, cattle, sheep and goats, provides food. However, within semi-nomadic groups, part of the tribe – often the women and children – remain near water-holes, and sow and gather crops whilst the men migrate to pastures with the herds. (D. B. Grigg, 1974).

4.4.4 Economy, employment and livelihoods

4.4.4.1 Economy

The Algerian economy's true growth was an estimated 3% in 2013, driven mainly by domestic demand, including public investment (AfDB[8], OECD[9], PNUD[10], 2014). The economy relies heavily on oil and gas, which provides more than a third of the GDP (36% in 2012), 70% of government revenue and 98% of exports.

As shown in Table 4.19, the agricultural contribution to the Algerian GDP increased in the period 2008-2012, from 7% to 9.7%, thanks to a good agricultural season. The industrial sector (excluding oil and gas) still contributes less than 5% towards the GDP, but grew strongly during the first six months of 2013. Construction and public works expanded in the period 2008-2014, driven by major infrastructure projects carried out as part of the five-year 2010-2014 public investment programme (*Programme investissements publics*) (refer to Section 4.4.5*)*. Services contributed almost 41% of the GDP in 2012.

Table 4.19 GDP by sector (percentage in 2008 and 2012)

	2008 (%)	2012 (%)
Agriculture, hunting, forestry, fishing	7.0	9.7
Mining[11]	49.1	36.0
Manufacturing (industry)	3.9	4.0
Electricity, gas and water (1)	0.9	0.8
Construction	8.4	9.6
Wholesale and retail trade, hotels and restaurants (1)	10.5	12.2
Transport, storage and communication (1)	8.0	7.4
Finance, real estate and business services (1)	1.0	1.2
Public administration, education, health and social work, community, social and personal services (1)	10.2	18.1
Other services (1)	1.0	1.0

Note: (1) This sectors are considered service industries.

Source: AfDB, OECD, UNDP, 2014

Illizi Wilaya presents physical constraints due to economic growth due to its geographical position, its distance from the important industrial centres (concentrated in the north of Algeria), its desert climate and its uneven topography.

The In Amenas commune, adjacent to the southern part of Debdeb commune, is mainly characterised by oil and gas activities which provide jobs for the majority of the local community, whereas the southern area has tourism (e.g., Tassili National Park) and agricultural activities (Directorate of Trade in Illizi Wilaya[12], 2013). Ouargla Wilaya located to the north of the Study Area is the most important oil and gas region in Algeria, and Hassi Messaoud, located approximately 300 km to the northwest of the Study Area, is the capital of the country's oil and gas industry (refer to Section 4.4.4 below).

[8] AfDB : Groupe de la Banque africaine de développement

[9] OECD; Organization for Economic Co-operation and Development

[10] PNUD : Programme des Nations Unies pour le développement

[11] The Mining sector includes oil & gas related activities which represents in 2008, 48.9% and in 2012, 35.9% of the Algeria's GDP.

[12] In French Direction du Commerce de la Wilaya d'Illizi

During the field survey performed in 2015, it was observed that the main economic activities and livelihoods in the Debdeb Commune area , pastoralism mainly camel husbandry, quarrying activities and informal trading. Although informal cross-border trade[13] was reported to be an important source of income during the field survey, no information is available on trading in the Study Area. See sub-sections below for further information on the other economic activities.

4.4.4.2 Employment

Algeria's labour force consists of approximately 11 million people from a total population of approximately 38 million. The overall unemployment rate in Algeria has declined considerably over the last decade falling from 30% in 2000 to 10% in 2010. According to the Algerian National Office for Statistics (ONS), unemployment in Algeria in September 2014 stood at 10.6%, being higher for women than men, and more prevalent amongst young people (25.2%).

However, international organisations and other observers believe the true unemployment rate to be as high as 25%. According to the European Training Foundation, over 80% of under 30s may be unemployed, including almost 70% of young people aged 16-19, 50.5% of 20-24-year-olds and 35.1% of 25-29-year-olds. Two thirds of the unemployed are new entrants, i.e., they have no work experience (European Training Foundation, 1999).The difference between these figures and estimates from national organisations may be due to the methods used to record employment and unemployment.

As shown in Table 4.20, the main economic sectors in terms of employment are services and construction. Services are particularly important in urban areas, especially for women (79.2% of female employment in urban areas); whereas construction is particularly important in rural areas, as is agriculture (19.4%).

Table 4.20 Active Population in Algeria (September 2014)

	Men (%)	Women (%)	Total (%)
Urban			
Agriculture	4.3	0.6	3.6
Industry	13.1	18.5	14.1
Construction	18.1	1.6	14.6
Services	64.5	79.2	67.4
Rural			
Agriculture	20.4	11.4	19.4
Industry	7.7	23.6	9.5
Construction	26.6	2.1	23.8
Services	45.3	62.9	47.4
Total			
Agriculture	9.9	3.1	8.8
Industry	11.2	19.7	12.6
Construction	21.1	1.7	17.8
Services	57.8	75.6	60.8

Source: ONS, 2014

[13] In this report, informal trade is defined as the flow of goods not reported or inadequately reported to authorities.

Table 4.21 shows the distribution of employment across different sectors in the Illizi Wilaya. As shown, the service sector employs the most people. In Illizi, Wilaya the industry sector, which it is assumed to include oil and gas[14], accounts for 13% of employment.

Table 4.21 Employed population per sector in Illizi Wilaya

	Illizi
Services*	48%
Agriculture	11%
Construction	28%
Industry	13%

*Notes: * Services include tertiary sector of the economy (e.g. Administration, healthcare, education, professional services and others)*
Source: DSPB, 2015

Similarly to the national trend reported by official Algerian sources, the official unemployment rate in Debdeb has decreased from 11.38% in 2008 (Debdeb APC, 2010) to 9.54% in 2014 (DPSB, 2015), which is still slightly lower than the Algerian official national average in 2014 (i.e., 10.6%).

No reliable and updated records on the employed population per sector of Debdeb Commune have been provided. However, it is known that the main sectors of official employment in Debdeb Commune are administration and construction. According to the information provided by the 2014 Statistical Yearbook of Illizi Wilaya (DPSB, 2015), no registered / official employment in Debedb Commune exist for the industry sector, which it is assumed to include oil and gas.

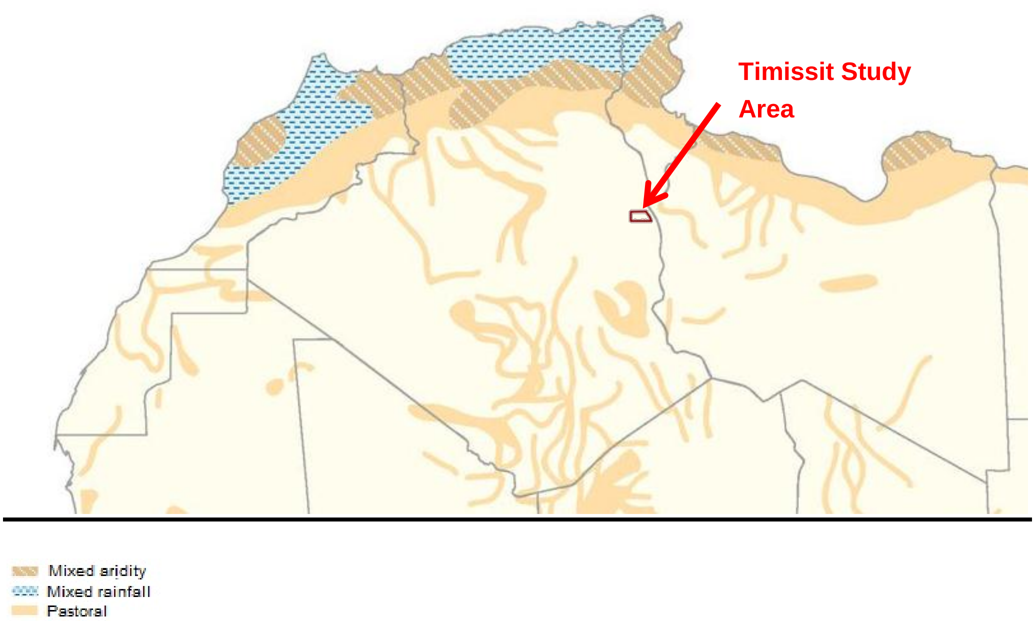
Nevertheless, during the field survey, some industrial activities were identified in the Study Area, such as oil and gas activities (Sonatrach camp) and stone quarrying. These are explained in the following sections.

4.4.4.3 Agriculture

As shown in Figure 4.44, agriculture in Algeria is mainly concentrated along a narrow fringe in the north, where the dominant climate is semi-arid with very irregular rainfall. The southern region of Algeria, including the Study Area, is arid and has very limited agricultural activity.

[14] There are no official numbers on the employment generated at national, wilaya or local level by the oil and gas sector.

Figure 4.44 Agricultural production in Algeria (Timissit license area in red)



Source: OECD 2014

There are no large irrigated areas in Illizi Wilaya (FAO, 2014). In southern Illizi, agriculture is limited to vegetable crops and is mainly developed through programmes to extend irrigated production. Despite this, in Illizi Wilaya, agriculture is a source of employment for 11% of the working population.

With the exception of some small farms mainly dedicated to the cultivation of date palms, found in the surroundings of Debdeb, the Study Area does not present any agricultural potential.
Figure 4.45 shows an irrigated farm in Debdeb with recently planted palm trees. During the field survey performed in 2015, the limited agricultural activities existing in the commune were reported to be for self-consumption.

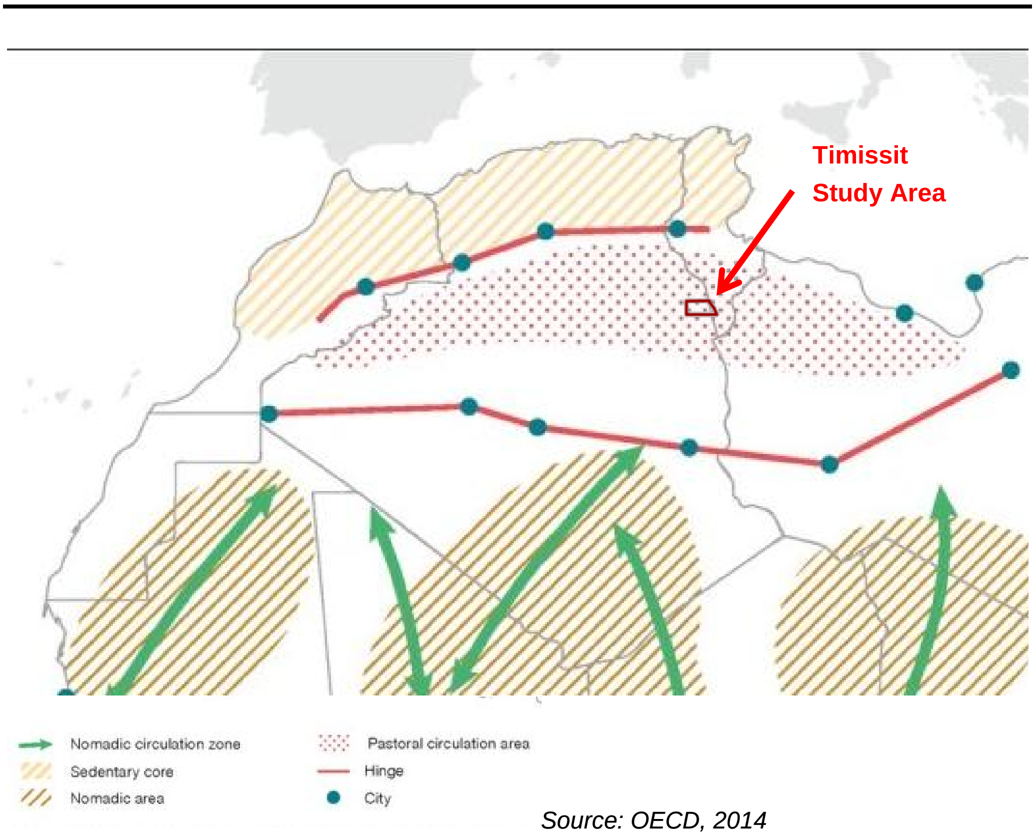
Figure 4.45 Farm outside Debdeb (Old)

Source: BEXAM 2015; Google Earth Pro 2015

4.4.4.4 Pastoralism

Pastoralism[15] was, for a long time, the dominant lifestyle in the Sahara. The pastoral migration patterns follow the rhythm of the seasons and involve frequent and regular travel as well as fragmentation of the social group and the herd. .As shown in Figure 4.46 the Study Area is located in a zone of pastoral circulation[16] (OECD, 2014). It is estimated that there are about 500,000 pastoralists in Algeria (Piquant, D. 2001).

Figure 4.46 Pastoralism in the Saharan region



Source: OECD 2014

During the field survey in May 2015, pastoralism was observed. The pastoralists have fixed living accommodation in Debdeb but they move around in the area with their herd looking for palatable pasture and water (in quality and quantity). The number and preferred areas/routes of pastoralists transiting the Study Area is unknown. Figure 4.47 shows a group, sheltered by their tents looking after their herd of camels.

The pastoralists are known to trace tracks called locally "Rjems" that are marked with pebbles and stones within the reg[17] to guide their herds.

Figure 4.47 A herd of camels and group of pastors observed in the Study Area

[15] Pastoralism is defined as the livelihood of a group of people based on the movement of large herds of herbivores maximising the use of vegetation and water resources, following the rhythm of the seasons.
[16] Pastoral circulation is defined as movement of pastors and their herds across different areas that have agricultural and pastoral vocations.
[17] Regs are areas covered by desert pavement, gravel and small stones coated with black-brown desert varnish (desert patina).

Source: BEXAM, 2015

4.4.4.5 Oil and gas industry

Algeria is the leading natural gas producer in Africa, the second-largest natural gas supplier to Europe outside the region, and is one of the top three oil producers in Africa.

As detailed in the subsections above, Algeria's economy is heavily reliant on revenues generated from its hydrocarbon sector, which account for about 35.9% of the country's gross domestic product (GDP) in 2012 and 98% of exports, and 70% of government revenues (AfDB, OECD, PNUD, 2014).

Algeria has four operational crude oil refineries: one at Hassi Messaoud (processing capacity of 1.1 million tons per year) which is the largest oil field in Algeria operated by Sonatrach, and which is located approximately 350 km to the north west of the Study Area. The three other refineries are located in the north of Algeria: Algiers refinery (2.7 million tons per year); Skikda refinery (15 million tons per year); and Arzew refinery (2.5 million tons per year).

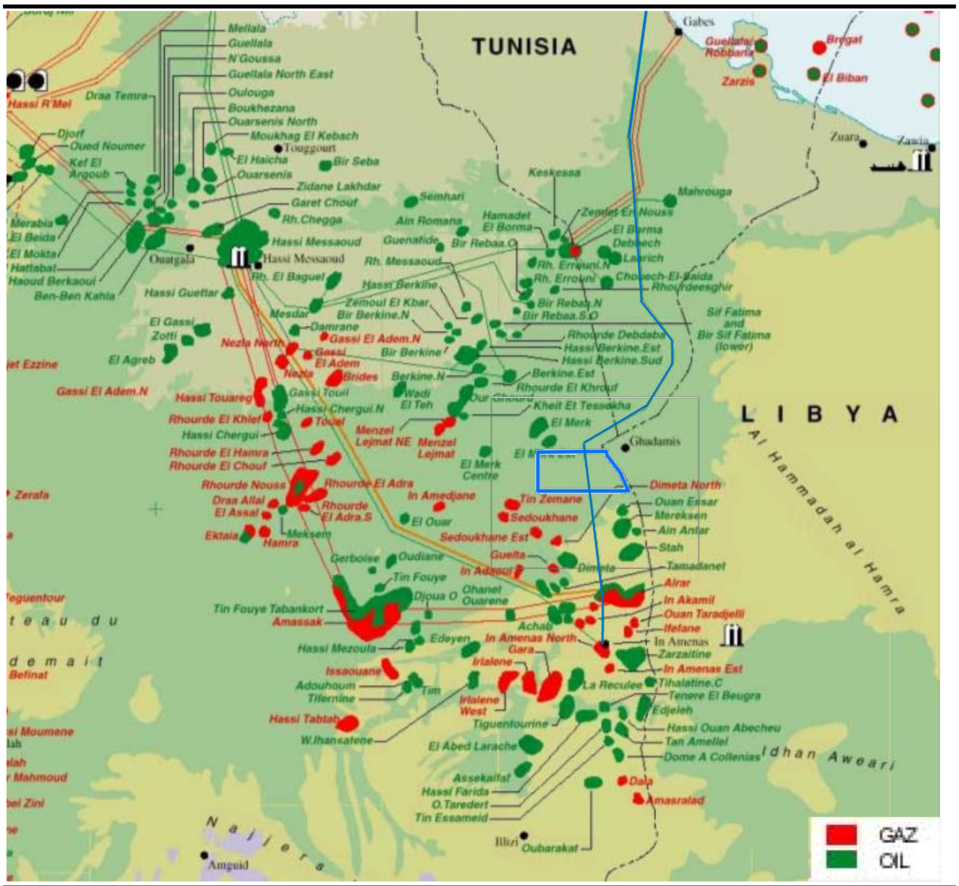
The country's pipeline network is approximately 2,270 km long. Crude oil is exported from terminals at Arzew, Skikda, Algiers, Annaba, Oran, Bejaia, and La Skhirra in Tunisia. Gas extracted from the south of Algeria is transported by pipeline to the facilities at Hassi R'Mel, the largest gas field in Algeria (located more than 500 km to the North of the Study Area),from where the gas is routed to the *Centre National de Distribution du Gaz* manifold for further processing and distribution.

Most of the oil and gas fields are located in Ghadames (Berkine) Basin (so this project) and the Illizi Basin[18]. The oil and gas fields in the north-eastern part of Algeria are shown in Figure 4.48.

In particular, the In Amenas Gas project is situated within the Wilaya of Ilizi, Commune of In Amenas (at approximately 222 km south of Debdeb). It is the largest wet gas development project in the country and includes the development of four primary gas fields in the Illizi Basin and the associated gas processing facility. It commenced production in 2006 and is owned and operated by a joint venture between Algeria's state-owned oil company Sonatrach, BP and Statoil. In Amenas produces nine billion cubic metres of natural gas and 50,000 barrels of condensate per year. It accounts for the one tenth of Algeria's gas output.

[18] The Illizi Basin is situated in the south of Illizi Wilaya, a small portion in western Libya, and south of the Ghadames (Berkine) Basin and encompasses 200,000 km^2. (Klett, 2000).

Figure 4.48 Oil and gas field map for the surroundings of Study Area (Timissit licence area in blue)



Source: MEM, 2014

A 160 km transnational pipeline, belonging to Sonatrach, called OT 1 and which transports crude oil (304,000-bbl/d) passes through the Study Area. The starting point for the OT 1 pipeline is in In Amenas' Central Processing Facility and ends on the Tunisian coast at the export terminal in Skhira, as shown in the Figure 4.48 (EIA, 2007), above. This pipeline is buried and signposted with stakes. Detail of how this pipeline traverses the Study Area is shown in Figure 4.56.

In addition, 40 km south of Debdeb, is a Pumping Station (in French *Station de Pompage or SP*), called SP2 (see Baseline Section 6 Past Operations for further details).

4.4.4.6 Other Industrial Activities in the Study Area

There are three stone quarries reported to exist in the Study Area and which are currently being exploited (*Direction des mines et de l'industrie de la Wilaya d'Illizi, 2012*):

- A gravel quarry (located in ST-07). The gravel extracted is used for the production of asphalt for roads.
- A pink sandstone quarry (located in ST-21)
- A grey beige limestone quarry (located in ST-23)

The precise locations of the stations are presented in Annex C.1.

The number of people from Debdeb Commune (if any) employed in these quarries has not been reported. The quarries are shown in Figure 4.49, Figure 4.50, and Figure 4.51, below.

Figure 4.49 ST-07- Quarry for gravel extraction, Field survey May 2015

Source: BEXAM, 2015

Figure 4.50 ST-21- Quarry for sandstone extraction, Field survey May 2015

Source: BEXAM, 2015

Figure 4.51 ST-23- Quarry for limestone extraction, Field survey May 2015

Source: BEXAM, 2015

4.4.4.7 Tourism

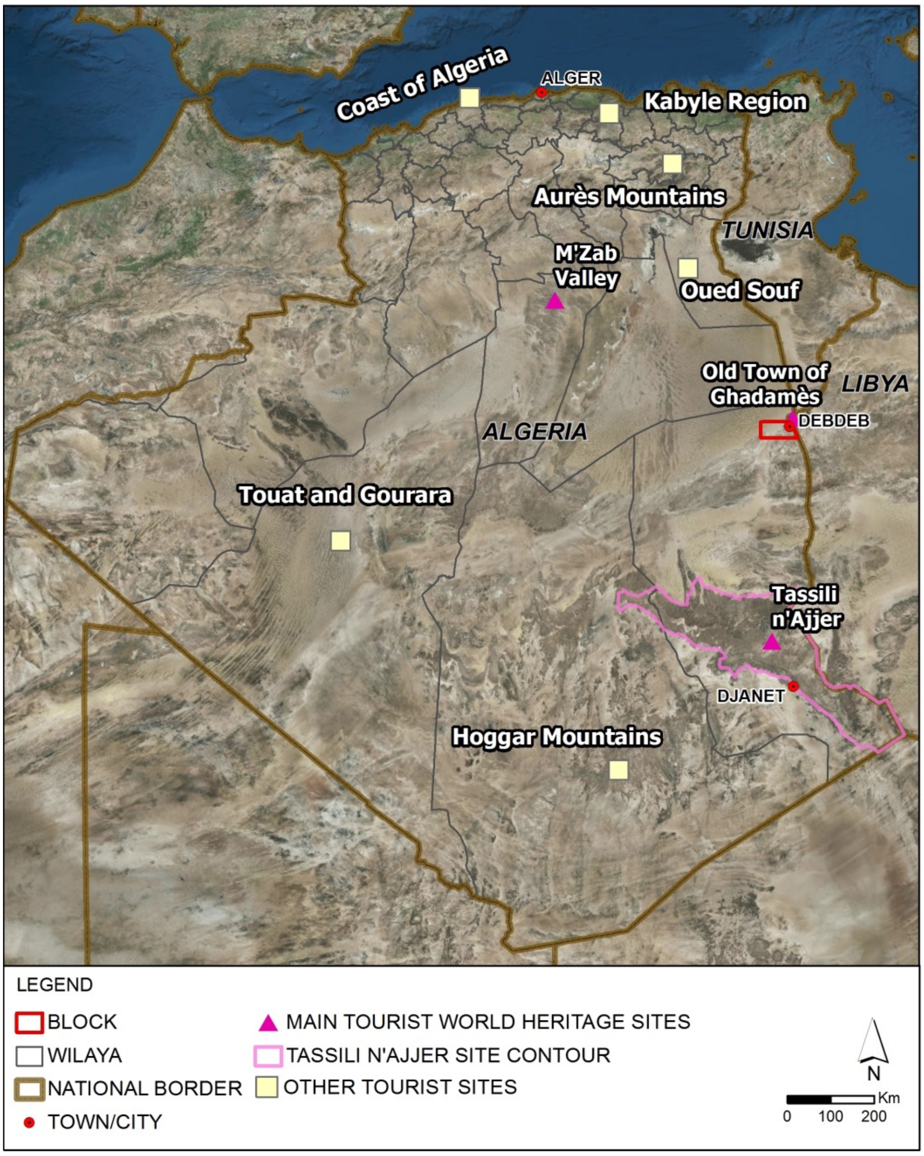
Algeria, with its rich and diverse natural resources and historic sites, has high potential for tourism. However, Algerian tourism is to date largely unrealised. The potential tourist areas identified include the coast, the Aurès Mountains, the Kabylie region, the Wadi Me Zab valley, Oued Souf, the Hoggar Mountains, Tassili N'Ajjer, and Touat and Gourara (Embassy of Algeria to the United States of America (no date)). Figure 4.52 shows the location of these tourist sites with respect to the Study Area.

The Study Area is not a known tourist destination. The nearest Algerian tourist area is the Tassili N'Ajjer National Park, located approximately 350 km to the south of the Study Area, in Illizi Wilaya. In addition, Ghadamès, known as 'the pearl of the desert' and located approximately 8 km to the northeast of the Study Area in Libya, is one of the oldest pre-Saharan towns. It was nominated a UNESCO World Heritage site in 1986.

At the time of writing this report (June, 2015) there is no available data regarding the contribution of Saharan tourism to the overall national tourism. During the field survey, a historical fort called Fort Bordj Messaouda, was observed 10 km northeast of Debdeb. Although this fort has historical/cultural value, it is abandoned and its conservation status is very poor. This fort does not therefore currently constitute a tourist attraction.

The Study Area is consequently not currently a tourist destination and has limited potential for the development of this sector in the immediate future due to its remoteness and security context.

Figure 4.52 Tourist sites and routes (Timissit Licence area in red)



Note: This figure does not include a complete list of Algerian UNESCO sites but only those of high tourist interest Refer to Section 5: Archaeology and Cultural Heritage for a complete list of UNESCO sites in Algeria.
Source: ERM, 2015

For a more detailed review of the historical/cultural sites and archaeological findings in the area, please refer to Section 5 Archaeology and Cultural Heritage.

4.4.5 National and regional development plans

Since 2001, Algeria has had a series of five-year National development plans, which aim to diversify the economy in order to reduce Algeria's heavy dependency on hydrocarbons. These plans contribute to economic growth, and hence to economic and social development, by assigning a specific budget for the construction and improvement of education, health, water supplies, land planning and electricity supply infrastructures; as well as for rural, agricultural, industrial, and research development.

The current National Plan is the five-year plan for economic and social development 2015-2019. Its main objectives include the following:

- Improvement of human development.
    - Further development of basic infrastructures (education, health, etc.) and improvement of public services.
- Support in the development of the national economy.
- Industrial development.
- Encouragement of employment creation.
- Development of a knowledge-based economy.

Moreover, in 2013 the Algerian Government promulgated Instruction nº01 of 11th March, 2013 aimed at promoting the development of employment in southern Wilayas. This Instruction determines that employment of locals from the Wilaya concerned must be prioritised, mainly for non-skilled positions (see Chapter 2 Administrative and Legislation Framework for further details).

During the meetings held in May 2015 with authorities at Illizi Wilaya, In Amenas Daïra and APC of Debdeb, the authorities mentioned that there were two regional development projects planned in the wilaya of interest for this project: a railway project for Hassi Messaoud-In Amenas-Illizi, and a renewable energy project to be developed by Sonelgaz. However, no information is publicly available regarding these projects at the time of writing this report (June, 2015).

4.4.6 Land Use and Ownership Structure

4.4.6.1 Land Ownership Structure

The land tenure system in Algeria involves a combination of customary, statutory and Islamic systems. Land reforms started as early as 1963, immediately after independence, with the first decrees stipulating state ownership of land.

Since the 1980s, land policy has been inspired by the model adopted by Eastern European countries to improve agricultural development. Whilst land ownership remains in the hands of the state, land tenants have been provided with usufruct rights. This policy has also been a condition for improving competitiveness in the process of trade liberalisation and WTO negotiations.

The Constitution of Algeria, Article 52, secures private property and guarantees the right to inherit. Expropriation and compensation of land is regulated by Law 91-11 completed by Executive Decrees 93-186, 05-248, and 08-202, which define expropriation for public utility and set the conditions for implementation as well as determining the procedure and terms for prior compensation which is fair and equitable.

4.4.6.2 Land Use

Urban Land Use

As presented above, the urban areas are represented by three main settlements: Debdeb, Meriksene and Timeroualine (with a surface area of 124.24 ha in 2008).

Figure 4.53 below shows the pattern of the Debdeb urban area present in the Study Area.

Figure 4.53 Urban areas in the Study Area (Debdeb)

Source: Google Earth Pro 7.0, 2015 (Satellite image dated July 2013).

Figure 4.54 Urban areas in the Study Area ("New" Debdeb)

Source: Google Earth Pro 7.0, 2015 (Satellite image dated July 2013).

<u>*Agricultural Land Use:*</u>

Illizi Wilaya is characterised by its bioclimatic constraints. It is marked by an arid and very dry environment that limits the development of agriculture within the area. With the exception of the southern section of Illizi Wilaya, where the presence of an oasis allows some farming, and the limited agriculture present in Debdeb, the area is dry and barren although it supports limited pastoral activity.

The total agricultural surface area in use in Debdeb Commune is 149 ha (1.4 km2) (Debdeb APC, 2010) which is negligible if we consider that the total surface of Debdeb commune is about 32,000 km2. All the agricultural land is found in the surroundings of the three settlements in the commune at a maximum distance of 2-3 km in the case of Debdeb and 150-200 m in the case of Timeroualine and Meriksene.

Figure 4.55 below shows the pattern of the limited agricultural areas present in the Study Area.

Figure 4.55 Agricultural areas in the Study Area (Debdeb)

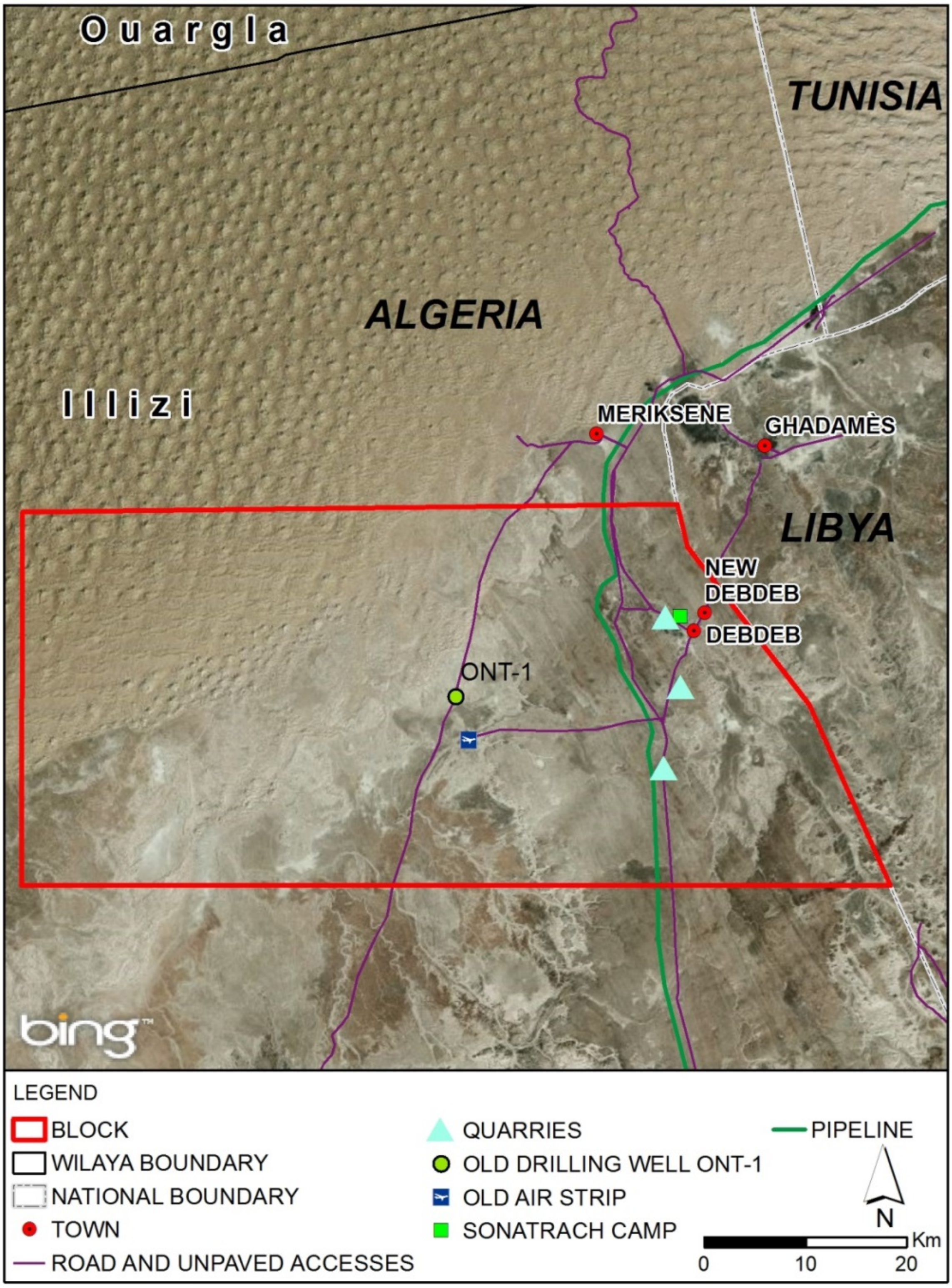
Source Google Earth Pro 7.0, 2015

Industrial Land Use

The Study Area is mostly undeveloped. Industrial land use includes quarrying areas (gravel, pink sandstone and grey-beige limestone) located 2 to 8 km from Debded, abandoned oil and gas exploration facilities (drilling site known as ONT-1 and seismic lines), an operative Sonatrach camp located in the proximity of Debded, as well as hydrocarbon transport (i.e., pipelines) and an abandoned airstrip. More information on evidence of existing and past activities identified in the Study Area (mainly associated to O&G activities) is included in Chapter 6 Evidence of Existing and Past O&G Operations.

Figure 4.56 below shows the location of the abandoned extraction activities, the Sonatrach camp, the pipeline, the quarries and the abandoned airstrip present in the Study Area.

Figure 4.56 Examples of industrial land use in the Study Area



Source: ERM 2015 ; BEXAM 2015

4.4.7 Infrastructure and Public Services

4.4.7.1 Roads and railways

Table 4.22 details the road and rail infrastructure in the Illizi Wilaya. There are plans to improve and extend the road infrastructure of Illizi Wilaya. Although there are roads in Illizi that connect the region with the north of the country, infrastructures remain of poor quality due to the extent of the Wilaya and the Saharan relief, especially in the southern areas of the Wilaya.

Table 4.22 Road and rail infrastructure in Illizi Wilaya

	Illizi
National roads	1,902 km (1,468 km are paved)
Wilaya tracks	904 km
Communal tracks	-
Rail	-

Source: DSPB, 2015

Illizi Wilaya essentially has 4 main routes:

- The National Road NR-53 is very important for the development of the eastern area of Illizi where the Commune of Debdeb is situated, and it also allows access to Libya . The NR-53 connects the Study Area with In Amenas and the NR-3.
- The NR-3, which links the northern and southern parts of the Wilaya, as well as connecting to Ouargla Wilaya (where Hassi Messoud is located).
- The NR-55 which connects Tamanrasset Wilaya and the southern part of Illizi Wilaya.
- The NR-54 which connects Bordj Omar Driss Commune with Tamanrasset Wilaya and also leads to frontier countries such as Mali and Niger.

The Study Area is crossed by the NR- 53 from north to south.as well as by some secondary unpaved roads. These are shown in Figure 4.57 and Figure 4.58, below. In addition, during the field survey some tracks, locally known as "rjems" were observed. Pastoralists mark these "rjems" with pebbles and stones and use them to guide the herds (see Section 4.3.4)

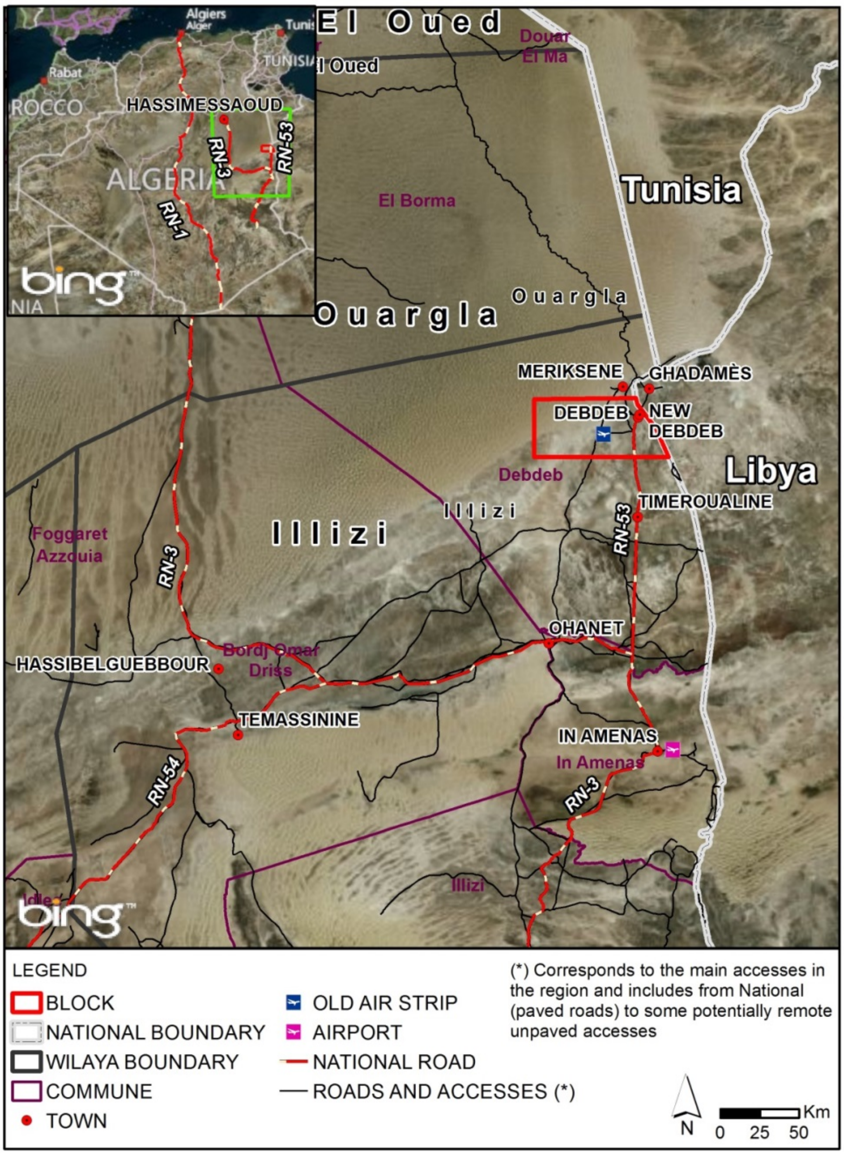
A brief summary of road connections for future transport activities during the project and estimated road distances is presented in Table 4.23, below:

Table 4.23 Road connections

	Debdeb – In Amenas	Debdeb – Hassi Messaoud	Debdeb – Algiers
National roads	RN-53 and N-3	RN-53	RN-53 ,RN-3 and other national roads
Distance	222 km	514 km	1 299 km

Source: Google Maps, 2015

Figure 4.57 Transport Infrastructure in the Study Area



Source: ERM 2015

Figure 4.58 National Road NR-53

Source: BEXAM, Field survey May 2015

4.4.7.2 Air transport

In Algeria there are eight international airports and ten national airports (EGSA, 2014). The airport network of Illizi Wilaya comprises nine aerodromes: a national airport in Illizi, two international airports at In Amenas and Djanet; four untarmacked airstrips (the former airport in Illizi, Bordj Omar Driss, Oued Arikine and Debdeb); and two airstrips with restricted access in Rhourd-Ennous and Stah.

The airstrip located in the commune of Debdeb is located within the Study Area, approximately 25 km to the west of Debdeb by the ONT-1 abandoned oil & gas exploration well (refer to Figure 4.57 and Figure 4.59).

Figure 4.59 Airstrip within the Study Area

Source: BEXAM, Field survey May 2015

4.4.7.3 Water and sanitation

Human consumption and irrigation

Water resources in Algeria are generally scarce. Population growth together with social and economic development has increased drinking water requirements, as well as the need for industrial and agricultural water (Ministry of Water Resources, 2011). Within Illizi Wilaya, surface waters are negligible and underground aquifers are the only water resources. The northern zone, encompassing the communes of Bordj Omar Driss, In Amenas and Debdeb, has a high underground water potential. For instance, the Sabkha region located in the northeast of Debdeb, is considered a humid zone due to the permanent presence of water at a depth of 6 to 8 m. In addition, various water sources are located in the region of Meriksene.

According to the results of the field survey, 11 wells are located within the Study Area, which consist of artesian and traditional wells and which are mainly used for drinking and irrigation. Examples are shown in Figure 4.60 below, where are illustrated an artesian well located in the station ST-04 and another in the station ST-15, a well destined for irrigation in station ST-18 and a traditional well which operates with solar powered pump in station ST-15 (refer to Annex C.1 for precise location). The water level in these wells ranges from approximately 1.55 to 3.5 m below the surface, and the depth of the wells extends from approximately 600 m to 750 m below surface.

These water wells are sourced mainly from the *Continental Intercalaire* aquifer, which is located, in this region, starting approximately 550 m below the surface. Additional information on the aquifer is provided in Section 2.8.3.

Figure 4.60 Water Wells in the Study Area

ST-04 - Artesian well 7km to the south of Meriksene

ST-15 - Artesian well north of Debdeb

ST-18 - Well destined for irrigation in an agricultural area of Debdeb

ST-31 - Traditional well with solar powered pump

Source: BEXAM, 2015

According to government sources, 83% of the population in Illizi Wilaya is reported to have access to drinking water (DPSB, 2015). Drinking water is sourced from artisanal wells and, in urban centres, water towers.

Figure 4.61, below, illustrates a water tower located in Debdeb town (which corresponds to the station ST-13 of the Field Survey, see Annex C.1 to see exact location). Within the Study Area (Debdeb) water is provided from two water towers. The tank for "old Debdeb" has a capacity of 225 m^3 and is supplied from two artesian wells with a flow of 55 l/s and 90 l/s respectively. The second is located in "new Debdeb" and has capacity of 500 m^3, which is supplied from a single artesian well with a flow of 60 l/s.

Figure 4.61 Water tower in New Debdeb (ST-13)

Source: BEXAM, 2015

Sanitation

The national sanitation network has significantly improved over the last decade thanks to the implementation of the national sewer network programme aimed at serving the entire country. In 2010, there were 123 sewage treatment plants dealing with about 1.2 billion m^3 wastewater per year. According to government sources, 82% of the population in Illizi Wilaya is served by the sanitation network (DSPB, 2015).

There are no water treatment plants in the Commune of Debdeb. According to the observations made during the field survey in 2015, domestic wastewater is discharged into the environment with no prior treatment.

4.4.7.4 Waste management

The quantity of municipal waste generated in Algeria is estimated to be 8.5 million tons/year (household and similar waste). Overall industrial waste generation (including ordinary industrial waste) is estimated at about 2.5 million tons per year. Hazardous waste represents around 325,000 tons per year and medical waste with infectious potential (DASRI) is around 37,000 tons per year (Sweepnet, 2010).

Landfills are the preferred final destinations for the disposal of urban solid waste. A survey undertaken by the services of the Ministry of Land Planning and the Environment (MATE) has revealed more than 3,000 unregulated dumps across the country, occupying an area of more than 150,000 hectares and most often situated on agricultural land or along oueds (dry rivers).

At the local level, the responsibility for managing and controlling urban solid waste (USW) lies entirely with the municipalities. At the level of each Wilaya (Governorate), the Directorate of Environment is the main body that controls the implementation of the laws and regulations relating to environmental protection.

Algeria still faces challenges with regard to the management and storage of generated industrial waste.

During the field survey in 2015, uncontrolled open-air waste discharges were observed, mainly near settlements and wells. This included domestic waste such as plastic bags, bottles and other solid waste such as electric cables and concrete blocks. An example of the waste dumping sites in the Study Area can be seen in Figure 4.62 below.

The information available as of June 2015 regarding the waste management facilities in the Study Area is very limited. The nearest waste management facility to the Study Area is located in the vicinity of the In Amenas Central Processing Facility (more than 200 km to the south). This is a private facility for the waste produced by the In Amenas gas project. Additional information regarding Waste Management Facilities is included in Annex D.2.2 of the Waste Management Plan (Annex D.2 of this ESIA).

Figure 4.62 Examples of waste dumping sites in the Study Area

ST-15 – Outskirts of Debdeb ST-9- Outskirts of Debdeb

Source: BEXAM, 2015

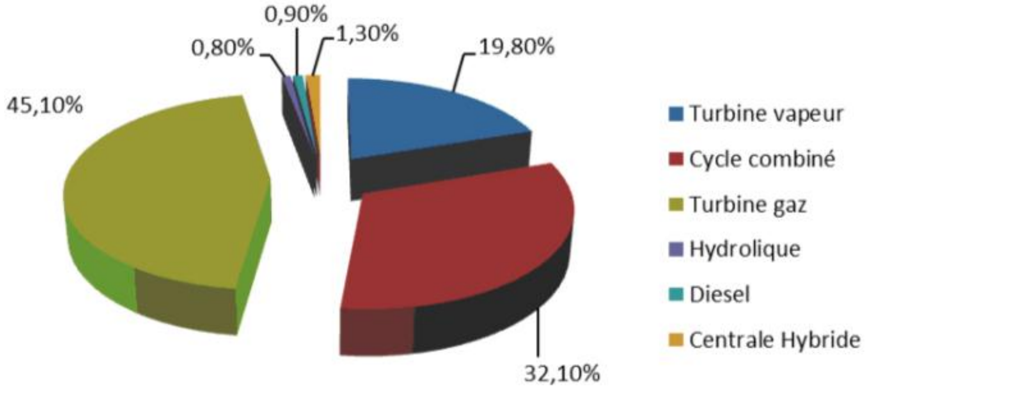
4.4.7.5 Energy

Algeria relies on its own oil and natural gas production for domestic consumption. Natural gas and oil account for almost all of Algeria's total primary energy consumption (98% of power generation).

Algeria's electricity generation capacity reached 15.2 gigawatts (GW) at the end of 2013, more than 17% higher than the previous year; and in 2012, its net electricity consumption was 44 billion kilowatt hours. The vast majority of the generation capacity comes from gas-fired and combined-cycle plants (refer Figure 4.63).

Algeria's government is attempting to reduce the country's dependence on natural gas in the power sector by initiating more renewable energy projects. Sonelgaz, Algeria's state electricity and gas utility, has signed contracts to bring solar projects online, and they recently initiated a pilot programme for a wind farm.

Figure 4.63 Electricity production per type of facility (2011)



Source: MEM, 2011

The national electricity system consists of an interconnected network that distributes power to northern and southern parts of the country. About 99% of Algeria's population is connected to the national grid. In Illizi, the electrification rate is 88% and gas coverage is 9%.

In Debdeb Commune, electricity is generated at the Sonelgaz electrical centre that has been in operation since 2008 and which has a capacity of 3.80 MW and a demand of 2.80 MW.

4.4.8 Education

At independence in 1962 the Algerian education system was highly exclusive and geared toward the training of French colonial elite. After independence, the system experienced major changes, including Arabisation of the curriculum and faculties, upgrading of teaching skills at all levels, and the promotion of a skilled class of workers and technicians through emphasis on technical and vocational education.

According to the Article 12 of the Law 08-04 on National Education, the period of compulsory education in Algeria is from 6 to 16 years of age for both boys and girls (UNESCO, 2010) ,

The structure of the school system is based on the 6+3+3 model: six years of primary school, three years of lower secondary school and another three years of upper secondary school. Together, the nine years of primary and lower secondary education constitute the compulsory basic education phase.

Table 4.24 shows the number of educational centres in Algeria as well as in the Wilaya of Illizi and the Debdeb and In Amenas Communes.

Table 4.24 Educational facilities in Algeria (2010), in the Illizi Wilaya, and in Debdeb and In Amenas Communes (2014).

Education level	*Algeria*	*Illizi Wilaya*	*Debdeb*	*In Amenas*
Primary education				
Number of establishments	17,680	65	5	6
Number of students	Not available	10,757	849	1,465
Lower secondary education				
Number of establishments	4,784	18	2	3
Number of students	Not available	4,994	389	720
Upper secondary education				
Number of establishments	1,745	7	1	1
Number of students	Not available	1,729	130	233
Vocational training				
Number of establishments	Not available	17	1	1
Number of students	Not available	1,616	81	196
High education				
Number of establishments	71 (comprising 35 universities)	one university with 3 different specialities	0	0
Number of students	Not available	249	0	0

Source: DSPB, 2015 and ONS, 2010

In Algeria, net enrolment in primary school in the period 2008-2012, was 98.4% for boys and 97% for girls (UNESCO). Illiteracy went down from 26.5% in 2002 to 22.1% in 2009 (Portail du Premier Ministre (2009), and the literacy rate among children is higher than for older age groups (UNESCO). No data regarding student enrolment and literacy rate is available at Wilaya or Commune level at this time.

4.4.8.1 Vocational training

Over the past decade government investment has focused on expanding infrastructure for technical education, which has grown from 824 teaching and training centres in 2003 to 1,207 in 2013 according to the Ministry of Vocational Training (In French, *Ministère de la Formation et de l'Enseignement Professionnels* or MFEP) (Oxford Business Group, 2015). Technical education has been one of the main ways of combating youth unemployment.

The Government recently announced an action programme in the field of vocational training and intends to thoroughly reform the present system. The objective is to make vocational training consistent with efforts to restructure the productive system in line with a market economy, while preserving the cohesion of the education and training systems. The authorities have been trying to close the gap between technical training centres and job market needs by opening up more training opportunities in sectors such as construction, tourism and agriculture (Oxford Business Group, 2015).

There is one vocational training centre (in French known as a *Centre de Formation Professionelle et d'Apprentissage* or CFPA) in Debdeb, with the capacity for 125 students, and one CFPA in In Amenas town (located approximately 222 km to the south of the Study Area) with the capacity for 175 students. The CFPA in Debdeb has 5 different specialties while the CFPA in In Amenas has 12 . Table 4.25 shows the specialties and number of students in each CFPA in 2014.

Table 4.25 Number of students and specialties imparted in the vocational training centres of the towns of Debdeb and In Amenas

	Number of students	
Specialities	**CFPA Debdeb**	**CFPA In Amenas**
Accounting	5	16
IT	17	15
Horticulture	9	-
Woodcarving	7	-
Building Electricity	-	12
Electromechanical	-	18
Industrial Refrigeration and Air Conditioning	-	18
Networks and Information Systems	-	13
Sanitation and gas facilities	-	21
Plumbing	-	26
Total	*38*	*139*

Source: DSPB, 2015

It should be noted that during the field team's visit to Debdeb APC, they were informed that the Gas Delegation of Sonelgaz signed a convention with Illizi Wilaya to promote the implementation of a new specialty in electric welding. A commission from Sonelgaz recently visited the Debdeb CFPA to assess the possibility of including this new specialty in its programme. However, there is no official confirmation of this yet.

4.4.9 Public health

The health system is public and has been free in Algeria since 1974. Since 2002, a development programme has been implemented in order to improve the health infrastructure and services, and make them more accessible. The health system is mainly financed by the state (43% in 2007) and social security (28% in 2007). In 2010, there was 1 doctor per 908 inhabitants.

Health Infrastructure

Table 4.26 presents the type and number of health facilities in Algeria, in the Illizi Wilaya, in Debdeb and in In Amenas Commune (due to its proximity to the Study Area). The organisation and structure of the health infrastructure in Algeria was established by the 2007 Executive Decree 07-140.

The health infrastructure in Debdeb and In Amenas communes consists of one health centre (in French *Etablissements Public de Santé de Proximité* or EPSP, one polyclinic (in French *Polyclinique*), one public maternity unit and three treatment rooms (in French *Salle de soins*) in each commune. The EPSP are equipped with X-Ray equipment, medical analysis equipment and a hygiene and control laboratory. In addition, the EPSP in In Amenas has an operating room. In the EPSP of Debdeb there are a total of 8 beds while in In Amenas there are 10 beds.

The closest hospital to the Study Area is located at Illizi town, at approximately 400 km to the south. Illizi Hospital (in French *Etablissements Publics Hospitaliers* or EPH) has three operating rooms, one medical analysis laboratory, one hygiene and control laboratory, one scanner and 4 X-ray machines.

The EPH structure revolves around diagnosis, care, hospitalisation and medical rehabilitation while the EPSP consists of a set of facilities and treatment rooms. Polyclinics (in French *Polyclinique*) constitute critical care units for community care and provide general medical treatment, dental care and basic consultations. Treatment rooms are considered to be the closest medical care unit to the general public where basic care and first aid is provided.

Table 4.26 Health facilities in Algeria, Illizi Wilaya Debdeb Commune and In Amenas Commune in 2014

Type Health Facility	Algeria	Illizi Wilaya	Debdeb Commune	In Amenas Commune
Hospitals (EPH)	231	2	-	-
University hospital centres	13	-	-	-
Specialised hospitals	32	-	-	-
Public maternity units	399	6	1	1
Private maternity units	77	-	-	-
Polyclinics	520	6	1	1
Health centre (EPSP)	1,248	4	1	1
Treatment rooms	4,684	35	3	3
Socio-medical centres	592	-	-	-

Source: ERM, based on ONS, 2006 and DSPB, 2015

It is estimated that there are 5 ambulances available for transporting patients in Debdeb Commune and 12 in In Amenas Commune.

Human Healthcare Resources

The medical staff available in Debdeb Commune, In Amenas Commune and Illizi Wliaya are presented in Table 4.27 below.

Table 4.27 Medical staff in Algeria (2006): Illizi Wilaya, Debdeb and In Amenas Communes (2014)

	General Practitioners	Specialized Practitioners	Dental surgeons	Pharmacists	Paramedical staff
Debdeb Commune	11	-	4	1	32
In Amenas Commune	22	3	7	2	62
Illizi Wilaya	95	64	22	7	437

Source: ERM, based on ONS, 2006 and DSPB, 2015

Health Situation

Communicable diseases have decreased in Algeria, due to high vaccination rates (99% BCG, 96% DPT Polio, 92% measles; 87% BCG, 82% DPT Polio, 76% measles in the Illizi Wilaya, and 89% BCG, 85% DPT Polio and 76% measles in Debdeb Commune).

In 2008 in Algeria, the prevalence of polio and diphtheria was zero, whooping cough stood at 0.08% and tetanus was 0.01%. The prevalence of blood and sexually transmitted diseases (i.e., Hepatitis B and C, HIV) was very low. In Illizi Wilaya, the prevalence of the main illnesses observed in 2014 was also low. These included diphtheria (2 cases reported), Hepatitis B (19 cases reported), Hepatitis C (1 case reported), meningitis (6 cases reported) and trachoma (37 cases reported) (DSPB, 2015).

Other illnesses recorded in Illizi Wilaya in 2014 included those controlled by vaccination: measles (1 case reported), TBC (10 cases reported) and poliomyelitis (1 case reported); as well as others such as food poisoning (23 cases reported), tuberculosis (10 cases reported), syphilis (8 cases reported) and malaria (6 cases reported) (DSPB, 2015).

The increase in morbidity as a result of non-communicable diseases such as diabetes, hypertension, chronic respiratory illnesses, chronic renal failure and cancer is associated with lifestyle changes related to food, obesity, physical activity and psychological stress (Lamri, L. et al., 2014). Health care in Algeria is now focused on the assessment and prevention of these diseases. As a result of this increase the main causes of death are as follows:

- High blood pressure diseases: 44.5%
- Malignant tumours: 16%
- Respiratory diseases: 7.6%
- Diabetes: 7.4%

4.5 Archaeological and Cultural Heritage Baseline

4.5.1.1 Introduction

Algeria has a rich and varied archaeological and cultural heritage that extends back for many hundreds of thousands of years into early human history. This includes physical heritage (i.e., archaeological sites, historical monuments and sites, cultural parks, paintings, and mosaics), as well as intangible heritage (i.e., the traditional arts, beliefs and ritual). Prehistoric remains in the Saharan region are particularly abundant, dating from periods of the distant past when climatic conditions were more amenable to human existence.

This chapter presents an overview of the history and archaeology of the region, and the likely implications for the character and distribution of any physical heritage located within the Study Area. The known archaeological findings from the Study Area, as well as the archaeologically sensitive zones, which are more likely to hold archaeological remains, within the Study Area have been localised and described.

For this purpose, we have undertaken a review of the legal and planning framework for archaeology (see Section 4.5.2) to help understand the archaeological and cultural management system in Algeria. Section 4.5.3 includes a description of the physical characteristics of the region and the Study Area. It enables a better understanding of the regional history and cultural background, allowing the type of archaeological findings expected to be located within the Study Area to be identified. Finally, there is a description of known archaeological sites at a regional level as well as within the Study Area itself (see Sections 4.5.5 and 4.5.6 respectively). Any archaeologically sensitive areas and potential archaeological findings that might be located within the Study Area have been identified (Section 4.5.7); the intangible heritage is also described (Section4.5.8).

It should be noted that to date Algeria has no official list of protected historical and archaeological sites. However, there is an initiative to develop an official archaeological inventory at a national level with the support of the European Union (refer to Section 4.5.2 for further information). This list has not yet been published and there is no official confirmation on when it will be publicly available.

The current chapter has been prepared by ERM and BEXAM (in collaboration with M. Iddir, a local archaeology expert[19]) initially through a desk-based review of the available information, including scientific reports and examination of the available satellite imagery and cartographic sources. All these sources are included in Chapter 7 References.

[19] Head researcher at Centre National de Recherches Préhistoriques, Anthropologiques et Historiques.

This was used to identify potential culturally sensitive locations within the development area which were then inspected by M. Iddir during the field reconnaissance of May 7th-9th, 2015.

4.5.2 Archaeological National Legal and Planning Framework

4.5.2.1 Administrative framework

The Ministry of Culture is the authority in charge of cultural heritage and its protection. *Law 98-04* created, within the Ministry of Culture, a National Commission of Cultural Heritage sites (*Commission Nationale des Monuments et Sites*) to answer questions relating to the application of *Law 98-04* and take decisions on proposals for the protection of tangible and intangible cultural property. There is also a regional, Wilaya-level, monuments and sites commission (*Commission de Wilaya des Monuments et Sites*).

Archaeological and cultural heritage management is performed by the Directorate for the Legal Protection of Physical and Intangible cultural sites, which is part of the Ministry of Culture. At the regional level, the Directorate of Culture of the Illizi Willaya is in charge of protecting cultural heritage within its limits.

All activities related to the protection of cultural heritage sites, are funded by the National Cultural Heritage Fund.

4.5.2.2 Legal and planning framework

The legal framework relating to Algerian cultural heritage (including archaeology) is provided in *Law 98-04 of 17 June 1998* that abrogates *Ordinance 67-281*. This law sets up restrictions and requirements for the collection, listing and conservation of archaeological remains, as well as for classifying cultural features into three main categories: movable cultural property (for example, archaeological excavations and investigations, artefacts, such as tools, pottery, inscriptions, coins, seals, jewels, traditional dress, weapons and funeral remains), immovable cultural property (historical monuments, archaeological sites and urban or rural units) and intangible cultural property (such as music, drama, skills, crafts, festivals, etc.).

According to Article 7 of *Law 98-04*, the Ministry of Culture must draw up a general inventory of classified cultural property, which has to be updated every 10 years. However, to date no official inventory is publicly available in Algeria.

There is a review planned of *Law 98-04* that will include measures for developing a new inventory of cultural sites and a preventive archaeological framework[20].

4.5.3 Physical Background

The following section summarises the physical characteristics of both the Study Area and the Sahara in general throughout time, and how the subsequent climate has affected the establishment of settlements in the area.

[20] http://www.aps.dz/culture/15811-patrimoine-culturel-la-loi-98-04-appel%C3%A9e-%C3%A0-%C3%AAtre-revue-ministre

4.5.3.1 Topography, Geology and Climate

The topography and geology of the northern Sahara is the result of a succession of marine and continental events that deposited sediments on the Precambrian crystalline basement from the Cambrian to Tertiary periods. (Askri et al., 1995).

It is now well-established that the patterns of occupation and movement of human ancestors in the Sahara over the past two million years has been high dependent on environmental/climatic cycles directly linked to the glaciation cycle. This is equally true for modern man since his evolution in the Rift Valley of East Africa some 200,000 years ago. For long periods the region has remained arid and inhospitable to human populations. However at other times, including during the early Holocene (c.12-6,000 years ago) increased rainfall has led to the creation of a savannah-type landscape, with widespread water, fauna and flora. At these periods the dry wadis and sabkha-filled depressions of the modern desert would have been the focus for both animal and human life, as reflected in the widespread presence of artefacts of all periods around their margins. These comprise stone tools from the Early and Middle Stone Age periods, being added to increasingly in the Late Stone Age by pottery, grinding stones, beads and ostrich shell.

In wetter periods in the past (including the early Holocene), the interdune areas contained lakes, ponds, and marshes. The extension of the palaeolakes would have varied from one wet phase to another, ranging from a single very large lake likely to have stretched across Algeria, Tunisia and Libya, covering much of the Ghadames Basin during periods in the mid-Pleistocene, to numerous shallow lakes in local depressions during other wet periods. These more humid epochs can be recognised across the Sahara, including in the landscape of the Study Area, by distinct duricrusts formed during the drying up of these water features in subsequent periods of hyper-aridity. The margins of surface water bodies would have constituted rich environments for prehistoric populations, and it is expected that archaeological evidence of prehistoric activities and/or occupation would be located within and particularly on the margins of interdune corridors and basins.

Modern humans *(Homo sapiens sapiens)* are thought to have evolved in East Africa during an arid glacial phase between 200,000 and 130,000 years ago (kyr), and migrated to North Africa during the subsequent wet interglacial phase (130-70 kyr). The beginning of this dispersal is archaeologically difficult to pinpoint, as stone tools manufactured by early humans did not differ substantially from those produced by other hominins until *c.* 300 kyr. However, once established in North Africa, these early humans developed a new cultural identity that involved distinctive stone tools (the Aterian). Subsequent to the colonisation of the region, the extremely arid conditions prevailing in the Sahara between 70 and 14 kyr probably severely restricted the human presence in the Study Area.

Although climatic amelioration took place around 14,000 years ago and the conditions once again became propitious for human settlements, re-colonisation of the area only took place from 12,000 years ago onwards. The people who migrated to the Central Sahara at this time were hunter-gatherers whose origins are yet not fully known. However, in their later phases, elements of their culture, particularly pottery styles, strongly suggest they were related to a large sub-Saharan cultural network whose subsistence was associated with the exploitation of the newly expanded riverine/lacustrine systems. Once they had occupied the area, they introduced animal herding as the main economic system. This 'Pastoral' Neolithic period can be divided into a series of sub-stages, in part related to an increased dependence on animal husbandry, with associated changes in material culture.

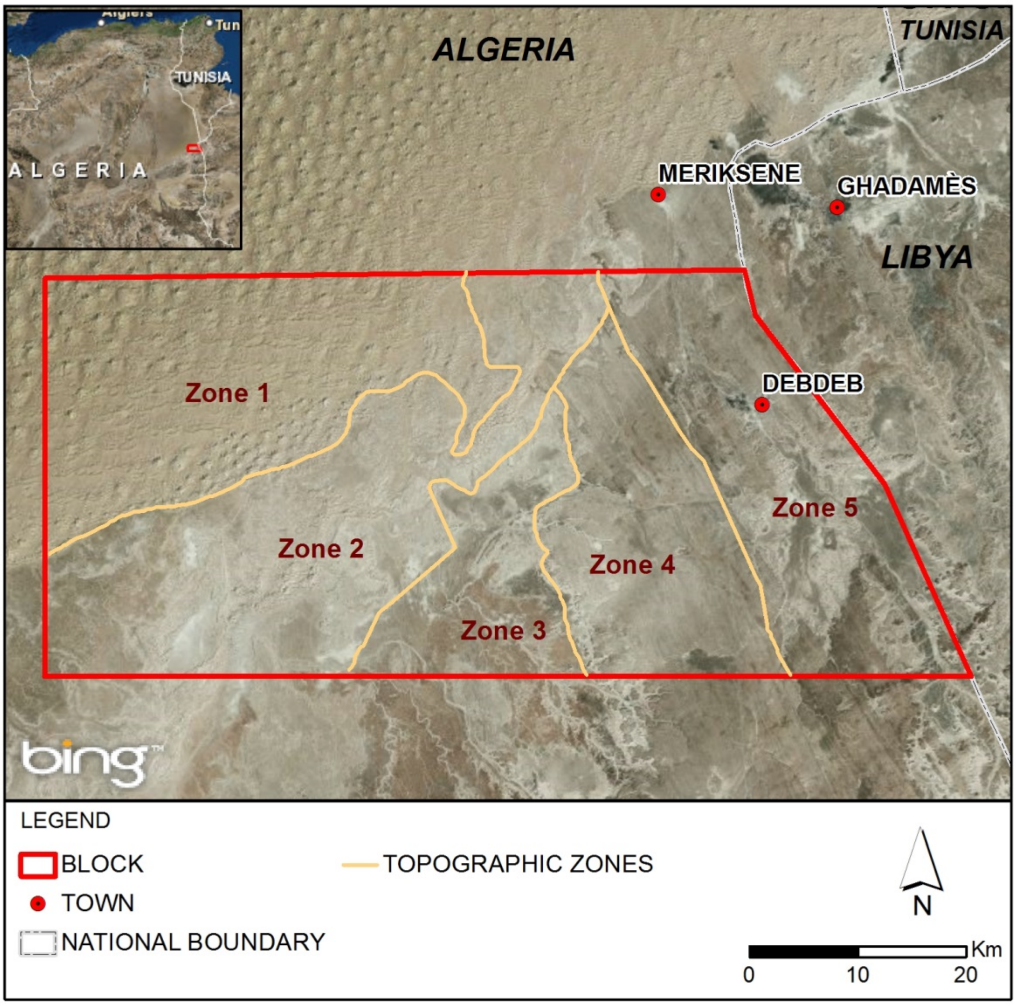
Around 5,000 years ago, there was another major change in climate, with the onset of the hyper-arid conditions that have continued up to the present. The Late Pastoral phase represents the adaptation of the human groups in the Central Sahara to the new conditions, culminating around 3,000 years ago with the development of irrigated agriculture in areas of higher rainfall (such as Ghadames, a historic oasis centre located in Libya approximately 25 km north-east of the Study Area and a UNESCO World Heritage Site) (see Figure 4.65).

4.5.3.2 Study Area Description

The main Study Area for this assessment is the area of proposed 3D seismic-survey and exploration wells, c.35km north-south x 10km east-west, that lies at the centre of the overall Statoil exploration concession, that extends westwards from Algerian/Libyan border south of Ghadames, c.65-85km east-west x 37 km north-south. The exploration concession provides a wider context within which the main Study Area can be understood. The whole area can be broken down into a number of topographic zones as follows:

- Zone 1: the Grand Erg Orientale/Great Erg, the edge of which runs across the north-west corner of the exploration area. This enormous sand-sea, many hundreds of kilometres across, comprises repeated patterns of very large, fairly stable sand-dunes separated by large interdune basins, which, at various point in the past, have been filled with water and formed a focus for human hunter-gatherer occupation. A projecting arms of sand dunes extends into the north-western corner of the main Study Area;
- Zone 2: this is a relatively low-lying area of rocky Hamada (c.280-320m above sea-level), sand flats and sabkhas that extends along the edge of the sand sea, forming a corridor that has been used by travellers since antiquity, wary of venturing across the largely dry sand sea. A number of the proposed test wells fall within this area;
- Zone 3: lying to the east of, and more elevated than Zone 2, this expanse of sabkha, sand and gravel is dissected by multiple dry wadis, draining westwards towards Zone 2. It occupies much of the central and southern part of the main Study Area and lies at elevations of c.300-350m above sea level;
- Zone 4: this comprises a limestone plateau situated to the east of Zone 3, with elevations over 400m in places, the western edge of which is dissected by occasional deeply-cut wadis. Three of the proposed test-well locations fall within the southern part of this zone, to the east of the proposed 3D seismic area;
- Zone 5: this zone is dominated by the NNW-SSE trending Oued Meriksene which runs along the Algerian side of the Algeria/Libya border, within the which the modern oil town of Debdeb sits. This, with its sources of water, was an ancient transport route of some importance leading from Ghadames to the south.

Figure 4.64 Topographic Zones in Statoil Exploration Area



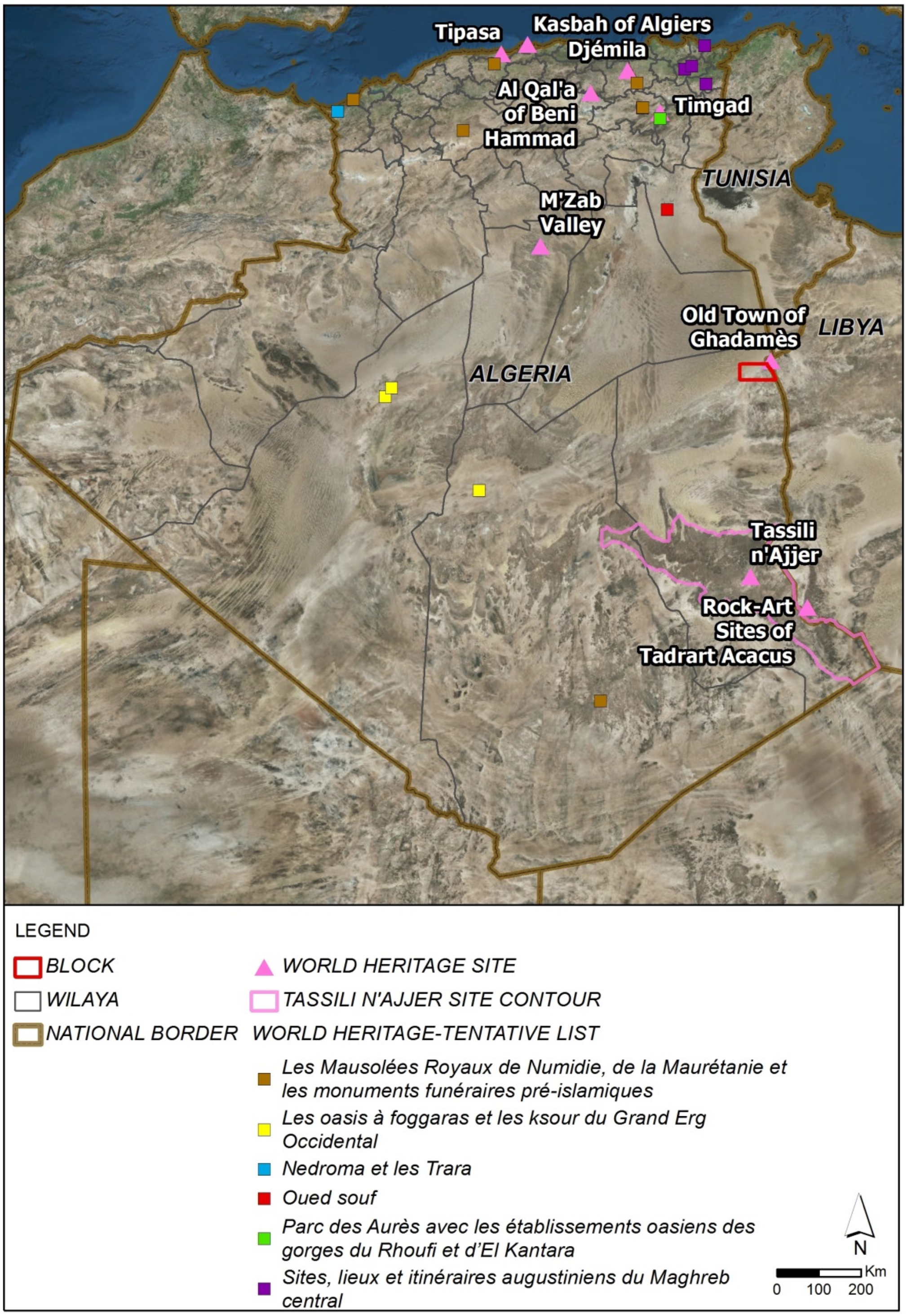
Source: ERM, 2015

Given its geographical context, it seems probable that the Study Area may contain evidence of past human connections between the Sahara and the Sahel. The area of proposed exploration is located approximately 25km west of the important oasis centre of Ghadames. This has been a centre of regional importance for millennia and has formed a key node in cross-Saharan trade networks for over 2,000 years. Important ancient and mediaeval trade and communication routes passed north and south along the margins of the sand sea and south c.550km to Ghat, a key stopping point in communications with sub-Saharan Africa. Figure 4.66 in Section 4.5.4 shows the location of these settlements and the Study Area.

4.5.4 International World Heritage sites in Algeria

At an international level, there are currently seven UNESCO World Heritage Sites in Algeria. All of them are located more than 300 km from the Study Area. The closest is Tassili N'Ajjer National Park which is included in the World Heritage List on the basis of both its natural and cultural value. In addition to these sites, there are six sites that have been placed on UNESCO's tentative list for World Heritage status since 2002. These six sites on the tentative list are all located more than 200 km from the Study Area. The closest UNESCO World Heritage site to the Study Area is the Old Town of Ghadames in Libya, located approximately 25 km to the east of the development area. Ghadames, known as the 'pearl of the desert', an oasis, is one of the oldest settlements in the region and an outstanding example of a traditional Saharan settlement. Although the site may have been populated since the 2nd millennium BC[21], it was first documented by the Romans in 19 BC.

Figure 4.65 UNESCO World Heritage sites in Algeria and around the Study Area



Source: ERM based on data from UNESCO, 2015

[21] As per international conventions, BC (Before Christ) is used for periods up to 12,000 years ago. For older periods, BP (Before Present) is used.

4.5.5 Archaeological and Historical Background – Regional context

No significant archaeological fieldwork has previously been carried out in the Willaya and specifically around Debdeb, although some work has been carried out around Ghadames, to the east, where significant number of Early Middle, and Late Stone Age sites have been found, as well as the extensive evidence of pre-Roman, Roman and medieval settlement in the oasis itself. The lack of properly documented sites is a reflection of the limited archaeological excavation and research that has taken place in the area, given the known existence of prehistoric material in surrounding areas[22]. The Epipaleolithic/Neolithic sites most characteristic of the region, are most frequently found around the fringes of palaeolakes/interdune basins. In some cases movement of sand may have partially buried such archaeological sites at the bases of the dunes.

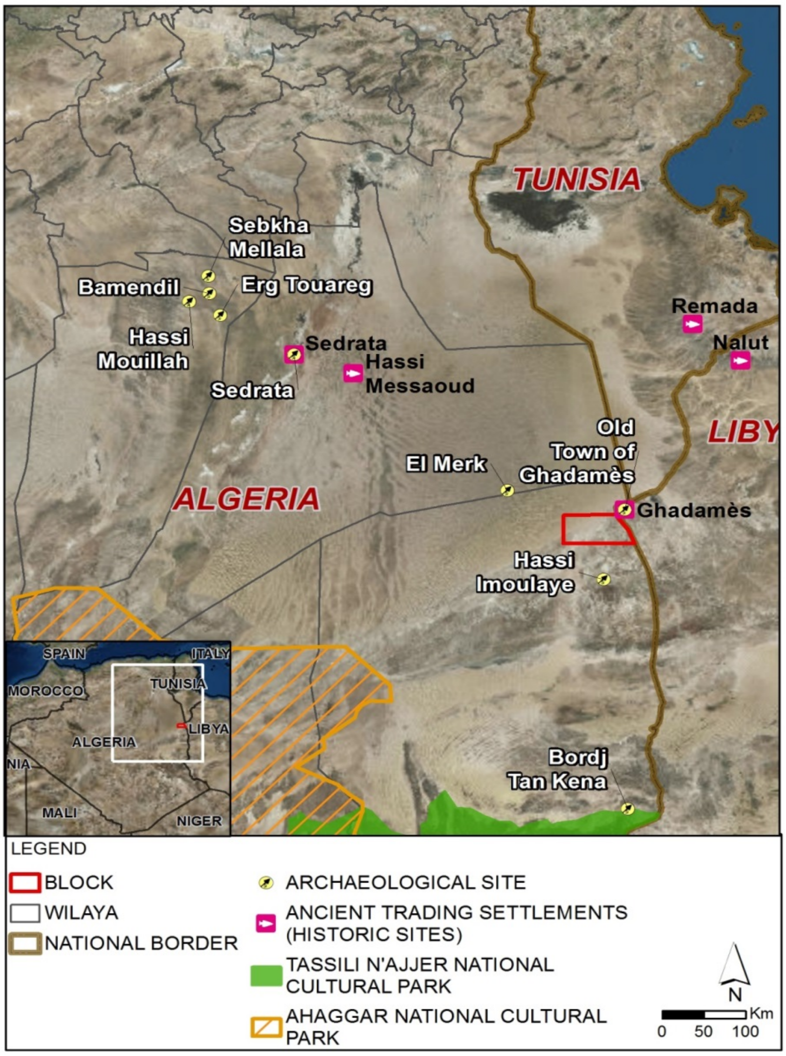
The Northern Sahara contains many thousands of documented prehistoric archaeological sites including both Palaeolithic and Neolithic remains, which can be summarised as follows:

- Lower Palaeolithic/Early Stone Age (800,000 - 250,000 BP) remains are represented almost entirely by worked stone tools, most characteristically hand-axes. There are no known sites within 200 km of the Study Area from this period; the closest being erg Touareg (450 km from the Study Area), Bordj Tan Kena (400 km from the Study Area) and numerous sites in the Fezzan, c.450km to the south-east (see Figure 4.66). This is probably reflective of a lack of archaeological investigation of such sites in the region.
- The Middle Palaeolithic/Middle Stone Age (250,000 - 40,000 years BP) is characterised by the Mousterian and late Aterian (c.110,000 - 70,000 BP) material cultures. The latter is typical of northern Africa and is believed by many to be associated with the spread of Homo sapiens. Its most characteristic feature is the presence of a tang, indicating composite tool technology. There are no known sites from this period within 200 km of the Study Area, although this is probably reflective of a lack of archaeological investigation of such sites in the region.
- The Upper Palaeolithic/Late Stone Age (40,000 - 10,000 years BP) prehistoric culture of the region is known as the Iberomaurasian: lithic technology characterised by backed blades. Surveys associated with oil and gas development less than 50 km away, in southern Tunisia and in the Libyan east of Ghadames, have identified many sites of this type in conditions very similar to those of the Study Area (ERM, 2009 , 2013).
- In the Epipalaeolithic/Mesolithic period (c.10,000 - 8,000 BP), the main regional culture was the Capsian, characterised by the development of a distinctive lithic industry, the use of ostrich shells and rock-art. A number of the sites discovered during in surveys carried in western Libya (ERM, 2009) and southern Tunisia (ERM, 2013), were from this period. The sites were all identified on the fringes of natural depressions or interdune basins (see Figure 4.66).
    - The Pastoral Neolithic (c.8,000 - 1,000 BP) is the most recent period of prehistory in the region and is characterised by an abundance of pottery, rock engraving and painting. It also represents the beginning of agriculture and animal domestication, with sites characterised by the presence of grinding stones, used for food processing, and trapping stones, used to tether and/or catch large animals. During the Pastoral Neolithic, agriculture and animal domestication was made possible by the semi-arid to sub-humid climate with a savannah rather than desert ecosystem. Neolithic sites are numerous in the Saharan region, as well as in the area surrounding the Study Area. No rock art is known in this region of the Sahara, although again this is likely to reflect a lack of exploration. Again, many sites of this period have been identified in recent years during oil development-related surveys in southern Tunisia and western Libya (see Figure 4.66).

[22] The typology of the archaeological remains specific to the Sahara region where the Study Area is located and the identification of sites is undeveloped. However, research conducted in other comparable areas, to the south of the Study Area (including Libya) – notably the work carried out in the Libyan Fazzan over the past 30 years (Mattingly, 2003) -, suggests that the region of the Algerian Sahara where the Study Area is located is likely to be relatively rich in prehistoric remains.

Human occupation of the Saharan area started to decline during the 3rd millennium[23] BP because of the increasing aridity and desertification of the Sahara. As sedentary settlements developed in oases and around the desert margins, caravan routes developed, allowing cross-desert travel. The Study Area lies close to one of the most important oasis-entrepots of the Saharan caravan system, Ghadames. Trade routes fanned outwards from the oasis in all directions, with one of the most important routes being that which connected to Ghat, c.550km to the south. Given its position immediately to the south-west of Ghadames, it is almost certain that, at one time or another, caravans passed across the current Statoil exploration concession on their way to and from Ghat, perhaps along the Oued Meriksene on the east side of the block.

Figure 4.66 Regional map showing the location of key historic/archaeological sites within and around the Study Area



Source: ERM and BEXAM based on a literature review

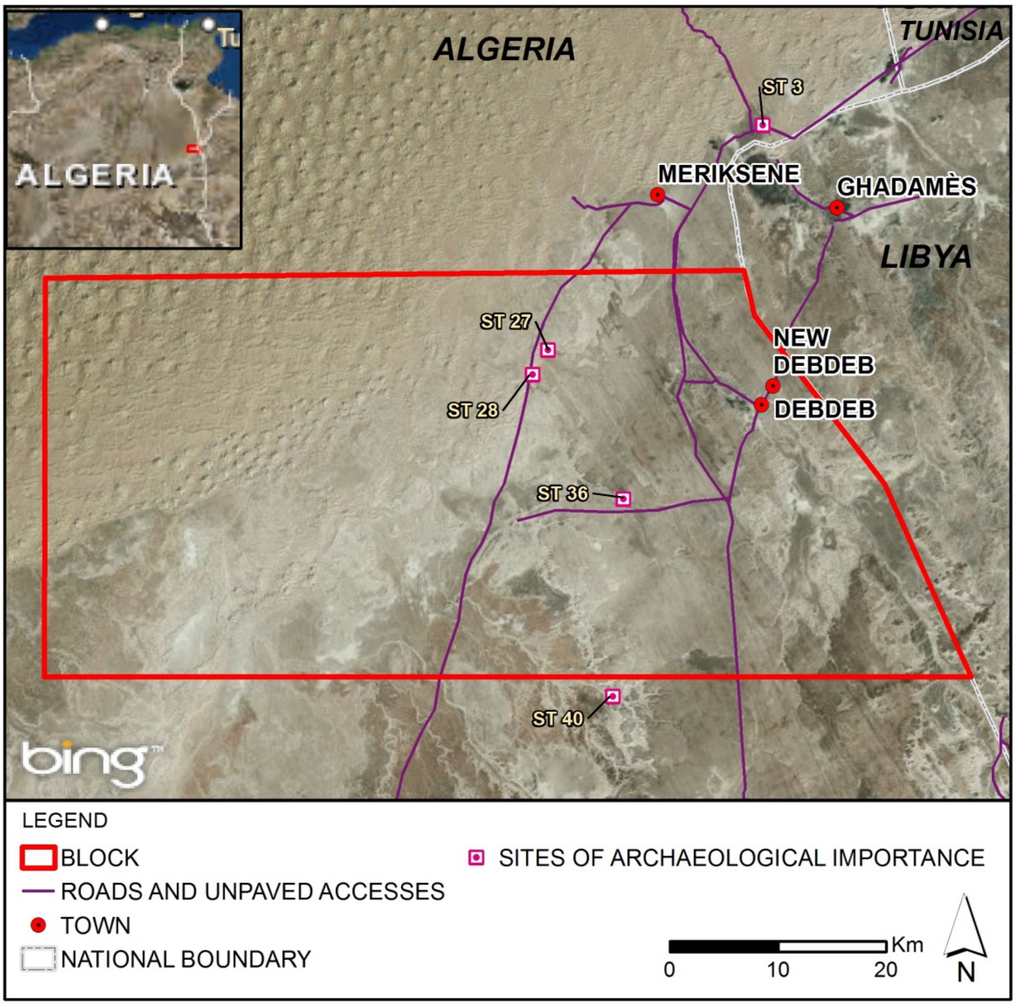
4.5.6 Results of Field Survey

A field reconnaissance of the area was carried out May 7th-9th, 2015 by a team from BEXAM, including M.Iddir, an archaeologist and prehistorian from the Algerian *Centre national de Recherches préhistoriques, anthropologiques et historiques* (CNRPAH).

23 In contemporary history, the third millennium is a period of time that according to official sources, such as the United States Naval Observatory, began on January 1, 2001, and will end on December 31, 3000, of the Gregorian calendar.

Figure 4.67 shows the locations where sites of archaeological interest were identified during the field survey. They are described in Table 4.28.

Figure 4.67 Locations of sites of archaeological importance identified during field survey



Source: ERM, 2015

Table 4.28 Archaeological findings within the Study Area discovered during the field survey in May 2015

Site	Description of the site
ST-3	A French colonial fort still in use by the Algerian army: 'Borj Messaouda', standing immediately north-east of the Statoil exploration area and 10km north-west of Ghadames. Lying on the fringes of the sand-sea this is an important strategic location controlling the trade routes into Ghadames and is likely to have remains of all periods.
ST-27	A scatter of Neolithic worked flint/chert at the base of a sand dune beside a large sabkha. It appears to have been extensively robbed in modern times, given the sparsity of the remains and the absence of diagnostic tools (eg arrowheads).
ST-28	Similar to the above – a scatter of worked flint at the base of the dunes at the edge of the Great Erg overlooking sabkha plains to the south and east.
ST-36	A group – c.140m across - of large prehistoric stone tumuli at the head of a oued: a location marked on 1956 US mapping as Hassi Tagenebri. They vary in size from 7.15 m in diameter x 1.3m high to 5m in diameter x 0.4 m high.
ST-40	A well in a small oued with scattered pieces of prehistoric worked flint and a small group of Islamic graves beside a flat, round tumulus marked by orthostats (vertical slabs)

Source: BEXAM, 2015

Despite checking more than 40 locations across the main Study Area, only a handful of sites with archaeological remains were recognised during the survey, as shown in Figure 4.67. Traces were found of the anticipated early prehistoric settlement sites around the edges of sabkha deposits, where there would have been pools of water during periods of higher rainfall. However the artefactual assemblages on these sites were thin and apparently degraded, perhaps as the result of illegal collection of antiquities in recent years.

Figure 4.68 Photographs of site 2 showing its location at the fringe of the dunes of the Great Erg and flint artefacts on the desert surface

Source: BEXAM, 2015

Only one group of prehistoric tumuli (ST-36) were found during the survey, although it is highly probable that others exist within the Study Area and could be identified using satellite imagery analysis. Based on comparison with dated tumuli of this type that have been excavated in the region, they could be as much as 5,000 years old.

Figure 4.69 Photographs of a group of prehistoric tumuli at Hassi Tagenebri (ST-36)

Source: BEXAM, 2015

The presence of Islamic – and possibly older - graves beside a well on a known cross-desert route (ST-40), is a reminder that these routes were intensively used throughout antiquity and the medieval period. The fort of Borj Messaouda (ST-3), lying on the route that runs along the edge of the Great Erg, is another remnant of this ancient communication system and a reminder that remains of the past can be expected along this corridor.

Figure 4.70 Photographs of Islamic graves beside a possible prehistoric tomb (ST-40)

Source: BEXAM, 2015

The information included in this section is not intended to be as an exhaustive visual record or audit for the Study Area, however provides an overall view of the findings in the block and locates them on the terrain.
The archaeological sites identified during the field survey do not represent an exhaustive record for the Study Area, however they provide and overall view of the type of archaeological and cultural heritage elements that can be present in the Study Area, where it is also likely to be present Early and Middle Stone Age sites, as well as evidence for the cross-desert trade of the medieval and later periods (camp sites, wells, burials and desert mosques).

4.5.7 Potential Archaeology in the Study Area

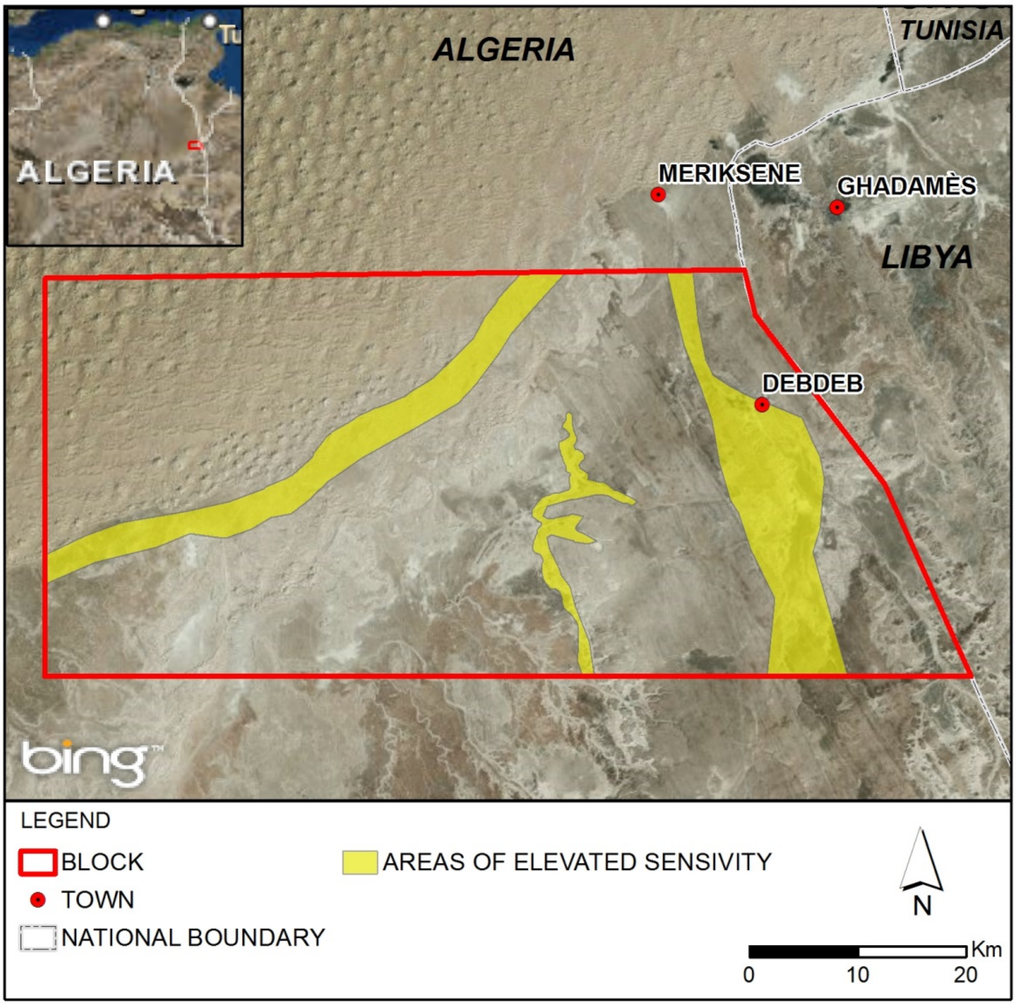
Based on the desk-based study and site survey summarised above, the key archaeological sensitivities within the main Study Area can be summarised as follows:

- Traces of prehistoric settlement – typically in the form of flint tools, pottery, grinding stones and ostrich shell - around the edge of areas of sabkha/palaeolakes;
- Prehistoric funerary monuments – groups of stone tumuli, typically on the edge of rocky high ground overlooking historic cross-desert routes;
- Traces of ancient/medieval use of cross-desert routes, including surviving paths, wells, Islamic graves and desert mosques (open-air structures marked out with rows of stones, usually with a qibla facing towards Mecca).

The significance of such sites depends largely on their level of preservation. Based on the survey results summarised above, the remains of prehistoric settlement that certainly used to exist within this region have been substantially degraded by illicit surface collection in recent decades.

By contrast it appears that the other two categories of sites have probably largely survived up to the present. On this basis, two areas of elevated heritage sensitivity within the Statoil exploration area can be identified (Figure 4.69). These are: i) the south-west to north-east corridor along the edge of the Great Erg leading to Ghadames, ii) the margin of topographic zones 3 and 4 where experience suggests prehistoric cemeteries and wells are most likely to be found and iii) the Oued Meriksene corridor on the eastern side of the area, within which Debdeb lies, an important historic cross-desert route leading south towards Ghat.

Figure 4.71 Areas of elevated heritage sensitivity



Legend: The orange areas mark zones of elevated cultural heritage sensitivity.
Source: ERM, 2015

4.5.8 Intangible cultural heritage

Intangible cultural heritage is defined by article 67 of *Law 98-04*: "*Intangible cultural assets are defined as the sum of knowledge, social representations, know-how, skills, techniques based on the traditions in different areas of cultural heritage representing the true meaning of attachment to the cultural identity of a person or a group of people."* These include the following areas: ethnomusicology, traditional and popular songs, hymns, tunes, theatre, choreography, religious ceremonies, culinary arts, oral literary expressions, historical accounts, stories, fables, legends, maxims, proverbs, and traditional games.

UNESCO has a list of intangible cultural heritage and a register of best safeguarding practices. The Representative List of the Intangible Cultural Heritage of Humanity is made up of those intangible heritage elements that help demonstrate the diversity of this heritage and raise awareness about its importance. The following items of Algerian intangible cultural heritage are included on the UNESCO list:

- Sebeïba rituals and ceremonies in the oasis of Djanet, Algeria.
- The annual pilgrimage to the mausoleum of Sidi 'Abd el-Qader Ben Mohammed (Sidi Cheikh).
- Practices and knowledge linked to the Imzad of the Tuareg communities in Algeria, Mali and Niger.

- Rites and craftsmanship associated with the wedding costume tradition of Tlemcen.
- Ahellil of Gourara.

None of these activities are likely to be affected by the current exploration program and potential future oil and gas developments, given the remoteness of the development area (all these places are located more than 500 km from the Study Area). The only known sites that might be directly affected are medieval or more recent burials/cemeteries, such as site 5 above. These are frequently found near wells and may well have enduring significance for the local population.

Stakeholder engagement with the population of Debdeb included questions about the presence of sites of traditional spiritual significance in the development area. They did not know of any sites of this nature, although as an industrial settlement established around 30 years ago, the community do not originate from the area and so do not have local associations of this kind. They did, however, speak of the former Hajj pilgrimage (and presumably also trade) route coming from sub-Saharan Africa up the Oued Meriksene, as referred to above.

4.5.9 Previous Impacts

The presence of industrial activity (oil and gas) in the Study Area and its surroundings has contributed to the identification and registration of a great number of archaeological and cultural heritage sites. The storage and retrieval of this information does not appear to be systematised at present. The human presence has also contributed to the disappearance and damage of some sites, through excavation and looting.

Law n° 98-04 of 15 June 1998 prohibits the collection of arrowheads, and oil operators are subject to implementing the Law 98-04 on their sites.

4.6 Evidence of existing and past O&G operations

As part of the baseline preparation, an identification of evidences of past activities (mainly associated to O&G activities) has been carried out. This evaluation has been performed through a combination of the following:

- Photo interpretation of freely available dataset imagery (i.e., ESRI Imagery, 2007 and Google Earth Pro, 2015).
- Ground truthing of evidences of past activities during the field survey in the Study Area.

The information included in this section is not intended to be as an exhaustive visual record or audit for the Study Area, however provides an overall view of the findings in the block and locates them on the terrain. Most of the findings, due to their nature, are known to be related to past O&G activities, however, in some cases, such as some wastes and debris, this cannot be completely confirmed[24].

Overall the following types of evidences have been identified in the Study Area:

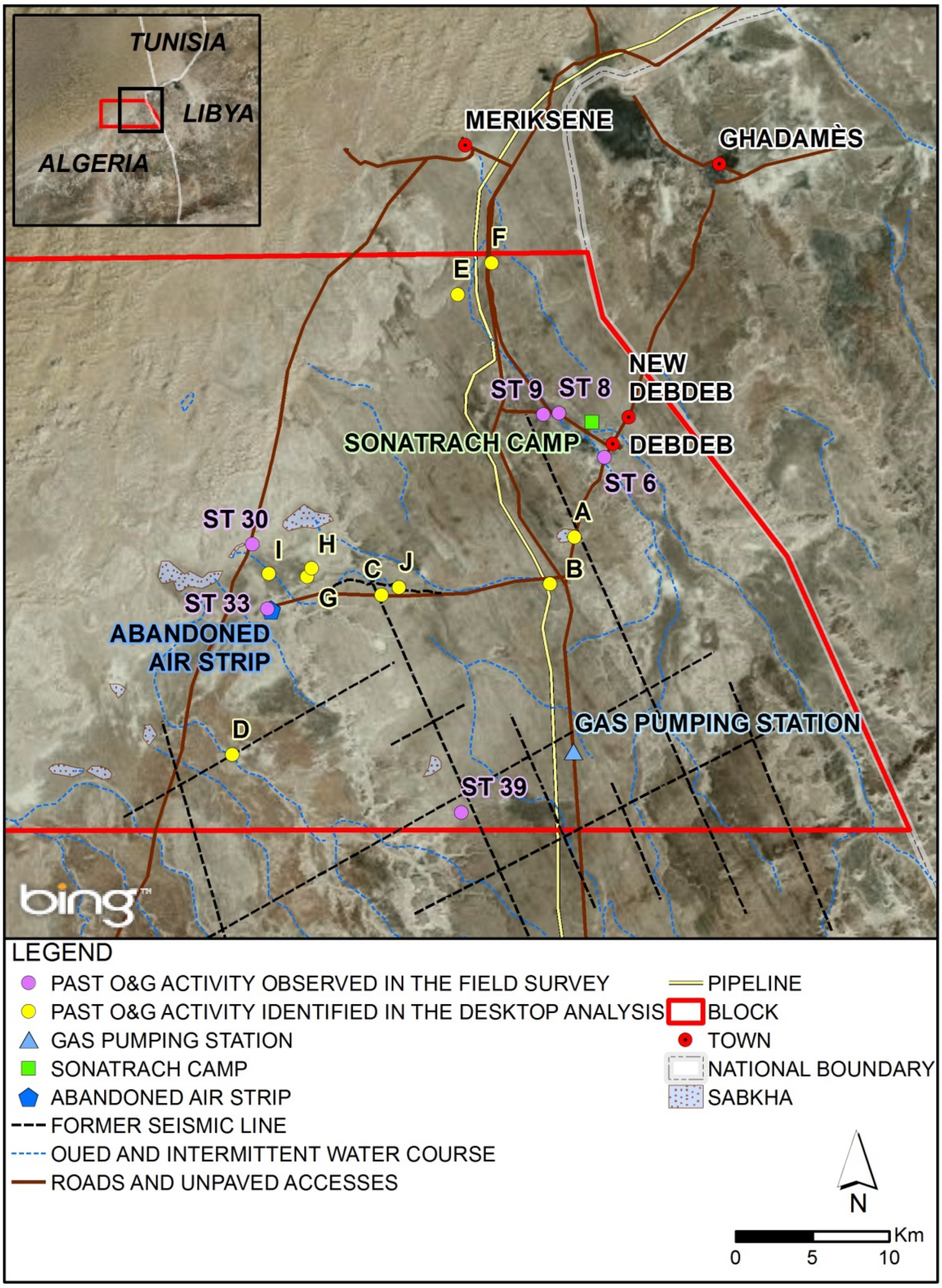
- o Waste areas and general garbage from base camps (typically engine oil cans, drilling materials, food cans, bottles, etc.)
- o Decommissioned drilling sites
- o Areas where earthworks occurred (possibly for extraction of construction material)
- o Old Seismic lines
- o Abandoned camps

[24] Some waste was found in the vicinity of Debdeb, however this has not been included because corresponds to urban waste.

In addition to the above, the Study Area includes operative O&G infrastructures such as the Sonatrach camp, located in the proximity of Debded, the pipeline that crosses the Study Area from south to north and parallel to the national road, and a gas pumping station, in the proximity of one of the tentative well location (associated to the Ordovician – in the southeast of the Study Area). Other relevant infrastructure (although no related with the O&G) is an old airstrip that was reportedly to be used by the Algerian army.

Location of the existing evidences of past O&G activities and operative infrastructures are shown below, in Figure 4.72.

Figure 4.72 Evidences of O&G activities in the Study Area



Source: ERM, 2015

Table 4.29 provides a description of the evidences of past O&G activities.

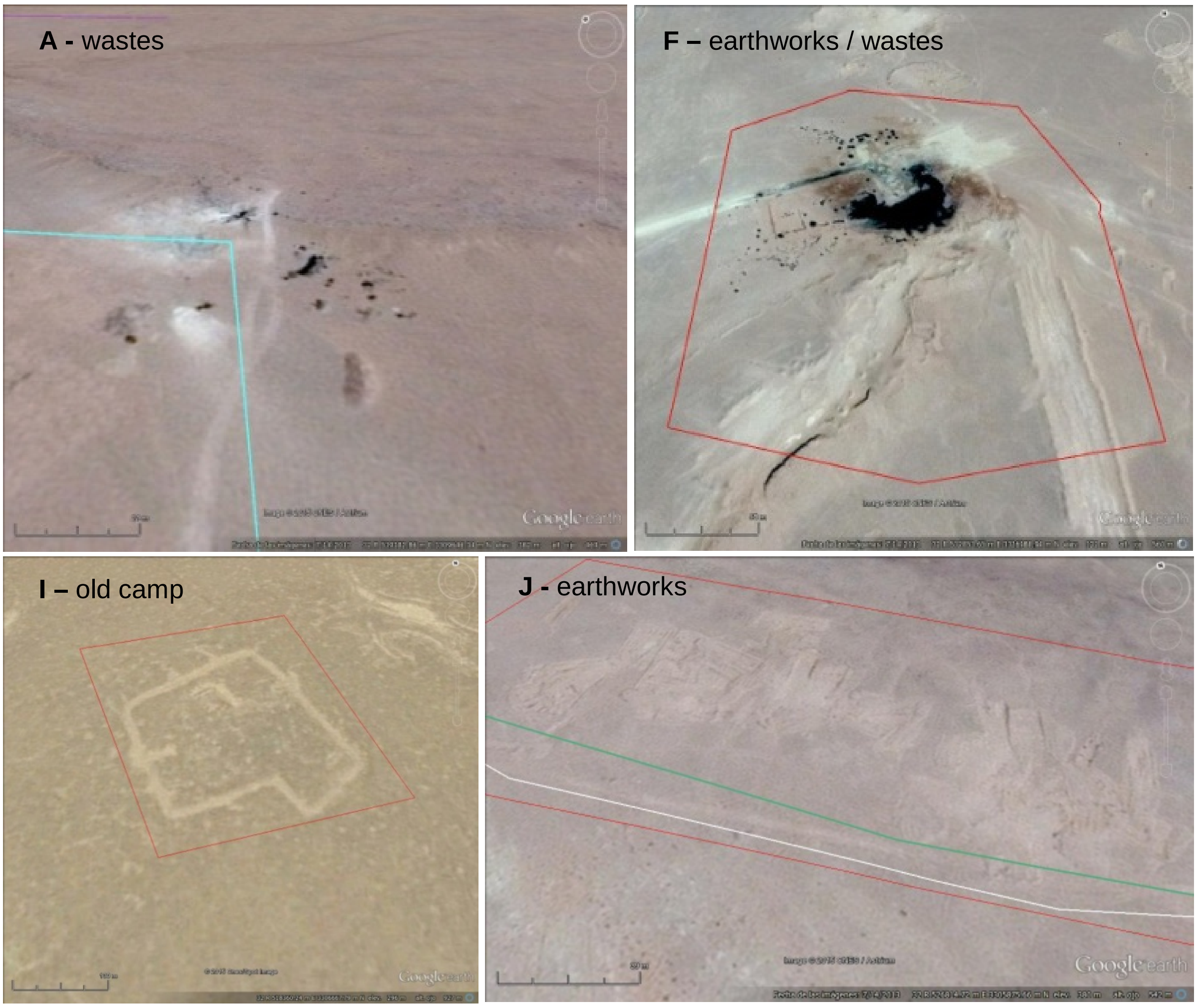
Table 4.29 Description of potential evidences of past O&G activities

Location	Description
ST-6	Earthworks
ST-8	Earthworks
ST-9	Wastes, earthworks
ST-30	Old seismic survey station.
ST-33	Old drilling well (ONT-1) that has been closed and that was located near the "garat".
A	Wastes
B	Old drilling site
C	Earthworks, seismic lines.
D	Seismic lines
E	Wastes
F	Earthworks, wastes
G	Wastes
H	Wastes
I	Old camp
J	Earthworks

Notes:
Locations described as ST-xx correspond with visited sites during the field survey.
Locations described as A to J correspond with locations were potential evidences of old O&G activities where observed during the photo interpretation of freely available dataset imagery.
Source: ERM, 2015

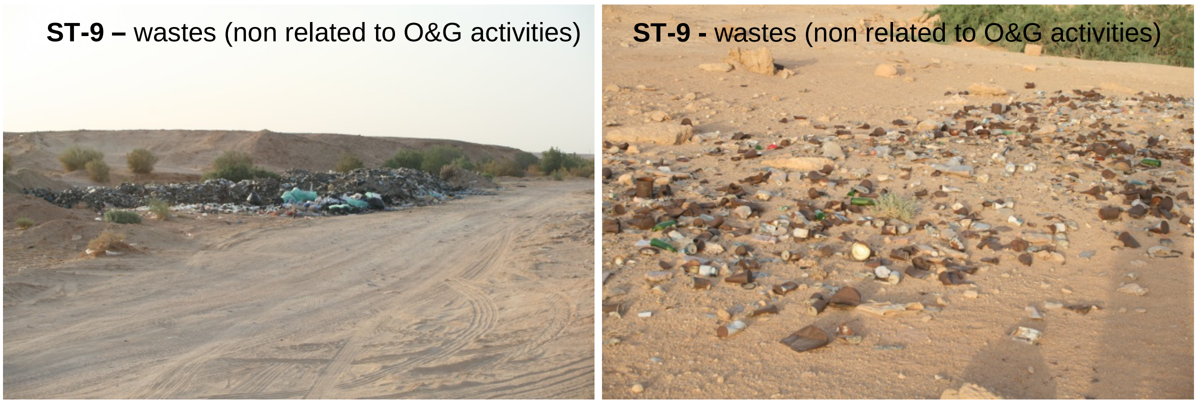
Next few figures include photographs and GIS images showing the evidences of past O&G activities. They are not meant to form an exhaustive visual record or audit of the Study Area. Rather these images provide a visual record of items considered to be of relevance to the Study Area, as they were encountered during the field survey.

Figure 4.73 Sites with potential evidences of past activities (photo interpretation)



Source: Google Earth Pro 7.0

Figure 4.74 View of areas with wastes (field survey)



Source: BEXAM, 2015

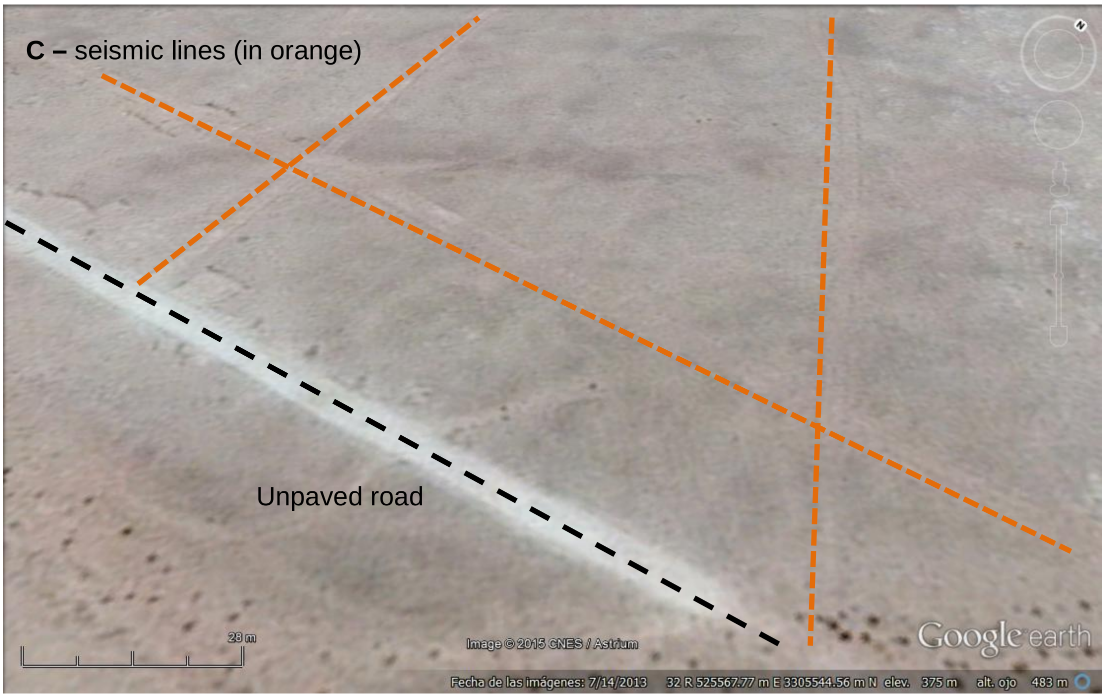
Figure 4.75 Old drilling sites (photo interpretation – left - and field survey – right)

Source: Google Earth Pro 7.0 (left) and BEXAM, 2015 (right)

Figure 4.76 View of earth works (field survey)

Source: BEXAM, 2015

Figure 4.77 Evidences of seismic lines (photo interpretation)



Source: Google Earth Pro 7.0

Figure 4.78 Air strip (photo interpretation – left - and field survey – right)

Source: Google Earth Pro 7.0 (left) and BEXAM, 2015 (right)

Figure 4.79 Location of the old seismic survey station (covered by sand and vegetation)

Source: BEXAM, 2015

Chapter 5 - Evaluation of Impacts and Mitigation Measures

Contents

5 Evaluation of Impacts and Mitigation Measures

5.1 Introduction

This chapter presents an assessment of the potential impacts associated with the project activities to be carried out in the Timissit License (Block210) in Algeria. The contents of this chapter address the following:

- A description of the environmental aspects of the project (activities affecting the surrounding area).
- A description of the potential impacts on the environment, the socioeconomic conditions and the cultural heritage.
- A description of the proposed mitigation measures to avoid, prevent, eliminate, minimise or eventually offset/compensate the negative effects of the project on the environment.

Impacts are assessed and presented according to their significance and the mitigation measures to be implemented, resulting in residual impacts. The content of this chapter is a key factor in producing this Environmental and Social Impact Assessment (ESIA) that will be useful both in the ongoing environmental management of the project and be accessible to stakeholders. This impact assessment process takes into account those preventive and mitigation measures which have been included as part of the project design process.

Finally, this impact assessment has been developed considering the execution of all 3 Phases of the exploration campaign. This is a conservative approach, because it entails the longest potential execution times, greatest raw materials, air emissions and waste generation (the development of Phase 2 and Phase 3 will be subject to the results of the previous phases and thus they may not be developed).

5.2 Impact Identification and scoping

The first step in impact identification is to identify the various activities associated with the project, together with their associated emissions and discharges where appropriate. At a high level, the main sources of impact are related to the footprint of the project and include:

- presence of personnel and equipment;
- physical ground disturbance;
- emissions, discharges and wastes; and
- accidental or non-routine events.

An ‘impact identification’ matrix, **Error! Reference source not found.**, identifies and scopes the predicted interactions between project activities and environmental/socio-economic resources and receptors. Each marked cell on the impacts matrix represents a potential interaction between a project activity and an environmental/socioeconomic resource/receptor (i.e., potential impact).

Blanks in the matrix indicate no primary effect or an absence of the resource in the general area.

Activities identified as ‘◦’ indicate the potential for a non-significant impacti, either or both with limited intrinsic effects on the identified resources or whose effects are adequately mitigated in the embedded project design. On the other hand, activities marked as ‘●’ indicate the potential for significant impact due to the presence of a resource, and which needs to be taken into consideration during detailed design (these impacts do not necessarily result in moderate or major impacts but more detailed project design/management is required to reduce the magnitude of potential impacts).

The specific impacts presented in the sections below have been defined based on a resource potentially being impacted by the activities. Grouping all the individual impacts (marked cells) in one single impact allows a comprehensive analysis of the project activities that would interact with each environmental, socioeconomic and cultural heritage resource, also considering potential synergistic processes. Thus each identified impact has an associated code (e.g., for Air Quality Impacts, AQ1 is for the seismic acquisition phase, whilst AQ2 is for the subsequent drilling/stimulation phase).

Figure 5.1 Impact Identification Matrix

		Physical					
		Air Quality	Noise Level	Hydrological Resources	Hydrogeological Resources	Geomorphology and Natural Landscape	Soils
Project Actions	Impact Id	A1	N1	SW1	GW1	GM1	S1
Seismic Exploration	Site preparation: seismic base camps	◦	◦	◦	◦	◦	◦
	Access and road construction	◦	◦	◦		•	◦
	Land occupation: presence of camps and seismic line clearance		◦			•	◦
	Use of vehicles and heavy machinery.	◦	◦	◦	◦	•	◦
	Power generation and other ancillary activities	◦	◦	◦	◦		◦
	Waste production and management			◦	◦		◦
	Presence of workforce		◦				
	Line surveying	◦	◦			•	
	Uphole drilling	◦	◦	◦	•	•	◦
	Closure of activities and demobilisation	◦	◦				◦
	Impact Id	A2	N2	SW2	GW2	GM2	S2
Drilling and Hydraulic Stimulation	Site preparation: well pads and drilling base camps	◦	◦	◦	◦	◦	◦
	Access and road construction (additional)	◦	◦	◦		◦	◦
	Land occupation: presence of camps and drilling rigs					◦	◦
	Use of vehicles and heavy machinery.	◦	•	◦	•	◦	◦
	Power generation and other ancillary activities	◦	•	◦	•		◦
	Presence of workforce		◦				◦
	Waste production and management (excluding drilling waste and flow back water)			◦	•		
	Water abstraction and use.			◦	•		
	Drilling and cementation	◦	•		•	◦	
	Muds, cuttings and completion fluid generation and management.			•	•		◦
	Hydraulic Stimulation		•		•	◦	◦
	Flowback water generation and management			•	•		◦
	Well testing.	•	•			◦	
	Closure of activities and demobilisation	◦	◦				◦
	Accidental non-routine events (AE)	•	•	•	•	•	•

			Biological		Socioeconomical and CH			
			Flora & Vegetation	Fauna	Economy and Livelihoods	Infrastructures and services	Community Health and Safety	Cultural Heritage and Archaeology
Project Actions		**Impact Id**	**FL1**	**FA1**	**EC1**	**IF1**	**PH1**	**CH1**
	Seismic Exploration	Site preparation: seismic base camps	◦	◦	◦	◦	◦	◦
		Access and road construction	◦	◦	◦	◦	◦	•
		Land occupation: presence of camps and seismic line clearance	•	•	◦	◦		•
		Use of vehicles and heavy machinery.	◦	◦	◦	◦	◦	
		Power generation and other ancillary activities	◦	◦	◦	◦	◦	
		Waste production and management	◦	◦	◦	◦	◦	
		Presence of workforce		◦	◦		◦	•
		Line surveying		◦				•
		Uphole drilling	◦	◦				◦
		Closure of activities and demobilisation		◦	◦			
		Impact Id	**FL2**	**FA2**	**EC2**	**IF2**	**PH2**	**CH2**
	Drilling and Hydraulic Stimulation	Site preparation: well pads and drilling base camps	◦	◦	◦	◦	◦	◦
		Access and road construction (additional)	◦	◦	◦	◦	◦	◦
		Land occupation: presence of camps and drilling rigs	◦	◦	◦	◦		
		Use of vehicles and heavy machinery.	◦	◦	◦	◦	•	
		Power generation and other ancillary activities	◦	◦	◦	◦	◦	
		Presence of workforce	◦	◦	◦	◦	◦	
		Waste production and management (excluding drilling waste and flow back water)		◦	◦		•	◦
		Water abstraction and use.	◦	◦			•	
		Drilling and cementation						◦
		Muds, cuttings and completion fluid generation and management.	◦	•	◦	◦	•	
		Hydraulic Stimulation						
		Flowback water generation and management	◦	◦	◦	◦	•	
		Well testing.					◦	
		Closure of activities and demobilisation		◦	◦			
		Accidental non-routine events (AE)	•	•	•		•	

Impact		Impact Definition/Name
AQ1		Impact on Air Quality during Seismic Exploration Phase
AQ2		Impact on Air Quality during Drilling and Hydraulic Stimulation Phases
N1		Impact on Noise during Seismic Exploration Phase
N2		Impact on Noise during Drilling and Hydraulic Stimulation Phases
SW1		Impact on Surface water during Seismic Exploration Phase
SW2		Impact on Surface water during Drilling and Hydraulic Stimulation Phases
GW1		Impact on Ground water during Seismic Exploration Phase
GW2		Potential overexploitation of groundwater aquifer.
GM1		Impact on geology, geomorphology and landscape during Seismic Exploration Phase
GM2		Impact on geology, geomorphology and landscape during Drilling and Hydraulic Stimulation Phases
	GM2.1	Impacts from drilling site preparation/operation
	GM2.2	Potential increase of microseismicity during hydraulic stimulation
	GM2.3	Potential mobilisation of NORM materials from exploration wells
S1		Impact on soil during Seismic Exploration Phase
S2		Impact on Soil during Drilling and Hydraulic Stimulation Phases
FL1		Impact on floral communities during Seismic Exploration Phase
FL2		Impact on floral communities during Drilling and Hydraulic Stimulation Phases
FA1		Impact on fauna during Seismic Exploration Phase
FA2		Impact on fauna during Drilling and Hydraulic Stimulation Phases
EC1		Impact on economy, employment and livelihoods during Seismic Exploration Phase
	EC1.1	Local procurement of goods and services
	EC1.2	Short-term direct and indirect employment opportunities and Long-term benefits of capacity enhancement (under job and formal training opportunities)
	EC1.3	Disturbance to animal grazing activities (mainly camel husbandry)
EC2		Impact on economy, employment and livelihoods during drilling and Hydraulic Stimulation Phase
	EC2.1	Local procurement of goods and services
	EC2.2	Short-term direct and indirect employment opportunities and Long-term benefits of capacity enhancement (under job and formal training opportunities)
	EC2.3	Disturbance to animal grazing activities (mainly camel husbandry)

Impact		Impact Definition/Name
IF1		Impact on infrastructure during Seismic Exploration Phase
	IF1.1	Potential competition for a water resources with local community
	IF1.2	Increased pressure on road infrastructure
	IF1.3	Increased pressure of waste management facilities
IF2		Impact on infrastructure during Drilling and Hydraulic Stimulation Phases
	IF2.1	Potential competition for a water resources with local community
	IF2.2	Increased pressure on road infrastructure
	IF2.3	Increased pressure of waste management facilities
PH1		Impact on community health and safety during Seismic Exploration Phase
	PH1.1	Traffic accidents due to increased traffic and presence of heavy vehicles on local roads
	PH1.2	Disturbance by occasional noise/vibration, dust and exhaust emissions to residents of the villages
	PH1.3	Interaction between the work force (including security forces) and the local community
	PH1.4	Increased transmission of communicable diseases
PH2		Impact on community health and safety during Drilling and Hydraulic Stimulation Phases
	PH2.1	Traffic accidents due to increased traffic and presence of heavy vehicles on local roads
	PH2.2	Disturbance by occasional noise/vibration, dust and exhaust emissions to residents of the villages
	PH2.3	Interaction between the work force (including security forces) and the local community
	PH2.4	Increased transmission of communicable diseases
CH1		Impact on cultural heritage during Seismic Exploration Phase
CH2		Impact on cultural heritage during Drilling and Hydraulic Stimulation Phases
CLD1		Impacts from closure and decommissioning after Seismic Phase
CLD2		Impacts from closure and decommissioning
AE		Impacts from accidental/non-routine events
AE 1		Blow-outs
AE 2		Ground Water
	AE 2.1	Accidental spillage of raw materials fuels oils and additives and waste on the well sites
	AE 2.2	Contact of drilling fluids with aquifers due to well construction and integrity issues during drilling
	AE 2.3	Potential contact of stimulation fluids with aquifers due to loss of well integrity during hydraulic stimulation.
	AE 2.4	Potential contact of stimulation fluids with aquifers due to induced fractures/seismicity.

5.3 Assessment Criteria

All development imposes some disturbance on aspects of the environment because of physical impact on natural systems or due to interference with human activities and human systems and potential cultural heritage features. Often such impacts are slight or transitory and have an effect which may be regarded as insignificant. This impact assessment seeks to predict, on a broad scale, the occurrence and potential significance of environmental impacts associated with the seismic, drilling and hydraulic stimulation activities to be carried out in the Timissit License (Block 210) and to propose measures by which they may be avoided, reduced, remedied and/ or compensated. The criteria used to identify the significance of impacts include the following:

- Compliance with relevant Algerian laws or regulations.
- Compliance with other relevant environmental standards or guidelines (international standards).
- Compatibility with Algerian government policies or plans.
- Professional judgement.

The significance of the environmental impact is assessed according to the following qualitative scale (see Figure 5.2):

- **Negligible:** Primary effect has the potential to impact a resource, although this would produce no lasting or long term change in relation to the overall resource. The resource would be tolerant to change and changes may be relatively indistinguishable.

- **Minor:** Primary effect has the potential to impact a resource producing a change on a localized area (project area and immediate surroundings) during the life of the project. The impacted resource would be reasonably tolerant to change.

- **Moderate:** Primary effect has the potential to moderately impact a resource producing a change on a localized area for a short period of time (during the life of the project). The impacted resource may not be reasonably tolerant to change.

- **Major:** Primary effect has the potential to intensively impact a resource over a small area or less intensively over a wider area for an extended period of time (during the life of the project and afterwards).

Figure 5.2 Impact significance matrix

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	Medium	High
Magnitude of Impact	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

Source: ERM, 2015

This matrix classifies all impacts (direct and indirect) according to the sensitivity of the receiving environment (i.e., *Low, Medium* and *High*) and impact magnitude (taking into account other criteria such as duration, extent, and reversibility, as well as considering the application of project embedded mitigation measures to produce an assessment of impact significance (i.e., *Negligible, Small, Medium* and *Large*).

The discussion and analysis of impacts follows two paths:

- Those impacts scoped during the initial process as representing negligible/minor ratings are discussed in general terms with regard to the activities that produce them and the generic mitigation measures that as part of good industry practices will suffice to avoid any considerable impacts (e.g., impacts on air quality during the seismic phase).

- Impacts that due to the nature of the receptor or the magnitude that a specific project activity may cause to it are assessed as moderate or major in the matrix are discussed in detail. The discussion is focused on which specific activities primarily contribute to producing the rating (e.g., the hydraulic stimulation process and associated waste streams such as flowback water), upon which further mitigation measures will be applied.

The impact identification and assessment process is somewhat mechanical in its application but presents a robust set of arguments. The result is a trail which can be easily followed and ensures that all activities are assessed against all identifiable receptors/resources: physical, biological and social.

The results of this process and the identification of mitigation measures are discussed in the text. The proposed preventive and mitigation measures will be implemented throughout the duration of the activities, so that impacts are kept within the final residual category.

Furthermore, an Environmental Management Plan (EMP) has been developed and will be implemented to establish measures, such as best practices and specific work procedures, to prevent, avoid, eliminate, minimise, or eventually offset/compensate the predicted adverse impacts. This will include mitigation measures, along with monitoring, remediation, and follow up evaluation to ensure the effectiveness of the management plan. Reference to the relevant sections and annexes in the EMP is made where relevant, to avoid unnecessary repetition. However the most relevant mitigation measures are discussed explicitly in this chapter and presented for each impact identified.

5.4 Potential environmental impacts during the seismic exploration activities

5.4.1 Air Quality (AQ1)

Impact description

As presented in the impact identification matrix (**Error! Reference source not found.**), there are several activities with the potential to affect air quality, throughout the seismic acquisition activities; though only a small number of these are considered to have the potential to reduce air quality on a local scale. These activities can be summarised as:

i) Exhaust emissions from vehicles/equipment (e.g., vibrators, trucks, bulldozers, uphole drilling rigs, and aircraft), power generators and camp incinerator, which may produce nitrogen oxides [NO_x], sulphur dioxide [SO_2], carbon monoxide [CO] and particles). It is estimated that 720m^3 of fuel, approximately, would be used to complete the camp preparation (civil works) and the 550 km^2 of seismic acquisition.

ii) Fugitive emissions of fuel and oil vapours that may occur during equipment refuelling or oil/fuel spills.

iii) Dust generated by vehicle movements and earthworks operations (mainly campsite preparation, potential seismic line clearance and vehicle movements on unpaved access roads), which may be blown over the immediate area. Usually a large portion of this dust will settle within a few tens to hundreds of metres from the source and will affect a small area of the desert habitat in the immediate vicinity of the works. This distance is likely to fluctuate depending on the prevailing wind direction and speed, and volume of dust generated, which will also be dependent on the land surface type (e.g., regs, dune areas).

Local air quality has been assessed as good, with most activities taking place in open remote areas, with no sensitive receptors nearby that may be disturbed by exhaust gases or dust, and where natural dispersion of these is favoured.

Mitigation measures

A series of management plans and procedures will be implemented throughout the project with the objective of controlling air emissions. Most mitigation measures will help in reducing emissions and keeping air quality in the area through to efficient use of diesel and minimization of airborne dust through minimization of bulldozing/line clearance (see Section 3.3.2 of Project Description) and campsite preparation (section 3.3.4 of Project Description). Key standard mitigation measures would include:

- Minimization of earthworks through maximising the use of existing roads/airstrip/camps (e.g., policy of minimal clearance and bulldozing in accordance with the IAGC Environmental Guidelines for Worldwide Geophysical Operations)
- Proper maintenance of vehicles and machinery to avoid unnecessary or excess exhaust emissions. and implementation of safe fuel transfer protocols

Amongst the most relevant plans the following can be mentioned:

- Plan for Traffic/Journey Management Plan
- Plan for Management of Liquid and Gaseous Waste
- Plan for Prevention and Control of Pollution

Residual Impact evaluation

Air quality residual impacts due to emissions deriving from the use of vehicles and machinery as well as dust generation is considered to be negligible, due to the nature of the area where the activities are to take place (high dispersion rate), the absence of sensitive receptors, temporality of the impact (would cease once the project is finished) as well as the implementation of a wide range of preventive and mitigation measures that will minimise the works to be performed, the efficiency of resource consumption, and thus, indirectly, the quantity of emissions produced.

Impact Rating for AQ1	**Negligible**

5.4.2 Noise (N1)

Impact description
Several activities undertaken during the seismic survey have the potential to create noise disturbances; especially those where vehicles/equipment are employed (e.g., civil works at camp site, vehicle movement, earthworks such as bulldozing and clearance of lines/areas, uphole drilling, and aircraft).
Nonetheless, general noise levels derived from the project are not expected to be significantly high (except for specific cases where, e.g., aircraft are used) and would be limited to the surroundings of the noise generating sources, being concentrated within the seismic basecamp and associated facilities (e.g., nearby airfield, power generators, borrow pits) and throughout the seismic lines that the acquisition crews will be following (e.g., from vibroseis operation, power generators, portable drilling rigs). It is worth noting that seismic acquisition will only take place in daylight hours.
The noise impact associated to seismic project activities is therefore expected to be mainly limited to the immediate campsite/line clearance area and surroundings, and to secondary effects on fauna (i.e., temporary displacement of fauna from the area where work activities are being performed, see Impact FA1 in Section 0).
Mitigation measures
Relevant project embedded mitigation measures that would affect noise levels in the area will overlap with those described in Air Quality (see Impact AQ1 in Section 5.4.1); and will be mostly related to the minimisation of noise source levels of the equipment employed (and indirectly of the activity), mainly involving an appropriate vehicle/equipment maintenance programme to ensure noise suppressors such as exhausts function properly. Indirectly, the Journey/Traffic Management Plan will minimise a variety of impacts associated with vehicle usage and traffic such as noise emissions, this is especially relevant in truck transport activities that may cross villages/cities within the License.
Residual Impact evaluation
Because of the expected limited area where significant noise levels could be experienced (limited to specific operation sites and accesses), the distance to sensitive receptors, the temporary nature of activities (and thus impacts), and the implementation of the above mentioned mitigation measures, the residual impact is expected to be negligible.

Impact Rating for N1	**Negligible**

5.4.3 Surface Water (SW1)

Impact description
No permanent surface water bodies have been identified in the areas of seismic interest, only oueds and several sabkhas can be described as ‘surface water’ features (these contain ephemeral water only after rains but can contain subsurficial water for longer periods of the year, and are locally important resources (see Chapter 4).
Potential impacts will be limited to those areas where direct interference occurs. Based on the baseline investigations and project Description (see Chapter 3) it can be anticipated that seismic activities will require the crossing of several oueds and sabkhas. In these sites the potential impact will be related to the use of hazardous raw materials and production of wastes (e.g. use of fuel and engine oil, uphole drilling muds, etc.). In all cases the impacts would be caused from potential for minor spills/leaks of fuel/oil in routine operations due to improper management procedures.
Potential surface water impacts from the seismic activities are therefore expected to be either focused at the campsite and in its immediate surroundings, or potentially along the seismic line grid and access roads, where these cross oueds or sabkhas.

Mitigation measures

Relevant mitigation measures to protect surface water features are related to (1) the avoidance of sensitive locations (to the extent feasible) and (2) related to the appropriate management of raw materials and wastes.

A series of management plans that will be implemented throughout the seismic activities will involve specific measures for the protection of surface water features. Amongst the most relevant plans the following can be mentioned:

- Journey/Traffic Management Plan, including specific measures for the crossing of oueds/Sabkhas will be developed to control all vehicle movements.
- Waste Management Plan that will identify all waste streams and describe their proper management in all footprint areas (camp, seismic lines, accesses, etc.),
- A Plan for the Shutting Down and Restoration of Site will be implemented for all footprint areas of the seismic works (including seismic lines), and
- Liquid Spill Response Plan, describing how to prevent and manage any spills that may occur during these activities.

The above plans will incorporate multiple preventive and mitigation measures such as the following:

- A field HSE Specialist will be incorporated into the seismic survey group to oversee all mitigation measures, carry out examination of areas that appear to be sensitive and evaluate its environmental vulnerability before the installation of seismic camp, access paths, roads or seismic lines.
- All ephemeral streams and other hydrological features found during the seismic survey should be recorded and, to the extent feasible, seismic lines planned to avoid crossing these.
- A one-track policy will prevail in all operations. Off-road driving is banned.
- The survey lines will be limited to a set working width and marked to prevent unnecessary off-road/line driving;
- Any significant need to perform clearance using a bulldozer will require the formal approval of the Statoil HSE representative in the field before being undertaken. Width of clearance with bulldozers will be limited to a maximum of 3.5 m in sensitive areas.
- Toolbox talks to be held to develop the construction crews' awareness of hydrological features.
- A photographic record will be kept to validate the applied procedures. Relevant locations in terms of oueds and sabkhas and locations of upholes and oued/Sebkha crossings will be also recorded with a GPS to allow future assessment.
- All vibrators will operate in accordance with the IAGC / Statoil / Sonatrach safe operating distances.
- A policy of minimal clearance and bulldozing will be implemented by the Contractor in accordance with the IAGC Environmental Guidelines for Worldwide Geophysical Operations and bulldozers will not be used on the reg.
- Wherever possible previous survey line crossings of these features should be re-used to avoid additional disturbance.
- No waste will be left on the lines. All will be returned to camp facilities.
- Uphole drilling sites will be located at a reasonable distance (>200 m) from any significant ephemeral water bodies and only water based bentonite fluid with no additives will be used wherever possible.
- Following completion of drilling the contents of mud pits should be allowed to evaporate before the pits are covered with at least 50 cm of clean soil and the landscape reinstated to its previous level.

Residual Impact evaluation

In broad terms, campsite operation and seismic acquisition (especially uphole drilling) implies the production of wastes and generates a localised risk of accidental spills during the seismic acquisition activities. However, based on the wide

range of management plans containing preventive and mitigation measures to be implemented, the potential residual impact on the oueds is considered to be minor.	
Impact Rating for SW1	**Minor**

5.4.4 Groundwater (GW1)

Impact description

There are several activities which, given the specifics of the 3D Seismic survey, could potentially interfere with hydrogeological resources. The project activities considered to be most relevant to potentially generate impacts on the groundwater resources include (1) the direct use of groundwater, (2) the production of wastewater streams at the camp, (3) the drilling of upholes and to a lesser extent (4) the potential minor spills/leaks that may occur as part of vehicle operations.

i) The use of groundwater resources: Water for seismic activities will be supplied from Debdeb, nonetheless, depending on the yields of water wells developed during the drilling/hydraulic stimulation campaign, these may be used as an alternative water source for seismic operations (i.e. no water well will be drilled for non-potable water needs such as uphole drilling, and camp maintenance).

   Should the seismic campaign rely on groundwater under the described circumstances it is expected that it will require some 25m^3/day, and that the water would be obtained from the Albian (Cretaceous) sandstone of the Continental Intercalaire (CI), which has an expected delivery rate within the 50-150m^3/h range.

ii) The management of campsite wastes: the presence of the seismic crew and camp services are expected to produce some 225m^3 of black/grey water in total, which will be managed by means of an appropriate onsite sewage treatment system. This system is likely to involve filtration, both anaerobic and aerobic bacterial treatment, chlorination, and final disposal through sprinkler systems or lined evaporation ponds. The locations of the sewage management/treatment facilities will be defined based on an understanding of local sensitivities.

iii) Spills/leaks: all activities that involve the use of hazardous materials or the movement of a significant number of vehicles and equipment generate certain risk of spills. Spills/leaks of fuel/ oil or raw materials/wastes could potentially affect shallow aquifers beneath the spill site.

iv) Earthworks (like uphole drilling operations): some 80 uphole sites will be approximately 50-100 m deep, thus it is expected that upholes may penetrate into shallow aquifers (e.g., associated to Quaternary deposits and Terminal Complex (CI) aquifers).

Mitigation measures

Multiple preventive and mitigation measures to protect groundwater during seismic activities are embedded in the project design and are included/organized in a series of management plans. Amongst the most relevant plans the following can be mentioned:

- Water Management Plan
- Waste Management Plan
- Liquid Spill Response Plan
- Plan for managing contaminated sites and soil
- Plan for Prevention and Control of Pollution
- Borrow pits (quarries) Management Plan

Relevant project-embedded mitigation measures to protect groundwater in the area will be mostly related to the appropriate management of the project's water needs in order to ensure a minimization and responsible use of this resource, the bunding of fuel/chemical storage areas to prevent any infiltration through the soil towards shallow aquifers, the use of drip pans for vehicle/equipment maintenance, and the proper management of the domestic/sanitary wastes produced at the well pads.

A series of mitigation measures for uphole drilling sites are outlined in Section 3.3.3 of the Project Description, favouring the protection of groundwater bodies through planning, drilling and abandonment (e.g., using site selection criteria to avoid sensitive groundwater areas and using only bentonite-based muds). Likewise several of the mitigation measures presented under the surface waters (Section 5.4.3 SW1) are also relevant to avoid potential interference with groundwater resources.

Residual Impact evaluation

The prospective use of the groundwater resource, together with the presence of different liquid waste streams, the potential direct interaction of uphole drilling operations with aquifers, and the potential risk of impacts from spills/leaks, could potentially affect groundwater resources, which is a highly sensitive resource in the project area. However, based on the project design and management plans in place, containing a wide range of preventive and mitigation measures to be implemented, the magnitude of the potential is considered small, thus residual potential impact on the aquifers from seismic acquisition operations is considered to be moderate.

Impact Rating for GW1	**Moderate**

5.4.5 Geomorphology and Natural landscape (GM1)

Impact description

Seismic surveys require the opening of lines across extensive areas and, depending on the clearance practices employed, have a high potential to significantly alter geomorphological features and the natural landscape). The extent to which each specific seismic survey generates these impacts depends basically on:

- i) The natural capacity of the landscape to absorb alterations (e.g., resilience); dependent on vegetation cover, type of substrate and morphology.
- ii) The seismic technology used (in this case vibroseis, which requires flat surfaces)
- iii) The 3D seismic design grid: number and distance between seismic lines and potential need for clearing lines (e.g., potential bulldozing needs).

Based on the project definition seismic lines will be spaced between 300 and 600 m and cover a total area of 550 km^2, mainly in the central portion of the Study Area. Clearance requirements may vary significantly depending on the specific desert substrate types. Since the aim of potential clearance is to guarantee access for the seismic crew and allow correct vibroseis (the plate must be in full contact with the substrate) those areas with coarser substrates (i.e., gravel and rocks) generally tend to require much more bulldozing than soft substrates.

Seismic acquisition over sand substrates (Erg)
Typically seismic lines on sandy substrates do not require much bulldozing nor much consolidation of terrain. Therefore impacts tend to be low and temporary because the wind clears lines very easily. Even when dune areas have to be crossed, wind storms have the capacity to clear signs of lines within few seasons. Sand dune areas cover approximately 20% of the total block; with just a fraction of it in the northern section of the area of seismic interest. On sand sheets and sand dunes, visual impacts are obvious and occur simply by the crossing of a single vehicle. However, these impacts are not long lasting because of the high resilience of fine substrate environments, and easily disappear within a short period of time (a few years or even less).

It is expected that following standard Project practices, impacts would be recovered in the short term. The operation of the vibroseis is not anticipated to have a significant impact, although if non passable sand dunes are encountered, clearing may be required and the extent of this clearance will be identified in the field.

Seismic acquisition over hard or rocky substrates (hamada or desert plateau)

A high percentage of the Study Area (80%) is characterised by the dominance of gravel and rocky substrates. This area can be further characterised by regs, sabhkas, dayas, oueds and escarpments. Regs make up the largest portion of the Saharan desert plateau, with geomorphological features related to surface water drainage being less common and sparser throughout the seismic acquisition area, as indicated in the Physical baseline.

The rough rocky nature of the hamada plateau can make them difficult to level, thus bulldozing could be required to clean seismic lines before acquisition. Bulldozing on these types of substrate creates a significant impact at a geomorphological/landscape level that may be permanent depending on the specific site conditions. The sabkhas are a peculiar substrate and are also particularly sensitive to seismic activities, being soft enough to allow very evident track formation and at the same time fragile because of the salt crust. The recovery process for this substrate is very slow. Additional areas of clearance will be associated to the main camp site, should a new one be necessary, and access route.

Mitigation measures

A series of management plans that will be implemented throughout the seismic activities will include specific measures for the protection of the natural morphology and landscape. Amongst the most relevant plans the following can be mentioned:

- Journey/Traffic Management Plan including specific measures for the crossing of oueds/Sabkhas
- Borrow pits (quarries) Management Plan
- Program for the Shutting Down and Restoration of Site will be implemented for all footprint areas of the seismic works (including seismic lines), and

A wide range of operational procedures, especially preventive measures (See Section 3.3.2 of Project Description), will be implemented throughout the seismic acquisition. Most of these measures are specifically designed to minimise the Project footprint and to avoid sensitive locations, which is the key aspect for the minimization of this impact.

Overall the most relevant measures will include:

- the detailed planning of survey line clearance to avoid any sensitive areas, either from a biological/archaeological standpoint as well as to avoid sensitive geomorphological features like oueds, dayas and sabkhas, single track policy, etc.
- Earthmoving will be kept to a minimum, with no bulldozing planned for the reg areas and in accordance to IAGC Environmental guidelines.
- The maximization of current accesses (e.g. from previous Project drilling phases) and old survey lines as well as former campsites/airfield will be maximised and thus land take minimised.

For additional mitigation and preventive measures refer to the mitigation measures presented under the surface waters (see Section 5.4.3 SW1) and groundwater (see Section 5.4.4 GW1) are also relevant to avoid potential interference with groundwater resources.

Residual Impact evaluation

Statoil will adopt a series of measures and procedures aimed primarily at avoiding and minimising impacts on geomorphological/landscape features by minimising the Project footprint. The sensitivity of the area in terms of landscape and morphology is considered as low and the successful implementation of the mitigation measures should therefore lead to a reduction in impacts by avoiding unnecessary clearance and restoring areas to their previous condition, where feasible. However, considering the slow impact recovery rates in this type of natural landscape (and potentially permanent under certain conditions), and the accumulated impact from the various seismic lines, potential magnitude could still be large and thus the residual impact is considered to be moderate.

Impact Rating for GM1	**Moderate**

5.4.6 Soils (S1)

Impact description

The severe arid climatic conditions do not allow important pedogenic activity; so only very localised and poorly developed soils are present in the area. These soils are mostly concentrated in topographic depressions, with a higher moisture content, and also in agricultural areas, where certain soils with a relatively higher organic matter content may be present. The seismic activities will not, however, directly affect the agricultural soil in farms (e.g., no crossing of crops and farms). As a consequence, the analysis of impacts on soil mainly focuses on potential alterations of the soil desert surface as a natural element. Soils (though poorly developed) are basically localised in depressions and in areas around sabkhas and oueds where vegetation is denser and organic matter input is relatively more abundant. The rest of the Study Area is mainly covered by mineral soils or rocky substrates.

The seismic project activities that could have an impact on soils are those which involve either land take or travelling over desert soil/pavement due to earth movements due to the access road, survey line and campsite clearance, compaction and desert scarring.

The total expected land take for the proposed project facilities will be low, considering the use of cleared sites derived from previous drilling activities and other projects (e.g., the basecamp and airfield respectively). Furthermore, the line survey width will be kept to a minimum, as will the use of seismic lines and existing access routes in the area.

With regard to potential impacts from spills/leaks/wastes, these are similar to those described for surface water/groundwater (see Sections 5.4.3 SW1 and 5.4.4 GW1).

Mitigation measures

All proposed Project activities that require land take will be planned in order to minimise substrate disturbance and clearing requirements and avoid any sensitive areas where soil or vegetated areas (e.g., oueds, sabkhas and depressions) are located. This will be achieved through the following plans:

The Journey Management Plan and the Borrow pits (quarries) Management Plan will be in place before the commencement of activities, which will prevent and minimise soil impacts associated with vehicle traffic along the area as well as a good selection of borrow pits.

Furthermore, the application of the protocols defined in the Liquid Spill Response Plan, as well as the Waste Management Plan (e.g., contaminated soil management, spill prevention), and Plan for Management of contaminated sites and soil (e.g., spill case analyses, first response and clean-up activities), include measures aimed at protecting the soil.

For additional mitigation and preventive measures refer to the mitigation measures presented under the surface waters (SW1) and groundwater (GW1).

Residual Impact evaluation

Soils are an important receptor in the context of the License area. However, considering the limited presence of soils within the area of seismic interest, it is envisaged that any clearance activities carried out would only potentially affect specific locations within the total area cleared and the magnitude of the impact would be negligible due to the lack of well developed soils. In any case, the implementation of preventive and mitigation measures for the identified activities will ensure impacts on soils are further minimised. The overall impact on soil is therefore considered to be negligible.

Impact Rating for S1	**Negligible**

5.4.7 Flora and Vegetation (FL1)

Impact description

Seismic operations need to guarantee access for the seismic crew and correct vibroseis operation, meaning the plate must be in full contact with the substrate. As a result, these activities may require the clearing of existing vegetation along the seismic lines. Campsite preparation and, to a lesser extent, uphole drilling may also require some vegetation clearance. Given that the seismic lines will be used as the main access route, it is not envisaged that additional impacts on flora, apart from this clearance, will arise from the presence of either heavy machinery or the workforce.

The potential need to clear the seismic lines, associated accesses, and campsite therefore constitute the main impact on flora derived from the planned seismic activities.

Based on the ecological characteristics of desert flora, as detailed in Section 4.3, any removal of the vegetation may modify the ecological integrity of the desert habitat and it must be properly controlled in order to avoid any potential long term effects, such as habitat modification or loss. Preserving the discrete areas where most shrubs and other long life cycle vegetation is present is the most important element in preserving the vegetation and minimising the potential impact from seismic activities.

According to the specifics of the proposed 3D Seismic survey detailed in *Section 3.3*, the magnitude of the expected work and associated Project footprint have been calculated. These are presented below:

- The mean distance between seismic lines will be about 300-600 m.
- Based on the distance between seismic lines and taking into account the whole survey area (350 km^2 plus an additional 200 km^2 in the 2 subsequent phases), approximately 1,000 to 2,000 km of seismic lines will be required. Considering only one base camp will be established a maximum of 0,08 km2 of additional cleared area will be required.

Given the ecology of vegetation in arid environments, whenever vegetation clearance is required the impact is expected to be long lasting (i.e., very slow growth recovery and unfeasibility of reseeding or revegetating). However, as presented in *Section 4.3*, most of the proposed seismic survey area lacks permanent vegetation and where present has a clumped distribution pattern; concentrated within the existing oueds and depressions (sabkhas and non-saline depressions). Its presence within the hamada and reg habitats is very scarce. As a result, the final area where vegetation clearance would be required will be much smaller than the total footprint along the seismic lines.

Since the potential impacts on vegetation could be locally relevant and long lasting a close follow up and enforcement of preventive and mitigation measures will be required. This will be especially important for the main sabkhas and oueds identified in the study area (see Figure 3.3) as well as in localized patches of vegetation that may be identified during the preparation of the seismic lines (whenever clearance affects woody vegetation a long-lasting effect is expected, however herbaceous plants, whose seeds lie dormant in the soil, may only be affected where substrate levelling works are required or in the camp as soil compaction will negatively affect the future development of these seeds).

Mitigation measures

A wide range of operational procedures, and especially preventive measures, will be implemented throughout the project's life cycle. Although some of these measures are especially designed to protect the vegetation most of them are designed to protect the environment as a whole (i.e., soil, fauna, and natural landscape).

In addition to the mitigation measures embedded in the Project design and outlined in *Section 3.3.2*, including the early planning of the seismic survey to avoid potentially sensitive areas like oueds and sabkhas as far as possible, the following mitigation measures will be implemented:

- A field HSE Specialist will be incorporated into the seismic survey group to oversee all mitigation measures, carry out examination of areas that appear to be sensitive and evaluate its environmental vulnerability before the installation of seismic camp, access paths, roads or seismic lines.
- A *Journey Management Plan* (*see Section 6.4.8*)*,* including specific measures for the crossing of oueds, will be developed to control all vehicle movements.
- All ephemeral streams and other hydrological features likely to host vegetation found during the seismic survey should be recorded and, to the extent feasible, seismic lines planned to avoid crossing these.
- A one-track policy will prevail in all operations. Off-road driving is banned.
- Vehicle tracks and accesses will avoid woody vegetation (bushes and trees) as far as possible, with special care taken of protected species. Straight lines will be accepted in densely vegetated areas that cannot be completely avoided and micro-rerouting will be implemented as needed.
- Any significant need to perform clearance using a bulldozer will require the formal approval of the Statoil HSE representative in the field before being undertaken. Width of clearance with bulldozers will be limited to a maximum of 3.5 m in sensitive areas.
- Toolbox talks to be held to develop the construction crews' awareness of protected plants, animals and habitats.
- A photographic record will be kept to validate the applied procedures. Relevant locations in terms of vegetation density will be also recorded with a GPS to allow future assessment of regeneration if required.
- No collection policy for flora
- A *Plan for the Shutting Down and Restoration of Site* (see *Section 6.4.6*) will be implemented for all footprint areas of the seismic works.

Residual Impact evaluation

Provided the existence of several oueds and sabkhas hosting locally important vegetation along the seismic survey lines, the effective implementation of the proposed mitigation measures, particularly in regard to the planning of the lines and the adoption of micro-re-routings when the lines may affect such features will minimise the impact on vegetation. Based on

- the adoption of the above-indicated mitigation measures,
- the absence of vegetation on the majority of the surface affected by the seismic activities and
- the relatively low vegetation density on the oueds and sabkhas, as recorded in the baseline field survey (that would facilitate the minimisation or even avoidance of vegetation clearance by allowing micro-rerouting of lines in some cases), it is considered that the residual impact on flora and vegetation will be minor

Impact Rating for FL1	**Minor**

5.4.8 Fauna (FA1)

Impact description

Several project activities have the potential to negatively affect the fauna in the study area as a result of seismic activities. As presented in the impact matrix, it is considered that the following are the project activities with the highest potential to negatively affect fauna as a result of the proposed seismic exploration activities:

- Campsite preparation and operation, including site clearance, traffic, presence of workforce and waste generation and management;
- All operations along the seismic lines preparation and survey area. Particularly relevant are the preparation of source lines (and associated potential clearance requirements) and general influx of the workforce to mark, prepare and survey the seismic lines (source and receiver lines); and
- Uphole drilling and access to the up to 80 proposed uphole locations.

The nature of the impacts on fauna that may occur due to the abovementioned activities include:

- Disturbance and temporary displacement of species due to land occupation, noise and human activity along the survey lines (short term displacement) and campsite (medium term displacement);
- Direct harm, injury or death to species due to collision with vehicles, clearance activities, unregulated hunting by crew, access to hazardous materials; and
- Secondary effects due to loss of habitat, food plants or loss of/displacement of prey species.

In the proposed seismic survey area, the main areas of relevance for fauna are the oueds and sabkhas as the vegetation in these areas provides most of the resources required by the fauna (e.g., food, shade, water supply, shelter, and protection from predators).

The impacts associated with the seismic survey process itself are considered to be temporary and short term, as they will disappear once the operations have been completed and will occur only at the precise place where the survey takes place at the exact time the survey is carried out with vehicles progressively moving across the planned survey grid. The impact will be higher in the planned campsite as it will be occupied for several months (an estimated 9 months for the Phase 1 seismic survey for instance). Moreover, direct disturbance, at least to mammal species, is likely to be relatively limited given they are mainly nocturnal, when no surveying activity will take place.

As a result, the most relevant impact on fauna will derive from vegetation clearance and the associated loss of habitat as well as potential physical harm resulting from the clearance of campsite and preparation of seismic lines.

Given the density of the proposed seismic survey, direct harm or some individuals loss on the less mobile species, such as turtles, or juveniles and eggs of birds and reptiles could potentially occur. However, any direct impact in terms of direct harm on large and highly mobile species is considered unlikely.

The impact due to habitat loss is considered to be limited, as shown by the assessment conducted in the previous Impact on Flora (FL1) Section.

The risks derived from any potential hunting or trapping of animals by the seismic workforce are, however, considered minimal given the adoption of a “no hunting, trapping or removal” policy.

Finally, exposure of fauna to harmful substances at waste disposal locations is another potential source of negative impact on faunal populations. It is widely known that fauna is attracted by seismic activities due to the potential availability of food and water resources. This effect would be temporary and restricted to the proposed campsite and managed as part of the management on-site management plans.

Mitigation measures

Considering that the main potential impact on fauna is associated to the potential loss of habitat, the mitigation measures included in Section 0 to minimise impacts on flora and habitats are also applicable for fauna. Similarly, in order to reduce any disturbance from the noise generated by the seismic activities, the mitigation measures considered in Section 5.4.2 will apply.

In addition, the following mitigation or preventive measures will be implemented:

- Workers Management Plan including a 'code of conduct' which will prohibit hunting, gathering, chasing or disturbance of any wildlife.
- Waste Management Plan, including campsite stores constructed in such a way that access by fauna is avoided.
- Stop work procedures will be in place for the protection of wildlife (e.g., when gazelles are observed).
- Drilled upholes will be backfilled to prevent wildlife falling in and decommissioned as per the practice set in Section 3.3.3.

Residual Impact evaluation

Considering the adoption of the indicated mitigation measures to minimise direct impacts on fauna or secondary impacts through habitat loss, the residual impacts on fauna will be of minor significance and short-term.

Impact Rating for FA1	**Minor**

5.4.9 Economy, Employment and Livelihoods (EC1)

Impact description

Based on the nature of the project activities, the main potential impacts (mainly positive impacts) to the economy, employment and livelihoods identified during seismic exploration will comprise the following:

- EC1.1 - Local procurement of goods and services.
- EC1.2.1 - Short-term direct and indirect employment opportunities.
- EC1.2.2 - Long-term benefits of capacity enhancement (on-the-job and formal training opportunities).
- EC1.3 - Disturbance to animal grazing activities (mainly camel husbandry).

The positive impact of increased government project revenues (i.e. tax payments and fees for water extracted from aquifers and extraction material such as sand and tuff) at local level cannot be accurately quantified at this stage of the project as the allocation of increased government revenue for local, regional or national development, or for other purposes, is unknown. Therefore, it cannot be assessed how the revenues from Project's tax payments and fees are returned to local level.

Moreover, increased expenditure will have the potential to trigger local inflation (e.g., for construction materials, fuel, food and transportation). However, the impact of price inflation is considered negligible since the camps will provide basic necessities (e.g., housing, food, laundry, communications, and health care) for the employees, and project controls will be in place (movement of personnel in and out the camps will be limited due to security issues and the distance/access to populated areas). The increase in price of construction material from the existing local licensed quarries is expected to be barely noticeable due to the limited volume of material expected to be needed and since it is expected that the project will use borrow pits located close to the civil works activities (new borrow pits will be opened up according to the procedures set by the Borrow Pits Management Plan, see Chapter 6 EMP).

Agriculture is very basic within the Timissit License area and is exclusively limited to the surroundings of Debdeb where no seismic activities are planned.

It is expected that seismic activities on site (including seimic planning, mobilization, accesses and camp site preparation, seismic acquisition, decommissioning and site preparation) will last approximately one year for Phases 1 & 2 (over an area of 450 km^2) and another year for Phase 3 (over an area of 100 km^2). Phases 1 & 2 would be developed between April 2017 and March 2018 and Phase 3 between October 2020 and August 2021 (see Section 3.1.2 for details).

EC1.1 - Local procurement of goods and services (positive impact)

The Project will purchase goods and services during site preparation (civil works, camp establishment) and also during the seismic acquisition operations. Daily water needs (potable and non-potable water) will be provided by a local water source in Debdeb and the required fuel will be transported from Hassi Messaoud, located in Ouargla Wilaya, approximately 300 km from the Timissit License area. There is the potential for local businesses to supply the camp with services such as catering, food supply, maintenance services for non-technical aspects, laundry, employee transport, consumables, and so on. However, potential suppliers will have to meet stringent health, safety and quality standards. For those companies that meet the eligibility criteria and enter the supply chain, there will be short-term benefits to the businesses and their employees through increased experience, capacity and training. However, these opportunities are considered to have a minor effect, given the limited need for goods and materials for the seismic operations (mainly for the camp), the barriers to become a supplier and the short duration of these seismic operations. It should be noted that during the field survey, it was observed that there are limited potential suppliers locally.

EC1.2 - Short-term direct and indirect employment opportunities and long-term benefits of capacity enhancement (on-the-job and formal training opportunities)– (positive impact)

The seismic operations will take an estimated 2 years in total, during which time up to 250 jobs will be available. The majority of the personnel will preferably be experienced Algerian nationals (who have worked for the survey Contractor elsewhere in Algeria), with a minimum number of expat managers estimated as 20 persons. For non or low skilled work local hires will be prioritised (i.e., people recruited from Debdeb and other towns close to the Timissit License area like Meriksene, Timeroualine and In Amenas). These local hires have been tentatively estimated around 10 percent (provided they meet relevant criterias defined by Human Ressources for the requested jobs). These people will be employed as site access control, drivers, and permitting personnel. Although the majority of the staff associated with the survey will be from outside of the Timissit License area, local hires do represent a positive impact on the area.

Indirect employment through the construction supply chain will be limited in the Study Area, due to the informal nature of the businesses in the zone and the lack of an industrial service industry. Induced employment is also expected to be limited due to the limited availability of goods and services.

Those who are able to secure employment on the Project will have the opportunity to improve their skills and experience through on-the-job training, and thereby improve their opportunities for future employment within the oil and gas sector.

EC1.3 - Disturbance to animal grazing activities

During the field survey performed in May 2015, the presence of camel herders within the Timissit License Area was reported (they were identified in the central zone of the Seismic Area of Interest near a water well and a sabkha in ST-31). However, it should be noted that no signs of nomadic or semi-nomadic activities were identified in the Study Area and local authorities consulted during the meetings reported that the area was not frequented by nomads. The pastoralists have fixed living accommodation in Debdeb but they move around in the area with their herd looking for palatable pasture and water.

Normally, direct impacts to vegetation used as grazing would have potential secondary impacts to livestock and herders. Currently (July 2015), there is not enough information available regarding the numbers and distribution of camel herders within the Study Area. However, it is suspected that the oueds and sabkhas in the Timissit License Area are used as grazing areas at some times in the year, particularly where they are located near water wells. Impacts to habitats and flora have been assessed as minor for the Seismic Area of Interest (see Impact FL1 in Section 0), although there will be potential secondary impacts to livestock and herders.

Mitigation measures

Relevant management plans for this impact are: the Plan for Worker Management, which includes the procedures for recruitment practices, transparency policy on employment and training as well as worker grievance mechanism and measures for working pay; the Plan for Local Content, which following Instruction nº01 of 11th March 2013 is aimed at maximising local employment; and the post-ESIA Public Consultation and Disclosure Plan (PCDP) which will establish a procedure to inform potentially affected local communities (including herders) about project activities as well as providing a grievance mechanism. Finally, mitigation measures defined in Section 5.3.7 (impacts on flora)and the Plan for the Shutting Down and Restoration of Site (outlined in Chapter 6 EMP), include measures for the restoration of any potential vegetated area affected during the seismic activities with potential for grazing activities.

In addition, other measures to be considered for enhancing positive impacts on the economy and employment and reducing as far as possible any potential impact on livelihoods are:

- The procurement policy will include local sourcing of goods and services where this does not affect local communities (e.g., through shortages or price increases).
- If no sustainable local sourcing of goods can be identified, provisions will be imported from larger commercial centres. There will be no purchase of goods by non-local workers from villages in order to reduce unnecessary interaction and impacts on local communities. Sourcing will be undertaken by the camp manager.
- The Engagement Procedure with local communities integrated within the PCDP would include the following:

o Engagement with the local communities (including camel herders) will start at least 3 months prior to the seismic activites commencing in order to understand the key areas to avoid and factor into laying seismic lines. It is important to note that the Engagement Procedure will include a specific section for the engagement of local herders.
o Through this engagement, the local herders will be provided with an opportunity to identify any vegetated or water sources areas (oueds, sabkahs or water wells) they require critical access to at particular times.
o During this early engagement, Statoil will identify the most adequate way for information provision to be done in a manner that enables them to receive it and will be the basis for the Communication Plan (which is also part of the PCDP).
o In addition, during this engagement Statoil together with the local government and communities will develop a common understanding of how project-related activities will impact, either positively or negatively, the local environment and the traditional livelihoods of the communities. This will allow Statoil to identify additional measures to enhance positive impacts and minimize to the extent possible any potential negative impacts. The outputs will be recorded in the PCPD and implemented through the corresponding Plan. At or before the start of the seismic survey, the local community (including camel herders) will be advised of survey timings and when the survey will occupy particular areas.

Residual Impact evaluation

Following the implementation of the Plans and mitigation measures described above, the impacts associated with the employment of the workforce and economic benefits locally (EC1.1 and EC1.2) are predicted to be positive but limited in scale and duration. It is noted that there will be a positive residual impact elsewhere in Algeria, from where the majority of workforce is sourced. At the national and regional levels the magnitude is considered to be small and the sensitivity of the receptor low as those that benefit will have high skills and capacity with ability to gain employment across the oil and gas industry.

Consequently the national benefit will be negligible. At local level the sensitivity of the unskilled labour that may secure short term employment, and gain important experience, is considered to be medium. However as the magnitude of impact remains small (short duration, low numbers of beneficiaries), the positive impact is considered to be Minor.

Given the project definition (e.g. density of seismic grid), the mitigation measures proposed above, the temporary nature of the access restriction and the limited numbers of herders that are expected to be affected within the area, the potential impact due to the disturbance of grazing activities is Moderate (due to small magnitude of impact but high sensitivity of the receptor). The sensitivity of the receptor has been considered as high since it is assumed that camel

rearing is the primary source of income of this group and the limited the ability to adapt (it would not be feasible to move livestock herd even further afield).	
Impact Rating for EC1.1	**Positive**
Impact Rating for EC1.2	**Positive**
Impact Rating for EC1.3	**Moderate**

5.4.10 Infrastructure and Services (IF1)

Impact description

Based on the nature of the project activities, the main potential impacts during seismic exploration to infrastructure and services will comprise the following:

- IF1.1 - Potential competition for water resources with local community.
- IF1.2 - Increased pressure on road infrastructure.
- IF1.3 - Increased pressure on waste management facilities.

There is no infrastructure within the proposed Seismic Area. The only elements identified within the proposed seismic areas include an unpaved access road (to be upgraded and used as the main access to the central part of the License area) and an old airstrip (that may be potentially restored/upgraded and used for the project). Thus provided the virtual absence of infraestrctures no impacts are expected from the seismic acquisition works.

In addition, based on the current plans it is expected that the workforce will not make use of local health infrastructure, as medical services will be provided on site (and where needed medevac to Hassi Mesaoud).

IF1.1 - Potential competition for water resources with local community

The seismic operations will use water and other consumables (food, fuel, etc.) for the duration of its presence in the Timissit License area. This raises the potential for conflict over resources with existing users, in particular with regard to water extraction[1]. It is initially anticipated that water for seismic activities will be supplied from Debdeb. Nonetheless, depending on the yields of water wells developed during the drilling/hydraulic stimulation campaign, these may be used as an alternative water source for seismic operations (i.e. no water well will be drilled for non-potable water during seismic works). In all cases non-potable water (uphole drilling, camp and access maintenance) will be sourced from the Albian CI aquifer which is the primary source of water both locally and regionally. Potable water will be purchased from outside the area.

In Debdeb, 72% of the water extracted from this aquifer is used for drinking purposes, 3% for irrigation and 25% for other undefined uses. In the License area, water for camels is abstracted from shallow, hand-dug wells. During the seismic activities, the non-potable water needs have been calculated as 25m^3/day, to be extracted during two phases of 60 days each (i.e., a total of 3,000 m^3). Debdeb reported an extraction rate of 4,100,000 m^3/year from the CI. Therefore, the total projected water demand for seismic purposes is equivalent to less than 0.1% of the Debdeb's annual extraction.

IF1.2 - Increased pressure on road infrastructure

During the seismic survey operations in the Timissit License area, there will be vehicle movement (on a daily basis) between the supply centres (e.g., Debdeb, In Amenas, and Hassi Messaoud) and the base camp using the various roads identified (the NR-53 and NR-3, and the unpaved airstrip access within the License area). It is likely that the airstrip will also be used to transport personnel and certain materials to the base camp. In addition, the vehicles to be

[1] The potential for impact on hydrological resources associated with the sourcing of water during the seismic activities has been addressed in Impact GW1 (see Section 5.3.3).

used for the seismic campaign (vibrators, off road vehicles, water trucks, uphole drilling rigs, etc.) will be transported by air or ground from Algiers/Hassi Messaoud. No additional roads will be constructed as all vehicles will have off-road capabilities. During seismic operations, traffic will be routed through defined access routes from the seismic base camp to the survey areas, and it is likely that these access routes will follow the seismic lines or paths opened to access the well sites drilled during Drilling Phase 1.

The seismic operations will last approximately two years in total (including the three phases), but vehicle movement will not be constant throughout the entire period. Vehicle movements along the existing road infrastructure will be limited during the seismic operations and, therefore, increased pressure on road infrastructure is expected to be limited. However, during the field survey, some tracks, locally known as "*rjems*", were observed within the Timissit License area. These are used by pastoralists to guide the herds to the grazing areas and water wells. It is unknown at this time, if these "*rjems*" were in the past used by the caravans on their way to and from Ghadames. These tracks are thus considered important and could be affected by project operations, causing disturbances to camel herders and locals.

IF1.3 - Increased pressure on waste management facilities

Due to the remoteness of the Timissit License area, access to the project area will be difficult and there will be limited facilities for waste management and disposal. In addition, waste management in Algeria is particularly challenging due to limited disposal and treatment facilities (especially with regard to hazardous industrial waste) and the fact that existing facilities are not always state of the art.

The management principles will be minimisation, segregation by type, recycling and disposal in a controlled manner. Non-hazardous solid waste will be incinerated on site and liquid waste evaporated on site. The waste to be transported to recognised Algerian facilities for treatment and disposal will be limited to hazardous waste, incinerator ashes and other solid waste suitable for recycling and reuse. Therefore, the increased pressure on waste treatment facilities as a result of the seismic operations is expected to be barely noticeable.

In addition, seismic surveys involve the potential for impacts to occur as a result of inappropriate waste management practices that have the potential to cause impact to soils, surface water and groundwater as well as causing potential risks to wildlife, livestock and human health that have been integrated in the various impacts analysed (see impacts on hydrology SW1, hydrogeological resources GW1, etc. for reference).

Mitigation measures

Relevant project-embedded mitigation measures that will contribute to avoiding/minimising potential impacts are mostly related to the appropriate management of the project's water needs in order to minimize water use and the potential impact on other local users of the same resource.

In addition, the following management plans include measures and management procedures that will contribute to preventing and minimising any potential impacts on infrastructures and services, in particular competition for water resources, increased pressure on transport infrastructure, and waste management facilities:

- Water Management Plan.
- Waste Management Plan.
- Traffic / Journey Management Plan, which includes measures to avoid damaging local infrastructure, and maintenance procedures.
- Plan for Environmental Information and Awareness which shall include awareness training on the use of water resources, infrastructures and waste management.
- Public Consultation and Disclosure Plan (Chapter 6 EMP) which will include a grievance mechanism process for communities where complaints about water resources and infrastructures can be addressed.
- During the stakeholder engagement, to be implemented before commencing the seismic activites as part of the PCDP (see Impact EC1 in Section 5.4.9), Statoil will work together with the local government, communities and herders to have a better understanding of the use of *rjems* within the Timissit License area and where necessary establish additional measures to avoid potential disturbance to the users of these local paths.
- Audit Management Plan to ensure compliance with the procedures and measures established in the plans listed above and correct any potential deviation.

In addition, the following mitigation and prevention measures will apply:

- The critera for the selection of the waste treatment facilities to be used by the Project will include, in addition to the nature of waste and volumes, the facility's capacity to prevent possible overpressure events and, therefore, a detrimental effect on the local population.

Residual Impact evaluation

The Albian aquifer, which is the principal fresh water resource in the region and will be the main water source for the Project seismic activities, is already being extensively exploited and it is an important and sensitive resource in the region (it is in fact considered as fossil water source). Given the small water volume to be extracted during seismic operations representing in overall less than 0.1% of Debdeb's annual extraction, the magnitude is considered to be negligible. As a result, impacts associated with the conflict for resources, in particular non-potable water, are predicted to be negligible during seismic operations. It should be noted that, impact on the potential depletion of the aquifer due to the seismic operations is assessed in GW1.

The impact of increased pressure on the road infrastructure and waste management facilities is considered, on the whole, to be negligible. This assessment is based on the (1) limited number of vehicle movements, (2) the temporary effect, (3) the waste types and quantities expected during the seismic operation and very impotantly (5) on the range of preventive and mitigation measures, including the Journey/Traffic Management Plan.

Impact Rating for IF1.1	**Negligible**
Impact Rating for IF1.2	**Negligible**
Impact Rating for IF1.3	**Negligible**

5.4.11 Community Health, Safety and Security (PH1)

Impact description

Based on the nature of the project activities, the main potential impacts during seismic exploration on community health, safety and security will comprise the following:

- PH1.1 - Traffic accidents due to increased traffic and the presence of heavy vehicles on local roads.
- PH1.2 - Disturbance by occasional noise/vibration, dust and exhaust emissions to residents of the villages (i.e., Debdeb, Meriksene, Timeroualine).
- PH1.3 - Interaction between the workforce (including security forces) and the local community.
- PH1.4 - Increased transmission of communicable diseases.

PH1.1 - Traffic accidents due to increased traffic and the presence of heavy vehicles on local roads

The main potential for negative impacts to local residents would result from the movement of project traffic on local roads (mainly the NR-53). This would potentially increase traffic movements through and near to settlements on and close to the access roads. Most of the project-related road traffic is expected to travel from/to Hassi Messaoud and In Amenas, or to be transported by air through the airstrip in the License area. Based on this, Debdeb and Merikesene (which are are located on the north of the junction between the unpaved access road to the Seismic Camp and the NR-53 road) are expected to avoid most of the project related traffic. Timeroualine, on the contrary, is located along the NR-53 road, several kilometres to the south, and therefore would receive, in transit, a good proportion of the traffic.

As explained in Impact IF1, increased vehicle movement during seismic operations will be limited in time and the volume will be mainly restricted to the mobilisation and demobilisation of machinery, equipment and personnel to the site and a few daily movements from the base camp to the supplier centres (during seismic operations traffic will be routed along the seismic lines to the survey areas). However, road safety is still one of the most significant significant issues for the Project and thus a Journey Management Plan will be in place before the commencement of activities, which will help in preventing and minimising a variety of impacts associated with vehicle use and traffic, with the aim of reducing the level of risk of traffic accidents and injury to other road users and pedestrians to as low as reasonably practicable. The Traffic/Journey Management Plan to be developed is outlined in Chapter 6 EMP.

PH1.2 - Disturbance by occasional noise/vibration, dust and exhaust emissions.

Noise, dust and exhaust emissions resulting from vehicle movement, machinery operation (such as the bulldozers used during line clearance and set up activities, 4WD vehicles and vibrator trucks used during uphole drilling and vibroseis activities), power generators, earthworks operations, and airstrip use (landing and take-off) may have an impact on the wellbeing of a community.

Due to the distance of receptors from the Seismic Area of Interest (which includes the airstrip and the base camp) workers are expected to be the only regular receptors, except for the potential presence of transient visitors such as herders and military personnel, which will probably temporarily avoid the area where the activities are taking place, and are not expected to be continuously affected by noise or dust.

Impacts related to noise levels and ambient air quality during seismic operations have been assessed in Impact AQ1 and N1, resulting in negligible impacts.

PH1.3 - Interaction between the workforce (including security forces) and the local community

There will be one crew of approximately 200-250 workers (see details provided EC1.2 for reference). It is expected that the crew will remain in the area for a total of 2 years, but not on a contiuous basis.

The likelihood of negative interactions between local communities and workforce (e.g. non respect to local customs and traditions, petty crime and fighting, etc.) will be considerably reduced by the following considerations:

- The remoteness of survey operations from communities. Although the exact location of the base camp is not yet defined it will be, most possibly, located in the center of the License area, close to the existing airstrip (more than 20 km from the nearest town, Debdeb, and the NR-53), where a previous camp was installed thus considerably reducing impacts from camp location.
- The typical schedule for seismic survey worker is to work 4 weeks on and 4 weeks of with 12h worktime/day. Breaks will take place during pauses in work in the field and at the seismic camp. Each worker's off time will be spent at their home location. Workers will therefore not have the time, nor be permitted, to spend time in the local communities.
- Access to and exit from the camp will be controlled for security reasons. In general, workers will not be allowed to leave the camp during breaks or at night.
- At night, only authorised personnel and vehicles will be permitted to operate outside the camp and their whereabouts will be monitored.

There may also be potential conflict between local residents and project security forces. The likelihood of negative interactions such as the above will be managed through the implementation, to the extent possible of internationally recognised human rights principles, such as the Voluntary Principles on Security and Human Rights[2] and UN Resolution regarding Small Arms[3]. These guidelines recognise the value for companies of engaging with civil society and host and home governments in order to contribute to the welfare of the local community while mitigating any potential for conflict wherever possible.

PH1.4 - Increased transmission of communicable diseases

The presence of an external workforce could lead to an increased transmission of communicable diseases.

[2] The Voluntary Principle on Security and Human Rights is a set of voluntary principles to help companies maintain the safety and security of their operations within an operating framework that ensures respect for human rights and fundamental freedoms (see www.voluntaryprinciples.org). The voluntary principles have been collectively developed by the government of the United States, the United Kingdom, Norway and the Netherlands, as well as companies operating in the extractive and energy sectors and non-governmental organisations.

[3] http://www.securitycouncilreport.org/un-documents/small-arms/

These diseases will be influenced by the disease profiles of (1) the local communities, and (2) the countries of origin of the workers. Communicable diseases are infectious diseases that can be transmitted from one individual to another either directly by contact or indirectly by vectors. Communicable diseases of concern are likely to include: tuberculosis, hepatitis A, B and C, diarrhoeal diseases and acute respiratory infections. The workplace is considered an important setting for interventions for the prevention and control of infections. It is expected that the majority of the workforce during seismic operations will be Algerians including a low percentage of locals and also a low percentage of expatriates. They will be housed in a communal setting, where the spread of infectious diseases can occur more rapidly.

As explained before, interaction between the workforce and the locals will, however, be very limited since the workers will be provided with accommodation, food and sanitary services. In addition, movements outside the camp will be very restricted due to security and safety issues inherent to the area where the Project is to be located. Therefore, the impact is considered to be unlikely to occur due to project controls regarding interactions between workers and the local population and the fact that the majority of the workforce will be nationals.

Mitigation measures

Refer to mitigation measures proposed for Impact AQ1 and N1 for mitigation measures to reduce potential disturbances to the wellbeing of the local population due to noise and air emissions during construction/operation of the seismic acquisition phase.

Relevant project-embedded mitigation measures that would help to minimise potential workforce-community interaction issues include camp siting criteria (proximity to communities is a consideration in site selection) and camp management policy (in order to minimise social disturbance arising from the behaviour of the workforce; personnel movement to and from the camps will be controlled and visitors to the camps will be restricted).

A series of management plans that will be implemented throughout the seismic phase will also contain specific measures for protecting Community health, safety and security. Amongst the most relevant are:

- The Plan for Worker Management which will include the implementation of a Workforce Code of Conduct and measures for living and working conditions which will contribute to reduce the risks of diseases transmissions into the community and a worker grievance mechanism.
- The PDCP which will implement a clear process for reporting any complaints/grievances.
- The Traffic/Journey Management Plan. The implementation of the Traffic/Journey Management Plan will minimise the risk of traffic accidents as far as possible. This Plan will cover aspects such as vehicle safety, driver and passenger behaviour, speed limits, and methods of enforcement, use of drugs and alcohol, operating hours, rest periods, driver competency, community education on traffic safety, and accident reporting and investigations.

In addition, in accordance with best industry practice, several mitigation measures will be implemented:

- There will be a dedicated Community Liaison Officer tasked with the responsibility of dealing with interaction with the local communities and individuals.
- There will be community awareness training for survey personnel and human rights awareness for local security forces protecting the project's operations (this training can be integrated within the Plan for Environmental Information and Awareness included in the EMP –see Chapter 6).
- Prior to procuring security services, human rights criteria as part of pre-qualification screening, integrity due diligence and contractual provisions and clauses, will be included as appropriate.
- The Project will check that the project's security providers commit to respecting human rights in a manner consistent with Statoil policies and standards and monitor these providers to ensure that required measures are adopted.
- Camps will be designed, constructed and managed in line with Algerian legal requirements.
- Conduct pre-employment screening protocols for all employees including contractors and subcontractors which will include testing for TB and other diseases appropriate to the individual's country of origin (eg. hepatities, acute respiratory diseases, malaria), vaccinations and voluntary testing for sexually transmitted diseases.
- Workforce (including subcontractors) will be provided with health awareness training, including a significant briefing of hygiene practices (such as hand washing), implementation of educational outreach to increase awareness of major communicable disease and how to protect against infection and about transmission routes

and the symptons of the communicable diseases of concerns (including STDs).

- Ensuring all workers, including contractors and subcontractors, comply with Algerian legal requirements with regards to health checks.

  Statoil will establish the right to audit on site contractors to ensure they are abiding with national legal requirements and clauses in the contract through all contracts and subcontracts. Failure to meet these standards will result in consequences up to and including termination of contract, to be decided on a case by case basis.

Residual Impact evaluation

The risk of traffic accidents always exists as by definition a risk cannot be zero. In the ESIA context, assigning it a level of significance in terms of impacts has some intrinsic limitations, however it does provides a framework that can be, at some point, compared with standard project activities.

The key consideration in analysing the residual impact of labour accidents is the significant level of importance attached to this issue by the Project and the consequent requirements for the survey Contractor to take the necessary measures to reduce the risk to as low as reasonably practicable. The development of a Journey/Traffic Management Plan will be key in ensuring minimisation of accidents. In addition, considering the low increase in traffic and the short duration of vehicle movements along local roads, the impact has been considered of small magnitude. The sensitivity of the receptor has been considered as medium, since any vehicle accident will likely cause an impact on human wellbeing (able to adapt with some difficulty and may require interventions). Therefore the impact on human wellbeing due to increased traffic during seismic operations is considered minor.

Regarding potential impacts on wellbeing from air and noise emissions, the impact is also considered Negligible due to the remoteness of the construction/operations of the seismic acquisition from the nearest communities.

The significance of residual impacts associated with interaction with local communities (including security force) is also predicted to be Negligible, following implementation of the mitigation measures described above and on the basis of its likelihood. The impact has been considered as unlikely to occur due to project controls regarding interactions between workers and the local population (movements outside the camp will be very restricted). It should be noted also that the License area is already highly militarised due to its proximity to the Lybian and Tunisian borders.

Finally, regarding the impact related to the spread of communicable diseases to the population, local workers will be recruited when feasible from the towns located within or in the surroundings of the License area (i.e., Debdeb, Meriksène, Timeroualine and In Amenas) or from other parts of Algeria. Therefore, only few foreigners will be interacting with the local population, and the interaction will be highly controlled . Consequently, the propagation of communicable diseases has been considered as a Minor (small magnitude considering the health profile in Algeria and medium sensitivity due to the limited access to the local population to health care facilities).

Impact Rating for PH1.1	**Minor**
Impact Rating for PH1.2	**Negligible**
Impact Rating for PH1.3	**Negligible**
Impact Rating for PH1.4	**Minor**

5.4.12 Cultural Heritage (CH1)

Impact description

The project activities that could result in a potentially significant impact on archaeology include the following:

- the construction of new access roads, particularly bulldozing, grading and the excavation of borrow pits;

- clearance for camps (and other footprint areas where needed);
- repeated vehicle traffic along seismic lines and, in particular, the use of bulldozers to clear lines;
- ground preparation for upholes;
- enabling easier vehicular access to remote areas may lead to further degradation of the archaeological record as the result of illegal collection of artefacts.

Archaeological remains are known to exist within the exploration area, the main types recognised being prehistoric surface artefact scatters, prehistoric cemeteries/burial tumuli and features associated with medieval trade routes (e.g. camp sites near water sources, 'desert mosques' and graves). The results of the field survey indicated that some prehistoric surface sites may have been previously degraded by illegal artefact collection, which is known to often be a result of industrial development –and associated settlement and infrastructure development – within the area.

The baseline analysis has indicated the presence of areas of elevated heritage sensitivity within the Statoil exploration area: (1) a south-west to north-east corridor along the edge of the Great Erg leading to Ghadames, (2) the escarpment edge that runs along the east side of the proposed 3D seismic area where experience suggests prehistoric cemeteries and wells are most likely to be found and (3) the Oued Mariksene corridor on the eastern side of the area, an important historic cross-desert trade and pilgrimage route leading south towards Ghat.

The main potential impacts to archaeological artefacts could result from the use of bulldozers and other vehicles to clear the ground or provide access ramps to poorly accessible areas which could then disturb or damage/destroy existing archaeological sites. In addition, there is the risk that personnel associated with the survey could either remove or damage/destroy archaeological finds.

As stated above any impacts to an important archaeological resource would be regarded as being of major significance and unacceptable. Of the known sites recognised by the field survey sites 1 and 5 (Borj Messouada Fort and the prehistoric cemetery at Hassi Tagenebri) are considered to be of high sensitivity and should be avoided by project activities. The survey was not exhaustive and other high sensitivity sites are likely to exist within the Statoil License area. The areas where such sites are most likely occur has been identified by the sensitivity mapping (see Chapter 4, Figure 5.5).

Mitigation measures

Mitigating archaeological impacts is first and foremost focused on avoidance. This requires detailed knowledge of the receiving environment, which can be achieved by the following measures:

- Avoidance of known features: camps, survey lines and uphole drilling locations will be located away from currently known archaeological sites.
- Given the increased risk of disturbing archaeological sites in the areas of identified elevated sensitivity, when planning works in or across these areas additional detailed heritage baseline assessment, including the analysis of high-resolution satellite imagery, and survey will be undertaken before works commence. Any sites of moderate of high sensitivity should be avoided. If such sites cannot be avoided further archaeological fieldwork may be necessary to investigate and record such sites before they are removed.
- In addition, training of the workforce will be undertaken to allow them to identify potential archaeological artefacts. For the remainder of the footprint and subsequent phases these procedures will ensure that any finds are left in situ, recorded, demarcated and reported to the authorities.

To address the above matters, the Project has develop an Procedure for Archaeological Chance Findings, see Annex D.9, incorporating the following:

- archaeological assessment/survey ahead of development within areas of identified elevated heritage sensitivity;
- training of crew in archaeological identification and the legalities of archaeological artefacts protection;
- issue of identification cards;
- a chance finds policy (which ensures that all work would be stopped in the immediate vicinity of a notable find of archaeological artefacts and ensures that an appropriate process is in place to define actions to be taken after a find); and
- reporting procedures.

In addition to the above there are multiple mitigation measures that have been presented under other impacts and will also contribute on the protection of cultural heritage resources, such as:

- All known archaeological sites to be avoided through micro siting of project footprints.
- Significant archaeological finds to be recorded using GPS, reported to the Algerian Department of Antiquities, and left in situ.
- Satellite imagery will be used to identify potential campsites. Site entry reports will then be prepared and a preliminary environmental assessment of proposed sites will be conducted before any activities for camps, upholes or bulldozing commences.
- Existing infrastructure will be used where possible to minimise impacts on any potentially unidentified archaeology in the area.
- Line clearance will be kept to a minimum.
- Vibrators will work independently allowing more flexibility in minimising their overall footprint.
- The receiver line will be deviated up to 50 m either side of the proposed line to avoid archaeological sensitivities.
- Data from existing upholes will be used to minimise the number of new upholes that will need to be drilled.
- Journeys will be limited to those necessary to contribute to the successful outcome of the survey (through the Journey/Traffic Management Plan).
- Multiple vehicles will travel in the lead vehicle's tracks.

Residual Impact evaluation

The Project will adopt measures and procedures that will have the primary aim of avoiding impacts. The successful implementation of these measures should lead to impacts that could be considered as minor at most.

As a result of the survey work in the study area, archaeological information will be generated. This information, including the location of all identified sites of heritage significance, will be disclosed to the Department of Antiquities in a format to be agreed. The production and dissemination of data from such exercises can be regarded as a positive impact.

Impact Rating for CH1	**Minor**

5.4.13 Closure and Decommissioning (CD1)

Impact description

In GM1 it has been assessed that geomorphology/landscape can be affected by different seismic activities. However, since most impacts on the landscape are dealt with when the seismic activities come to a close, they are assessed in this section on camp closure, which considers the visual impacts stemming from seismic lines, uphole drilling, waste generation, and camp operation and decommissioning.

Mitigation measures

Relevant management measures for this impact are described in (1) the Plan for the Shutting Down and Restoration of Sites, as well as (2) the Plan for Management of Contaminated Sites and Soil and (3) the Waste Management Plan.

Key preventive and mitigation measures of interest (integrated in the above-mentioned plans) include:

- During decommissioning, ensuring all materials are removed from the site or disposed of in compliance with the Waste Management Plan.
- The cleaning up and restoration of seismic lines, base-camps and sites.
- The taking of photographs of the locations before any activity in the area and after decommissioning to ensure that the areas have been properly cleaned and treated during decommissioning.

Residual Impact evaluation The decommissioning activities themselves will not have an impact, with the visual impact originated by the project considered to be negligible. This is a combination of the current absence of receptors and implementation of mitigation measures together with the natural low sensitivity of the landscape in the area of seismic interest.	
Impact Rating for CLD1	**Negligible**

5.5 Assessment Summary of Potential Environmental & Social Impacts during the Seismic Exploration Activities

Table 5.1 Impact significance summary for the Seismic Exploration Activities

	Seismic Exploration Activities		
Physical	Air Quality	**AQ1**	**Negligible**
	Noise Level	**N1**	**Negligible**
	Hydrological Resources (surface water)	**SW1**	**Minor**
	Hydrogeological Resources (groundwater)	**GW1**	**Moderate**
	Geomorphology and Natural Landscape	**GM1**	**Moderate**
	Soils	**S1**	**Negligible**
Biological	Flora	**FL1**	**Minor**
	Fauna	**FA1**	**Minor**
Socioeconomic	Economy and Livelihoods	**EC1**	
	• Local procurement of goods and services	**EC1.1**	**Positive**
	• Short-term direct and indirect employment opportunities and Long-term benefits of capacity enhancement	**EC1.2**	**Positive**
	• Disturbance to animal grazing activities	**EC1.3**	**Moderate**
	Infrastructures and Services	**IF1**	
	• Potential competition for water resources with the local community	**IF1.1**	**Negligible**
	• Increased pressure on the road infrastructure	**IF1.2**	**Negligible**
	• Increased pressure on waste management facilities	**IF1.3**	**Negligible**
	Community Health and Safety	**PH1**	
	• Traffic accidents from increased traffic and the presence of heavy vehicles on local roads.	**PH1.1**	**Minor**
	• Disturbance by occasional noise/vibration, dust and exhaust emissions to the residents of villages	**PH1.2**	**Negligible**
	• Interaction between the workforce and the local community	**PH1.3**	**Negligible**
	• Increased transmission of communicable diseases	**PH1.4**	**Minor**
	Cultural Heritage and Archaeology	**CH1**	**Minor**
Closure and Decommissioning		**CLD1**	**Negligible**

Impact Rating	**Positive**	**Negligible**	**Minor**	**Moderate**	**Major**

5.6 Potential Environmental impacts during the Drilling and Hydraulic Stimulation activities

5.6.1 Air Quality (AQ2)

Impact description

The nature and quantity of atmospheric emissions during the drilling/hydraulic stimulation activities will vary considerably between civil works (construction) and drilling/stimulation operations.

During civil works and well site operation, potential impacts on air quality due to atmospheric emissions will be a result of:

i) Exhaust emissions from vehicles/equipment (e.g., trucks, bulldozers, aircraft), power generators and camp incinerators.

ii) Dust generated by vehicle movements and earthworks operations (e.g., well pad preparation, auxiliary facilities such as water/waste pits, and access road clearance), which may be blown over the immediate area. Usually a large part of this dust will settle within a few tens to hundreds of metres from the source and will affect a small area in the immediate vicinity of the works. This distance is likely to fluctuate depending on the prevailing wind direction and speed, and volume of dust generated which will also be dependent on the land surface type (e.g., regs), where potential drilling sites have been identified.

iii) Fugitive emissions of fuel and oil vapours that may occur during the refuelling of equipment, equipment leaks and oil/fuel spills.

Activities undertaken exclusively during the drilling and stimulation will produce air quality impacts and greenhouse gas emissions from the following primary sources:

- Drilling rig: exhaust emissions from drilling equipment .Drilling activities only involve the use of a single drilling rig, which will move between the drill sites. Based on the current planning drilling wells will be drilled and stimulated one after the other (i.e. no potential accumulative emissions are expected between drilling sites). It is expected that the drilling equipment will consume, approximately 650m^3 per vertical well and 720m^3 per horizontal well.

- Hydraulic stimulation: exhaust emissions from hydraulic stimulation equipment such as pumps/compressors. It is expected that hydraulic stimulation equipment will consume some 260 m^3 of fuel per well vertical well and 500m ^{3} per horizontal well approximately.

- Well testing: emissions for the gas flare stack, along with any non-combusted fugitive emissions, which may account for significant greenhouse gas (GHG) generation. The gas flow rate from a vertical well could be up to 2000 E3M3 and for a horizontal well from up to 4000 E3M3. Emissions from testing a horizontal well would be expected to be much larger than in the vertical due to the larger hydraulically stimulated area. In exploration projects, the main sources of fugitive emissions are much more controlled, and are limited to the wells. No significant fugitive emissions of CH_4 are expected during the Project.

Local air quality impacts due to emissions derived from the use of vehicles and machinery as well as dust generation are considered to be minor, due to the nature of the area where the activities are to take place (high dispersion rate), and the absence of sensitive receptors in the prospective drilling area.

In terms of emissions from the drilling and stimulation, the sources are more concentrated geographically (rig, compressors, test flare) and therefore there's certain potential for having a local impact on the air quality (i.e. in the vicinity of the well site). Nevertheless, the high dispersion rate, the absence of nearby receptors in the prospective drilling area, and the short-term of these emissions lead to a minor potential impact.

With respect to the emissions of greenhouse gases, in spite of the relatively high fuel consumption/emissions volumes ($C0_2$ production calculated per well is 1500-2000 tonnes), these can be considered insignificant compared to the total emission generated in Algeria. Based on World Bank data, in 2014 Algeria emitted approximately 3.2 tonnes per capita. Considering a population of 39.93 million inhabitants in 2014 in Algeria, this means a total of 125,472 million tonnes. The Project will emit approximately 0.0096% of the country's emissions.

Mitigation measures

Relevant project-embedded mitigation measures for air emission controls related to vehicle emissions, are the same as those already described in Section 5.4.1 for Air Quality during the seismic activities, which basically consist on minimising resource use and related emissions.

Specific embedded mitigation measures for drilling/hydraulic stimulation will be related to the maintenance and testing of equipment to maintain combustion efficiency, and the design of compressor exhausts and flare stack to maximise dispersion. The same control measures for well integrity that prevent liquid leaks from wells, (see Section 5.6.4,) are valid for gases, and will minimise fugitive emissions.

Main plans for the management of air emissions include:

- Plan for Traffic/Journey Management Plan
- Plan for Management of Liquid and Gaseous Waste (note that the plan requires air quality modelling should a receptor be found within 2 km of the drilling/hydraulic stimulation sites).
- Plan for Prevention and Control of Pollution
- Procedure for Management of Change.

The implementation of the above-mentioned Procedure for Management of Change could require, where appropiate, the following:

  - Updating of environmental social and archaeological conditions of drilling locations
  - Updating of technical specifics of the activities, if relevant
  - Assessment of impacts and mitigation measures will be updated, if relevant
  - Field identification of additional sensitive areas that should be avoided, prior to the commencement of drilling activities.

Residual Impact evaluation

Local residual impacts on air quality are considered to be minor, due to the nature of the area where the activities are to take place (high dispersion rate), and the absence of sensitive receptors in the prospective drilling area. GHG emissions are not significant on the national, regional and global scale. Also the implementation of a wide range of preventive and mitigation measures will minimise the amount of works to be undertaken, improve the efficiency of resource consumption, and thus indirectly decrease the amount of emissions produced and facilitate the dispersion of emissions and prevention of unexpected effects.

Impact Rating for AQ2	**Minor**

5.6.2 Noise (N2)

Impact description

Several activities carried out throughout the drilling/hydraulic stimulation activities have the potential to create noise

disturbances; especially those where vehicle/equipment is employed (e.g., vehicle movement from/to/within the drilling sites, borrow pits, aircraft, earthworks, drilling rig operation, hydraulic stimulation equipment, and well testing). General noise emissions levels derived from the project activities are expected to be relevant but localized in the well site (except for cases where aircraft is used). Drilling (vertical and horizontal) may be around to 95 dBA (horizontal/vertical drilling); whilst hydraulic stimulation compression and flaring may range between 95 to 102 dBA. Noise from these operations is expected to only be an issue within a relatively small radius around the sources, and its potential impact will depend on the potential presence of receptors (human settlements, sensitive fauna, etc.). Currently, there is no human habitation around the proposed drilling sites and fauna in the desert environment is mobile and dispersed. Thus, noise impacts associated with drilling/hydraulic stimulation activities are expected to be focused at the well pad sites and in the immediate surroundings, as well as having secondary effects on fauna (i.e., temporary displacement of fauna from the area where working activities are being carried out, see Impact FA2).
Mitigation measures Relevant project-embedded mitigation measures that will affect noise levels during the drilling/hydraulic stimulation activities will be the same as for seismic acquisition (Section 5.4.2), especially with regard to vehicle/equipment operation and maintenance. Likewise, there will be an overlap with those described in Section 5.6.1 AQ2, where plans such as the Journey/Traffic Management Plan/ Procedure for Management of Change and Plan for Management of Borrow Pits will minimise noise emissions, especially involving truck transport activities that may cross villages/cities within the Study Area, and from crusher equipment. Specific to drilling/hydraulic stimulation will be flare stack design to reduce noise from flaring during well testing.
Residual Impact evaluation Considering the remoteness of the area, the virtual lack of sensitive receptors in the prospective drilling area, the temporary nature of activities, and the implementation of the above-mentioned mitigation measures, the residual impact is expected to be minor.

Impact Rating for N2	**Negligible**

5.6.3 Surface Water (SW2)

Impact description No permanent surface water bodies have been identified in the areas of drilling interest. However several oueds and Sabkhas, which can be described as surface water features, have been identified within the prospective drilling area. Based on the current project design none of the tentative well sites or drilling camps are located in oueds or Sabkhas. However, potential well sites for Phase 2 and 3 are still to be defined (2 vertical and 2 horizontal wells). The drilling/hydraulic stimulation activities have the potential to interfere with these surficial features either through the footprint selection (i.e. if well sites, accesses, borrow pits, etc. are located within these areas) or due to unplanned, non-routine events, such as the potential accidental releases of wastes or raw materials to the oueds/sabkhas. The main wastes and raw materials produced or stored in the well sites include the drilling mud sand cuttings and the stimulation fluids and flowback water. All these will be are stored with dedicated waste pits (e.g., for drill cuttings and flowback water). Furthermore, these activities employ a high volume of process fluids (e.g., drilling muds and stimulation fluid), requiring a high volume of additives that must be transported/stored/managed at the site; thus the potential for minor spills/leaks of fuel/oil/chemicals cannot be disregarded. Potential surface water impacts from the drilling/hydraulic stimulation activities are therefore expected to be either localised at the well pads and in their immediate surroundings (e.g., water/waste pits), or potentially dispersed along the

access roads, in case of accidental releases, where fuel/chemicals will be in transit.

Mitigation measures

Relevant project-embedded mitigation measures that will protect surface waters in the area will be mostly related to: (1) site selection and management and (2) the appropriate management and transport of project wastes and raw materials.

A series of management plans will be implemented along the drilling and stimulation activities in all Phases of the exploration campaign. These plans will include specific measures that will contribute to the protection of surficial waters and their features (oueds and Sabkhas). Amongst the most relevant plans the following can be mentioned:

- Liquid Spill Response Plan
- Waste Management Plan
- Chemical Management Plan
- Procedure for Management of Change
- Plan for Prevention and Control of Pollution
- Plan for Intervention in case of Pollution
- Plan for Management of Contaminated Sites and Soil
- Plan for Management of Liquid and Gaseous Waste
- Borrow Pits (quarries) management Plan
- Journey/Traffic Management Plan
- Borrow pits (quarries) Management Plan
- Program for the Shutting Down and Restoration of Site

Several specific preventive and mitigation measures are presented in the Project Description (see Sections 3.2.1, 3.2.2 and 3.2.7) and will be implemented throughout the drilling and stimulation activities. Among the most relevant ones the following can be mentioned:

- A field HSE Specialist will supervise HSE related to drilling, stimulation, and testing operations. A primary responsibility of this role will be to oversee all mitigation measures, carry out examination of areas that appear to be sensitive and evaluate its environmental vulnerability before the installation of well sites, access paths and roads.
- The design will maximize the use of existing current accesses (e.g. from previous Project drilling phases) old survey lines (as accesses if needed) as well as former campsites and the air strip, thus land take minimised.
- International best practice will be followed, in accordance with Statoil's policies, which will include but will not be limited to the following:
    - All waste pits will be lined
    - All waste pits will be located safe distances from sensitive receptors (human settlements, water sources and other environmentally important areas)
    - The location of pits will be recorded and documented
    - Properties of cuttings and flowback water will be determined to define corresponding treatment and final disposal.
    - Water Based Muds will be used (OBM would only be considered if necessary due to technical and safety considerations).
    - Cuttings potentially infested with hydrocarbons will be either treated to reduce oil content below 1% and disposed at site or transported to a treatment facility.
    - Flowback will be allowed to evaporate on site with outstanding fluids transported to a disposal facility.
    - The additives for drilling muds and stimulation fluids will be subject to screening process to evaluate (and minimize) HSE risks.

For additional mitigation and preventive measures refer to the mitigation measures presented under the surface waters (SW1) and groundwater (GW1) are also relevant to avoid potential interference with groundwater resources.

Residual Impact evaluation

The potential impact on surface waters will be related to well pad construction and operational activities such as drilling and hydraulic stimulation, which imply the production of significant liquid wastes and constitute a localised risk of accidental spills/leaks. The sites will be located in areas where no surficial waters or relevant features will exist and therefore it can be assumed that the sensitivity of the sites would be medium at most. Provided, this and based on the wide range of management plans containing preventive and mitigation measures to be implemented, the potential residual impact on the oueds is considered to be minor.

Impact Rating for SW2	**Minor**

5.6.4 Overexploitation of groundwater aquifer (GW2)

The potential impacts on groundwater during drilling and stimulation evaluated within this section are those related to the use of the resource and potential overexploitation of aquifers. There are other potential scenarios on which impacts to groundwater may occur but all of these are related with accidental situations, and therefore these are discussed and evaluated in their corresponding section (see Section 5.8)

Impact description

Abstraction of groundwater at volumes beyond the recharge capacity of the aquifer could worsen the situation of an already overexploited aquifer. The most feasible of the prospective sources considered for the supply of non-drinking water is the drilling of on-site wells.

According to the Water Management Plan, the total quantity of water necessary will range between 124 000 m^3 (for 2015/2016, 2017 and 2018) and a maximum of 275 000 m^3 (for the year 2019). Two primary options have been considered: the Albian (Cretaceous) aquifer of the Continental Intercalaire (CI) and the TAGI (Triassic sandstone) aquifer. Both aquifers have a limited recharge capacity (i.e., they are fossil aquifers), with the first being the principal water source in the area (it is shallower than the TAGI). In the most likely scenario, the Albian CI aquifer will be targeted for the exploration phase of this project.

The expected consumption of water for the project is equivalent to between 3% for 2015-2018 and 7% for 2019 of the total annual water use reported for the town of Debdeb in 2015 (see Water Management Plan). Although these quantities may not pose a significant impact on local water users in the short term, the use of this aquifer is in direct competition with local water needs and it does contribute to the long term depletion of the primary fresh water and fossil aquifer in the region.

A comprehensive analysis of the water supply options considered for the Project is available in the Water Management Plan (Table 6.1 Evaluation of water supply options).

The Albian aquifer is the principal fresh water resource in the region and is already being extensively exploited making it both an important and sensitive resource. Given the volumes and timeframes considered, the magnitude of the potential impact is considered small, making the overall impact significance moderate.

Mitigation measures

- The abstraction system that will provide water for the project will be implemented in accordance with the criteria established by the local Algerian authorities in the water abstraction permits that will be processed prior to the initiation of project works.
- The Water Management Plan includes records being kept of water consumption for the entire project and guidelines for minimising water consumption throughout the different project activities.
- Model the anticipated "cones of influence" or depletion cones expected from the planned abstraction wells to inform their proper location in order to minimize the potential impact to local water users.

Residual impact evaluation. The potential impact of a possible overexploitation of the aquifer is considered, on the whole, Minor. This assessment is based on the considered volumes and time frame and assumes measures will be taken to limit direct competition with other local water users.	
Impact Rating for GW2	**Minor**

5.6.5 Geomorphology and Natural landscape (GM2)

5.6.5.1 Impacts from drilling site preparation/operation (GM2.1)

Impact description

The construction of the well pads and associated facilities (e.g., water/waste pits), as well as their access roads, will produce a localised modification of the substratum and the morphology of the territory. This will impact the geomorphology and natural landscape; the latter continuing throughout the operations on the well site. It is envisaged that prospective drilling sites may be located on hard substrate on the desert plateau (e.g., regs). It has been estimated that each of the 6 well sites would require a total surface of 12,5 ha approximately and that a maximum of 6 well would be drilled. Thus resulting in a maximum of 75 ha (0,75 km^2).

Initial well site preparation requires the potential levelling of terrain, compaction of substrate and digging of pits (for future water storage, drill cuttings, etc.), well pad preparation and cement casing installation. In all cases the general levelling of the area will constitute a large proportion of the earthworks required. Typically footprint areas “cleared” on hard substrates (i.e. regs and hamadas) are difficult to restore are long lasting (impacts can be permanent depending on the specific site conditions and type of substrate).

Construction materials for these activities will include material extracted from nearby quarries (or borrow pits); which may be opened whenever quality material is found close to access roads/well pads. Road upgrades and additional access road construction will be necessary, resulting in further potential geomorphological impacts. Road/access requirements will be minimized through the use/refurbishment and maintenance of existing accesses. Overall access requirements are presented in Figure 3.3 as follows: (1) refurbishment of existing unpaved access from road N-53 (20 km approx.), (2) construction of new access road to the South and North of the license (35 km approx.) and the individual connecting roads from various well pads (less than 10 km each).

Mitigation measures

Most of the mitigation measures for well pad/camp sites and overall footprint management have already been described in previous impacts (see surface water impacts SW1 & SW2 as well as impacts on landscape GM1 for reference) and are common to those for the seismic acquisition activities, where maximised use of existing sites/accesses and minimization of occupation on sensitive sites are favoured.

Some of the most important mitigation measures for the minimization of impacts on morphology and landscape include the following:

- A field HSE Specialist will supervise HSE related to drilling, stimulation, and testing operations. A primary responsibility of this role will be to oversee all mitigation measures, carry out examination of areas that appear to be sensitive and evaluate its environmental vulnerability before the installation of well sites, access paths and roads.
- Minimization of project footprint and maximization on the use of existing old survey lines (as accesses) as well as

former campsites/airfield.

- Earthworks will be kept to a minimum and trailers and other equipment will be levelled by jack-ups rather than earthworks.
- A one-track policy will prevail in all operations. Off-road driving is banned.
- Any significant need to perform clearance using a bulldozer will require the formal approval of the Statoil HSE representative in the field before being undertaken.

The above measures will be incorporated in a series of management plans. Amongst these, the most relevant plans would include the following::

- Plan for Prevention and Control of Pollution (overarching plan)
- Journey/Traffic Management Plan
- Burrow pits (quarries) Management Plan
- Program for the Shutting Down and Restoration of Site

Residual Impact evaluation

The preliminary well site locations defined by Statoil are located in relatively flat areas where minimum site levelling may be required. In addition, in the past there has been some works in the License, meaning the area already has some accesses and other past footprint areas (see Chapter 4. Past Operations). Taking advantage of the past footprint areas/accesses, together with the appropriate application of the mitigation measures will reduce any potentially significant change in substrate morphology, thus the overall impact is considered to be minor.

Impact Rating for GM2.1	**Minor**

5.6.5.2 Potential increase of microseismicity during hydraulic stimulation (GM2.2)

Impact description

During the hydraulic stimulation activities, there may be a risk of induced seismicity, as a result of the injection of hydraulic stimulation fluids into the Frasnian shale formation.

Hydraulic stimulation is used to create small cracks in the “shale” formations and allow the gas caught inside the rock to flow into the well. In normal situations, this stimulation process may generate an increase in seismicity or microseismicity. This increase is generally various orders of magnitude less than the minimum increase detectable by people (IEA, 2012).

It is important to specify that the relationship between human activities and the occurrence of small or minor earthquakes, called induced seismicity, is also known and common in activities such as construction, mining, and other activities that imply the deep injection of important volumes of liquids, i.e., geothermal energy, deep injection of waste, and the capture and injection of carbon (Department of Energy and Climate Change, 2012). The generation mechanism is common in all these situations and is based on the reactivation of capable faults.

Recently, during the hydraulic stimulation operations near Blackpool, in the United Kingdom, a couple of earthquakes occurred, with an intensity range of 2-2.3 ML. These earthquakes have been studied and it has been concluded that the most probable cause of occurrence was the displacement of a previously unidentified capable fault that was located near the base of the well (D. Healy, 2012). This has also enabled the definition of preventive measures.

The Preese Hall Shale Gas Stimulation; Review & Recommendations for Induced Seismic Mitigation study (C.A. Green, P.Styles & B.J. Baptie, 2012), established specific recommendations for “shale gas” operations both in the Blackpool area (Bowland Basin) and in general for the control of induced seismicity. In general, these types of earthquakes, of small magnitude, around 2-3 on the Richter scale, while they can be felt by people, do not constitute a risk for buildings and and/or infrastructures.

In any case, it is important to indicate that the probability of generating an induced seismic event as a result of hydraulic stimulation is very low. As an example, according to a study published by the National Research Council of the United States, of the 35,000 wells where hydraulic stimulation has been undertaken, only in one case did an induced seismic event occur, with an intensity of 2.8 on the Richter scale. However, it has not been confirmed that hydraulic stimulation was the cause of the event. For this reason, it is considered that the probability of an induced seismicity event due to hydraulic stimulation is very low, due to the short duration of the hydraulic stimulation and to the low volume of hydraulic stimulation fluid that is injected (6 wells maximum distributed over a large area).

The Baseline describes the Timissit License as being located in the south of Algeria in an area of very low natural seismicity. It is thus assumed that the project location would not be within the area of influence of any capable faults, and thus the probability of generating induced seismicity is very low; any such induced seismicity would be small in magnitude, and while it may be felt by people, would not constitute a risk for buildings and/or infrastructures.

Mitigation measures

An assessment to confirm the absence of capable faults within the prospective drilling area will be carried out before the stimulation activities start.

A Seismicity Monitoring Plan will be drawn up. The details of the monitoring system will be defined prior to commencement of stimulation activities, but a potential example of such type of plans is the system known as the “Traffic Light System”, involving the installation of a network of seismographs (accelerometers) on the sites, and the definition of operational levels based on the intensity measured by the seismographs.

Residual Impact evaluation

No significant increase in the probability of seismic activity is foreseen as part of the Project. In any case the probability of perceivable seismic events on the surface that could damage structures or buildings is considered highly unlikely. With the application of the proposed mitigation measures the impact is considered Minor.

Impact Rating for GM2.2	**Minor**

5.6.5.3 Potential mobilisation of NORM materials from exploration wells (GM2.3)

Impact description

During hydraulic stimulation activities, a risk of mobilising Naturally Occurring Radioactive Material (NORM) could be generated. As their name implies, these materials may occur naturally in the geological strata up to the Frasnian shale formation. The materials present in the geological formations may include naturally radioactive elements such as uranium (isotopes 238 and 235), radium (isotopes 226 and 228), and so on, so drilling towards and in the targeted formation may result in the mobilisation of these NORM, bringing them to the surface through drill cuttings or flowback water.

Finding NORM is, in any case, very uncommon and based on the current geological knowledge of the License this is not expected to be the case.

Mitigation measures

In order to confirm the absence of NORM materials, NORM will be monitored from the well core samples extracted in the first two vertical wells, which will be drilling the two formations of interest (Lower Devonian and Ordovician).

In the unlikely event of NORM being detected, Statoil will liaise with Sonatrach and define the specific management measures needed, in alignment with the requirements in Algeria and international Best practice.

Residual Impact evaluation

In the case of NORM, the assessment is based on the fact that the probability of encountering this type material is low but still possible. Nevertheless, as early monitoring and management actions are planned for this scenario, the potential impact of NORM mobilisation is considered Minor.

Impact Rating for GM2.3	**Minor**

5.6.6 Soils (S2)

Impact description

As indicated in Section 5.4.6 the severe arid climatic conditions do not allow important pedogenic activity; so only very localised and poorly developed soils are present in the area. The prospective drilling sites are found within the desert plateau and expected to be on very poor soils (mineral substrate mainly). Nonetheless this activity entails the transport, storage and use of a significant amount of chemicals (besides fuel/oil) as well as significant waste production by the Project. Thus, the main activities related to an impact on soils will be those of unplanned events during drilling/hydraulic stimulation followed, to a lesser extent, by those related to earthworks for access/well pad construction.

i) Impacts from liquid spills/leaks may occur within the well pad area or during transport. At the well pad there will be use/storage of fuels, additives (for drilling muds and hydraulic stimulation fluids), drilling muds/cuttings and flowback water. Considering this and the duration of the activity (several months) there is the potential for a traffic-related accident to occur.

ii) Impacts from routine operations (e.g., earthworks) in well pad/access construction: similar activities have been described for other impacts such as those affecting surface water as well as geomorphology.

Mitigation measures

The Project has a series of embedded project design measures and management plans to reduce the probability of spills and the effects that spills and earthworks may have on soils.

Most of the mitigation measures are presented under surficial waters (SW2) and groundwater (GM2) for drilling and stimulation activities.

The main mitigation measures related to the management of chemicals are described in the Chemical Management Plan Appendix of the EMP, with regard to the proper design of chemical storage and handling (e.g., pit liners, sealing of storage containers, and bunding), and the selection of products with a good environmental profile (for formulating drilling muds and hydraulic stimulation fluids).

The Waste Management Plan identifies the different kind of waste streams and their specific management according to their nature (e.g., hazardous vs non-hazardous). Additionally, the Liquid Spill Response Plan describes all protocols for spills/leaks that may occur during the drilling/hydraulic stimulation activities.

The Journey/Traffic management plan will include guidelines for reducing the possibility of an accident or affecting other receptors during activities that involve vehicular traffic, for example speed limits, access routes, transportation timings, etc. In the case of chemical transport (e.g., additives), the mentioned selection of products with a good environmental profile for the formulation of drilling muds and hydraulic stimulation fluids will make a significant contribution to the reduction of consequences related to a potential accident.

Residual Impact evaluation

The impact on soils during the drilling/hydraulic stimulation activities is considered, on the whole, minor**,** since under normal conditions there would be no risk to soil quality as a result of proper chemical/waste management practices. Likewise, the characterisation of the impact due to a leakage or spillage associated to a road accident is considered, on the whole, minor; considering proper mitigation measures are taken to significantly minimise this risk.

Impact Rating for S2	**Minor**

5.6.7 Flora (FL2)

Impact description

Project activities considered to be most relevant in terms of potential impact on flora are related to the preparation of the sites (well pads, drilling base camps and access roads). The magnitude of this impact depends on the potential clearing of existing vegetation. Vehicles and heavy machinery used during construction and operation activities could also affect flora by potentially driving over plants. The more vegetation is affected the higher the impact will be.

Mitigation measures adopted to avoid depletion of water resources and the adoption of a Waste Management Plan (see *Annex D.2*) will avoid potential secondary impacts on flora (which could arise as a result of improper waste management, including drilling muds and flow backwater), and water resource consumption (see Sections 5.6.7 and 5.6.4).

Therefore the potential impacts on flora will be limited to the land requiring vegetation clearance for the preparation and construction of the well pads, campsites and access roads.

The land required for each well would be approximately 0.125 km^2 (12,5 ha), including well pads and campsites and a military camp. Thus the total occupation if all 6 wells are drilled would be approximately 0,75 km^2 (i.e. 75 ha.). The land occupation associated to the construction of new access roads is expected to be 3 km^2 (300 ha). Therefore the total occupation for the three Phases would be 3,75 km^2(375 ha) approximately. The proposed central airstrip and a camp already exists (0,25 Km^2). This airstrip we may be widened and/or extended for flight safety reasons.

As reflected in the baseline section (Chapter 4), the prospective drilling area is characterised by a mostly denuded substrate with vegetation occurring only in scattered locations and generally in very low densities. The most vulnerable areas in terms of flora are the depressions (oueds and sabkhas), where vegetation tends to concentrate, while it is scare within the hamada and reg habitat.

The field survey confirmed that the preliminary drilling locations and their surroundings have no distinctive features in terms of flora when compared to the rest of the Study Area, though it also confirmed the scattered presence of a protected plant species, *Ephedra alata* ssp*. alenda* in the surroundings of one of the preliminary well locations at ST-27.

In summary, the impact on flora from any of the Project phases considered will mainly depend on the final location of the wells and associated campsites and the density of vegetation in the selected locations (especially woody vegetation) as any damage to individual plants (either the root system or the aerial part of the plant) may require several seasons to recover.

Mitigation measures

The following management plans include measures and management procedures that will contribute to preventing and minimising any impact on the flora:

- Traffic/Journey Management Plan (see *Section 5.4.6* referring to impacts on flora from seismic activities)
- Waste Management Plan (*Annex D.2*)
- Plan for the Shutting Down and Restoration of Site (outlined in *Section 6.4.7*)

In addition, the following mitigation and prevention measures shall apply :

- When defining the final well coordinates (site selection process), sites with dense vegetation should be avoided and a minimum distance between existing vegetation and the well pad of 100 m is recommended.
- The layout of the campsites will respect the original vegetation (i.e. marking and keeping the vegetation within the camps will be a standard practice whenever feasible).
- Access roads should cross existing oueds perpendicularly, trying to avoid vegetated areas as much as possible, and taking special care with woody vegetation and protected species.
- A one-track policy will prevail in all operations and off-road driving will be banned.
- The project's Procedure for Management of Change (see Annex D.8) will be implemented and potential actions taken such as:
    - Updating of environmental social and archaeological conditions of drilling locations
    - Updating of technical specifics of the activities, if relevant
    - Assessment of impacts and mitigation measures will be updated, if relevant
    - Field identification of additional sensitive areas that should be avoided, prior to the commencement of drilling activities.

Residual Impact evaluation

The overall impact of drilling and stimulation activities on flora can be considered minor after the application of the mitigation and monitoring measures, especially thanks to the well site selection that will allow sensitive locations and species to be avoided and will ensure that potential impacts on flora will not be relevant and will be kept as low as reasonably possible.

Impact Rating for FL2	**Minor**

5.6.8 Fauna (FA2)

Impact description

The locations where potential impacts to fauna might occur are the drilling sites and the campsites, particularly the areas designated for the storage and disposal of liquid and solid wastes, as well as areas along roads and accesses. No impacts are expected outside of these areas.

Impacts on fauna may be caused by different factors such as the presence of people and working activities, potentially leading to the disturbance and temporary displacement of faunal species. However, these factors are not considered as producing any relevant disturbance to local fauna. In fact, several opportunistic species such as foxes, ravens, and gerbils are expected to take advantage on these areas in search of food and shelter.

The use of vehicles and heavy machinery during construction activities can also impact fauna mainly through driving over animals and destroying burrowsSimilarly, fauna will be disturbed by drilling and stimulation activities impacting the vegetated areas that provide most of their resources (see Section 5.6.7 for impacts on flora).

However, the main source of impact for fauna is derived from the different waste storage areas and especially the pits for storing/treating drilling muds (either water- or oil-based), completion fluids and flowback water. The scarcity of water in the region makes these pits very attractive to local fauna, something that could result in animals drowning or being poisoned by hazardous substances present in the pits if they drink from them.

According to the environmental baseline, the preliminary well locations are not within areas of special sensitivity for fauna as they are mainly characterised by barren land lacking vegetation. The most relevant areas for fauna (assumed to be the areas with the highest vegetation density) are located outside the drilling areas of interest, not only for Phase 1 but also for subsequent phases, in the vicinity of Debdeb along the Merksène oued.

Mitigation measures

The following management plans include measures and management procedures that will contribute to preventing and minimising any impact on fauna:

- Traffic/Journey Management Plan (outlined in *Section 6.4.8*)
- Waste Management Plan (*Annex D.2*)
- Plan for the shutting down and restoration of site (outlined in *Section 6.4.7*)
- Chemical Management Plan (*Annex D.6*)
- Environmental Audit Plan (*Annex D.7*)

In addition to the above plans and the mitigation measures presented in the impacts on flora (FL2), the following mitigation or preventive measures will be implemented:

- Workers Management Plan including a ‘code of conduct’ which will prohibit hunting, gathering, chasing or disturbing any wildlife.
- Wastes will be stored in such a way that access of fauna is avoided (i.e., fencing of waste storage areas, ponds and pits).

Finally, the mitigation measures included in Section 5.6.2 for minimizing impacts from noise emissions are also applicable for fauna, given the potential consequences of noise emissions as a disturbance factor for fauna.

Residual Impact evaluation

Due to the low density of fauna and considering the application of the mitigation measures that will minimise the risk of fauna interacting with generated wastes, this impact is considered Negligible.

Impact Rating for FA2	**Negligible**

5.6.9 Economy, Employment and Livelihoods (EC2)

Impact description

The main potential impacts identified during the drilling/stimulation phases are similar to the impacts identified for the construction and operation of the seismic campaign and include:

- EC2.1 - Local procurement of goods and services.
- EC2.2.1 - Short-term direct and indirect employment opportunities.
- EC2.2.2 - Long-term benefits of capacity enhancement (on-the-job and formal training opportunities).
- EC2.3 - Disturbance to animal grazing activities (mainly camel husbandry).

Similarly to the seismic acquisition activities, the increased government revenue from taxes and fees paid by the project (e.g., fees for water consumption, material extraction and gas flaring) is expected to have a positive impact at the national and regional levels. The impact during the drilling operations will be expected to be of greater magnitude due to potential revenues raised from taxes and fees from the potential drilling of up to 6 wells (over a period of 4 years). However, the allocation of increased government revenue for local development is unknown at the time so this impact cannot be assessed.

EC.2.1 Local procurement of goods and services (positive impact)

A main worker camp and a military camp will be located at each well site (note that construction and operation of the different well sites will not overlap in time). Water supply for civil works, drilling operations and stimulation and testing will be provided via a water bore drilled in the vicinity of the well and camp site and potable water will be trucked from a local water source. However, sourcing of food, fuel and other consumables will be supplied by air or ground from larger commercial centres (e.g., Hassi Messaoud or Algiers) given the lack of appropriate suppliers within the License area and its surroundings. Therefore, the impact on the local economy as a result of local procurement of goods and services is considered to be minor.

EC.2.2 Short-term direct and indirect employment opportunities and long-term benefits of capacity enhancement (on-the-job and formal training opportunities) (positive impact)

The civil works, drilling, stimulation, testing and decommissioning of the 6 wells (in case all three Phases are completed) will last a maximum of 4 years. During this time the field work force will be composed of approximately 100-140 people comprising mainly the employees of the contractors in addition to a limited number of Statoil supervisors. In addition, there will be 80-120 military/security personnel. It is likely that the contractor will provide most of the senior personnel and the majority of the workforce. Most likely a large proportion of both personnel categories will be from within Algeria but from outside the Debdeb Commune. However, Statoil will ensure maximisation of Algerian nationals and locals employees according to Instruction nº01 of 11th March 2013, of Local content.

The description included in Impact EC1 for the seismic acquisition activities should be considered regarding indirect employment and capacity enhancement.

EC.2.3 Disturbance to animal grazing activities (camels)

Disturbance to animal grazing activities due to drilling construction and operation activities will be mainly due to the occupation of areas with potential vegetation. The total footprint of the six well pads and access roads will be 3.75 km^2, representing 0.14% of the total License area footprint. Well site selection criteria includes the avoidance of sites with dense vegetation, water wells and topographic features such as oueds and sabkhas (see Section 3.1.5 of Chapter 3 Project Description) which are areas with potential for camel pasturing. Impacts to habitats and flora have been assessed as minor for the Prospective Drilling Area (see Impact FL2). Therefore, the impact on the camel herders will depend on the final location of the well sites.

Mitigation measures

The following management plans include measures and management procedures that will contribute to enhancing the positive impacts on the economy and employment and preventing and minimising any impact on livelihoods:

- Plan for Worker Management (see Section 5.4.9 referring to impacts on economy, employment and livelihoods from seismic activities).
- Plan for Local Content (see Section 5.4.9) referring to impacts on economy, employment and livelihoods from seismic activities).
- Public Consultation and Disclosure Plan, PCDP (see Section 5.4.9).
- Plan for the Shutting Down and Restoration of the Site (outlined in Chapter 6 EMP) which will include measures for the restoration of any potential vegetated area affected by the well site construction with potential for grazing activities.

Moreover, same mitigation measures proposed for Impact EC1 (Section 5.4.9) and Impact FL2 with regard to site location selection will apply (Section 5.6.7).

Residual Impact evaluation

Following implementation of the Plans and mitigation and monitoring measures described above, the impacts associated with the employment of a local workforce and economy (EC2.1 and EC2.2) are predicted to be “positive” and of “minor” significance. At the national and regional levels the magnitude is considered to be small and the sensitivity of the receptor low as those that benefit will have high skills and capacity with ability to gain employment across the oil and gas industry. At local level the sensitivity of the unskilled labour that may secure short term employment, and gain important experience, is considered to be medium. However as the magnitude of impact remains small (short duration, low numbers of beneficiaries), resulting in a positive Minor impact. In addition, the use of “closed camps” and likely sourcing of labourers from outside the region will limit localised economic spin-off benefits for the town of Debdeb.

There will also be a “minor” positive impact elsewhere in Algeria, where the bulk of workforce will be sourced from. In addition, the majority of taxes will be paid at National (flaring taxes) and Wilaya (aggregates and water abstraction) levels and the allocation of these revenues is unknown.

The impact on livelihoods (camels grazing activities, EC2.3) can be considered Moderate, assuming a worse case scenario, after the application of the mitigation and monitoring measures, especially those related to well site selection and engagement with camel herders. Sensitivity of the receptor has been considered high since the camel rearing would be the primary source of income and of small magnitude provided that the measures agreed with the camel herders during the Engagement process will be implemented and considering that the well site selection process will avoid sensitive areas for camel herders.

Impact Rating for EC2.1	**Positive**
Impact Rating for EC2.2	**Positive**
Impact Rating for EC2.3	**Moderate**

5.6.10 Infrastructure and Services (IF2)

Impact description

The main potential impacts identified during the drilling/stimulation activities are similar to the impacts identified for the construction and operation of the seismic campaign but greater in magnitude. These include:

- IF2.1 - Potential competition for water resources with the local community.
- IF2.2 - Increased pressure on the road infrastructure.
- IF2.3 - Increased pressure on waste management facilities.

Given the characteristics of the project, the affected infrastructures will mainly be those related to transportation, due to an increase in traffic, mainly during civil works and mobilisation and demobilisation of drilling and stimulation activities. The general network of services related to electricity and water supply will not be affected, since the well sites will be equipped with electricity generators and its own water supply system.

Similar to the seismic operations, it is expected that the workforce will not make use of local health infrastructures as medical services will be provided on site.

IF2.1 - Potential competition for water resources with the local community

Water supply for civil works, drilling operations, and stimulation and testing will be provided via a water bore drilled in the vicinity of the well and camp site. Potable water is expected to be trucked from Debdeb or other available local source. According to the Water Management Plan (Annex D.4, the projected annual water demand for the project is equivalent to between 3% (from 2015 to 2018) and 7% (in 2019) of the annual water use in Debdeb. Although these quantities may not pose a significant impact on local water users in the short term, the use of this aquifer is in direct competition with local water needs and it does contribute to the long term depletion of the primary fresh water and fossil aquifer in the region.

It is worth noting that the project activities with the highest demand include road maintenance (57%), camp water (22%) and road surfacing (12%). Hydraulic stimulation becomes a more significant component during completion of horizontal wells, when it accounts for between 8 and 14% of the total annual demand. Horizontal wells will be stimulated only if Phase II and Phase III of the project take place (ons single well in each phase).

However, as important as the real impact of stimulation activities on underground water resources in the exploration phase, is the perception that communities have regarding the environmental impact of oil and gas activities (either exploration or development), especially when related to unconventional O&G resources. It is possible that communities within and around the License area imagine these developments are linked to the rapid depletion and deterioration of water quality and resources. The negative perception of oil and gas activity impacts over the years and the industry's contribution to environmental degradation is important and needs to be addressed through continuous communication and awareness raising in communities as this may compromise the future of the Project.

Refer to Impact AE2 for risk of groundwater contamination in the case of an accidental or non-routine event.

IF2.2 - Increased pressure on road infrastructure

The project design considers using the existing roads and tracks in order to access the sites, reducing civil works as far as possible.

The main routes that will be used during the project activities include NR-53 and NR-3. In addition, new and existing access roads (if any) to and between the well sites will be used.

Daily heavy truck traffic is anticipated during the civil works, drilling and well stimulation. An average of 20-40 trucks moving in a convoy per day during mobilization and demobilization (for drilling services and stimulation equipment) is expected, which would typically last 2 months per phase (not consecutive).

During drilling and stimulation activities a maximum of 2-4 trucks per day is expected. Therefore, it can be estimated that during a period of approximately 11 months (not consecutive) over the total project (approximately 4 years), there will be an increase of 2-4 trucks per day. It should be noted that the seismic and drilling operations will not occur in parallel, so there will not be any cumulative effects on traffic. Similarly, each well site will be decommissioned before the crew moves to the next drilling location, so no potential cumulative effects between wells is possible.

The project will, therefore, increase the traffic on the main road and on the existing unpaved access to the airstrip, although only temporarily. The frequency of use of the airstrip access track is unknown, but it is expected that it will be mainly used by camel herders equipped with 4W vehicles. It should be noted that the airstrip is currently (July 2015) not operative. The existing road network, never of a high standard, is likely to deteriorate as a result. The combination of potential road surface deterioration on the unpaved road and increased traffic volume could potentially cause an increase in road accidents (see Impact PH2 in Section 5.6.11).

In order to reduce the impact on the road infrastructure a Journey/Traffic Management Plan will be implemented, maintenance of accesses to the well sites (existing and new) will be conducted during the project activities, and improvements will be made to the existing access to the airstrip.

IF2.3 - Increased pressure on waste management facilities

As explained in Impact IF1 for seismic operations, waste management in Algeria is particularly challenging due to the limited availability of appropriate disposal or treatment facilities (capacity and quality), especially for hazardous industrial waste. In addition, several areas of northern Africa are known to currently suffer from past poor waste management practices, resulting in localised but relevant visual impacts, liabilities and risk to community health.

Waste generated during the Project will be managed in accordance with Statoil standards, Algerian laws and regulations, as well as recognised good international industry practices. To the extent possible, solid waste and wastewater will be reused, treated and disposed of onsite according to Algerian legal requirements. If adequate disposal on site is not possible in accordance with Algerian legislation, it will be transported to an external treatment site.

A Framework Waste Management Plan has been developed during the ESIA preparation stage (see Annex D.2 Waste Management Plan). This Plan aims to set the framework for the procedures and general requirements that will be considered during the Project operations. It is intended that this Framework Plan will be transformed into an operation plan during the post-ESIA phase.

The Framework Plan includes an assessment of the most suitable solutions for the reuse, treatment and disposal of each type of waste, taking into account several criteria, including local conditions at the time. It also includes an inventory of treatment plants in Algeria taking into consideration the type and estimated volumes that will be generated by the Project and the capacity of the plants at the time (July 2015). The final disposal solution for each type of waste will be selected in the operational Plan.

The operational Plan will try to maximise the use of local companies without compromising local needs whenever possible.

Mitigation measures

Relevant embedded mitigation measures that could contribute to avoiding/minimising potential impacts on infrastructure and services, as well as competition with local users, are mostly related to the appropriate management of the project's water needs, site selection criteria for abstraction wells and evaporation pits, road maintenance procedures and waste minimisation, reuse, and on-site treatment management practices.

The management plans and mitigation measures proposed for the equivalent impact during seismic operations (IF1) will apply. Refer to Section 5.4.10.

In addition, the following mitigation and prevention measures will apply:

- Statoil will work together with the local government, communities and herders to better understand the use of the airstrip access track and other existing roads/tracks expected to be used during the drilling activities. This will be done as part of the Stakeholder Engagement three months before commencing the drilling operations (see Impact EC1 in Section 5.4.9).
- The possible degradation of unpaved accesses (due to the activities of the project) will be monitored and, any necessary actions defined.
- Maintenance works will be performed on the unpaved accesses used by machinery. Once works are completed, these accesses will be left in a good state of preservation and all affected services will be restored.
- As part of the operational Waste Management Plan, the chosen treatment for each waste will take into account the capacity of local treatment plants to prevent possible overpressure events and, therefore, any detrimental effect on the needs of the local population.
- If relevant and technically feasible, some produced water will be monitored throughout the project and the technical capability for reusing the water in subsequent drilling and stimulation phases will be considered (the ultimate objective being to understand flowback properties and evaluate potential for reducing groundwater consumption).

- As part of the PCDP and in coordination with ARH, Sonatrach and other shareholders, communication with water agencies, local authorities and communities is recommended in order to better understand their concerns regarding the project activities (expected to be mainly related to the use of water for hydraulic stimulation), and identify opportunities to benefit local communities and contribute to create lasting values.

Residual Impact evaluation

Considering the preventive measures already embedded in project design and the implementation of the plans and mitigation measures listed above, the potential impact of competition for water resources is considered to be Moderate, since although the water demand will not affect the quantity and quality of groundwater resources for locals under normal operations (small magnitude), the CI aquifer is a highly sensitive resource since it is a fossil aquifer and the only water source available in the area.

The impact of increased pressure on the transport infrastructure and waste management system is considered minor. Increased traffic will be significant for short periods during the drilling, stimulation, and testing operations but the trucks will be moved in convoy at peak times. The implementation of the Traffic/Journey Management Plan will ensure that the impact is kept to an acceptable level. Finally, any impact involving increased pressure on waste management facilities is also considered minor considering the project's waste philosophy, which is based on minimisation at source, reuse and safe treatment and disposal on site in order to reduce the transport of large quantities of waste and wastewater to treatment facilities, as far as possible. It should be noted that the Framework Plan has enabled the Project to identify potential waste management constraints at an early stage of the project taking them into consideration during definition of the project. The exact waste treatment facilities to be used will be defined in the operational Waste Management Plan using the selection criteria previously explained.

Infrastructures and Services IF2.1	**Moderate**
Infrastructures and Services IF2.2	**Minor**
Infrastructures and Services IF2.2	**Minor**

5.6.11 Community Health, Safety and Security (PH2)

Impact description

Considering the nature of proposed project activities, the main potential during drilling and hydraulic stimulation impacts on community health, safety and security will comprise the following:

- PH2.1 - Traffic accidents from increased traffic and the presence of heavy vehicles on local roads.
- PH2.2 - Disturbance by occasional noise/vibration, dust and exhaust emissions to the residents of villages (i.e., Debdeb and Timeroualine)..
- PH2.3 - Interaction between the workforce (including security forces) and the local community.
- PH2.4 - Increased transmission of communicable diseases.

Potential impacts on the population's health derived from the storage of chemicals and hazardous waste would only be produced in the event of an accidental situation resulting from pollution of soils and groundwater, which is evaluated in Sections 5.6.6 and 5.6.4.

PH2.1 - Traffic accidents from increased traffic and the presence of heavy vehicles on local roads

This impact is expected to be similar to the seismic operations but as explained in Impact IF2, above, the increased traffic on main roads is expected to be higher than during seismic works. Peak transport activities will be related to civil works and mobilisation/demobilisation for the drilling and stimulation activities. The implementation of the Journey/Traffic Management Plan will help reduce the level of risk of traffic accidents and injury to other road users and pedestrians to as low as reasonably practicable. See Impact PH2 in Section 5.6.11 for further explanation.

PH2.2 - Disturbance by occasional noise/vibration, dust and exhaust emissions

Due to the distance of receptors from the tentative well locations selected for Phase I, disturbance due to air quality, light and noise emissions are expected to be limited to the potential presence of transient visitors such as camel herders and military personnel, which will probably temporarily avoid the area where the activities are taking place, and they are not expected to be continuously affected by noise and dust.

During drilling operations, there will be an increase in lighting levels on the site at night, and the well sites will be located in a desert area with no other type of anthropogenic lighting. The lighting system will be exclusively directed towards areas where lighting is needed, avoiding illuminating the area outside that location. Given the distance between the proposed well locations for Phase I and population centres, the only receptors that may be affected are potential transient visitors near the site at night, whose exposure time will be limited and occasional. In addition, the presence of transient visitors at night is expected to be very limited due to the security context of the License area. For this reason, possible disturbance to the population as a consequence of well pad lighting is considered to be minimal.

Impacts related to noise levels and ambient air quality during drilling operations have been assessed in Impact AQ2 and N2, resulting in minor impacts.

PH2.3 - Interaction between the workforce (including security forces) and the local community

There will be approximately 100-140 workers plus 80-120 military personnel present. The majority will be Algerian nationals but from outside the Debdeb Commune.

The use of “closed camps” and the “offshore” philosophy regarding contact with local communities will minimise any negative impacts resulting from the concentration of a predominantly male, migrant workforce living in proximity to local communities (including increases in communicable diseases, crime and conflict). Interaction with the local communities is anticipated to be minimal.

The description included in Impact PH1 for the seismic acquisition activities should be considered regarding interaction between the workforce (including security forces) and the local community.

PH2.4 - Increased transmission of communicable diseases

The same description as for Impact PH1 applies. However, magnitude of the impact is considered to be slightly lower since the number of workers will be smaller than during seismic operations. The majority of the workers will be Algerian nationals reducing the likelihood to introduce new diseases. As explained before, the use of closed camps, the availability of health facilities within the camp and the routine health checks that will be implemented reduce the potential of transmission to local communities. The sensitivity of the receptor is however considered medium, due to the limited access to health facilities.

Mitigation measures

The same management plans and mitigation measures proposed for the equivalent impact during seismic operations (PH1) will apply. Refer to Section 5.4.11. Moreover, the implementation of the Procedure for Management of Change included in Annex D.8 is particularly important for reducing the potential impact on community health derived from noise, air emission and lighting during Phase 2 and Phase 3. The implementation of the Liquid Spill Response Plan will be also key during drilling operations to avoid any impact on community health in the case an accidental spill occurs.

In addition, in accordance with best industry practice, several mitigation measures will be implemented:

- Lighting systems will be used onsite that prevent the spread of light beams into areas that do not require lighting (eliminating glare, as light leakage fades into the sky and respecting the natural environment and nocturnal species).
- Lamps with greater energy efficiency will be used for the lighting system. These lamps will be compatible with all functional and landscape requirements of the area where the site is located. Preferably sodium lamps or amber LED lamps will be utilized, if available by local Algerian service providers.
- As part of the site selection process for the well locations as part of Phase 2 and 3, noise and air quality modelling should be considered depending on the distance to the sensitive receptors and potential changes in project design with respect to the design included in this ESIA. The decision will be made as a result of the Procedure for Management of Change.

Residual Impact evaluation

The predicted increase in road traffic will increase the risk of road traffic accidents occurring which could result in injuries or fatalities to drivers and passengers in non-project related vehicles or pedestrians. The sensitivity of the receptors has been considered as medium, since any vehicle accident will likely cause an impact on human wellbeing . Considering the increasein traffic expected (in numbers and frequency) and the expected existing traffic, the magnitude has been considered as medium. As result the impact on community health due to the increased traffic has been considered as Moderate.

Despite of the uncertainties on the final well locations (especially for Phases 2 & 3), considering the implementation of the Procedure for Management of Change (included in Annex D.8), the potential impacts to community health due to increased noise and air emissions, are considered Minor (this impact will be largely dependent on the well site locations). In particular, the sensitivity has been considered as medium due to the limited access to health facilities by the community.The magnitude is small due that a minimum distance to the communities will be respected as part of the site selection process and the type and quantity of emissions expected. This would also reduce the likelihood of the impact since only transient visitors (if any) would be expected to be affected.

The impact involving interaction between the workforce (including security forces) and the local community is considered negligible, due to the use of “closed camps” the distance to the populated areas and the fact that the majority of the workforce will be Algerian nationals resulting in a small magnitude of the effect. Tthe current presence of military personnel within the License area results in a low sensitivity of the receptor which is already used to the presence of armed security forces.

Finally, regarding the impact related to the potential spread of communicable diseases similarly to the seismic activities, it has been considered as a Minor (small magnitude considering the health profile in Algeria and medium sensitivity due to the limited access to the local population to health care facilities).

Impact Rating for PH2.1	**Moderate**
Impact Rating for PH2.2	**Minor**
Impact Rating for PH2.3	**Negligible**
Impact Rating for PH2.4	**Minor**

5.6.12 Cultural Heritage (CH2)

Impact description

As described in Section 4.4 (CH Baseline), the Timissit exploration area does contain remains of cultural heritage significance, notably prehistoric surface artefact scatters, prehistoric cemeteries/tumuli and traces of former trade/pilgrimage routes (eg camp sites near water sources, 'desert mosques' and graves). The construction of well sites and associated access roads/infrastructure, including the opening of new quarries/borrow pits, could all have major effects on such sites (see Section 5.4.11 for reference).

Mitigation measures

Where drilling activities are planned within or across areas of identified elevated cultural heritage sensitivity as identified in the baseline study (Figure 5.5), preliminary archaeological assessments (including the analysis of satellite imagery) and, where appropriate, surveys should be carried out in advance of the commencement of works. Where the surveys identify sites of moderate or high sensitivity, these should be avoided. If avoidance is not possible, further archaeological fieldwork will be necessary to create a proper record of them before they are destroyed. Such surveys and fieldwork should be carried out in consultation with the Algerian Department of Antiquities, and all results submitted to them upon completion of fieldwork. In all other areas an Chance Finds should be implemented, including the training of project staff in the identification of remains of archaeological value and clear guidance for the the management and protection of scuh material.

Residual Impact evaluation

The implementation of the proposed mitigation measures should ensure that in case of identification of archaeological artefacts these are not impacted; and also that those archaeological artefacts that are likely to be affected during the development of the project will be identified and actions will be developed to avoid the area or to collect the materials according to standard archaeological procedures.

Special consideration should be taken while evaluating potential impacts on cultural heritage/archaeology as a result of land occupation (site preparation activities, road construction activities and camp operation/worker presence). Considering the full application of the set of proposed mitigation measures, and ensuring that the already identified sites are protected, the overall impact is considered to be minor.

For detailed list of mitigation measures, refer to Impact CH1 (Section 5.4.11).

Impact Rating for CH2	**Minor**

5.6.13 Closure and Decommissioning (CD2)

Impact description

The same impact description as that for seismic operations applies here, especially with regard to the camp site, where all accommodation and temporary buildings will be removed and the location of the landfills and soakaways will be recorded prior to being covered. All surface wastes will be properly disposed of in a landfill, and any contaminated ground or hazardous waste will be properly managed.

Limited landscaping may be required to reduce erosion and visual impact; with the water wells being abandoned and closed by a metal plate being welded to the top of the pipe, to avoid any contamination and allow their future use.

Mitigation measures Applicable plans and mitigation measures for camp decommissioning will be the same as CD1. The most important areas relevant to the drilling sites will be the water/waste pits associated to the well pads, which will be cleaned out and covered, and all contained wastes will be removed for treatment according to the Waste Management Plan.	
Residual Impact evaluation The decommissioning activities themselves will have no impact. However, the residual impact in the area after the project has been completed can be defined as minor if all proposed mitigation and monitoring measures are correctly applied.	
Impact Rating for CLD2	**Minor**

5.7 Assessment Summary of Potential Environmental & Social impacts during the Drilling and Hydraulic Stimulation activities

Table 5.2 Impact significance summary for the Drilling and Hydraulic Stimulation activities

	Drilling and Hydraulic Stimulation Activities		
Physical	Air Quality	AQ2	Minor
	Noise Level	N2	Negligible
	Hydrological Resources (surface water)	SW2	Minor
	Hydrological Resources (groundwater)	GW 2	Minor
	Geomorphology and Natural Landscape	GM2	
	• Impacts from drilling site preparation / operation	GM2.1	MInor
	• Potential increase of microseismicity during hydraulic stimulation	GM2.2	MInor
	• Potential mobilisation of NORM materials from exploration wells	GM2.3	MInor
	Soils	S2	MInor
Biological	Flora	FL2	MInor
	Fauna	FA2	Negligible
Socioeconomic	Economy and Livelihoods	EC2	
	• Local procurement of goods and services	EC2.1	Positive
	• Short-term direct and indirect employment opportunities and Long-term benefits of capacity enhancement	EC2.2	Positive
	• Disturbance to animal grazing activities	EC2.3	Moderate
	Infrastructures and Services	IF2	
	• Potential competition for water resources with the local community	IF2.1	Moderate
	• Increased pressure on the road infrastructure	IF2.2	Moderate
	• Increased pressure on waste management facilities	IF2.3	Moderate
	Community Health and Safety	PH2	
	• Traffic accidents from increased traffic and the presence of heavy vehicles on local roads.	PH2.1	Moderate
	• Disturbance by occasional noise/vibration, dust and exhaust emissions to the residents of villages	PH2.2	Minor
	• Interaction between the workforce and the local community	PH2.3	Negligible
	• Increased transmission of communicable diseases	PH2.4	Minor
	Cultural Heritage and Archaeology	CH2	MInor
Closure and Decommissioning		CLD2	MInor

Impact Rating	Positive	Negligible	Minor	Moderate	Major

5.8 Accidental and Non-routine events (AE)

This section presents the evaluation on those non-routine events that could, potentially, occur during the drilling and stimulation operations. These potential risks are in all cases related to accidental situations that are not expected to occur and that have a very low probability of occurrence.

Two types of risks have been assessed in this section:

A "blow-out" from the loss of control of a well (Risk AE1): a blow-out produced from a pressure gradient in the reservoir may occur during drilling activities or during stimulation and testing activities. In severe cases the blow-out may lead to an uncontrolled combusted or uncombusted hydrocarbon release on the surface of the well pad.

Accidental spills of chemicals or waste, drilling/stimulation (Risk AE2): an accidental spillage or contact of drilling fluids with aquifers can lead to deteriorated groundwater quality (i.e aquifers located in the Study Area). The main impact scenarios include the following:

- Risk AE 2.1: Accidental spillage of raw materials (fuels, oils and additives) and waste.
- Risk AE 2.2: Contact of drilling fluids with aquifers due to well construction and integrity issues during drilling.
- Risk AE 2.3: Contact of stimulation fluids with aquifers due to loss of well integrity during hydraulic stimulation.
- Risk AE 2.4: Contact of stimulation fluids with aquifers due to induced fractures.

As with all the other accidental or non–routine events, the methodology for assessing these risks is slightly different than for routine impacts. The risks are modelled using a specific approach that requires:

- Identification of hazards and potential Source-Pathway-Receptor (S-P-R) linkages.
- Estimation of the probability of the risk being realised;
- Identification of consequences;
- Estimation of the magnitude of the risk;

A conceptual model has been created to describe the scenario in which the risks could occur. The conceptual model uses the S-P-R (Source-Pathway-Receptor) methodology as recommended by DEFRA, UK (2011) where:

- The source is the activity that can allow the risk from the hazard to be realised;
- The pathway is the route by which the source can reach the receptor; and
- The receptor is the specific component of the local environment and/or community that could be reached by the hazard.

For a specific risk to exist, all three elements of the potential source-pathway-receptor (S-P-R) linkage must be present.

A number of the S-P-R linkages identified in the conceptual models presented in this section require several coinciding pathways to exist in order to realise the risk. Each of these constituent pathways has its own probability and consequence (i.e., a discrete risk), and the ultimate receptor could be described as indirect or secondary. Where multiple pathways are required to realise the risk, the probability of all the required pathways coinciding must be considered. The probability of all the required pathways coinciding may be so low as to be considered negligible, i.e., there is no plausible linkage, and therefore it is not appropriate to assign a risk magnitude.

Table 5.3 Likelihood scale for an accidental or non-routine event

Likelihood	Descriptor	Comment/clarifications
High	Repeated occurrences expected	Very likely to occur in the short term and almost certain to occur over the long term. Repeated occurrences expected based on experience in comparable industries. Where no comparable industry experience is available, a cautious approach will typically be adopted to allow for uncertainty.
Medium	Can be expected to occur several times per year	An event is possible, but not inevitable, in the short term, and likely over the long term.
Low	Infrequent occurrence	The linkage occurring is by no means certain in the long term and is less likely in the shorter term. May have been reported in the past in other similar industries.
Very low	Rarely encountered, never reported, or highly unlikely	It is improbable that an event would occur even in the long term. Very few, if any, industry examples are available.

Table 5.4 Consequence scale for an accidental or non-routine event

Consequence	Descriptor	Comment/clarifications
High	A major environmental incident resulting in significant damage to the environment and/or harm to human health.	Irreversible adverse change to an ecological receptor. Short term (acute) risk to human health likely to result in "significant harm"
Medium	Moderate, localised effect on people and/or the environment in the vicinity of the incident.	Moderate effect on a sensitive water resource characterised by a breach in a regulatory standard. A significant effect on an ecological receptor or ecosystem.
Low	Minor environmental effect which may breach a regulatory standard but is localised to the point of release with no significant impact on the environment or human health.	No effect on a high sensitivity receptor (for example a groundwater source)
Very low	Slight environmental effect that does not exceed a regulatory standard.	No appreciable effect on human health

Table 5.5 Risk magnitude matrix

<table>
<tr><td rowspan="4">Probability</td><td>High</td><td>Low</td><td>Medium</td><td>High</td><td>High</td></tr>
<tr><td>Medium</td><td>Low</td><td>Medium</td><td>Medium</td><td>High</td></tr>
<tr><td>Low</td><td>Low</td><td>Low</td><td>Medium</td><td>Medium</td></tr>
<tr><td>Very Low</td><td>Low</td><td>Low</td><td>Low</td><td>Medium</td></tr>
<tr><td colspan="2" rowspan="2"></td><td>Very Low</td><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td colspan="4">Consequence</td></tr>
</table>

Table 5.6 Description of risk magnitude and required action for accidental/non routine events.

Risk magnitude	Description/action
High	There is a high to medium probability that there is a pathway for the source to reach the receptor and result in significant adverse effect to a sensitive receptor or evidence exists of significant adverse effect on the receptor. Additional mitigation is required as a priority and may include further investigation to understand and, if appropriate, reassess the significance of the risk.
Medium	Risks must be acted upon, but only if measures are not sufficient to reduce risks as to be ALARP (As Low as Reasonable Practical) as they do not pose such an immediate threat and thus the project can continue while the risk response measures are integrated and/or performed. Additional mitigation may be required which may include further investigation to understand and, if appropriate, reassess the significance of the risk.
Low	Risks may not require additional responses – it may be effective enough simply to monitor the risk to ensure that it does not arise during the project.

For accidental/non routine situations, a conceptual model of potential S-P-R linkages is identified and the probabilities and consequences are subsequently considered. Embedded mitigation (defined as mitigation which has already been implemented or is a confirmed part of the Project design) has been included when undertaking the risk assessment. For example, the mitigation measures to be employed during well drilling and installation have been included in the assessment of potential pollutant linkages.

5.8.1 Blow-Out (AE1)

Risk Impact description

One of the accidental situations that could happen during exploratory drilling is the loss of control of the drilling, otherwise known as a blow-out. This type of situation, although very rare, can happen. It consists of an uncontrolled surface flow from the explored geological formation, normally as the result of unexpected pressure in the formation. This pressure pushes the fluid into the well and from there up to the surface.

Some typical causes for this type of accident are:

- Failure of the casing system or the drilling mud column.
- Unexpected geological conditions in the formation.
- Failure of the drilling control elements.

Conceptual model

Source	Pathway	Receptor
During drilling operations, an uncontrolled pressure increase in the well leads to a spill on the surface (well pad)	The well itself, through which the contents would flow up to the surface of the well pad.	Directly: Air, soil and groundwater as well as fauna flora and population that may be in the vicinity of the well at the moment of the Blow-out.

Assessment of Probability

According to the existing literature on this type of situations, the probability of an occurrence is very low. The loss of control of a well has a very low probability, as a result of the application of current technologies, as well as the design of the wells, equipment maintenance and testing, the use of blow-out preventers (BOP's), training of on-site personnel, the practices employed and previous knowledge acquired on the geological formations to be exploited.

The Project Description shows how the project's execution contemplates all the elements mentioned earlier for the application of current technologies, including:

- Density and type of drilling muds used.
- Type of casings and cementing, as well as the durability and resistance of the material used.
- Use of blow-out preventers (BOP).
- Monitoring of the drilling mud conditions.
- Monitoring of the pressure.
- Inspection of the pressure control systems and the blow-out preventer (BOP) systems.
- Staff with the appropriate training in control of wells during drilling activities.
- Hydrostatic and function testing of BOP's as per Algerian regulatory or API Standards, whichever is more stringent.
- Hydrostatic testing of the casing strings.
- Testing the integrity of the exposed formation at the casing shoe prior to drilling to greater depth. Commonly known as formation integrity tests (FIT) or leak-off tests (LOT).

Estimation of Consequence

Air Quality Impacts

As already described, a blow-out may, in serious cases, lead to an uncontrolled combusted or uncombusted hydrocarbon release, resulting in potential impacts to air quality through gaseous or particulate emissions. The air quality in the Study Area is assumed to be very good due to the lack of densely populated areas and relevant emission sources in the region, so consequently, the atmosphere's capacity to absorb any air emissions from a hypothetical blow-out in the Study Area is very high.

Furthermore, the potential human receptors are located several kilometres from the operational sites.

It is expected that in case of a blow-out, any air quality impacts would be limited to the area around the drilling site and would be short-term.

Groundwater and soils
The target resource for the drilling programme is gas, however light hydrocarbons (condensate) are also expected . Therefore in the unlikely event of an uncontrolled hydrocarbon release there exists the possibility for condensate spill on the surface.

Flora/fauna and human population
As described already, a blow-out may, in serious cases, lead to an uncontrolled combusted or uncombusted hydrocarbon release, resulting in potential fires or explosions as well as indirect effects from air pollution, noise, and so on.

On the one hand, potential human receptors are located several kilometres from the operational sites. On the other, the drilling sites will have virtually no fauna or flora. However, if a blowout occurred, fauna and flora in the vicinity of the site would be affected.

Risk Magnitude

Pathway	probability of S-P-R link	Level of consequences	Risk Magnitude
The well itself during the drilling process. In the case of those receptors located at the surface of the well pad (air, soil, vegetation and fauna).	*Very Low*	Air quality, soils, vegetation and fauna in the immediate vicinity of the well pad (i.e. within the well site area). *Medium*	Low
For the aquifers path would include the well itself and in addition of drainage systems and spills on adjacent soil with percolation down through to aquifers		Potential shallow aquifers under the well pad) *High*	Medium

Mitigation measures

These are related to minimising the probability of the event occurring. The relevant plan is the Blow-out Contingency Plan, which makes a series of recommendations to be implemented prior to drilling operations commencing, including amongst other measures:

- General well design (with blow-out prevention BOP)
- Well control operations
  - Well control action and prevention plan
  - Surface pressure control
  - Shut in procedures
  - Primary and secondary kill strategy
  - Kill fluid
  - Appropriate safety procedures, inspection, maintenance and training
  - Contract with a professional well control response company for response to a blow-out

Other relevant plans that contain procedures to be implemented in case of a blow-out event are the Liquid Spill Management Plan and the Plan for Prevention and control of pollution.

Residual Impact evaluation

On the basis that best industry practice is applied to the drilling and completion of all wells, the likelihood of a blow-out occurring is very small. With the appropriate mitigation measures in place the impact of a blow-out will be minimised. The potential risk of a blow-out on the receptors considered above is assessed as low, due to the very low probability of a blowout occurring.

Risk Magnitude rating for AE1	**Low**

5.8.2 Contamination of Groundwater (AE2)

5.8.2.1 Accidental spillage of raw materials (fuels, oils and additives) and waste on the well site (AE2.1)

Risk Impact description

Accidental spills or surface discharges could lead to deteriorated groundwater quality. This situation is most likely to happen during the various activities of the operation stage, including drilling and hydraulic stimulation.

Impact S2 summarises the elements which could potentially generate the aforementioned risk, considering that they could equally pose a risk to groundwater quality, if there was a spill/leakage from the surface that migrated into a shallow aquifer. The elements potentially involved in this type of accidental situation are fuels, additives (for drilling muds and stimulation fluid), drill cuttings, drilling mud and flowback water, both from site activities and transport. Similarly, Impact S2 and SW2 describe a set of preventive and corrective measures to minimise risks. It should be noted that, in any case, both raw materials and waste will arrive and/or be removed from the site progressively, to reduce the amounts stored onsite.

On the other hand, spillage risks also depend on the nature of the aforementioned products and waste. Favouring the use of environmentally-compatible materials (as defined in the Project Description) reduces the risk to increasingly low levels, even under accidental situations.

Conceptual model

Source	Pathway	Receptor
Fluid spillages in the pad due to equipment/ infrastructure failure, collisions and operator error, both on site and during transport These fluids could be: fuels, lubricants, drilling muds additives, stimulation fluid additives, waste (drill cuttings, flowback water, hazardous and non-hazardous solid waste, domestic wastewater).	Vertical migration through defects in containment and waterproofing elements, which include pit liners, bunding and storage containers, or during transport.	Direct: Groundwater from shallow aquifers. Indirect: Local population using specific aquifer.
	Overfilling within drainage systems and spills on adjacent soil with percolation down to aquifers.	Direct: Groundwater from shallow aquifers. Indirect: The local population using a specific aquifer.

Assessment of Probability

The S-P-R link probability associated with fluid spillages on the pad or migration through containment and watertight elements is assessed as low, due to the following project-embedded measures, further described in Chapter 3 Project Description:

- Well sites will have waste collection channels that will drive liquid waste towards a collection pit.
- Fuel/chemical storage areas will be provided with drip pans and bunding structures to contain potential spills/leaks.
- Appropriate containers providing hermetic seals will be used for the storage of materials/waste.

With regard to transport, a high number of vehicles for transportation of wastes and raw materials are expected. Considering this and the duration of the activity (several months) there is the potential for a traffic-related accident to occur. However, the Journey/Traffic Management Plan includes guidelines for reducing the probability of an accident and the effect on other receptors during activities that entail vehicular traffic, for example, truck requirements, speed limits, access routes, and transportation timings.

Estimation of Consequence

Any impact on the water quality in shallow aquifers would have the potential for important consequences where such shallow aquifer exists (note that these are expected to have a localized distribution in the Study Area). The consequence would be different depending on the nature of the product accidentally spilled. On one hand, if caused by products such as fuels, oils, other compounds or hazardous waste, the consequence would be considered as high. On the other hand, if caused by drilling muds or stimulation fluid additives the consequence would be assessed as low, given the environmental behaviour described for the additives considered by the Statoil Chemical Centre as standard for this project, see Chapter 3 Project Description and Chemical Management Plan.

Risk Magnitude

Pathway	probability of S-P-R link	Level of consequences	Risk Magnitude
Vertical migration through defects in containment and waterproofing elements, which include a polyethylene liner, various types of deposits considered for each fluid, and bunds.	*Low*	Shallow Aquifer (fuels, oils, other hazardous substances or waste). *High*	Medium
		Shallow Aquifer (drilling mud or stimulation fluid additives). *Low*	Low
Overfilling (due to spills or excessive precipitation) of drainage systems and spills on adjacent soil with percolation down through to aquifers.	*Very Low*	Shallow Aquifer (fuels, oils, other hazardous substances or waste). *High*	Medium
		Shalllow Aquifer (drilling mud or stimulation fluid additives). *Low*	Low

Mitigation measures

As with all the other GW2-related impacts, there is a wide range of measures that are related to both decreasing the probability of the event happening and minimising the consequences if an event occurs. All these have been embed in the risk assessment and mainly include the following:

- The measures related to decreasing the probability are those embedded in the project, already highlighted in the Assessment of Probability paragraph, above, and described in detail in Chapter 3 Project Description and impact SW2 (Surface Water). They are also incorporated in a set of management plans.
- The overarching Plan for Prevention and Control of Pollution includes well pad layout and secondary

containment, chemical selection, waste management, vehicle/equipment maintenance and transportation (the latter especially relevant to the transport of materials and waste, and related to the Traffic/Journey Management Plan).

- The Liquid Spill Response Plan describes the appropriate protocols to be followed in the event of a spill, ensuring the correct management of spills or leaks. Should any residual impact remain, the Plan for Management of contaminated sites and soil will address remediation practices to avoid any chronic pollution.
- In terms of consequence management, the selection of hydraulic stimulation additives considers their environmental profile in addition to their technical behaviour, through the Statoil HSE screening tool, described in detail in the Chemical Management Plan, Appendix of the EMP),

Finally, apart from the evident traces of an event involving a superficial spill, groundwater samples will be collected from several sampling points, as part of the monitoring programme described in the EMP.

Risk Magnitude.

Based on the probability of the accidental events and the potential consequence two different risk magnitudes have been evaluated, deppending on the type of spill. Where the spill involves hazardous materials and wastes the risk has been considerd as medium. Where the spill involves drilling or stimulation additives, thanks to HSE Screening embeded in the project, the risk magnitude is considered as low.

All efforts should be made, in any case, to keep or the to prevent accidents and unplanned events related to the transport and handling of these hazardous chemicals.

Risk Magnitude rating for *AE2.1*	***Medium*** (hazardous substances)	**Low** (drilling & stim. additives)

5.8.2.2 Contact of drilling fluids with aquifers due to well construction and integrity issues during drilling (AE2.2)

Risk Impact description

Exploratory drilling operations considered for the Timissit License are similar in both technology and materials to any hydrocarbon exploration well, whether conventional or unconventional (i.e.: shale). These well construction works require the use of fluids with different purposes (e.g., most importantly to bring drill cuttings to the surface during drilling, control the pressure of the formation, cool down and lubricate the drill bit and the drill string, and maintain borehole wall stability, thereby avoiding collapse and friction during the rotation).

The purpose of the cement used is (together with the casing) to prevent the borehole walls from collapsing, isolate the different geological formations (thus avoiding fluid or gas flow), and allow the control of formation fluids and gases and pressure during drilling.

Water-based muds will be used for drilling the vertical wells down to the target formations. Similarly, the additives to be used for the drilling of the upper sections, where commercially exploitable aquifers are located, have been limited. Oil-based muds (OBM) are not planned to be used but such scenario cannot be fully discarded at this stage of the project. However, should OBM be required these would be used for drilling the horizontal section of the 2 horizontal wells only. Chapter 3 Project Description includes a description of the currently proposed additives.

Conceptual model

Source	Pathway	Receptor

Water based muds come into contact with drilled aquifers.	By the nature of the operation, before installation of casing and cementing.	Direct: Drilled shallow aquifer Indirectly: Local population using a specific aquifer
Oil-based muds (OBM) come into contact with drilled aquifers.	Loss of well integrity during drilling with OBM or migration towards shallower formations.	Direct: Drilled shallow/deep aquifer Indirectly: Local population using a specific aquifer

Assessment of Probability

The S-P-R probability associated with the contact of drilling fluids with underground aquifer formations is considered high for the case of water-based muds as water-bearing formations will be exposed throughout the process of drilling the shallow sections of the well. Prior to drilling through potentially hydrocarbon bearing formations the fresh water aquifers will be protected through casing and cementing.

In the case of oil-based muds are required to drill horizontal wells, the S-P-R is considered very low, given that they would only be used in the deeper sections and therefore the wells would already be isolated from all aquifers by multiple physical barriers. The potential use of OBM would occur only once the target geological formation has been reached, at which time multiple geological barriers would exist:

- The cementing process will prevent the migration of drilling mud through the previously constructed annular spaces.
- The casing will be installed and prevent drilling mud coming into contact with formations above that point.

Estimation of Consequence

The receptors that could potentially be affected by the contact of drilling fluids will be the different aquifers traversed by the well column. In the case of contact occurring, the consequence level for the water quality in the aquifer would be very low for the use of water-based muds, considering the good environmental behaviour of the additives considered.

For oil-based mud, the consequence is assessed as medium, taking into account the condition of the aquifers, the potential indirect impacts on other receptors that could be affected by these aquifers, and the environmental performance of the additives used (Section 3.2.3.6), which will minimise any negative effects.

Risk Magnitude

Pathway	**Probability of S-P-R linkage**	**Level of consequences**	**Risk Magnitude**
Water based muds come into contact with drilled aquifers.	*High*	*Very Low*	Low
Oil based muds come into contact with drilled aquifers.	*Very Low*	*Medium*	Low

Mitigation measures

All the preventive and mitigation measures related to both decreasing the probability of the event happening and minimising the consequences if an event occurs have been already presented in the project design (see Chapter 3, Project Description). Those that are considered as the most relevant ones are highlighted here as for the reader's benefit.

- Water-based muds (WBM) will be used during drilling activities for all sections. OBM would be used if required due to technical and safety requirements and limited to the horizontal sections of 2 wells. All drilling sections crossing aquifers would be drilled with WBM;

- Mud additives have been selected taking into account both their technical and environmental performance using Statoil's system, as explained in the Chemical Management Plan Appendix of the EMP.
- WBM is treated to build a filter cake on the borehole wall and minimize infiltration of fluids into the shallow geologic formations.
- Well design is based on Algerian Regulatory requirements, API construction standards, and Statoil Work Requirements.
- Drilling processes shall be monitored throughout the drilling stage. All parameters, such as mud weight, pressure, and drilling rate will be registered, verified and analysed in real time. Different properties (rheology, filtering, viscosity and density) will be calibrated to ensure proper operational design.
- Well integrity tests will be performed as drilling progresses.
- Drilling mud volume will be minimised by means of a recirculation system.
- Groundwater samples will be collected from several sampling points, as part of the monitoring programme described in the EMP.

Risk Magnitude

The risks on groundwater due to possible contact between the drilling muds and aquifers during the drilling process is considered as Low based on both, (1) the good characteristics of the water-based drilling muds and (2) on the impossibility of oil-based muds being in contact with the aquifers (as if finally required, they will only the used once the casing is set below all aquifers).

Risk Magnitude rating *for AE2.2*	**Low**

5.8.2.3 Contact of stimulation fluids with aquifers due to loss of well integrity during hydraulic stimulation (AE2.3)

Risk Impact description

The hypothetical loss of well integrity during hydraulic stimulation activities could lead to a migration of the hydraulic stimulation fluids from the well to the geological formations located at the vicinity of the well's potential damaged element.

Hydraulic stimulation has been described in detail in Chapter 3 Project Description and consists of injecting a fluid into the interior of the well. The injection is undertaken with sufficient pressure to create small cracks in the rock of the targeted formation. The hydraulic stimulation fluids will comprise mainly water and a propping agent (sand, ceramic, bauxite, etc.), as well as other additives in minimal proportions, up to <2% of the total weight (but typically around 1%). Information on the additives used in the preparation of the hydraulic stimulation fluid are detailed in Section 3.2.4.4.

Well integrity control measures will minimise the probability of any event occurring. Furthermore, if the hydraulic stimulation fluids used have a good environmental profile (as is the case through the implementation of Statoil's chemical HSE Risk assessment), the risk is reduced even more significantly.

Table above depicts a hypothetical migration pathway that occurs when a defective or poorly constructed well is damaged by excessive pressure from hydraulic stimulation operations. A migration pathway is established through which fluids could travel through the cement or the area near the wellbore into the overlying aquifers.

Conceptual model

Source	Pathway	Receptor

Hydraulic stimulation fluid or flowback fluid.).	Loss of wall integrity during hydraulic stimulation due to defective construction resulting in the liberation of the hydraulic stimulation or flowback fluids into one of the aquifers intersected by the well.	Directly: Water in the aquifer located at the spot of integrity loss (if an aquifer is situated in this place) Indirectly: Other aquifers, due to the filtration of drilling fluids from the initially-affected aquifer.

Assessment of Probability

The probability of the S-P-R link associated with the loss of integrity of the wells during hydraulic stimulation activities because of defective construction or because of the action of the hydraulic stimulation, is assessed as very low, due to the following (described in detail in Chapter 3 Project Description):

- Cementing activities shall be conducted in accordance with best practices and API international standards, with cement evaluation logs on specific casing strings to ensure integrity.
- BOP systems and surface equipment, such as piping, connections and valves, will undergo pressure tests, once settled and prior to commissioning.
- Once casing-cementing processes for each drilled section are completed, a hydrostatic leakage test will be carried out by means of a controlled pumping of fluid and monitoring the readings obtained from the pressure gauges installed on the equipment.
- Well design will include multiple protective barriers, consisting of cement and metal tubing (double casing), thus avoiding contact between the internal well conduit and aquifers. In the event of a loss of integrity in the inner layers, the fluids will be contained by the next level of protection (casing and cementing).
- The pressure inside the wells during hydraulic stimulation will be controlled and monitored at all times, and the use of pressure relief valves and electronic pump shut-downs will ensure that maximum permitted pressures are not exceeded for the design of the well casing.
- Throughout all stages of the drilling, stimulation, and testing process the maximum allowable pressure will be documented and communicated to supervisor personnel on the site managing the operations. The maximum allowable pressure will include safety factors, which are used in all facets of the drilling and stimulation design.
- The use of pumping equipment allows the flow to be controlled and pressures managed in the system.
- Any loss of integrity during hydraulic stimulation will be detected through pressure controls and the process will be halted.

Estimation of Consequence

The direct receptors that could be affected by an integrity loss in the wells during drilling activities are the various aquifers present in the stratigraphic column intersected by the well. In the very unlikely event of an uncontrolled release of hydraulic stimulation fluids, the effect on the water quality of the aquifer would be, at most, medium, considering the very low volume and relatively good environmental behaviour of the additives based on the standards followed by Statoil for this Project (see Chemical Management Plan and list of additives in Section 3.2.4.5 of the Project Description).

Risk Magnitude

Pathway	Probability of S-P-R link	Level of consequences	Risk Magnitude
Loss of well integrity during hydraulic stimulation due to defective construction resulting in the liberation of hydraulic stimulation or flowback fluids into an aquifer cut by the well.	*Very Low*	Aquifers (additives that compose the hydraulic stimulation fluids or flow back fluid). *Medium*	Low

Mitigation measures

The mitigation measures are related both to decreasing the probability of the event happening, and minimising the consequences should an event happen anyway:

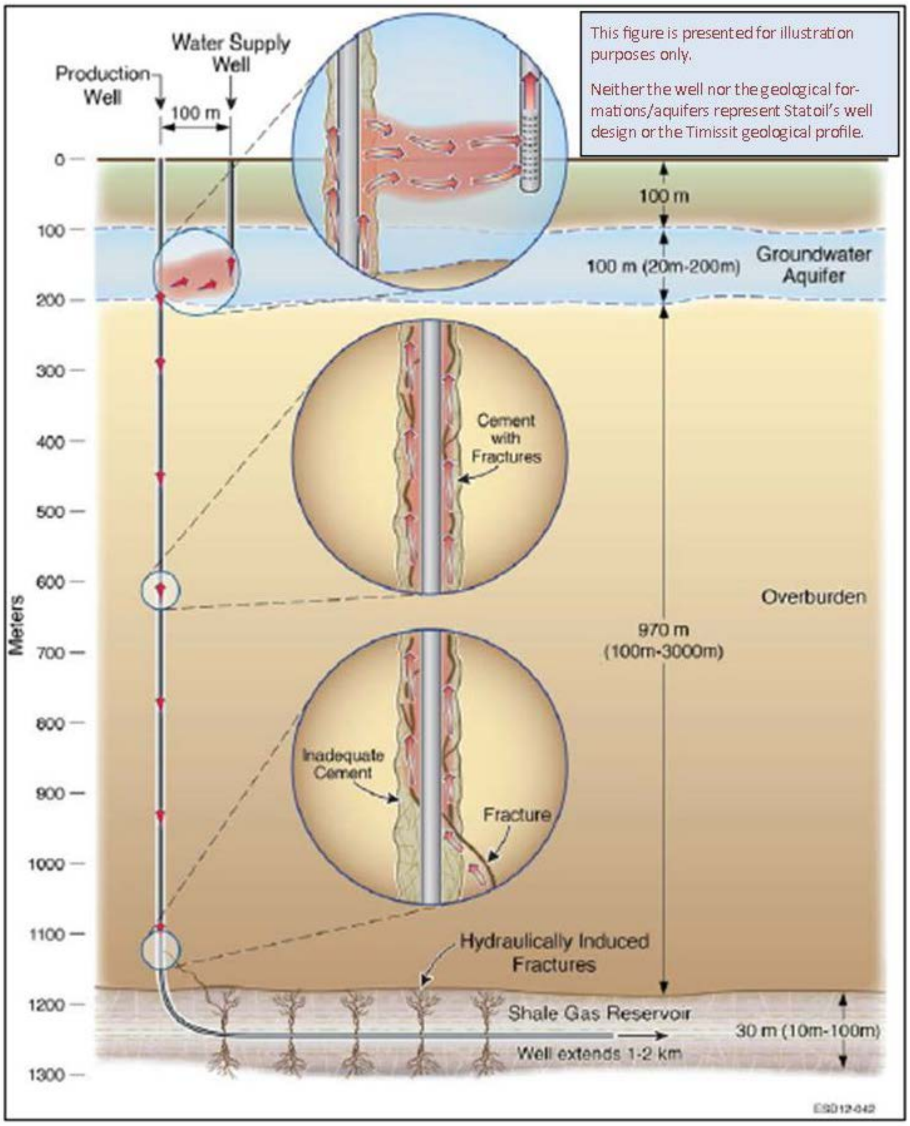
- The measures related to decreasing the probability are the embedded in the project and already highlighted in the Assessment of Probability paragraph above, and described in detail in Chapter 3 Project Description).
- In terms of consequence management, the selection of hydraulic stimulation additives considers their environmental profile in addition to their technical behaviour using Statoil's HSE screening tool, described in detail in the Chemical Management Plan Appendix of the EMP.).
- Groundwater samples will be collected from several sampling points, as part of the monitoring programme described in the EMP.

Residual impact evaluation.

Based on the likelihood of the accidental event and the potential consequence, the risk magnitude associated to the potential impact on groundwater (due to the possible loss of integrity of the wells during hydraulic stimulation) is considered low.

Risk Magnitude rating *for AE2.3*	**Low**

Figure 5.3 Example of a hypothetical contact of stimulation fluids with aquifers due to loss of well integrity during hydraulic stimulation



Source: EPA, 2012

5.8.2.4 Contact of stimulation fluids with aquifers due to induced fractures/seismicity (AE2.4)

Risk Impact description
The objective of the hydraulic stimulation described in detail in Chapter 3 Project Description, and included in the previous impact description, is to create small cracks in the rock to facilitate gas flow from the formation towards the well. A greater extent of these cracks than planned, or contact between cracks and ground irregularities, could, in theory, facilitate the migration of the hydraulic stimulation fluid from the cracks generated towards geologically shallower layers, including aquifers. depicts a hypothetical scenario simulating fluid communication, either directly or indirectly, between shale gas reservoirs and ground water aquifers as a result of the hydraulic stimulation design having created fractures.
Conceptual model

Source	Pathway	Receptor

Hydraulic stimulation fluid or flowback fluid (including gases from the targeted formation)	Cracks generated in the targeted formation extend significantly beyond the top of the target formation, generating communication pathways with shallower geological formations, aquifers, etc.	Directly: Fresh groundwater of aquifers located above the targeted formations. Indirectly: Other aquifers, due to the filtration of stimulation fluids from the initially affected aquifer. Local population using a specific aquifer.

Assessment of Probability

The probability of the S-P-R link associated with the migration of the hydraulic stimulation or flowback fluids (including hydrocarbons from the targeted formation) from cracks generated in the targeted formation towards other geological formations, aquifers, etc. is evaluated as very low, for the following reasons:

- The length of the cracks in the targeted formation, according to references existing in the literature, is normally in the order of tens of metres, and only in certain cases have they been hundreds of metres long.
- Differences in plasticity and geomechanical characteristics, in general, between the targeted formation (Frasnian shale formation) and the immediately overlying one (Upper Devonian), prevent the transmission of the cracks into the upper formation.
- The presence of semi-permeable layers alternating with permeable layers over more than 1500 meters between the main target formation (Fransian) and the TAGI aquifer or 2500 meters in the case of the Albian aquifer, the most important fresh water aquifer locally and regionally.

Estimation of Consequence

The direct receptors that could potentially be affected by a loss of well integrity during the drilling processes are the various aquifers present in the stratigraphic column intersected by the well.

In the unlikely event of an uncontrolled release of hydraulic stimulation fluids, the effect on the water quality in the aquifer would be, at the most, medium, considering the very low volume and relatively good environmental behaviour of the additives based on the standards followed by Statoil for this Project (see Chemical Management Plan and list of additives in Section 3.2.4.5 of the Project Description).

Risk Magnitude

Pathway	probability of S-P-R link	Level of consequences	Risk Magnitude
The cracks generated in the targeted formation extend further than the limits of the formation, generating communication paths with other geological formations and reaching the aquifers, etc.	*Very Low*	Aquifers (additives that compose the hydraulic stimulation fluids or flowback fluid). *Medium*	Low

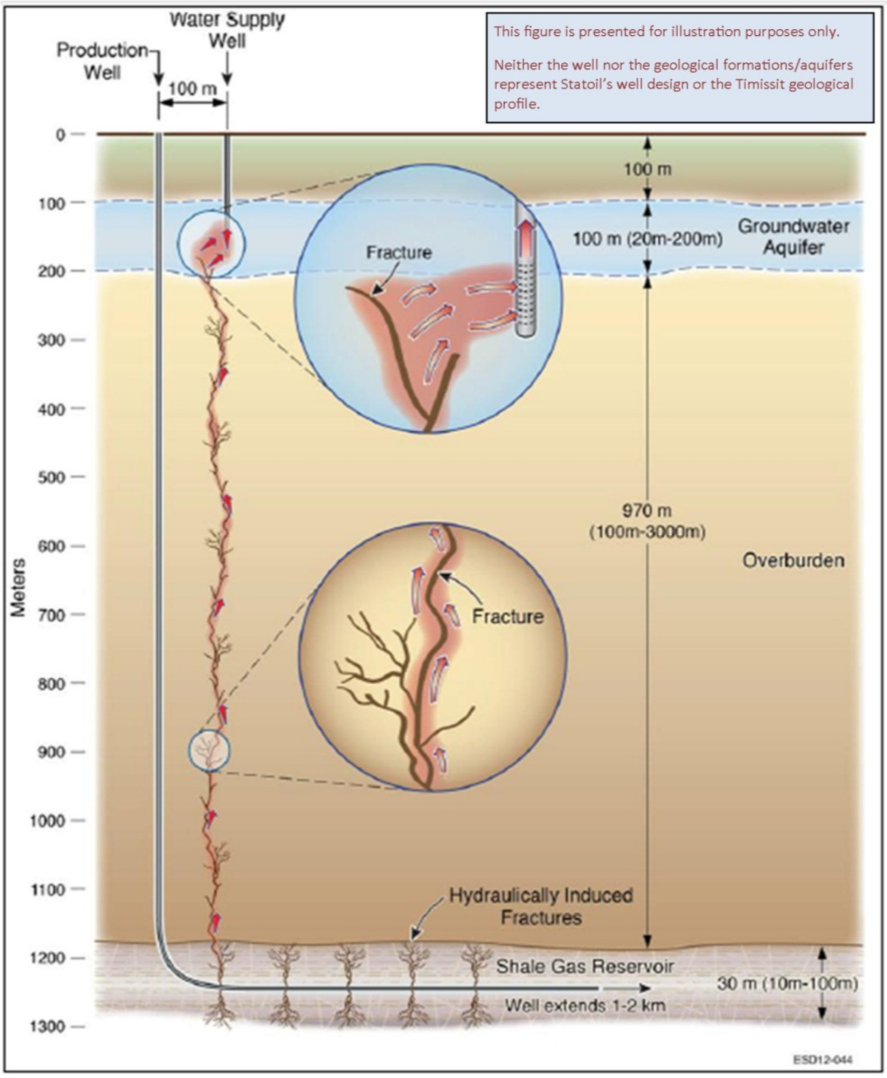
Mitigation measures

In this case, the measures for decreasing the probability of an event occurring are related to confirming the expected characteristics of induced fractures in the target formation using the Geomechanical Model explained in Chapter 3 Project Description and further calibrating the model and stimulation fluids as data from the first wells is being gathered in the course of the various exploratory Phases. Subsurface mapping will be conducted in the area of interest identifying large geologic faults, which can then be avoided.

In terms of consequence management, the selection of hydraulic stimulation additives considers their environmental profile in addition to their technical behaviour using Statoil's HSE screening tool, described in detail in the Chemical Management Plan Appendix of the EMP.

Groundwater samples will be collected from several sampling points, as part of the monitoring programme described in the EMP.	
Residual impact Based on the likelihood of the accidental event and the potential consequence the risk magnitude associated to the contact of stimulation fluids with aquifers due to induced fractures has been evaluated as low	
Risk Magnitude rating *for AE2.4*	**Low**

Figure 5.4 Hypothetical contact of stimulation fluids with aquifers due to induced fractures



Source: EPA, 2012

5.9 Assessment Summary of Accidental and Non Routine Events Impacts during the Drilling and Hydraulic Stimulation activities

Table 5.7 Risk Magnitude Rating summary for Accidental and Non Routine Events

Accidental and Non Routine Events		Risk Magnitude Rating	
Blow-out	**AE1**	**Low**	
Contamination of Groundwater	**AE2**		
• Accidental spillage of raw materials (fuels, oils and additives) and waste on the well site	**AE2.1**	**Medium** (hazardous substances)	**Low** (drilling & stim. additives)
• Contact of drilling fluids with aquifers due to well construction and integrity issues during drilling	**AE2.2**	**Low**	
• Contact of stimulation fluids with aquifers due to loss of well integrity during hydraulic stimulation	**AE2.3**	**Low**	
• Contact of stimulation fluids with aquifers due to induced fractures/seismicity	**AE2.4**	**Low**	

Risk Rating	**Low**	**Medium**	**High**

5.10 Cumulative impacts

Cumulative impacts can be divided into internal and external. The internal cumulative impacts relate to those generated by the various components of the project itself, the seismic campaign and exploratory drilling/stimulation/testing. The drilling/stimulation/testing and the seismic campaign are not significantly cumulative, due to their different geographical locations and/or temporary nature, and the low level of overlap of intrinsic effects on the surrounding environment. Because of the overlap between seismic and drilling/stimulation operations cumulative impacts derived from the increased waste generation and water use are expected. However, these would be minimal and there are already in place common plans to manage them jointly (e.g. Waste MP, Water MP) and in fact the total amount of raw materials and wastes produced are within the standard quantities managed in similar exploration campaigns.

On the other hand, external cumulative impacts refer to potential planned or foreseen activities expected to take place in the area. In this respect there is no expected development project planned in the area, with the exception of O&G projects in neighbouring blocks. These projects do not closely overlap in time and location, the only clear cumulative impacts from them being related to water abstraction and the depletion of existing resources (if they coincide in extraction of water from non-renewable, fossil aquifers as it is the case), and socioeconomic effects, if they have common socioeconomic receptors at the regional level.
Appendix D.4 Water Management Plan, contains a detailed description of the water supply options for the Timissit Project, and a comparison with available resources and current consumption. The importance of the SASS as the main source of drinking, irrigation and industrial water is recognised at national and international levels, as it is shared with neighbouring countries. The cumulative impacts on this aquifer are possibly the most relevant in terms of any project that needs water for its development, but numerous variables are involved (chronological, temporal and conceptual) in terms of water use, which are difficult to assess in the context of an ESIA for a single exploration project. In any case, as can be seen in Section 5 Impact Assessment, the water abstraction volumes involved in the Timissit Project are orders of magnitude lower than the current local abstraction for human and agricultural use in the area. This is typical of O&G exploration projects, including for shale gas, which although involve large amounts of water is still relatively low or moderate when compared to other uses.

If and when shale gas projects progress into the development phase, water use will increase substantially, and there could then be potential significant cumulative impacts and conflicts of priorities in terms of water use in a limited resource scenario. However, in the development phase there is also more room for potential reuse of treated flowback water from well to well. Also the significant volumes of water involved mean that it may be necessary (as the Water Management

Plan has already assessed) to abstract water from deeper aquifers, such as the TAGI, which is not used for human or agricultural supply in the Study Area and thus would avoid direct competition with other local water users.

Chapter 6 - Environmental Management Plan

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6 Environmental Management Plan

6.1 Purpose

The purpose of the Environmental Management Plan (EMP) is to describe measures for the prevention and management of environmental risks associated with said activities according to legislation and regulations in force in environmental matters. To also comply with Statoil ESIA philosophy and internal requirements the EMP will also cover the social aspects.

The EMP is prepared in accordance with Algerian Legal Requirements, Law 03-10, Article 6 of Executive Decree 07-145, Article 6 of Executive Decree 08-312, Instruction Nº2, international and Statoil internal procedures and best industry practices, see *Chapter 2 Administrative and regulatory Framework*.

The EMP will be applicable to all project phases (set up activities, line clearance, seismic and vibroseis, drilling, hydraulic stimulation, decommissioning and site restoration).

6.2 Structure of the EMP

An environmental management plan shall contain the description of the program for overseeing prevention and management measures implemented by the applicant with a view to eliminating, mitigating and/or compensating damaging environmental impacts.

The EMP will form the cornerstone of the Environmental and Social Management System, which will allow Statoil to adopt a systematic approach to managing environmental issues and to ensure continuous environmental improvement, while complying with relevant legislation. This system will detail what, how, who and when all stated commitments outlined in this document will be implemented. Moreover, environmental management will be an integral part within the management systems of both contractor and client companies, as bridging documents will be developed.

The project management is responsible of the EMP implementation although the successful implementation of the EMP is dependent of all personnel so Statoil will ensure they are aware of the requirements of this EMP.
Awareness training will be given, see *Annex D.5 Plan for environmental information and awareness* and implementation will be verified according to *Annex D.7 Environmental Audit Plan*.

The EMP will be a collection of Plans, Programs and Procedures and it is intended to be a working document which will require periodic review and updates.

In an attempt to go beyond the outlines for each Plan, to be developed in a further stage of the project, Statoil has developed detailed framework plans and procedures for the key challenges, such as:

- Liquid Spill Response Plan
- Waste Management Plan
- Water Management Plan
- Plan for Oversight and Monitoring of Environmental Impacts
- Plan for Environmental Information and Awareness
- Chemical Management Plan
- Environmental Audit plan
- Procedure for Management of Change and
- Procedure for Archaeological Chance Findings

These Plans and procedures have been developed as far as possible considering the current project design and local conditions. These documents will continuously be updated as project information becomes available, and the documents shall be issued as final prior to awareness training sessions and the commencement of the operation.

The EMP also includes outlines of additional plans and programs that will be prepared prior to training and start operations, which are:

- Plan for Prevention and Control of Pollution
- Plan for Intervention in case of Pollution
- Plan for Management of Contaminated Sites and Soil
- Plan for Management of Liquid and Gaseous Waste
- Borrow Pits (quarries) Management Plan
- Program for the Shutting Down and Restoration of Site

These plans are summarized in Table 6-1, where there is a separation between those required by Executive Decree 08-312 and Instruction Nº 2. As it can be seen, Statoil presents plans beyond what is strictly speaking required by Algerian legislation, to show their commitment to sustainable development anywhere they operate

Table 6-1 Environmental and Social management plans, programs and procedures, as required by Executive Decree 08-312 and Instruction Nº2

.Environmental Management Requirement (Decree 08-312 and Instruction Nº2)	Project Management Plan and Operating Procedure	References
Plan for Prevention and control of pollution (Plan de prévention et de maitrise des pollution)	Plan for Prevention and Control of pollution (including Blow Out Contingency Plan)	Outlined in Section 6.4.1 below
	Other subsidiary plans, such as Liquid spill response plan, Liquid and Gas Effluent Management Plan, Waste Management Plan, Chemical Product Management Plan, etc.	Annex D.1, Annex D 2, Annex D 6, Section 6.4.1below, etc,
Plan for Intervention in case of pollution (Plan d'intervention en cas de pollution)	Plan for Intervention in case of Pollution	Outlined in Section 6.4.2 below
	Liquid Spill Response Plan	Annex D.1
Plan for Waste management (Plan de Gestion des déchets)	Waste Management Plan	Annex D.2
Plan for Management of contaminated sites and soil (Plan de gestion des sites et sols contaminés)	Plan for Management of Contaminated Sites and Soil	Outlined in Section 6.4.3 below
Plan for Management of liquid and Plan for gaseous waste (Plan de Gestion des rejets liquids & Plan de Gestion des émissions atmospheriques)	Plan for Management of Liquid and Gaseous Waste	Outlined in Section 6.4.4 below
	Waste Management Plan	Annex D.2
Plan for Oversight and Monitoring of environmental impacts (Program de surveillance et de suivi des impact environnementaux)	Plan for Oversight and Monitoring of Environmental Impacts	Annex D.3
Plan for the optimum use of natural	Water Management Plan	Annex D.4

.Environmental Management Requirement (Decree 08-312 and Instruction N°2)	Project Management Plan and Operating Procedure	References
resources (Plan d'utilisation optimale des ressources naturelles)	Borrow Pits (Quarries) Management Plan	Outlined in Section 6.4.5 below
Plan for Environmental information and awareness (Plan d'information et de sensibilisation environnmentale)	Plan for Environmental Information and Awareness	Annex D.5
Plan for Management of chemical products (Plan de Gestion des produits chimiques)	Chemical Management Plan	Annex D.6
Program for Environmental audit (Programme d'audit environnemental)	Environmental Audit Plan	Annex D.7
Program for the shutting down and restoration of site (Plan d'abandon et de remise en état des lieux)	Plan for the Shutting Down and Restoration of Site	Outlined in Section 6.4.6 below
Additional documents required by Statoil/Industry Best practice		**References**
Procedure for Management of Change		Annex D.8
Procedure for Archaeological Chance Findings		Annex D.9
Plan for Traffic/Journey Management Plan		Outlined in Section 6.4.7 below
Plan for Worker Management Plan		Outlined in Section 6.4.8 below
Public Consultation and Disclosure Plan		Outlined in Section 6.4.9 below
Plan for Local Content		Outlined in Section 6.4.10 below

6.3 Roles and responsibilities

This section outlines overall roles and responsibilities of those involved in the planning and implementation of the proposed exploration campaign. Protection of the environment is a line management responsibility, which starts with senior management and ends with the personnel in the field. All line managers will be aware of their responsibilities for the EMP and the maintenance of environmental standards. All individuals involved in the project should be made aware of their environmental responsibilities and relevant standards and procedures, as necessary. Staff induction should include training in environmental standards and clarification of the roles and responsibilities outlined in this section, see *Annex D.5 Plan for Environmental information and awareness.*

6.3.1 Roles and Responsibilities of Statoil

As operator for the project, Statoil is responsible for implementing the EMP. The Country Manager of Statoil Algeria will have overall responsibility for the environmental performance of the project and compliance with Algerian law and projects standards and commitments. Statoil will obtain relevant permissions and approvals and consult and notify relevant stakeholders.

Statoil will appoint a Health, Safety and Environment (HSE) Advisor to monitor the performance of the seismic and drilling operations and advise on health, safety and environmental matters during the project. Statoil should ensure that any environmental incidents or accidents are notified and reported according to applicable regulations.

The HSE is responsible for ensuring that all environmental responsibilities are implemented by the contractors, in accordance with the contract signed between the Company and the contractors.

The HSE should brief the contractors on sensitive aspects of the environment in which the activities will occur and should give information on recommendations and commitments presented in this ESIA and any other environmental management documents and policies. The HSE should monitor the environmental performance of the contractors and provide environmental advice as necessary.

The HSE is responsible for compiling environmental records based on information provided by the contractors and will prepare a final summary report submitted to Statoil at the end of the project. This should include environmental monitoring, incidents/accidents and recommendations for future activities. The HSE will report to the reports to Statoil's Site manager.

6.3.2 Roles and responsibilities of Contractors

The seismic and drilling contractors are responsible for implementation of, and adherence to, all provisions of the EMP. Overall responsibility for the environmental performance of the contractors will rest with Statoil's Manager. The Party Chief will be responsible for the effective implementation of the mitigation measures during the survey.
Personnel should be trained regarding environmental procedures and the requirements of the EMP.

Statoil should supply the contractors with all relevant information concerning the project as required for environmental evaluations, such as details of camp, personnel, resources use, vehicles, fuel and chemicals, hazardous materials and anticipated waste. The contractors should report any environmental incident/accident details to the HSE and should take account of any recommendations made by the HSE.

6.4 Outlines of plans, programs and procedures

This section provides an outline for the plans and programs that will be detailed prior to the starting of the activities, as the project is being further defined (i.e. each of these will be detailed and fully operational prior the commencement of on-site activities).

6.4.1 Plan for Prevention and Control of Pollution

The purpose of this plan is to describe the environmental prevention measures and processes applicable to the project activities. This plan will be prepared prior to commencing field operations. The plan will compile relevant measures that have been assessed and decided to conduct to prevent pollution to soil and water and air. This plan will be prepared prior to commencing the field operations. It has to be noted that most of the measures applicable to this plan are already included in other plans, such as Liquid and Gas Effluent Management Plan, Waste Management Plan, Chemical Product Management Plan, Environmental Audit Plan etc. Therefore, one of the key objectives of this plan will be to ensure alignment between the various plans and multiple procedures, tools and preventive and mitigations measures set in other plans and also in the Impact Assessment (see Chapter 6).

In general the Plan for prevention of pollution will cover different areas, such as:

- Well site/camp location
- Well pad layout
- Secondary Containment (liner, pits, dikes)
- Well design
- Chemical selection and management
- Waste management
- Maintenance (preventative and corrective) and inspection of equipment

- Blowout prevention
- Transportation
- Fuel management
- Flaring

A key aspect of this plan for well pad operations will be a Liquid Spill Response Plan (LSRP) detailed in Annex D 1. The LSRP addresses how the facility (rig, completions and hydraulic fracturing equipment, well pads, tank batteries, etc.) prevents spills due to failure of primary containment (tanks, drums, oil filled equipment/piping, etc.) by implementing secondary containment systems (dikes, berms, non-permeable liners with curbing, sorbent materials, drip pans, etc.) to contain spilled material. It also includes information on the following:

- Maintenance of secondary containment structures
- Capacity of secondary containment system
- Identifies materials stored on location and their respective volumes
- contact information for internal/external personnel and reporting to applicable government agencies

As part of this Plan for Prevention and Control of Pollution, Statoil will develop an specific Blowout Contingency Plan (BCP) prior to commencing drilling operations. For the Timissit project this plan will be prepared in Q4 2015 and Q1 2016. Once operations commence this plan will be communicated and available to all personnel that may be called upon to provide assistance during a response.

Statoil employs a highly skilled Well Control Specialist who has the technical capability and experience for this type of planning. In addition, Statoil engages international well control contractors in the development of these plans. Through detailed planning and training the potential environmental and safety risks associated with blowouts are reduced to a low level.

The purpose of the BCP is to assist in establishing an efficient blowout intervention response for field developments. This plan intended to provide a starting point, to guide, stimulate and complement Statoil engineers and management in the blowout intervention planning process.

This plan addresses the response activities of the Line 1 On-Scene Commander and provides references that will give guidance in handling the process. This document is supplemental to the country emergency response plan.

The plan will include the following:

- Site specific information
- General well design
- Well control operations
    - Well control action and prevention plan
    - Shut in procedures
    - Primary and secondary kill strategy
    - Kill fluid
- Blowout scenarios
    - Simulation study of Blowout Rates and Kill Rates
- Relief well planning
- Emergency response, Incident Classification, and Immediate Action Plans
- Rig, services, and equipment selection

6.4.2 Plan for Intervention in case of pollution

Potential accidents and emergency situations, such as fire, explosion, accidental oil or other chemicals spills, etc. are being considered in Timissit Project. Therefore, this plan will be part of the general Emergency response plans (1st line and 2nd line plans), in what pertains specifically to pollution as emergency events (spillage of chemicals, fuel or hydrocarbons, unexpected air emissions or liquid discharges, etc.) solely or associated with events with other potential damages consequences .A plan for actions to be taken if pollution occurs will be developed.

This plan will summarize actions for all type of events described in *Annex D.1 Liquid Spill Response Plan* and *Annex D.2 Waste Management Plan,* and if there is any doubt that contamination still remains at the site after the application of this plan in the Plan for management of contaminated sites and soil, see section 6.4.3.

6.4.3 Plan for Management of contaminated sites and soil

Statoil will reduce risk to the environment from hydrocarbon or chemical spills and leaks during operations through physical measures and processes, described in the Plan for Intervention in case of pollution above, *Annex D.1 Liquid Spill Response Plan* (LSRP) and *Annex D.2 Waste Management Plan*, amongst other, which will be in place and implemented. This plan for Management of contaminated sites and soil will be activated if pollution is identified as a result of project activities and will address the remediation (clean-up) of sites contaminated from spills/leaks including the following:

- Spill clean-up activities will follow local regulatory requirements and Statoil procedures.
- Mitigation of the environmental and social impact will be the key consideration.
- Initial response actions in the event of a spill.
- The specific spill will be analysed on a case-by-case basis and a complete spill cleanup action plan developed depending on the extent of contamination, material spilled, impacted media (air, land, water), drinking water sources, residential areas, impacted endangered species and/or sensitive habitats, etc.

This Plan relates only to any potential contaminated sites related to Project's Operations.

6.4.4 Plan for Management of liquid and gaseous waste

The management of liquid waste will be performed in accordance with Annex D.2 Waste Management Plan.

The gaseous waste component of this plan will include all mitigation measures related to air emissions which are described in Chapter 5 Evaluation of Impacts and Mitigation Measures and the Plan for Oversight and Monitoring of environmental impacts included in Annex D.3 (dust emissions during construction works, machine and vehicle exhaust emissions, emissions from flaring /well testing, fugitive emissions, pressure relief raw gas) as well as the relevant components of the Plan for Prevention and Control of pollution introduced in Section 6.4.1 above.

One of the main ways to manage gaseous waste is controlling the volumes of gas sent to flare and flare destruction and removal efficiency (DRE) to maximize combustion of gases. This will increase the amounts of CO_2, NO_x, SO_x, but will lower the volume of un-combusted gas released to the atmosphere (CH_4 and VOCs). In the case a drilling well is located near a receptor, then the potential impacts will be evaluated and a modelling will be performed if needed (for instance, receptor located at 2 km or less from the well pad/location of drilling equipment).
Fugitive emissions are reduced by using high quality equipment that is hydrostatically and function tested prior to use. In addition, inspections of valves/flanges, seals, and other equipment, on a regular basis and repairing and/or replacing equipment when leaks are detected is a key component of the plan for managing gaseous waste.

6.4.5 Plan for Management of Borrow Pits (Quarries)

Statoil will develop a Quarry (Burrow pit) Management Plan prior to commencing civil construction operations. For the Timissit project this plan will be finalized by Q2-Q3 of 2016.

The number of quarries, to source gypsum for road construction, should be kept to a minimum. In case of needed the site selection process will be applied, as for the site selection of the other project infrastructure, considering criteria such as: avoidance of oueds, vegetated areas, archaeological features, minimization of access roads etc. Once sites have been selected an inventory of the sites will be prepared to aid remediation including GPS coordinates logged, photograph prior to excavation and materials to be extracted (type and extraction volumes). Quarries should be located as close as possible to a main access road and only one access track should be used.

Quarries will be reinstated to the following standards:

- Backfill the excavation with available excess material.
- Smooth over the backfilled areas (slopes must be less than 30 degrees).
  - The restored quarries should resemble a naturally occurring depression that can be safely crossed humans and animals.
  - Access tracks should be smoothed over if possible.

The plan will include an overview, detailed quarry or burrow pit management. The plan will meet all applicable local regulations, where these apply, and best practices.

Overview of Plan:

- Site establishment
- Type of Extraction for aggregate, i.e. loader, track hoe, blasting
- Transportation of aggregate to hopper, plant, crushing
- Any concrete batching involved
- What offices or warehouses are on the site
- Any Backfill on the site
- Site rehabilitation
- Legal description

In detail the Quarry Management section of the Plan will include the following:

- Extraction method (description of the extraction of the material by machine and methods of crushing to be used for the rock)
- Recording and measuring excavation (The type of recording and measuring will be done and the frequency of this operation)
- Survey Method (What is the method used to survey)
- Survey Parameters (limits of the quarry)
- Staging (Any method given for the quarry excavation, development of the scale house and what will be established in steps)
- Stockpiles (stockpiling of the material in the quarry and management of the stockpiles)
- Site Management for Stormwater Areas (environmental plan to store contaminates and how this will be managed)
- Rehabilitation (How extraction areas will be reclaimed)
- Clean filling (Any backfill on the pit)
- Site Security/Safety (Fencing, guards, monitors)

The Environmental Effects and Mitigating Measures section of the Plan will identify environmental and social impacts and how these will be minimized. The following factors will be taken into consideration:

- Quarry dust
- Noise (Crusher location and how it will affect the surroundings in terms of noise)
- Operating hours
- Spill Response and Mitigation (Spill Response Plan)
- Groundwater Protection (Testing and prevention measures)
- Landscape and Visual Amenities

In terms of meeting local regulations, and beyond the above considerations, Algerian applicable legislation must be considered when preparing the Borrow Pit (Quarry) Management Plan.

6.4.6 Plan for the shutting down and restoration of site

At the conclusion of Statoil's exploration activities in the Timissit license the well sites, access roads and camp locations will be reclaimed in accordance with Algerian legislation and best industry practice. A Plan for shutting down and restoration of sites will be developed and will be applicable for both the seismic and the drilling operations and shall cover all footprint areas of the project.

The plan will cover:

- Plugging any remaining upholes
- Seismic lines
- Camp removed and surface returned back to original state
- Mud and waste water pits to be cleaned out and covered up if appropriate
- Removal and/or treatment of all fluids and cuttings to eliminate potential for negative environmental impact
- All pits, berms, and other above ground structures constructed for the drilling of the well will be levelled and back-filled to restore the site to approximate pre-existing conditions
- Waste material will be disposed of in an environmentally responsible manner in accordance with *Annex D.2 Waste Management Plan*
- Potential application of Management of contaminated sites and soil for sites restoration
- Photographic records will be acquired to document the reclamation

6.4.7 Plan for Traffic/Journey Management Plan

A Traffic Management Plan will be developed. The plan will describe how Statoil and its contractors will manage transport operations during all phases of seismic and drilling activities to minimise the risk of either a vehicle incident or damage to local infrastructure by using a variety of safety equipment and procedures.

The plan will include the responsibilities, resources and processes that will apply in response to identified traffic situations.

The plan will also include procedure for crossing of Oueds (wadis).

6.4.8 Plan for Worker Management

A plan for Worker management will be developed. The plan will include topics like:

- recruitment practices,
- worker pay and conditions,
- training,

- accommodation conditions,
- worker code of conduct.

6.4.9 Public Consultation and Disclosure Plan (PCDP)

Although according to the Decree 08-312 the public consultation and disclosure of the project (ESIA Phase) falls under the responsibility of the Wali, Statoil is allowed to offer its assistance in the Public Inquiry as part of the ESIA approval process (although the decision remains with the Wali).

Several mitigation measures have been identified in *Annex D.3 Plan for Oversight and Monitoring of Environmental Impacts of environmental impacts* relevant for the social management.

In addition, Statoil is committed to implementing projects according to corporate, industry and international mandates for social responsibility and consultation within a sustainable framework. Under this framework, Statoil in coordination with the relevant authorities and shareholders will assess the convenience of the development of a Public Consultation and Disclosure Plan (PCDP) post ESIA for engaging with local communities, local governments and other key external stakeholders, support to project activities and dissemination of grievance mechanism etc. A PCDP document in line with International Finance Corporation (IFC) guidance would include:

- Algerian regulation requirements on consultations and disclosure
- Shareholders policies on consultations and disclosure
- International requirements and best practices on consultations and disclosure
- Stakeholder mapping and analyses
- Key Social and Environmental issues
- Grievance mechanism
- Communication plan
- Procedure to engage with potentially affected local communities to inform about Statoil activities

6.4.10 Plan for Local Content

Instruction nº01 of 11th March, 2013, is aimed at promoting the development of employment in southern Wilayas. It determines that employment of locals from the Wilaya concerned must be prioritised, mainly for non-skilled positions. In this sense, employers have to notify an authorised recruitment agency or the Commune, of any vacancy and the employer has to ensure the training of non-skilled workers. This instruction also establishes that salaries cannot be lower than 80% of the salaries for similar positions.

The Plan for Local Content will be developed to meet these instructions and will describe the projects objectives and actions to ensure local employment and procurement.
Relevant measures will be included in the services contracts.

6.5 Estimate for Mitigation Measures

This section presents the financial allocations to implement the proposed mitigation measures and management plans in the project, as requested by Article 6 of Executive Decree 07-145.

This estimation of financial allocations does not include however those measures that can be considered as “good practice” within the industry (which have actually been incorporated within the project design), since good practice is considered within the common operational procedures of Statoil, and the adoption of good practice will occur regardless of the project location, its costs included in the overall operations by default. Some relevant examples of these preventive and mitigation measures not budgeted but implemented would include:

- Use of double casing and cementing of well
- Screening and evaluation of drilling and stimulation additives.
- Well integrity tests

It must be stated that costs included are only estimation. They will most likely be refined when the activities are defined to a greater degree of detail. In addition, in order to provide an overall cost estimation it has been assumed that all activities from Phase 1 to Phase 3 are fully developed, which, as clearly described in *Chapter 3 Project Description*, may not be the case. Costs have been estimated using past experiences and best judgement.

Table 6.2 Financial Allocations for Mitigation Measures per Well

Responsible Party	Activity	Proposed Mitigation Measure	Estimated financial allocation
Contractor	Seismic & Drilling	Appoint a Health, Safety, Security and Environmental Manager to the crew (will manage and oversee application of the EMP and HSE commitments at rig site.	**250,000 US$**
Contractor	Seismic & Drilling	Identification of and consultation with potential landowners/users and agreeing access routes for permission and maximization of local benefits.	**15,000 US$**
Statoil & Contractor	Seismic & Drilling	Implementation of the Plan for Local Content as well as an assessment of the availability of goods will be undertaken (with the objective of maximizing benefits on local economy/population but pressure is not placed on local resources and services (e.g. food, water, fuel, healthcare).	**40,000 US$**
Statoil & Contractor	Seismic & Drilling	Site works to identify, locate and avoid sensitive sites (e.g. vegetated areas, CH sites, Sabkhas, wadis…). This will encompass the drilling sites and especially the routing of accesses to all areas and seismic lines.	**150,000 – 200,000 US$**
Contractor	Seismic & Drilling	Development, validation and follow-up of the Journey Management Plan.	**40,000 US$**
Contractor	Drilling	Fencing, marking and protecting sensitive sites in the vicinity of the access roads;	**10,000 US$ (per well)**
Statoil	Seismic & Drilling	Maintenance of access roads.	**150,000 US$**
Contractor	Drilling	Rig layout elements for HSE purposes - Waste pits - Water reserve pit - Chemical store area - Domestic waste storage area - Flare line discharge area - Septic tanks & PVC pipes - Burn pit	**140,000 US$ (per well)**
Statoil	Seismic & Drilling	Training awareness as well as preparation of communication materials (e.g. posters, markers, etc). Typically including: • Identification of sensitive ecological features • Identification of CH/Archaeological sensitive features • Sustainable/Responsible use of natural resources (e.g. water) • Training of CH awareness	**60,000 US $ (will vary based on number of trainings)**
Contractor	Drilling	Flowback water pits construction, maintenance and eventual transport of flowback (depending on composition).	**100,000 - 500,000 US$**
Contractor	Drilling	Monitoring of waste properties (flowback water, muds and cuttings) as well as groundwater and induced seismicity.	**40,000 US$**
Contractor	Seismic &	Secondary containment for diesel storage.	**25,000 US$**

	Drilling		
Statoil	Seismic & Drilling	Environmental audits during the implementation of the seismic, drilling and completion activities.	**100,000 US$**
Statoil & Contractor	Seismic & Drilling	Preparation of detailed operational plans and corresponding updates along the project development: • Waste Management Plan • Liquid Spill Response Plan • Water Management Plan • Chemical Management Plan • Plan for Management of Liquid and Gaseous Waste	 **25,000 US$** **25,000 US$** **25,000 US$** **25,000 US$** **15,000 US$**
Contractor	Seismic & Drilling	Decommissioning and restoration works on all project footprint area (cleaning the site, restoring natural topography and drainages, etc). Photographic recording and reporting.	**150,000 – 250,000 US$**
Statoil	Seismic & Drilling	Auditing on decommissioning works on the Well sites, camps, seismic lines, burrow pits, access roads, air strip as well as any other footprint areas.	**60,000 – 120,000 US$**
Statoil	**Seismic & Drilling**	**Implementation of the Procedure for Management of Change (actual cost will vary based on the potential magnitude of changes and needs potentially raised.**	**50,000 – 150,000 US$**

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Annex A - MATET approval of BEXAM

Annex A.1 MATET's approval of BEXAM

الجمهورية الجزائرية الديمقراطية الشعبية
REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE

Ministère de l'Aménagement du Territoire et de l'Environnement

Direction de la réglementation et des affaires juridiques

Sous –direction de la réglementation

وزارة التهيئة العمرانية و البيئة

مديرية التنظيم والشؤون القانونية

المديرية الفرعية للتنظيم

رقم 2012/DRAJ/..53

05 جوان 2014

الجزائر في : ..... 14 AOUT 2012

رخصة

- بمقتضى القانون رقم 03-10 المؤرّخ في 19 جمادى الأولى عام 1424 الموافق 19 يوليو سنة 2003 والمتعلق بحماية البيئة في إطار التنمية المستدامة،

- وبمقتضى المرسوم الرئاسي رقم 10-149 المؤرخ في 14 جمادى الثانية عام 1431 الموافق 28 مايو سنة 2010 والمتضمن تعيين أعضاء الحكومة،

- وبمقتضى المرسوم الرئاسي رقم 10-236 المؤرّخ في 28 شوال عام 1431 الموافق 7 أكتوبر سنة 2010 والمتضمن تنظيم الصفقات العمومية، المعدّل و المتمم،

- وبمقتضى المرسوم الرّئاسيّ رقم 12-229 المؤرّخ في 3 رجب عام 1433 الموافق 24 مايو سنة 2012، يكلف بعض أعضاء الحكومة لتولي نيابة الوزراء الذين انتخبوا أعضاء في المجلس الشعبي الوطني،

- وبمقتضى القرار الوزاري رقم 202/أ.خ.و/2002 المؤرّخ في 19 مايو سنة 2002، والمتضمن إنشاء لجنة الترخيص لمكاتب الدراسات التقنية التي تنشط في مجال تهيئة الإقليم و البيئة، المعدل و المتمم،

- وبمقتضى طلب تجديد لاعتماد المقدم من طرف **م.ش.و.ذ.م.م بيكسام** ،

- وبمقتضى قرار اللجنة رقم 12/22 المؤرخ في 6 أوت سنة 2012 والمتعلق بمنح الاعتمادات لمكاتب الدراسات في ميدان البيئة وتهيئة الإقليم.

يرخص

المادة الأولى: يرخص لـ م.ش.و.ذ.م.م **بيكسام** ، والمسيرة من طرف السيدة **العمري حفيظة** و الحاصلة على **شهادة مهندس دولة في الجيولوجيا.**

العنوان: حوش روبية رقم 68 الرويبة، ولاية الجزائر.

بتقديم العروض في الصفقات التي تبرمها وزارة التهيئة العمرانية و البيئة في **ميدان تهيئة الإقليم و البيئة.**

المادة الثانية: هذه الرخصة صالحة لمدة خمسة (05) سنوات ابتداء من تاريخ إمضائها.

المادة الثالثة : يمنع استعمال هذه الرخصة لأغراض إشهارية مهما كان شكلها، تعرض صاحبها إن فعل ذلك إلى حد سحبها منه.

المادة الرابعة: يكلف مدير التنظيم و الشؤون القانونية بتنفيذ هذه الرخصة.

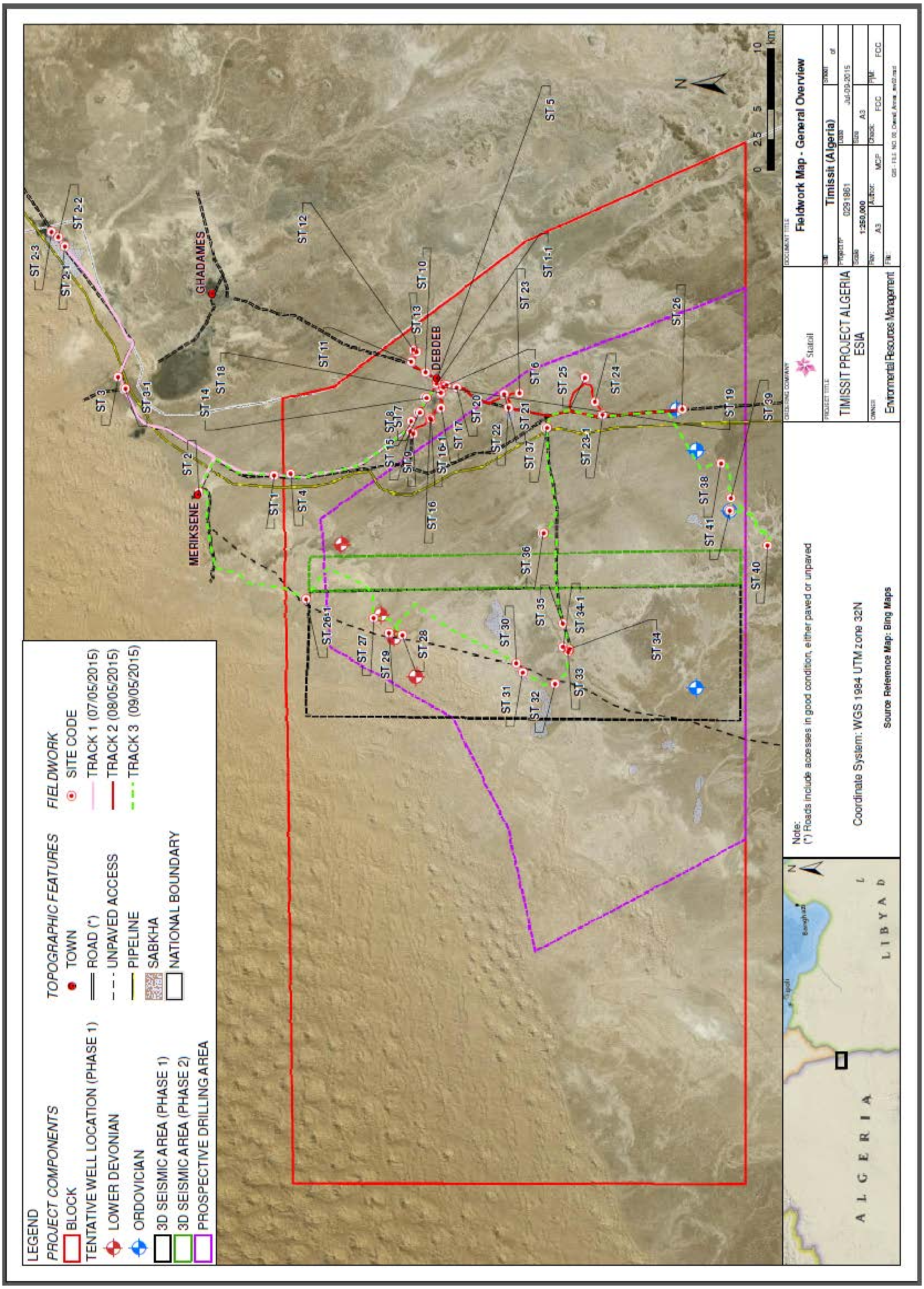
ن.حفاصي
بالنيابة

عن الوزير وبتفويض منه
مديرة تقييم الدراسات البيئية
نعيمة حفاصي

Annex C

Table of contents

Annex C.1 – Map and Summary Field Table Activities


LEGEND
PROJECT COMPONENTS
BLOCK
TENTATIVE WELL LOCATION (PHASE 1)
LOWER DEVONIAN
ORDOVICIAN
3D SEISMIC AREA (PHASE 1)
3D SEISMIC AREA (PHASE 2)
PROSPECTIVE DRILLING AREA
TOPOGRAPHIC FEATURES
TOWN
ROAD (*)
UNPAVED ACCESS
PIPELINE
SABKHA
NATIONAL BOUNDARY
FIELDWORK
SITE CODE
TRACK 1 (07/05/2015)
TRACK 2 (08/05/2015)
TRACK 3 (09/05/2015)
GHADAMES
DEBDEB
MERIKSENE
Note:
(*) Roads include accesses in good condition, either paved or unpaved
Coordinate System: WGS 1984 UTM zone 32N
Source Reference Map: Bing Maps
TIMISSIT PROJECT ALGERIA ESIA
Environmental Resources Management
Fieldwork Map - General Overview
Timissit (Algeria)
0291861
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Jul-09-2015
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FCC
ALGERIA
LIBYA
Km

Table 1 Summary Field Table Activities

Site code	Date	Geomorphomology / Habitat	Noise Measurements	Soil Samplings	Water well and Water Samplings	Flora	Fauna	Cultural Heritage
ST-1	07/05/2015	Hamada with dry oued surrounded by escarpments				Presence of flora		
ST-2	07/05/2015	Hamada bordered by the erg – Human environment			Water well	Presence of flora (ornamental)		
ST-3	07/05/2015	Hamada at the edge of the erg with oued	Noise measurement		Water well	Presence of flora	Dromedaries	French colonial fort
ST-4	07/05/2015	Hamada with dry oued surrounded by escarpments	Noise measurement	Soil Sample SS08_07052015	Water well / water sample WELL8_07052015	Presence of flora		
ST-5	07/05/2015	Hamada with oued surrounded by escarpments – human environment				Presence of flora (nearby oued)	Dromedaries	
ST-6	07/05/2015	Hamada with oued surrounded by escarpments				Presence of flora		
ST-7	07/05/2015	Hamada surrounded by escarpments						
ST-8	07/05/2015	Hamada surrounded by escarpments	Noise measurement					
ST-9	07/05/2015	Sabkha with oued surrounded by escarpments.	Noise measurement			Presence of flora		
ST-10	08/05/2015	Hamada with fine oued alluvials	Noise measurement			Presence of flora		
ST-11	08/05/2015	Hamada – Human environment	Noise measurement	Soil Sample SS03_08052015		Presence of flora		
ST-12	08/05/2015	Hamada – Human environment	Noise measurement			Presence of flora		
ST-13	08/05/2015	Hamada			Water well	Presence of flora		
ST-14	08/05/2015	Sabkha with one escarpment			Water well	Presence of flora		
ST-15	08/05/2015	Sabkha surrounded by escarpment	Noise measurement		Water well	Presence of flora		

Site code	Date	Geomorphology / Habitat	Noise Measurements	Soil Samplings	Water well and Water Samplings	Flora	Fauna	Cultural Heritage
ST-16	08/05/2015	Sabkha crossed by oued surrounded by escarpment	Noise measurement	Soil sample SS15_08052015		Presence of flora	Jackal footprints, Hare footprints	
ST-16-1	08/05/2015	Hamada with oued surrounded by escarpments				Presence of flora		
ST-17	08/05/2015	Hamada with oued surrounded by escarpments				Presence of flora	Jackal bones	
ST-18	08/05/2015	Sabkha with oued surrounded by escarpment			Water well	Presence of flora		
ST-19	08/05/2015	Hamada surrounded by escarpments – Human environment (agricultural area)			Water well / water sample WELL24_08052015	Presence of flora		
ST-20	08/05/2015	Hamada crossed by oued	Noise measurement			Presence of flora		
ST-21	08/05/2015	Hamada	Noise measurement			Presence of flora		
ST-22	08/05/2015	Sabkha surrounded by escarpment				Presence of flora		
ST-23	08/05/2015	Hamada						
ST-23-1	08/05/2015	Hamada bordered by oued				Presence of flora		
ST-24	08/05/2015	Hamada with oued	Noise measurement			Presence of flora		
ST-25	08/05/2015	Sabkha with oued	Noise measurement			Presence of flora		
ST-26-	08/05/2015	Hamada						
ST-26-1	08/05/2015	Hamada				Presence of flora		
ST-27	09/05/2015	Sabkha surrounded by escarpment on the edge of the erg	Noise measurement			Presence of flora		Traces of silex
ST-28	09/05/2015	Reg on the edge of the erg on one side and on the other escarpment						Traces of silex
ST-29	09/05/2015	Hamada near the erg						

Site code	Date	Geomorphology / Habitat	Noise Measurements	Soil Samplings	Water well and Water Samplings	Flora	Fauna	Cultural Heritage
ST-30	09/05/2015	Sabkha surrounded by escarpments	Noise measurement	Soil sample SS36_09052015		Presence of flora		
ST-31	09/05/2015	Sabkha surrounded by escarpments			Water well / water sample WELL37_09052015	Presence of flora	Dromedaries	
ST-32	09/05/2015	Hamada			Water well	Presence of flora		
ST-33	09/05/2015	Hamada surrounded by escarpments	Noise measurement	Soil sample SS39_09052015				
ST-34	09/05/2015	Hamada with oued				Presence of flora		
ST-34-1	09/05/2015		Noise measurement					
ST-35	09/05/2015	Hamada with valley landscape						
ST-36	09/05/2015	Hamada				Presence of flora		Prehistoric Necropolis
ST-37	09/05/2015	Hamada			Water well	Presence of flora		
ST-38	09/05/2015	Non-saline depression						
ST-39	09/05/2015	Hamada				Presence of flora	Gazelle footprints	
ST-40	09/05/2015	Sabkha surrounded by escarpments		Soil sample SS_47_09052015	Water well / water sample WELL47_09052015	Presence of flora		Cemetery, Traces of silex
ST-41	09/05/2015	Hamada with oued				Presence of flora		

Annex C.2 – Noise measurements

Table 2 Noise measurements undertaken during the field survey (May, 2015)

Location	Date	Noise level dB(A)	Description
ST 3	07/05/2015	60.6	Noise associated to water sourcing and dromedaries.
ST 4	07/05/2015	80.4	Noise associated to wind (strong).
ST 8	07/05/2015	76.5	Noise associated to wind (strong).
ST 9	07/05/2015	84.5	Noise associated to wind and traffic on a road located 700 m away.
ST 10	08/05/2015	70.4	Noise associated to wind, the city of Debded and road traffic .
ST 11	08/05/2015	80.4	Noise associated to wind, APC[1] of Debded, and road traffic.
ST 12	08/05/2015	87.8	Noise associated to wind (strong).
ST 15	08/05/2015	65.6	Noise associated to slightly windy conditions.
ST 16	08/05/2015	89.1	Noise associated to wind (strong) in the oued.
ST 20	08/05/2015	65.4	Noise associated to traffic on the road south of the city of Debded.
ST 21	08/05/2015	98.7	Noise associated to wind and a quarry.
ST 24	08/05/2015	41.1	No noise sources detected.
ST 25	08/05/2015	64.5	Noise associated to slight windy conditions.
ST 27	09/05/2015	54.4	No noise sources detected.
ST 30	09/05/2015	58	No noise sources detected.
ST 33	09/05/2015	70.3	Noise associated to wind.
ST 34-1	09/05/2015	69.3	Noise associated to slightly windy conditions.

Annex C.3 – Soil Sample Certificates

ALcontrol Laboratories

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Rapport d'analyse

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ES-28046 MADRID

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Votre nom de Projet	: TIMISSIT
Votre référence de Projet	: 0291861
Référence du rapport ALcontrol	: 12150476, version: 1
Code de Certification	: YNHALCHK

Rotterdam, 25-06-2015

Cher(e) Madame/ Monsieur,

Veuillez trouver ci-joint les résultats des analyses effectuées en laboratoire pour votre projet 0291861.
Le rapport reprend les descriptions des échantillons, le nom de projet et les analyses que vous avez indiqués sur le bon de commande. Les résultats rapportés se réfèrent uniquement aux échantillons analysés.

Ce rapport est constitué de 7 pages dont chromatogrammes si prévus, références normatives, informations sur les échantillons. Dans le cas d'une version 2 ou plus élevée, toute version antérieure n'est pas valable. Toutes les pages font partie intégrante de ce rapport, et seule une reproduction de l'ensemble du rapport est autorisée.

En cas de questions et/ou remarques concernant ce rapport, nous vous prions de contacter notre Service Client.

Toutes les analyses, à l'exception des analyses sous-traitées, sont réalisées par ALcontrol B.V., Steenhouwerstraat 15, Rotterdam, Pays Bas.

Veuillez recevoir, Madame/ Monsieur, l'expression de nos cordiales salutations.

R. van Duin
Laboratory Manager

ALcontrol Laboratories

ERM Iberia
Anna Vinardell

Rapport d'analyse

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Projet	TIMISSIT	Date de commande	08-06-2015
Référence du projet	0291861	Date de début	08-06-2015
Réf. du rapport	12150476 - 1	Rapport du	17-06-2015

Code	Matrice	Réf. échantillon
001	Sol	SS08_07052015
002	Sol	SS03_08052015
003	Sol	SS15_08052015
004	Sol	SS36_09052015
005	Sol	SS39_09052015

Analyse	Unité	Q	001	002	003	004	005
matière sèche	% massique	Q	99.3	80.5	98.7	83.6	96.2
MÉTAUX							
antimoine	mg/kg MS	Q	<1	<1	<1	<1	<1
arsenic	mg/kg MS	Q	6.3	<4	10	<4	6.0
baryum	mg/kg MS	Q	60	53	82	<20	<20
cadmium	mg/kg MS	Q	<0.2	<0.2	<0.2	<0.2	0.38
chrome	mg/kg MS	Q	11	11	14	11	17
cuivre	mg/kg MS	Q	<5	<5	<5	<5	<5
mercure	mg/kg MS	Q	<0.05	<0.05	<0.05	<0.05	<0.05
plomb	mg/kg MS	Q	<10	<10	<10	<10	<10
molybdène	mg/kg MS	Q	<0.5	1.00	<0.5	4.5	2.6
nickel	mg/kg MS	Q	5.2	5.9	6.7	4.0	7.2
sélénium	mg/kg MS	Q	<1	<1	<1	<1	<1
zinc	mg/kg MS	Q	<20	<20	21	<20	37
HYDROCARBURES TOTAUX							
fraction C5-C6	mg/kg MS		<10	<10	<10	<10	<10
fraction C6-C8	mg/kg MS		<10	<10	<10	<10	<10
fraction C8-C10	mg/kg MS		<10	<10	<10	<10	<10
fraction C10-C12	mg/kg MS		<5	<5.1 1)	<5	<5	6.7
fraction C12-C16	mg/kg MS		<5	<5.1 1)	<5	<5	320
fraction C16-C21	mg/kg MS		<5	<5.1 1)	<5	<5	1600
fraction C21-C40	mg/kg MS		<5	<5.1 1)	<5	<5	1400 2)
Hydrocarbures Volatils C5-C10	mg/kg MS	Q	<30	<30	<30	<30	<30
hydrocarbures totaux C10-C40	mg/kg MS	Q	<20	<20	<20	<20	3300

Les analyses notées Q sont accréditées par le RvA.

Paraphe :

ALcontrol Laboratories

ERM Iberia
Anna Vinardell

Rapport d'analyse

Projet	TIMISSIT	Date de commande	08-06-2015
Référence du projet	0291861	Date de début	08-06-2015
Réf. du rapport	12150476 - 1	Rapport du	17-06-2015

Commentaire

1	Limite de quantification élevée en raison d'une faible matière sèche.
2	Présence de composants supérieurs à C40

Paraphe :

ALcontrol Laboratories

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Anna Vinardell

Rapport d'analyse

Projet	TIMISSIT	Date de commande	08-06-2015
Référence du projet	0291861	Date de début	08-06-2015
Réf. du rapport	12150476 - 1	Rapport du	17-06-2015

Code	Matrice	Réf. échantillon
006	Sol	SS47_09052015

Analyse	Unité	Q	006
matière sèche	% massique	Q	99.5
MÉTAUX			
antimoine	mg/kg MS	Q	<1
arsenic	mg/kg MS	Q	6.3
baryum	mg/kg MS	Q	110
cadmium	mg/kg MS	Q	<0.2
chrome	mg/kg MS	Q	<10
cuivre	mg/kg MS	Q	<5
mercure	mg/kg MS	Q	<0.05
plomb	mg/kg MS	Q	<10
molybdène	mg/kg MS	Q	3.4
nickel	mg/kg MS	Q	7.3
sélénium	mg/kg MS	Q	<1
zinc	mg/kg MS	Q	<20
HYDROCARBURES TOTAUX			
fraction C5-C6	mg/kg MS		<10
fraction C6-C8	mg/kg MS		<10
fraction C8-C10	mg/kg MS		<10
fraction C10-C12	mg/kg MS		<5
fraction C12-C16	mg/kg MS		<5
fraction C16-C21	mg/kg MS		<5
fraction C21-C40	mg/kg MS		<5
Hydrocarbures Volatils C5-C10	mg/kg MS	Q	<30
hydrocarbures totaux C10-C40	mg/kg MS	Q	<20

Les analyses notées Q sont accréditées par le RvA.

Paraphe :

ALcontrol Laboratories

ERM Iberia
Anna Vinardell

Rapport d'analyse

Projet	TIMISSIT	Date de commande	08-06-2015
Référence du projet	0291861	Date de début	08-06-2015
Réf. du rapport	12150476 - 1	Rapport du	17-06-2015

Analyse	Matrice	Référence normative
matière sèche	Sol	Sol: Equivalent à ISO 11465 et équivalent à NEN-EN 15934. Sol (AS3000): Conforme à AS3010-2 et équivalente à NEN-EN 15934
antimoine	Sol	Méthode interne (destruction conforme à NEN 6961, analyse conforme à ISO 22036 et conforme à CEN/TS 160170)
arsenic	Sol	Méthode interne (destruction conforme à NEN 6961 et équivalent à NEN-EN 16174, analyse conforme à ISO 22036 et conforme à CEN/TS 16170)
baryum	Sol	Idem
cadmium	Sol	Idem
chrome	Sol	Idem
cuivre	Sol	Idem
mercure	Sol	Conforme à NEN 6950 (destruction conforme à NEN 6961, analyse conforme à NEN-ISO 16772). Méthode interne (destruction équivalente à NEN-EN 16174, analyse conforme à CEN/TS 16175-2)
plomb	Sol	Méthode interne (destruction conforme à NEN 6961 et équivalent à NEN-EN 16174, analyse conforme à ISO 22036 et conforme à CEN/TS 16170)
molybdène	Sol	Idem
nickel	Sol	Idem
sélénium	Sol	Méthode interne (destruction conforme à NEN 6961, analyse conforme à ISO 22036 et conforme à CEN/TS 160170)
zinc	Sol	Méthode interne (destruction conforme à NEN 6961 et équivalent à NEN-EN 16174, analyse conforme à ISO 22036 et conforme à CEN/TS 16170)
fraction C5-C6	Sol	Méthode interne, extraction methanol, analyse par GC/MS
fraction C6-C8	Sol	Idem
fraction C8-C10	Sol	Idem
fraction C10-C12	Sol	Méthode interne (extraction acétone hexane, purification, analyse par GC-FID)
fraction C12-C16	Sol	Idem
fraction C16-C21	Sol	Idem
fraction C21-C40	Sol	Idem
Hydrocarbures Volatils C5-C10	Sol	Méthode interne, headspace GCMS
hydrocarbures totaux C10-C40	Sol	équivalent à NEN-EN-ISO 16703
Chromatogramme	Sol	Méthode interne, GC-FID

Paraphe :

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Rapport d'analyse

Projet	TIMISSIT	Date de commande	08-06-2015
Référence du projet	0291861	Date de début	08-06-2015
Réf. du rapport	12150476 - 1	Rapport du	17-06-2015

Analyse	Matrice	LOQ	CAS #	Erreur Systématique	Erreur Aléatoire	Incertitude de mesure
matière sèche	Sol	- % massique		2 %	2 %	8 %
antimoine	Sol	1 mg/kg MS	7440-36-0	6 %	11 %	26 %
arsenic	Sol	4 mg/kg MS	7440-38-2	6 %	4 %	14 %
baryum	Sol	20 mg/kg MS	7440-39-3	0 %	6 %	23 %
cadmium	Sol	0.2 mg/kg MS	7440-43-9	1 %	5 %	10 %
chrome	Sol	10 mg/kg MS	7440-47-3	2 %	6 %	12 %
cuivre	Sol	5 mg/kg MS	7440-50-8	4 %	5 %	12 %
mercure	Sol	0.05 mg/kg MS	7439-97-6	0 %	9 %	19 %
plomb	Sol	10 mg/kg MS	7439-92-1	0 %	5 %	12 %
molybdène	Sol	0.5 mg/kg MS	7439-98-7	6 %	9 %	21 %
nickel	Sol	3 mg/kg MS	7440-02-0	0 %	5 %	12 %
sélénium	Sol	1 mg/kg MS	7782-49-2	10 %	9 %	27 %
zinc	Sol	20 mg/kg MS	7440-66-6	0 %	6 %	20 %
fraction C5-C6	Sol	10 mg/kg MS		2 %	19 %	38 %
fraction C6-C8	Sol	10 mg/kg MS		2 %	19 %	38 %
fraction C8-C10	Sol	10 mg/kg MS		2 %	19 %	38 %
fraction C10-C12	Sol	5 mg/kg MS		-11.9 %	7.3 %	28 %
fraction C12-C16	Sol	5 mg/kg MS		-11.9 %	7.3 %	28 %
fraction C16-C21	Sol	5 mg/kg MS		-11.9 %	7.3 %	28 %
fraction C21-C40	Sol	5 mg/kg MS		-11.9 %	7.3 %	28 %
Hydrocarbures Volatils C5-C10	Sol	30 mg/kg MS		2 %	19 %	38 %
hydrocarbures totaux C10-C40	Sol	20 mg/kg MS		-11.9 %	7.3 %	28 %
Chromatogramme	Sol	-		-	-	-

L'incertitude étendue (U) est l'incertitude à 95% de fiabilité. Pour plus d'informations se référer au document sur la mesure d'incertitude.

Code	Code barres	Date de réception	Date prelèvement	Flaconnage	
001	V6852795	08-06-2015	05-06-2015	ALC201	Date de prélèvement théorique
002	V6852780	08-06-2015	05-06-2015	ALC201	Date de prélèvement théorique
003	V6852792	08-06-2015	05-06-2015	ALC201	Date de prélèvement théorique
004	V6852774	08-06-2015	05-06-2015	ALC201	Date de prélèvement théorique
005	V6852787	08-06-2015	05-06-2015	ALC201	Date de prélèvement théorique
006	V6852768	08-06-2015	05-06-2015	ALC201	Date de prélèvement théorique

Paraphe :

ALcontrol Laboratories

ERM Iberia
Anna Vinardell

Rapport d'analyse

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Projet	TIMISSIT	Date de commande	08-06-2015
Référence du projet	0291861	Date de début	08-06-2015
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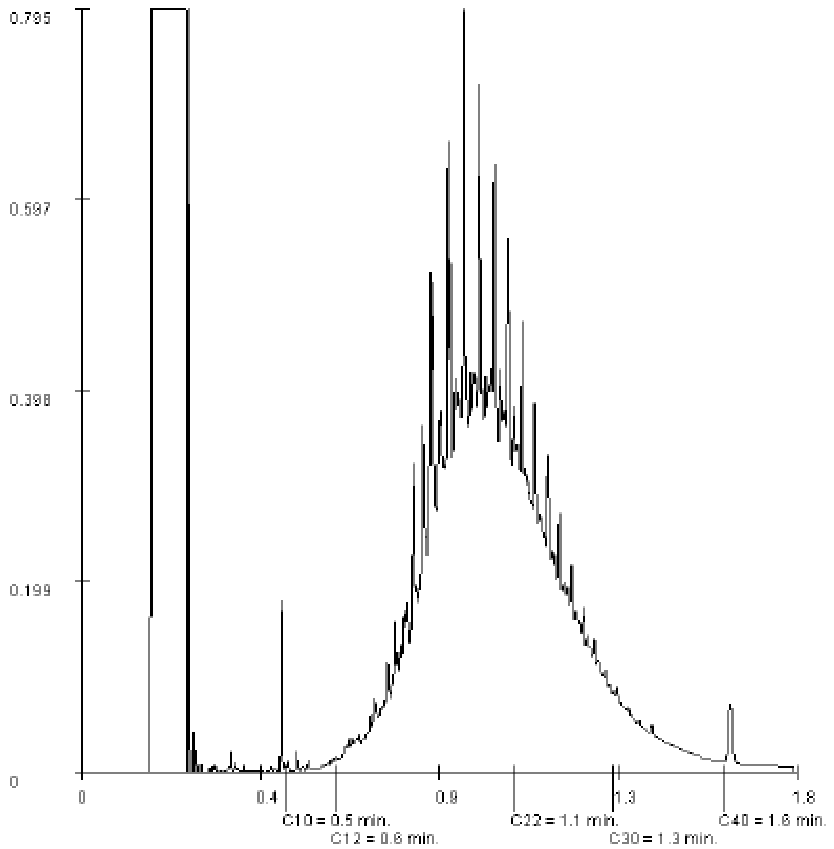
Référence de l'échantillon:	005
Information relative aux échantillons	SS39_09052015

Détermination de la chaîne de carbone

essence	C9-C14
kérosène et pétrole	C10-C16
diesel et gazole	C10-C28
huile de moteur	C20-C36
mazout	C10-C36

Les pics C10 et C40 sont introduits par le laboratoire et sont utilisés comme étalons internes.



Paraphe :

Annex C.4 – Water Sample Certificates

ALcontrol Laboratories

ALcontrol B.V.
Adresse de correspondance
C/ Diego de León, 47 - 28006 Madrid
Tel.: +34 91 838 85 39 - Fax: +34 91 838 85 88
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Rapport d'analyse

ERM Iberia
Perera Deleuze
Paseo de la Castellana, 184. 3°
ES-28046 MADRID

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Votre nom de Projet	: TIMISSIT
Votre référence de Projet	: 0291861
Référence du rapport ALcontrol	: 12148251, version: 1
Code de Certification	: ZNNL3QZH

Rotterdam, 11-06-2015

Cher(e) Madame/ Monsieur,

Veuillez trouver ci-joint les résultats des analyses effectuées en laboratoire pour votre projet 0291861.
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R. van Duin
Laboratory Manager

ALcontrol Laboratories

ERM Iberia
Anna Vinardell

Rapport d'analyse

Projet	TIMISSIT		Date de commande	02-06-2015
Référence du projet	0291861		Date de début	02-06-2015
Réf. du rapport	12148251 - 1		Rapport du	10-06-2015

Code	Matrice	Réf. échantillon
001	Eau souterraine	Well08_07052015
002	Eau souterraine	Well24_08052015
003	Eau souterraine	Well37_09052015
004	Eau souterraine	Well47_09052015

Analyse	Unité	Q	001	002	003	004
MÉTAUX						
filtration métaux	-		1 [1)]	1 [1)]	1 [1)]	1 [1)]
aluminium	µg/l	Q	<50 [1)]	<50 [1)]	<50 [1)]	<50 [1)]
arsenic	µg/l	Q	<5 [1)]	<5 [1)]	<5 [1)]	<5 [1)]
baryum	µg/l	Q	36 [1)]	34 [1)]	<15 [1)]	<15 [1)]
bore	µg/l	Q	900 [1)]	320 [1)]	720 [1)]	530 [1)]
calcium	µg/l	Q	420000 [1)]	620000 [1)]	560000 [1)]	510000 [1)]
dureté calcium	meq/l		21 [1)]	31 [1)]	28 [1)]	25 [1)]
chrome	µg/l	Q	<1 [1)]	<1 [1)]	<1 [1)]	<1 [1)]
Chrome (VI)	µg/l	Q	<2.5	<2.5	<2.5	<2.5
potassium	µg/l	Q	51000 [1)]	27000 [1)]	150000 [1)]	26000 [1)]
mercure	µg/l	Q	<0.05 [1)]	<0.05 [1)]	<0.05 [1)]	<0.05 [1)]
plomb	µg/l	Q	<2.0 [1)]	<2.0 [1)]	<2.0 [1)]	<2.0 [1)]
magnésium	µg/l	Q	100000 [1)]	34000 [1)]	780000 [1)]	180000 [1)]
dureté magnésium	meq/l		8.6 [1)]	2.8 [1)]	64 [1)]	15 [1)]
sodium	µg/l	Q	2000000 [1)]	190000 [1)]	2400000 [1)]	330000 [1)]
sélénium	µg/l	Q	<3.9 [1)]	<3.9 [1)]	5.9 [1)]	<3.9 [1)]
silicium	µg/l		9700 [1)]	14000 [1)]	15000 [1)]	7800 [1)]
strontium	µg/l	Q	6300 [1)]	6400 [1)]	12000 [1)]	11000 [1)]
fer	µg/l	Q	<50 [1)]	<50 [1)]	<50 [1)]	<50 [1)]
Dureté (TH)	meq/l		30 [1)]	34 [1)]	92 [1)]	40 [1)]
dureté totale	deg. all		83	94	260	110
COMPOSÉS INORGANIQUES						
carbonate	mg/l	Q	<10	<10	<10	<10
bicarbonate	mg/l	Q	140	170	250	160
résidu à sec	mg/l	Q	9510	3320	16400	4490
COMPOSÉS AROMATIQUES VOLATILS						
benzène	µg/l	Q	<0.2	<0.2	<0.2	<0.2
toluène	µg/l	Q	<0.2	<0.2	<0.2	<0.2
éthylbenzène	µg/l	Q	<0.2	<0.2	<0.2	<0.2
orthoxylène	µg/l	Q	<0.1	<0.1	<0.1	<0.1
para- et métaxylène	µg/l	Q	<0.2	<0.2	<0.2	<0.2
xylènes	µg/l	Q	<0.30	<0.30	<0.30	<0.30
BTEX total	µg/l	Q	<1	<1	<1	<1
HYDROCARBURES TOTAUX						
fraction C10-C12	µg/l		<5	<5	<5	<5
fraction C12-C16	µg/l		<5	<5	<5	<5
fraction C16-C21	µg/l		<5	<5	<5	<5
fraction C21-C40	µg/l		<5	<5	<5	<5
hydrocarbures totaux C10-C40	µg/l	Q	<20	<20	<20	<20

Les analyses notées Q sont accréditées par le RvA.

Paraphe :

ALcontrol Laboratories

ERM Iberia
Anna Vinardell

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Rapport d'analyse

Projet	TIMISSIT	Date de commande	02-06-2015
Référence du projet	0291861	Date de début	02-06-2015
Réf. du rapport	12148251 - 1	Rapport du	10-06-2015

Code	Matrice	Réf. échantillon
001	Eau souterraine	Well08_07052015
002	Eau souterraine	Well24_08052015
003	Eau souterraine	Well37_09052015
004	Eau souterraine	Well47_09052015

Analyse	Unité	Q	001	002	003	004
AUTRES ANALYSES CHIMIQUES						
chlorures	mg/l	Q	3600	220	3200	480
matières en suspension	mg/l	Q	14	<10	<10	11
vol. d'éch. utilisé	ml		250	250	250	250
sulfate	mg/l	Q	920	1500	5600	1800
Turbidité	FNU	Q	28	<0.5	<0.5	4.0
ANALYSES SOUS-TRAITÉES						
Dénombrement des bactéries aérobies revivifiables à 37°C			voir annexe	voir annexe	voir annexe	voir annexe
Coliformes totaux à 37°C (méthode par filtration			voir annexe	voir annexe	voir annexe	voir annexe

Les analyses notées Q sont accréditées par le RvA.

Paraphe :

ALcontrol Laboratories

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Anna Vinardell

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Rapport d'analyse

Projet	TIMISSIT	Date de commande	02-06-2015
Référence du projet	0291861	Date de début	02-06-2015
Réf. du rapport	12148251 - 1	Rapport du	10-06-2015

Commentaire

1	L'échantillon a été filtré au laboratoire

Paraphe :

ALcontrol Laboratories

ERM Iberia
Anna Vinardell

Rapport d'analyse

Projet	TIMISSIT	Date de commande	02-06-2015
Référence du projet	0291861	Date de début	02-06-2015
Réf. du rapport	12148251 - 1	Rapport du	10-06-2015

Analyse	Matrice	Référence normative
aluminium	Eau souterraine	Conforme à NEN 6966 et analyse conforme à NEN-EN-ISO 11885
arsenic	Eau souterraine	Idem
baryum	Eau souterraine	Idem
bore	Eau souterraine	Idem
calcium	Eau souterraine	Idem
dureté calcium	Eau souterraine	Méthode interne
chrome	Eau souterraine	Conforme à NEN 6966 et analyse conforme à NEN-EN-ISO 11885
Chrome (VI)	Eau souterraine	Conforme à CMA/2/II/C.7
potassium	Eau souterraine	Conforme à NEN 6966 et analyse conforme à NEN-EN-ISO 11885
mercure	Eau souterraine	Conforme à NEN-EN-ISO 17852
plomb	Eau souterraine	Conforme à NEN 6966 et analyse conforme à NEN-EN-ISO 11885
magnésium	Eau souterraine	Idem
dureté magnésium	Eau souterraine	Méthode interne
sodium	Eau souterraine	Conforme à NEN 6966 et analyse conforme à NEN-EN-ISO 11885
sélénium	Eau souterraine	Idem
silicium	Eau souterraine	Méthode interne
strontium	Eau souterraine	Conforme à NEN 6966 et analyse conforme à NEN-EN-ISO 11885
fer	Eau souterraine	Idem
Dureté (TH)	Eau souterraine	Méthode interne
dureté totale	Eau souterraine	Idem
carbonate	Eau souterraine	Méthode interne
bicarbonate	Eau souterraine	Idem
résidu à sec	Eau souterraine	Conforme à NEN 6499 et conforme à NEN-EN-ISO 12880
benzène	Eau souterraine	Méthode interne, headspace GCMS
toluène	Eau souterraine	Idem
éthylbenzène	Eau souterraine	Idem
orthoxylène	Eau souterraine	Idem
para- et métaxylène	Eau souterraine	Idem
xylènes	Eau souterraine	Idem
BTEX total	Eau souterraine	Idem
hydrocarbures totaux C10-C40	Eau souterraine	Méthode interne (extraction hexane, analyse par GC-FID)
chlorures	Eau souterraine	Conforme à NEN-ISO 15923-1
matières en suspension	Eau souterraine	NEN 6484
sulfate	Eau souterraine	Conforme à NEN-ISO 15923-1
Turbidité	Eau souterraine	Conforme à NEN-EN-ISO 7027
Dénombrement des bactéries aérobies revivifiables à 37°C	Eau souterraine	Analyse sous-traitée
Coliformes totaux à 37°C (méthode par filtration)	Eau souterraine	Idem

Paraphe :

ALcontrol Laboratories

ERM Iberia
Anna Vinardell

Rapport d'analyse

Projet	TIMISSIT	Date de commande	02-06-2015
Référence du projet	0291861	Date de début	02-06-2015
Réf. du rapport	12148251 - 1	Rapport du	10-06-2015

Analyse	Matrice	LOQ	CAS #	Erreur Systématique	Erreur Aléatoire	Incertitude de mesure
filtration métaux	Eau souterraine	- -		-	-	-
aluminium	Eau souterraine	50 µg/l	7429-90-5	3 %	5 %	15 %
arsenic	Eau souterraine	5 µg/l	7440-38-2	3 %	5 %	15 %
baryum	Eau souterraine	15 µg/l	7440-39-3	2 %	4 %	10 %
bore	Eau souterraine	50 µg/l	7440-42-8	9 %	9 %	20 %
calcium	Eau souterraine	1000 µg/l	7440-70-2	0 %	3 %	6 %
dureté calcium	Eau souterraine	0.05 meq/l		-	-	-
chrome	Eau souterraine	1 µg/l	7440-47-3	2 %	4 %	10 %
Chrome (VI)	Eau souterraine	2.5 µg/l	18540-29-9	-6 %	3.5 %	14 %
potassium	Eau souterraine	1000 µg/l	7440-09-7	8 %	6 %	24 %
mercure	Eau souterraine	0.05 µg/l	7439-97-6	7 %	4 %	29 %
plomb	Eau souterraine	2 µg/l	7439-92-1	2 %	4 %	12 %
magnésium	Eau souterraine	1000 µg/l	7439-95-4	6 %	9 %	19 %
dureté magnésium	Eau souterraine	0.1 meq/l		-	-	-
sodium	Eau souterraine	1000 µg/l	7440-23-5	2.8 %	4.6 %	12 %
sélénium	Eau souterraine	3.9 µg/l	7782-49-2	2 %	5 %	15 %
silicium	Eau souterraine	10 µg/l	7440-21-3	-	-	-
strontium	Eau souterraine	5 µg/l	7440-24-6	2 %	5 %	12 %
fer	Eau souterraine	50 µg/l	7439-89-6	2 %	4 %	10 %
Dureté (TH)	Eau souterraine	0.15 meq/l		-	-	-
dureté totale	Eau souterraine	0.42 deg. all		-	-	-
carbonate	Eau souterraine	10 mg/l	3812-32-6	-	-	-
bicarbonate	Eau souterraine	20 mg/l	71-52-3	-	-	-
résidu à sec	Eau souterraine	50 mg/l		10 %	7.6 %	26 %
benzène	Eau souterraine	0.2 µg/l	71-43-2	-4 %	16 %	31 %
toluène	Eau souterraine	0.2 µg/l	108-88-3	2.2 %	11 %	23 %
éthylbenzène	Eau souterraine	0.2 µg/l	100-41-4	-4 %	16 %	31 %
orthoxylène	Eau souterraine	0.1 µg/l	95-47-6	5.3 %	12 %	26 %
para- et métaxylène	Eau souterraine	0.2 µg/l	179601-23-1	5.3 %	14 %	29 %
xylènes	Eau souterraine	0.3 µg/l		5.3 %	14 %	29 %
BTEX total	Eau souterraine	1 µg/l		5.3 %	14 %	29 %
fraction C10-C12	Eau souterraine	5 µg/l		-13 %	12 %	36 %
fraction C12-C16	Eau souterraine	5 µg/l		-13 %	12 %	36 %
fraction C16-C21	Eau souterraine	5 µg/l		-13 %	12 %	36 %
fraction C21-C40	Eau souterraine	5 µg/l		-13 %	12 %	36 %
hydrocarbures totaux C10-C40	Eau souterraine	20 µg/l		-13 %	12 %	36 %
chlorures	Eau souterraine	3 mg/l	16887-00-6	3 %	2 %	16 %
matières en suspension	Eau souterraine	10 mg/l		0.1 %	13 %	26 %
vol. d'éch. utilisé	Eau souterraine	- ml		-	-	-
sulfate	Eau souterraine	5 mg/l	14808-79-8	6 %	10 %	23 %
Turbidité	Eau souterraine	0.5 FNU		5.5 %	1.8 %	13 %
Dénombrement des bactéries aérobies revivifiables à 37°C	Eau souterraine	-		-	-	-
Coliformes totaux à 37°C (méthode par filtration	Eau souterraine	-		-	-	-
Dénombrement des bactéries aérobies revivifiables à 37°C	Eau souterraine	-		-	-	-
Coliformes totaux à 37°C (méthode par filtration	Eau souterraine	-		-	-	-

L'incertitude étendue (U) est l'incertitude à 95% de fiabilité. Pour plus d'informations se référer au document sur la mesure d'incertitude.

Paraphe :

ALcontrol Laboratories

ERM Iberia
Anna Vinardell

Rapport d'analyse

Projet	TIMISSIT	Date de commande	02-06-2015
Référence du projet	0291861	Date de début	02-06-2015
Réf. du rapport	12148251 - 1	Rapport du	10-06-2015

Code	Code barres	Date de réception	Date prelèvement	Flaconnage	
001	G8815701	29-05-2015	29-05-2015	ALC236	Date de prélèvement théorique
001	G8815700	29-05-2015	29-05-2015	ALC236	Date de prélèvement théorique
001	H0608948	29-05-2015	29-05-2015	ALC208	Date de prélèvement théorique
001	B4251072	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
001	B4251068	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
001	B4251067	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
001	B4251075	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
001	G8816117	29-05-2015	29-05-2015	ALC236	Date de prélèvement théorique
001	N1000702	29-05-2015	29-05-2015	ALC226	Date de prélèvement théorique
001	B4251071	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
002	B4251031	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
002	B4251040	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
002	H0608942	29-05-2015	29-05-2015	ALC208	Date de prélèvement théorique
002	B4251057	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
002	G8816164	29-05-2015	29-05-2015	ALC236	Date de prélèvement théorique
002	N1000705	29-05-2015	29-05-2015	ALC226	Date de prélèvement théorique
002	G8816123	29-05-2015	29-05-2015	ALC236	Date de prélèvement théorique
002	G8815712	29-05-2015	29-05-2015	ALC236	Date de prélèvement théorique
002	B4251052	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
002	B4251063	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
003	N1000706	29-05-2015	29-05-2015	ALC226	Date de prélèvement théorique
003	B4251034	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
003	G8816126	29-05-2015	29-05-2015	ALC236	Date de prélèvement théorique
003	H0608947	29-05-2015	29-05-2015	ALC208	Date de prélèvement théorique
003	B4251035	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
003	G8816122	29-05-2015	29-05-2015	ALC236	Date de prélèvement théorique
003	B4251041	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
003	B4251055	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
003	B4251061	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
003	G8816143	29-05-2015	29-05-2015	ALC236	Date de prélèvement théorique
004	B4251054	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
004	N1000708	29-05-2015	29-05-2015	ALC226	Date de prélèvement théorique
004	B4251051	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
004	G8816127	29-05-2015	29-05-2015	ALC236	Date de prélèvement théorique
004	H0608940	02-06-2015	02-06-2015	ALC208	
004	B4251064	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
004	B4251033	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
004	B4251062	29-05-2015	29-05-2015	ALC207	Date de prélèvement théorique
004	H0608943	29-05-2015	29-05-2015	ALC208	Date de prélèvement théorique
004	G8816120	29-05-2015	29-05-2015	ALC236	Date de prélèvement théorique
004	G8816128	29-05-2015	29-05-2015	ALC236	Date de prélèvement théorique

Paraphe :

ALcontrol Laboratories Reportnumber 12148251 - 1 Page 8 sur 8

ALcontrol Laboratories

ALcontrol Food B.V.
Locatie:
Everdenberg 41
4902 TT Oosterhout

ANALYSERAPPORT

Certificaatnummer	: 1027287-NL-1
Opdrachtgever	: ALcontrol BV (Hoogvliet), Steenhouwerstraat 15 3194 AG HOOGVLIET
Werkopdrachtnummer	: 1027287
Blad	: 1 van 1
Aangeleverd d.d.	: 04/06/2015 Transport door ALcontrol Food & Water
Onderzoek gestart d.d.	: 04/06/2015
Resultaten gereed d.d.	: 07/06/2015
Projectcode	: 12148251
Project	: 12148251

	Monster				Product
001	001				Grondwater
	Monsternamedatum:	03/06/2015	Monsternametijd:	15:13	
002	002				Grondwater
	Monsternamedatum:	03/06/2015	Monsternametijd:	15:13	
003	003				Grondwater
	Monsternamedatum:	03/06/2015	Monsternametijd:	15:13	

Analyse	001		002		003	
Aëroob kiemgetal (37 °C, filtratie)	>200	kve/100 ml (1)	>200	kve/100 ml (1)	>200	kve/100 ml (1)
Coliformen (37 °C, filtratie)	3.700	kve/100 ml	40	kve/100 ml	8	kve/100 ml

	Monster				Product
004	004				Grondwater
	Monsternamedatum:	03/06/2015	Monsternametijd:	15:13	

Analyse	004	
Aëroob kiemgetal (37 °C, filtratie)	>200	kve/100 ml (1)
Coliformen (37 °C, filtratie)	<1	kve/100 ml (1)

Opmerkingen resultaten

(1) Resultaat is indicatief

Methoden van onderzoek

Grondwater

- Aëroob kiemgetal (37 °C, filtratie) — Conform ISO 4833-1
- Coliformen (37 °C, filtratie) — Q — Conform ISO 9308-1 (1990)

De methoden met een Q zijn geaccrediteerd door de Raad voor Accreditatie (verrichtingenlijst L 106)
De resultaten hebben uitsluitend betrekking op (het) onderzochte monster(s).
Gegevens aangaande de meetonzekerheid (MO) zijn opvraagbaar.

Handtekening site manager
Dhr. E.J. Dingemanse

Annex C.5 – Geomorphological Description

Table 3 Field Survey Geomorphology Description

Site code	Description
ST-1	Wide hamada between two "garats" in the form of a terrace.
ST-2	Wide hamada bordered by erg. No relief.
ST-3	Located at the edge of the erg, on a plateau that limits the hamada.
ST-4	Hamada between two "garats".
ST-5	Debdeb city centre. Hamada surrounded by a “garat”.
ST-6	Hamada with “garats” of average height.
ST-7	Crushing plant for gravel and aggregates. Hamada between two "garats" in the form of a terrace.
ST-8	Hamada with “garats”.
ST-9	Sabkha incised with a oued and surrounded by “garats”.
ST-10	Narrow alluvial oued and hamada in the north.
ST-11	Hamada.
ST-12	Hamada.
ST-13	Hamada near a water tower.
ST-14	Sabkha near a “garat”, a drilling station and a water tower.
ST-15	Sabkha near “garats”.
ST-16	Sabkha crossed by a oued. Wetlands are also present near the oued which is surrounded by “garats”.
ST-16-1	Hamada valley surrounded by two “garats”.
ST-17	Basin composed of a oued and hamada, surrounded by “garats”.
ST-18	Oued and sabkha surrounded by “garats”.
ST-19	Hamada surrounded by “garat”, near an agricultural exploitation.
ST-20	Oued Ouhadjrine going through a hamada surrounded by terraces that corresponds to the oued banks.
ST-21	Active quarry located on a hamada.
ST-22	Salt depression (sabkha) surrounded by terraces crossed by a gas pipeline.
ST-23	Hamada on very uneven ground.
ST-23-1	Active quarry located on a hamada limited by the oued Ouan Ahmed.
ST-24	Oued Ouan Ahmed, surrounded by relatively high oued banks.
ST-25	Sabkha located in the discharge zone of the oued Ouan Ahmed. The area is widely open on the sides and limited in the north by a high hill. With outliers in terrace form that continue to the Libyan border.
ST-26-	Hamada on very uneven ground.
ST-26-1	Hamada.
ST-27	Sabkha on the edge of the erg. Wide ground surrounded by terraces near the Grand Erg Oriental.
ST-28	Reg located on the edge of the Grand Erg Oriental.
ST-29	Hamada near the Grand Erg Oriental.
ST-30	Sabkha surrounded by high “garats”.
ST-31	Sabkha, surrounded by terraced “garats”.

ST-32	Hamada.
ST-33	Hamada surrounded by high “garats”.
ST-34	Airstrip on Hamada.
ST-35	Hamada in deep valley
ST-36	Hamada.
ST-37	Hamada.
ST-38	Depression surrounded by an abrupt, high hill opening on the side to a Hamada.
ST-39	Hamada.
ST-40	Sabkha surrounded by various high “garats”.
ST-41	Hamada composed of fragmented rocks for which the ground is very uneven. A oued crosses the hamada.

Source: BEXAM, 2015

Annex C.6 – Soil and Lithology Description

Table 4 Field survey soil and lithology description

Site code	Description
ST-1	Gravels and stony sand with gypsiferous banks.
ST-2	Fine stony sand.
ST-3	Gravels and stony sand on the hamada. Near the oued, the soil is composed of fine humid sand: clayey and gypsiferous.
ST-4	Gravels and stony sand with white spots, humid and a bit clayey near a well.
ST-5	Fine sand with sandstone and limestone blocks.
ST-6	Gravels and stony sand with sandstone and limestone blocks, due to the degradation of the sandstone banks of the “garat”.
ST-7	Gravels and stony sand with sandstone and limestone blocks, due to the degradation of the sandstone banks of the “garat”.
ST-8	Fine yellowish limestone sand. Sometimes this presents a slightly clayey and gypsiferous lithology in form of crusts.
ST-9	Gravels and stony sand surrounded by sandstone in the “garats”. Fine yellowish to brownish clayey sand with white spots of salt with sandstone blocks.
ST-10	Fine sand, gravels, cobbels and pebbles. Gypsiferous with brown/grey blocks of limestone.
ST-11	Sandstone, beige slab coated by fine gravel and gravelly sand.
ST-12	Sandstone, reddish-greyish slab coated by fine gravel and gravelly sand.
ST-13	Sandstone reddish-greyish slab coated by fine gravel and gravelly sand.
ST-14	Fine sand (slightly clayey), and gravels with white spots of gypsum near a well.
ST-15	Fine brownish/greyish clayey sand with white spots with gravels and sandstones blocks.
ST-16	Fine yellowish-brownish humid loamy and clayey sand with white spots of salt.
ST-16-1	Stony and gravelly soil with white spots. In the “garats” clayey and sandstone soil occurs, with alluvial cones.
ST-17	Fine-medium grained, dry brownish sand with white spots. Stones and gravels also occur with sandstone blocks.
ST-18	Fine yellowish - brownish sand. Sand is slightly clayey and humid with white spots of salt, and with presence of gravels.

ST-19	Fine clayey sand, with gravels and some sandstone blocks.
ST-20	Soil consists of gravels with interbedded beige limestone and formations composed of sand with limestone and gypsum blocks (beige and white in colour, respectively).
ST-21	Clayey sand and reddish sandstone slab with oxidation traces on the top.
ST-22	Fine brownish clayey sand and outcrop of a formation composed of sandstone blocks.
ST-23	Clayey sand and reddish sandstone slab, coated by fine clayey sand with gravels.
ST-23-1	Limestone and sandstone banks, beige-grey colour, with fine sands and gravels.
ST-24	Stony sands with gravels and big blocks of rocks (limestone and sandstone). Oued banks are composed of beige limestone, and oxidised, fractured and very hard limestones, partially coated with sands and gravels.
ST-25	At the oued level, soil is composed of beige limestone oxidised with cavities and micro cavities (on left bank), alluvial cones coated in some places by fine to medium sand.
ST-26-	Gravels and sand with sandstone blocks.
ST-26-1	Fine to medium sand with gravels. Erosion on surface, showing outcrops of white limestone and sandstone.
ST-27	Sand with gravels. Surface erosion shows yellowish to brownish sandstone slabs, oxidised and very hard. Traces of silex.
ST-28	Gravelly ground, surrounded on one side by light coloured sand dunes and on the other side by terraced “garats” composed of sandstone banks. Some gravel is black to brown in colour, iron-rich and coated by sand.
ST-29	Gravels and stony sand with outcrop of hard white limestone.
ST-30	Fine to medium sand, with clayey and gypsiferous characteristics. Humid.
ST-31	Fine and humid clayey sand with gravels. Terraces are composed of sandstone banks, fractured and hard, beige to brownish in colour.
ST-32	Sand with gravels.
ST-33	Sand with gravels.
ST-34	Sand with gravels.
ST-35	Sandstone rock.
ST-36	Fractured sandstone blocks.
ST-37	Sand with gravels.
ST-38	Hamada composed of fragmented limestone blocks.
ST-39	Hamada composed of sandstone crossed by little shallow and sandy oueds.
ST-40	White coloured soil around water well and black coloured soil near the regs and the “garats”.
ST-41	Sandy surface.

Source: BEXAM, 2015

Annex D

Table of Content

Annex D1 - Liquid Spill Response Plan

Table of contents

Abbreviations

AOD	Above Ordnance Datum
CNOSS	Centre National des operations de surveillance et de sauvetage en Mer
DNP	Development and Production
DSS	Drill Site Supervisor during drilling operations
ESHIA	Environmental, Social and Health Impact Assessment
F/ASC	Finance/Admin Section Chief
HNS	Hazardous Noxious Substances
IAP	Incident Action Plan
IC	Incident Commander
ICC	Incident Command Centre
ICS	Incident Command System
ISB	*In Situ* Burinng
IPIECA	International Petroleum Industry Environmental Conservation Association
ICP	Incident Command Post
ITOPF	International Tanker Owners Pollution Federation
L1ERT	Line 1 Emergency Response Team
L2IMT	Line 2 Incident Management Team
LNAPL	Light Non-Aqueous Phase Liquid
LSC	Logistics Section Chief
LSRP	Liquid Spill Response Plan
NEBA	Net Environmental Benefit Analysis
NSCEP	National Service Center for Environmental Publications
OBR	On Board Representatives
OPRC	Oil Pollution, Preparedness, Response and Cooperation
O-SC	On-Scene Commander
OSC	Operations Section Chief
OSRO	Oil Spill Response Organisation
OSRL	Oil Spill Response Limited
OSPREC	Oil Spill Response Company
PPE	Personal Protective Equipment
PSC	Planning Section Chief
REMPEC	Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea
RPE	Respiratory Protective Equipment
SDS	Safety Data Sheet
VOC	Volatile Organic Compounds
WWC	Wild Well Control

1. Introduction

1.1 Response Fundamental Priorities

In the event of an uncontrolled release of liquids[1] associated with drilling and/or well completion, rapid and effective response actions are needed to protect:

- Human health and safety;
- Environmental values;
- Socio-economic resources; and
- Statoil's assets and reputation.

1.2 Objectives of this Liquid Spill Response Plan

This Liquid Spill Response Plan (LSRP) has been written in general accordance with international best practice and Algerian legislation. The LSRP aims to offer guidance to the personnel involved in a spill response related to Statoil's exploration drilling activities in the Algeria Timissit exploration area (Figure 2.1).

Specifically, the objective of this plan is to provide information to guide the Line 1 Emergency Response Team (L1ERT) and Line 2 Incident Management Team (L2IMT) where mobilised to:

- Make the rapid selection of the appropriate technique to combat a liquid release;
- Ensure the rapid implementation of action to reduce the impact of a liquid release;
- Monitor the effectiveness of spill response measures; and
- Continually re-assess the overall response strategy.

The LSRP is intended to guide users towards a suitable course of action in the event of a liquid spill incident with consideration of the following factors:

- Liquid properties
- Proximity of identified environmental and socioeconomic sensitivities
- Available response resources at all tier levels

This plan interfaces with the Statoil Algeria Emergency Response Country Plan (WR 1492) and Waste Management Plan (Timissit Environmental Impact Assessment (EIA) Appendix 1 – Waste Management Plan)

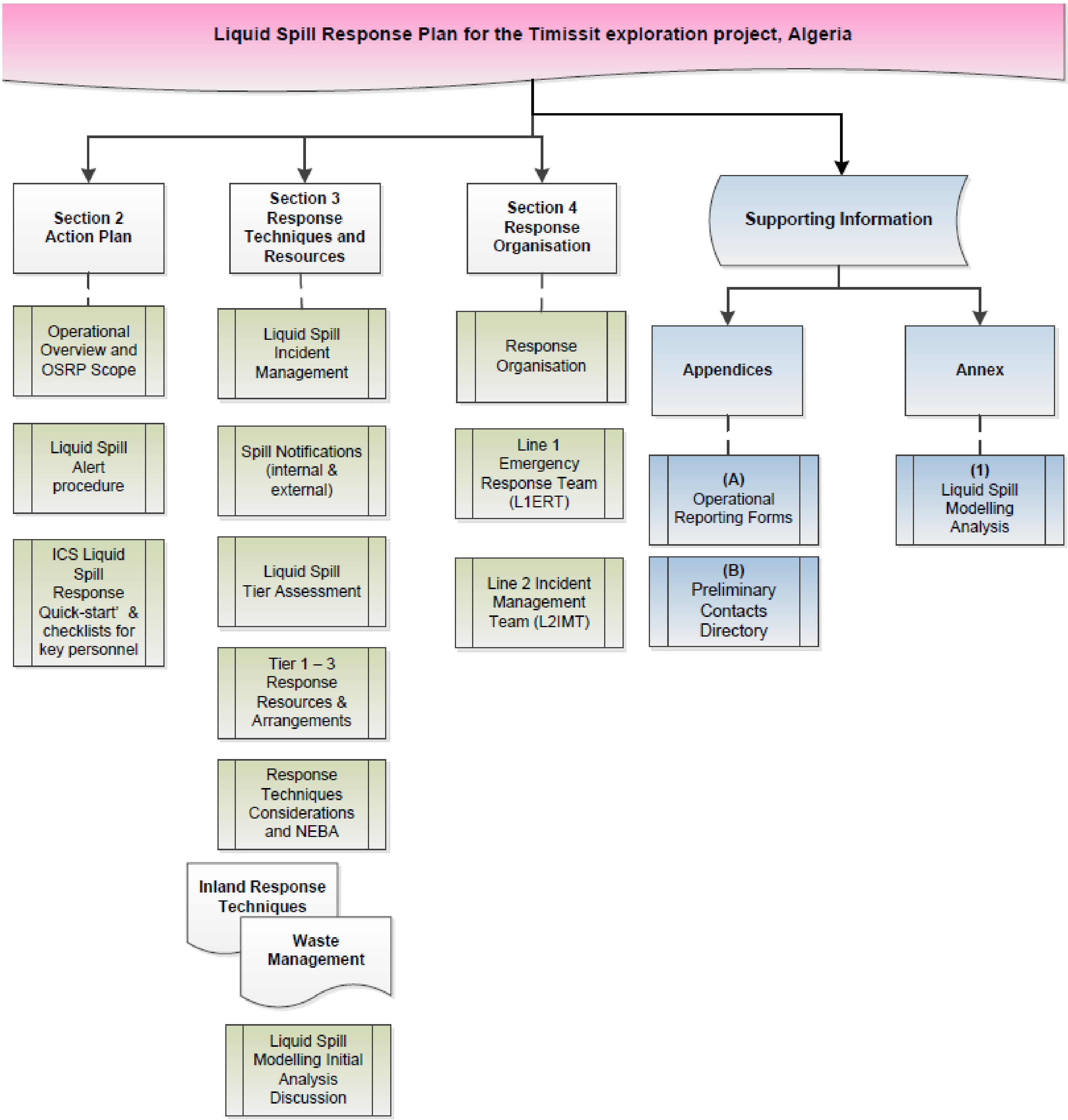
1.3 Use of the Liquid Spill Response Plan

This Liquid Spill Response Plan (LSRP) consists of three (3) main sections and related appendices.

The first three sections (Action Plan, Response Techniques and Resources and Response Organisation) should be utilised in the event of an emergency, with the appendices and annexes containing background information.

[1] In this response plan there is reference to liquids, hydrocarbons, oil and individually named specific compounds. Together these are all referred to as liquids and hence the naming of this as a Liquid Spill Response Plan (LSRP).

Figure 1.1 LSRP for the Timissit exploration project, Algeria



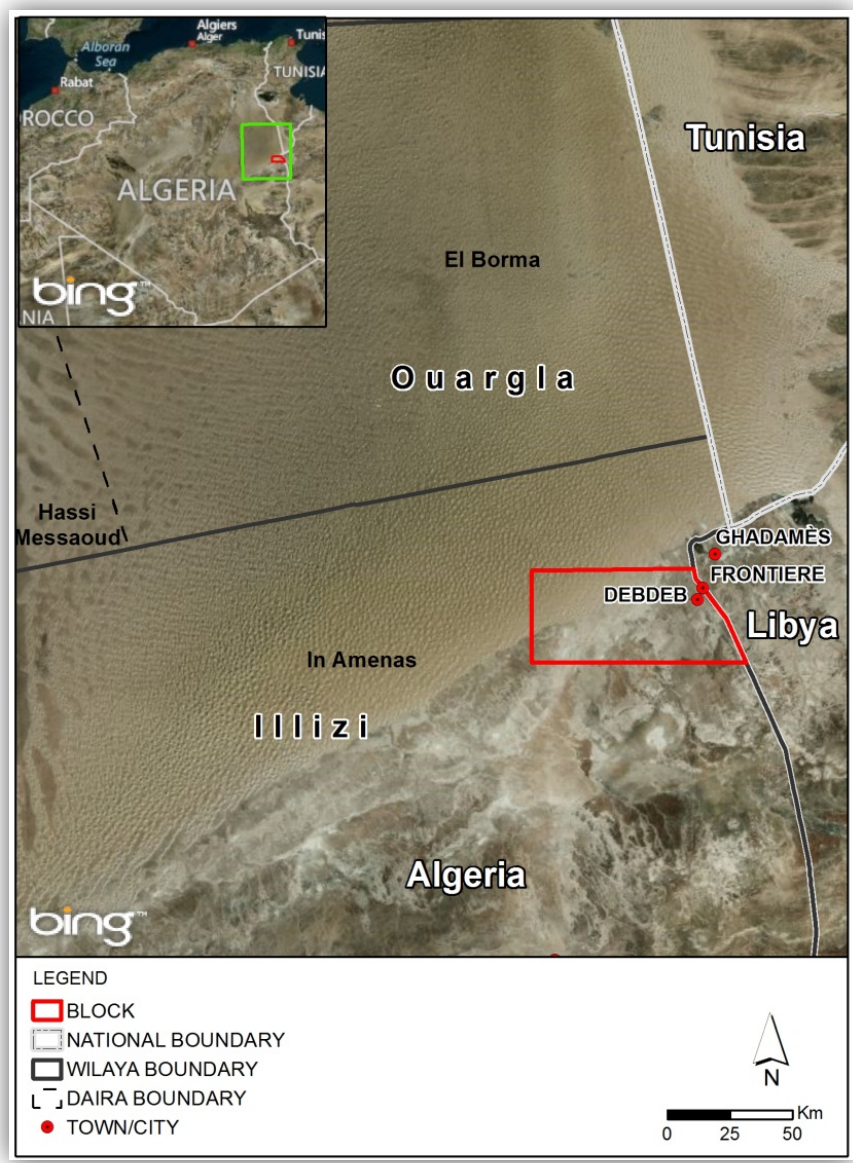
2. Action Plan

2.1 Alert Plan

2.1.1 Operational Overview and LSRP Scope: Timissit exploration project, Algeria

The Timissit License Area is located at the border with Libya, just south of the border with Tunisia. It has an area of approximately 1,080 km^2 and the boundary of the license area is approximately 900 km southeast of Algiers, 300 km southeast of Hassi Messoud and 10 km southwest of Ghadames, Libya. It contains one town, Debdeb, located to the east (Figure 2.1).

Figure 2.1 Map of the region showing Timissit exploration area



Source: ERM, 2015

Table 2.1 Operational Overview Summary

Management of emergency response	Statoil
Response Plan Coverage Overview	
License Holder	Statoil
Licence partners	Sonatrach and Shell
*Proposed co-ordinates of the Wells 1	Lat: 29.79091, Long: 9.39489
Proposed co-ordinates of the Wells 2	Lat: 29.77668, Long: 9.359798
Proposed co-ordinates of the Wells 3	Lat: 29.75198, Long: 9.308264
Proposed co-ordinates of the Wells 4	Lat: 29.77708, Long: 9.157248
Proposed co-ordinates of the Wells 5	Lat: 30.03762, Long: 9.280604
Proposed co-ordinates of the Wells 6	Lat: 30.00908, Long: 9.220166
Proposed co-ordinates of the Wells 7	Lat: 29.99926, Long: 9.200393
Proposed co-ordinates of the Wells 8	Lat: 29.98241, Long: 9.167445
Drilling Operation	Exploration
High Pressure/High Temperature	No
Location Characteristics	
Approximate drilling depth	4000 m
Approximate distance to international border (Libya)	50 km
Nearest Installations / Operations	
Ohanet gas field	150 km south of Timissit

** Information based on well locations provided by Statoil to ERM and using WGS 1984 coordinate system in decimal degrees.*

Drilling Unit Contact information	
Satellite telephone number Satellite fax number Drill Site Supervisor during drilling operations (DSS) email address Statoil On Board Representative (OBR) email address	**To be updated prior to drilling**

Emergency liquid spill scenario information: Drilling				
DSHA Description	**Duration (days)**	**Flow Rate Gas (e3m3/day)**	**Flow Rate Liquid (m3/day)**	**Potential volume**
Diesel Fuel	0.5	N/A	N/A	90 m3
Drilling Cuttings	1	N/A	N/A	655 m3
Water base mud	1	N/A	N/A	225 m3
Chemical	0.5	N/A	N/A	79 m3
Hazardous waste	0.5	N/A	N/A	90 m3
Oil Base Mud	1	N/A	N/A	47 m3
Loss of Well Control	N/A	N/A	N/A	N/A
Emergency liquid spill scenario information: Completions				
Catastrophic Scenario Loss of Well Control	4	280	Condensate: 125 + Prod. Water: 125	Condensate: 400m3 Gas: 1,000 e3m3 Produced Water: 400m3
Diesel Fuel	0.5	N/A	N/A	90 m3

Emergency liquid spill scenario information: Drilling				
Produced Water	1	N/A	N/A	1,600 m3
Produced Condensate	1	N/A	N/A	400 m3
Chemical	0.5	N/A	N/A	10 m3
Hazardous waste	0.5	N/A	N/A	90 m3

Liquid Characteristics			
Type	**Physical/Chemical Properties**	**ITOPF Group**	**Spill Characteristics**
Condensate	Expected characteristics of crude (currently untested): API Gravity: 55	I	• High proportion of light ends which evaporate quickly
Diesel	API Gravity: 30 Density @ 15°C: 0.839 – 0.903 g/ml Flash Point (^{0}C): 71 - 116 Viscosity @ 40^{0}C (cST): 2.9 – 11 Pour Point (^{0}C): -23 to -5	I / II	• Variable depending on product • High proportion of light ends which evaporate quickly

2.1.2 Operational Overview

Statoil is proposing to carry out an exploration programme in the Timissit license area, Block 210. The exploration programme includes minimum one phase and may extend for another two phases, see Table 2.2. After each phase Statoil will evaluate whether to

- Continue the exploration activities to increase the understanding of the subsurface
- Finalise exploration activities and continue with a field development programme
- Finalise exploration activities and exit the Timissit license

Phase 1 for the Timissit exploration campaign has the objective to drill two vertical wells to acquire additional subsurface data for evaluation of the project area. The results from Phase 1 will be used to identify areas for further exploration activities. Phases 2 and 3 of the exploratory campaign will be planned following the results of Phase 1.

Table 2.2 Exploration phases and planned work program

Activities	Phase 1	Phase 2	Phase 3
Seismic acquisition	3D seismic, 350 km^2	3D seismic, 100 km^2	3D seismic, 100 km^2
Exploration wells	2 vertical wells	2 vertical wells 1 horizontal well	1 horizontal well
Water wells	2	3	1
Start	Jun 2015	2018	2020
Finish	Jan 2018	2019	2021

Tentative well locations for Phase 1 have been identified, as has the area for acquisition of 3D seismic data. Identification of final well locations for all exploration phases will be undertaken following internal evaluations and dialogue with Algerian authorities.

The following operations will be covered by this LSRP:

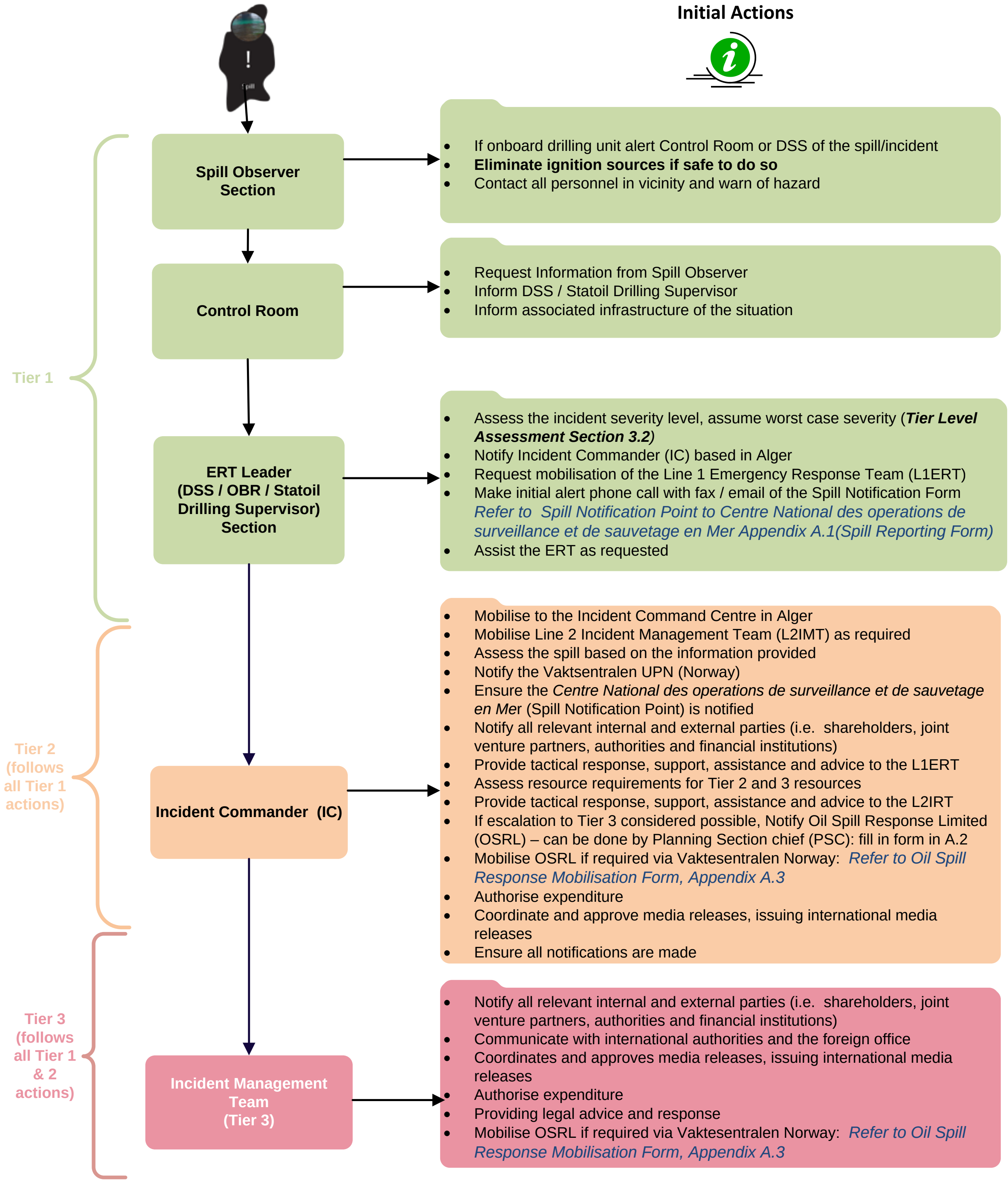
- **Drilling/Completions**: Liquid spills arising from exploration drilling activities (first set of exploration wells); and
- **Field Support**: Liquid spills arising from activities involving field support vehicles (e.g. diesel) and planned seismic activities

2.1.3 Alert Procedure

The Alert Procedure illustrates the initial flow of communication between key roles within the line 1 incident response and line 2 incident management teams. The initial actions of these key roles are identified in the following flowchart (Figure 2.2) and the initial actions of these key roles are identified in each case.

Role specific check-lists (Section and contacts directory (Annex C) are developed and will be updated and included in the final version of the LSRP prior to operations.

Figure 2.2 Liquid Spill Alert Procedure



2.1.4 Liquid Spill Response 'Quick-Start'

Action	Personnel Required	Outcome
IC to ensure all facts from Drilling Superintendent are known and recorded	IC and Drilling Supervisor / Superintendant	• IC to fully understand incident
IC to mobilise all section chiefs and support staff to Incident Command Room	All command and general staff including support staff	• Incident Command room to be fully manned • Complete ICS211p (check in form)
IC to ensure regulator has been notified ***Centre national des Opérations de Surveillance et de Sauvetage en Mar*** (oil and HNS)	IC and Liaison Officer	• Competent National Authority **(Comitte National [TELBAHR])** informed of incident, Liaison Officer to send through ICS201 once completed
IC to brief all on facts as known at time *Guide: 10 minutes max.*	All command and general staff including support staff	• All personnel to be aware of incident and the incidents potential • Initial Incident objectives to be set • Tier Assessment to be completed by PSC • ICS 201 to be completed by IC/OSC
OSC to notify Tier 2 contractor if required PSC to notify OSRL *Form in Appendix A.2*	OSC and Tier 2 contractor Duty Manager PSC and OSRL Duty Manager / Technical Advisor (if mobilised)	• Review Annex 1 Liquid Spill Modelling Initial Analysis • Receive information on mobilisation times and equipment availability
PSC to develop meeting schedule with IC	PSC with input from IC	• ICS230 Meeting Schedule should be completed by PSC
IC / OSC / PSC to mobilise Tier 2 contractor and OSRL as required	IC, PSC and Vaktsentralen UPN	• PSC / IC to send completed mobilisation form to Vaktsentralen UPN for authorisation
LSC to assist in the mobilisation of all Tier 2 response recourses	LSC / PSC / OSC	• All resources should be mobilised and recorded on ICS215 then passed to PSC • PSC to allocate resources as required to OSC • PSC to complete initial NEBA assessment • OSC to task resources as required • OSC to develop air work order for plane
Tactics Meeting	All command and general staff including officers	• Define tactics that will be used to respond in the next operational period • Complete ICS231 Meeting Summary (Log Keeper)
Planning Meeting	LSC / PSC / OSC	• OSC/PSC to complete ICS204 work assignments for next period • Consider waste management, dispersant resupply, equipment, accommodation needs
Development of Incident Action Plan (IAP)	Co-ordinated by PSC, input by all command and general staff	• IAP to include: • Incident Objectives (ICS 202), Organisation List (ICS 203), Organisation Chart (ICS 207), Assignment Lists (ICS 204), Communication Plan (ICS 205) and a Situation Map

Meeting | **Mobiliation** | **Notification** | **Document Development**

2.1.5 Example Incident Objectives and Techniques

Table 2.3 provides examples of incident objectives and techniques that may be used throughout a response.

These examples do not cover all possible situations, and will need to be developed according to the circumstances of the spill and response at the time and should be referred to within the Incident Action Plan.

Table 2.3 Example Incident Objectives and Techniques for Liquid Spill Response

Objectives	Strategies	Techniques
Safety of personnel	Monitoring and personnel awareness	Gas monitoring
	Site safety forms	Ignition source control
	Risk assessments	Provision of PPE Pre-operation safety briefings
Source control	Capping and containment	Utilisation of capping plan and team
	Drilling of a relief well	Sourcing drilling unit
Released liquid recovery	As close to the source(s) as possible	Utilise the available resources as effectively as possible
	Net Environmental Benefit Analysis (NEBA)	Evaluate the most environmental beneficial method to use (refer to 3.2.1 Net Environmental Benefit Analysis)

3. Response Techniques and Resources

3.1 Liquid Spill Incident Management

The notification matrix (Table 3.1), Tier Assessment (3.1.2 Tier Assessment) and Incident Action Plan provide the initial tools required to respond to the incident on site.

- Notifications will be followed as defined in the notification matrix following the tier assessment of the spill.
- The tier assessment will be conducted following the spill release to ascertain the spill severity and this information will be passed on to the L2IMT.
- The incident action plan will be actioned and implemented in response to the incident.

3.1.1 Liquid Spill Notifications

Table 3.1 details all notifications that are required to be made in the event of a liquid spill along with anticipated time frame. All contact details are held in the Contact Directory (Appendix B Preliminary Contacts Directory).

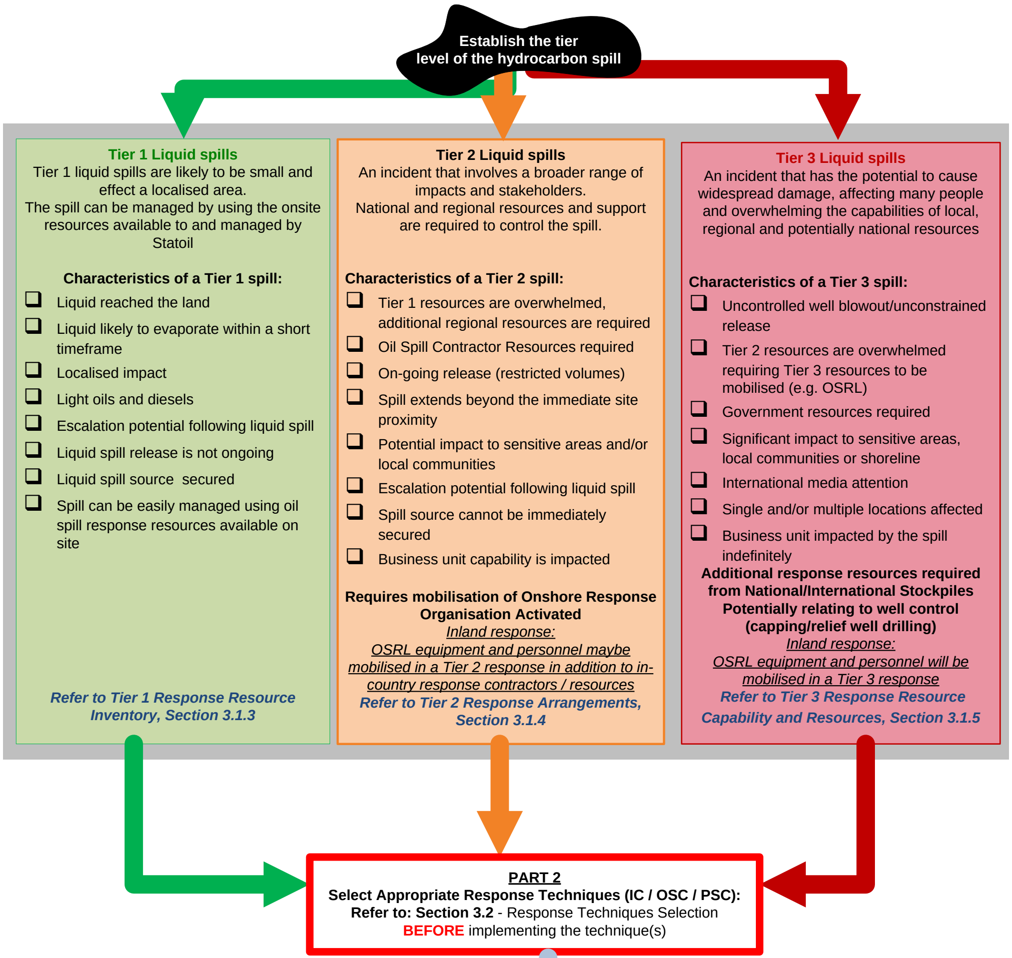
Table 3.1 Spill Notifications

Organisation		Notification Required	Reporting Timeframe	Responsible for Notification
External notification				
Spill Notification Point for oil and HNS	Centre National des operations de surveillance et de sauvetage en Mer (CNOSS)	Verbal Written	All Spills –confirmation via Notification Form within 2 hrs.	Incident Commander (IC)
Oil Spill Response Contractor Tier 3 responses		Verbal Written	As soon as possible	Incident Commander / Planning Section Chief PSC
	Oil Spill Response Limited (OSRL)	Verbal Written (forms)	As required	Notification: Incident Commander / Planning Section Chief (PSC) Mobilisation: Line 2 DPN Norway via the Main alarm and notification centre Forus, Norway
Internal notification				
Internal Operational Requirements	DSS / Drilling Supervisor	Verbal	Immediately, or as soon as safely possible	Spill Observer
	Statoil Algeria	Verbal Written	Immediately, or as soon as practically possible	Drilling Supervisor
	Statoil Crisis Management Team Line 3	Verbal Written	Immediately after Line 2 has been mobilised	IC/Planning Section Chief (PSC)
	Partners	Verbal Written	As required according to Statoil notification matrix	Liaison Officer

3.1.2 Tier Assessment

- Classification of the incident as Tier 1, 2 or 3 is determined by the level of response required and not the volume of liquid spilled.
- Any liquid spill can be categorised in terms of its potential severity based on the influencing factors of size location, and the potential consequences for people, assets, reputation, economy and the environment.
- The spill Tier is identified by satisfying any characteristic in the highest Tier, i.e. always assume worst-case.

Figure 3.1 Liquid Spill Tier Level Assessment



Key Recommended Technique Options ✓	Hydraulic Oil / Lube Oil			Diesel / Aviation Fuel			Condensate		
	T1	T2	T3	T1	T2	T3	T1	T2	T3
Assess the Spill	✓	✓	✓	✓	✓	✓	✓	✓	✓
If spill is contained mobilise spill kits	✓			✓			✓		
Inland Protection and Clean-up					✓	✓	✓	✓	✓
Sand Sieving/ Sediment Washing / Bioremediation		✓	✓		✓	✓		✓	✓
Relief Well Drilling (Tier 3)									✓

3.1.3 Tier 1 and 2 Response Resource Inventory

Tier 1 and 2 equipment will be defined and included in the plan prior to commencement of drilling operations.

3.1.4 Tier 3 Response Arrangements

Statoil has a contract with Oil Spill Response Limited (OSRL) for the provision of Tier 2 and Tier 3 oil spill response. OSRL can provide equipment and staff resources to assist Statoil Algeria with their response to a major incident.

Response equipment at the three locations is maintained in a state of constant readiness. OSRL can provide a range of equipment to deal with a variety of different scenarios and specific to the environmental conditions.

During a Tier 3 spill response OSRL would assist Statoil with the onshore / inland response and will provide a technical advisor at no cost for the first 48 hours.

OSRL Equipment stockpile Status Report can be accessed at
http://www.oilspillresponse.com/activate-us/equipment-stockpile-status-report

3.1.4.1 Mobilisation Procedures

To speed the response OSRL will mobilise its equipment using aircraft. There are a number of alternatives available and these include the use of OSRL's own aircrafts, one located in the UK and one in Singapore, the chartering of cargo jets and the use of scheduled freighters. The time to mobilise will depend on the aircraft used, amount of equipment transported and the location it comes from. This will be discussed by the Duty Manager during a response.

Under the Participants Agreement, which governs the mobilisation of resources from the Bahrain, Southampton or Singapore bases, OSRL must receive official notification to mobilise from one of the Nominated Call-Out Authorities. These are identified individuals within Statoil Group who have been appointed to approve the expenditure of mobilising Tier 3 equipment.

OSRL can only be mobilised through
Line 2 DPN Norway via the Main alarm and notification centre
Forus, Norway

It is however important that Statoil and OSRL have direct discussions to assess the incident and decide upon strategies, equipment and staff.

3.1.4.2 Role of Statoil in Support of OSRL Mobilisation

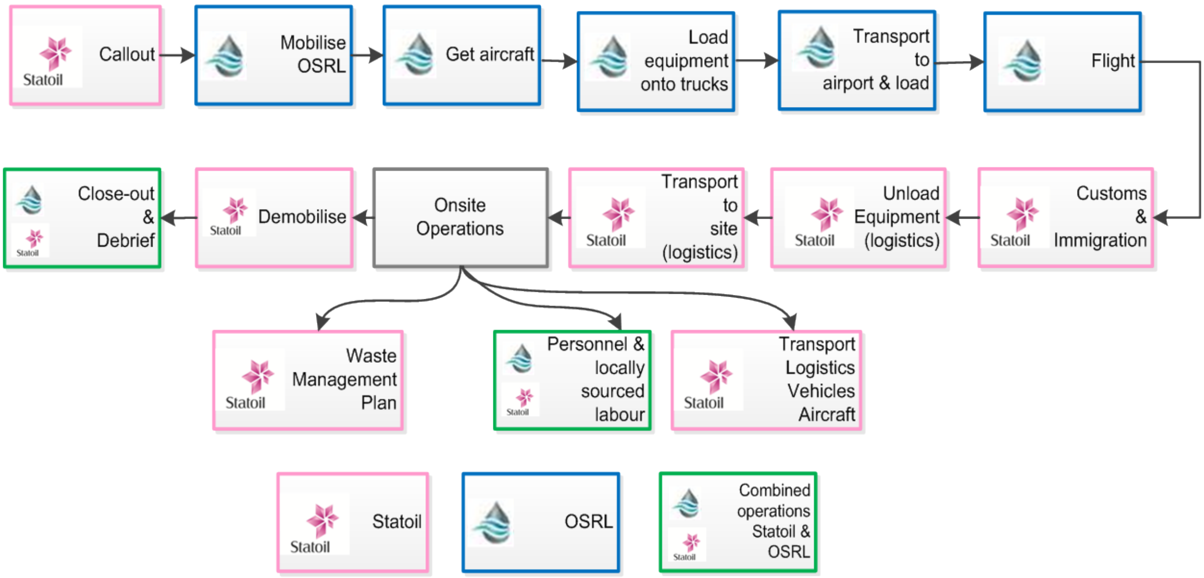
It has been agreed between OSRL and its members that the response contractor will be responsible for all aspects of equipment and personnel mobilisation up to and including the loading and departure of aircraft from the contractor's county.

Statoil must have the logistics planned and ready for the arrival of OSRL personnel and equipment both at the airport and any final destinations.

Figure 3.2 shows the tasks involved in moving equipment from the OSRL base to the scene of the incident and subsequent deployment of these resources.

This figure shows the tasks which are the responsibility of OSRL (blue) and those which are the responsibility of Statoil (pink).

Figure 3.2 Key Logistics Responsibilities



OSRL requires the support of Statoil to ensure that the chain is not broken or hindered. OSRL can assist with customs documentation, information on the types of vehicles and boats required and manpower requirements, but will rely on Statoil to ensure that the in-country requirements are met.

To speed up the process of clearing response equipment through customs, Statoil should establish early contact and interacting with the Douanes Algériennes (Customs Department - Algeria) prior to and in the event of a spill to clarify requirements and facilitate rapid customs clearance of equipment and personnel.

Under OPRC 1990, to which Algeria is a member, there is an obligation for authorities to facilitate the movement of equipment and personnel for spill response; however this does not guarantee that the process will be efficient. Contact should be established immediately a spill occurs where it is considered there may be a need for additional personnel and equipment to be mobilised into the country to make arrangements for the required approvals.

3.1.5 First Response for Tier 1 Spills

LIQUID SPILL

Initial Actions

Spill Observer

Raise the alarm and inform other workers in the area that there has been a spill

Stop the source of the spill

- **Ensure Gas Monitoring is undertaken and if levels are high, remove all personnel from the area.**
- **Stop the source of the leak or spill as soon as possible.**
- **Isolate appropriate nozzles or valves from the leaking container.**
- **Use a wooden plug, bolt, band or putty on a puncture-type hole or tear.**

Contain the spill

- **If the spill or leak cannot be stopped, contain the flowing liquid using a container, a temporary bunded area or move the leaking container into an oversized drum or onto a bunded pallet or area.**
- **Prevent the spilt product impacting the marine environment - block drain inlets or dam any drainage channels.**
- **Spread sorbent material (sand, sawdust, sorbent pads) to soak up the spilt product.**

Continuously monitor gas levels (Gas & VOC generation)

Collect the contaminated sorbent

- **Brooms can be used to sweep up the sorbent material and put in into buckets or barrels or on top of plastic sheeting.**
- **Control ignition sources.**

Secure and Dispose of the waste

- **The contaminated sorbent material should be collected and stored in liquid tight bags or containers until it can be disposed of correctly.**

Final Cleaning of the Site

- **If required, the area of the spill can be washed down with a water degreaser mix to remove any residual product and reduce the likelihood of a remaining slipping hazard.**

3.2 Response Techniques

There are different factors that will affect the decision in choosing the most appropriate response technique for inland environments. In order to conduct successful response operations, these factors need to be understood and taken into consideration from the outset. The selection of response techniques will depend on the nature of the incident, the threat to sensitive resources and the feasibility of each technique (Figure 3.3).

Figure 3.3 Considerations for an appropriate response technique

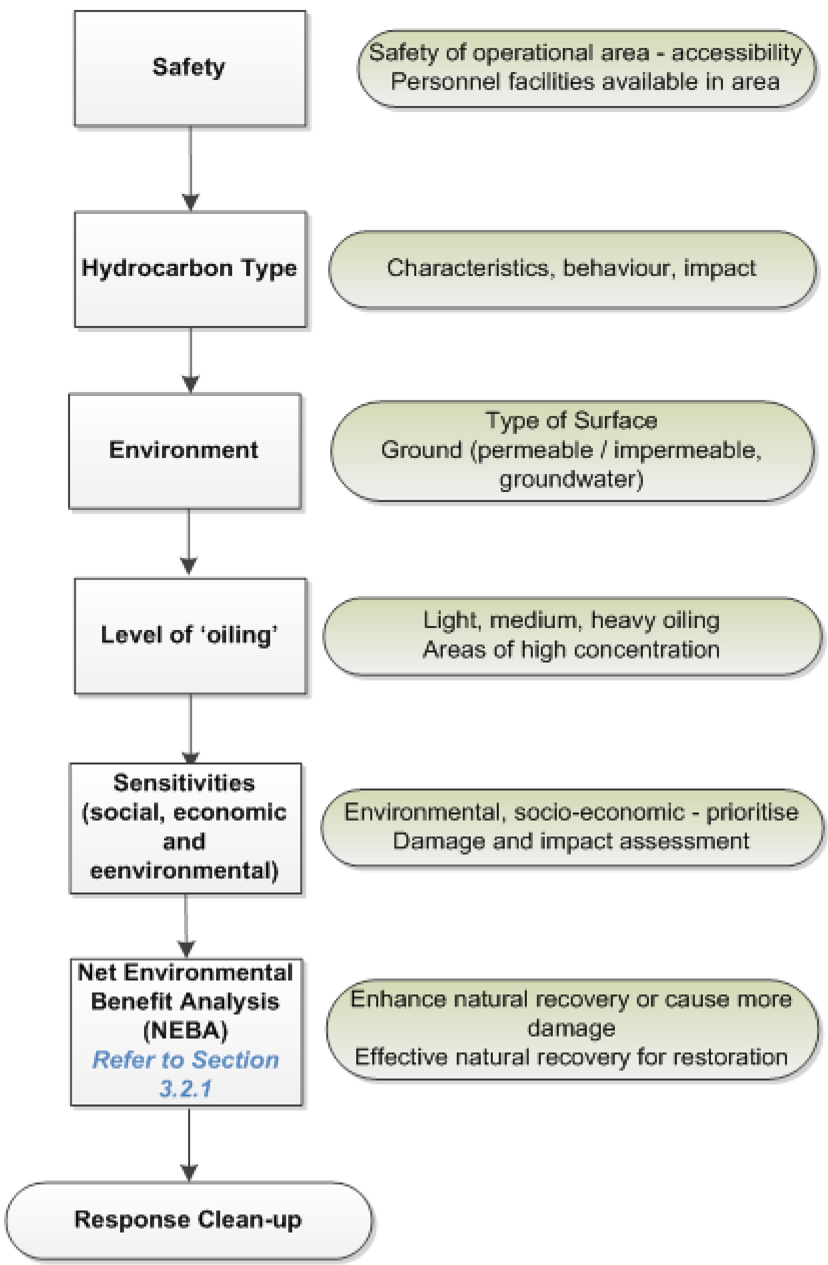
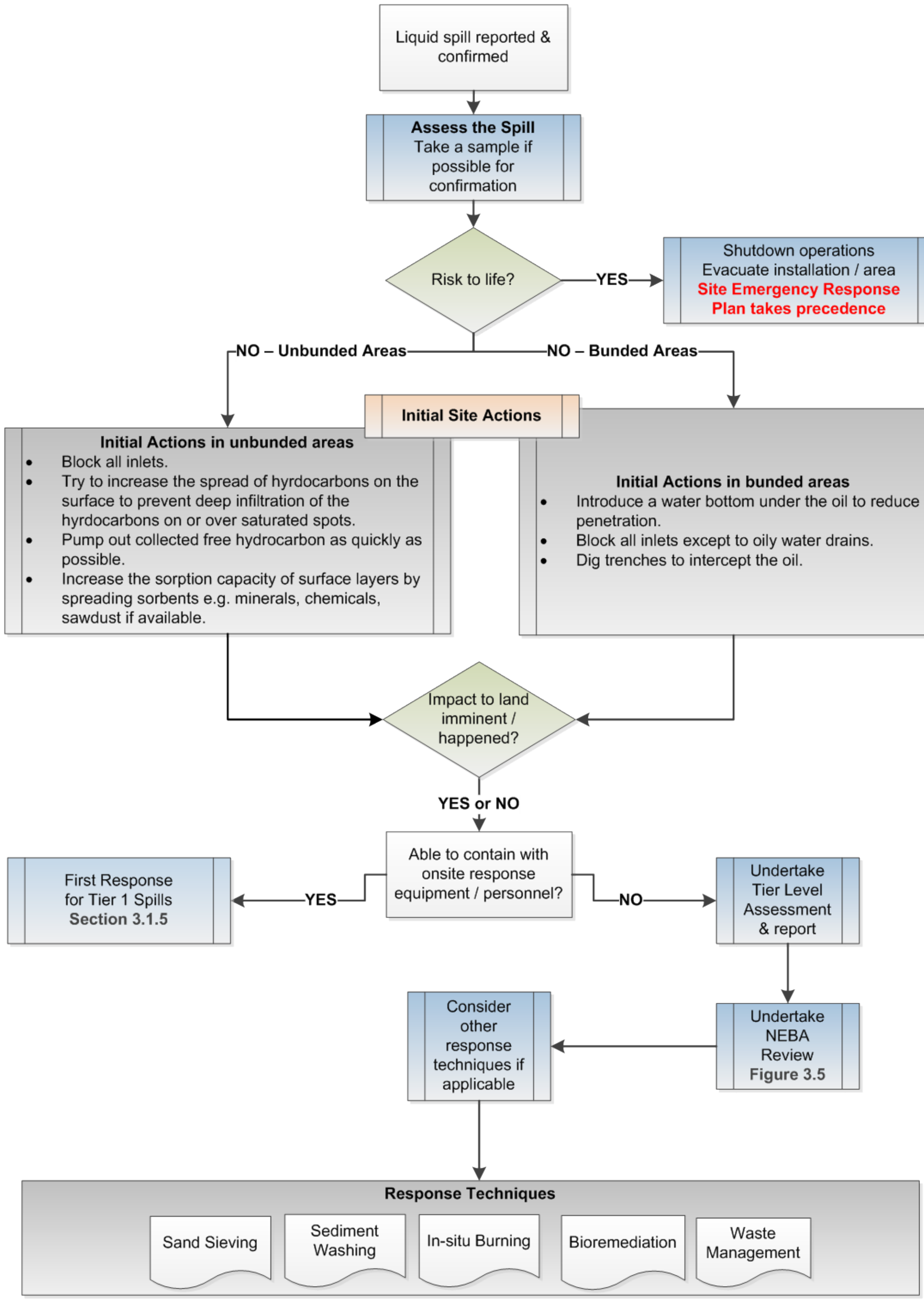


Figure 3.4 provides a flowchart to support the overall response strategy decision making process, noting that multiple techniques may be applicable, either in conjunction or at different times. **The response techniques should be reviewed regularly throughout the response.**

Figure 3.4 Response Technique Decision Flowchart



3.2.1 Net Environmental Benefit Analysis

The aims of any liquid spill response are to minimise damage to environmental and socio-economic resources, and to reduce the time for recovery of affected resources by achieving an acceptable standard of cleanliness.

Following a liquid spill, urgent decisions need to be made about the options available for clean-up, so that environmental and socio-economic impacts are kept to the minimum. Getting the correct balance is a difficult process and conflicts inevitably arise that need to be resolved in the best practicable manner.

The advantages and disadvantages of different responses need to be considered and compared both with each other and with the advantages and disadvantages of natural clean-up.

A detailed receptor analysis has been undertaken and is presented in *Annex 1: Liquid Spill Modelling Initial Analysis* this will help to determine the potential environmental and social receptors potentially at risk within the Study Area.

This systematic process of comparison is generally referred to as Net Environmental Benefit Analysis (NEBA).

NEBA should be completed by an individual or team with a good understanding of the sensitivity of the environmental receptors to a liquid spill and who also understand the operational nature of different response techniques and how they will impact on the environment

The NEBA process includes the following key steps (Figure 3.5):

Figure 3.5 Example of the NEBA Decision Making Process (high level)

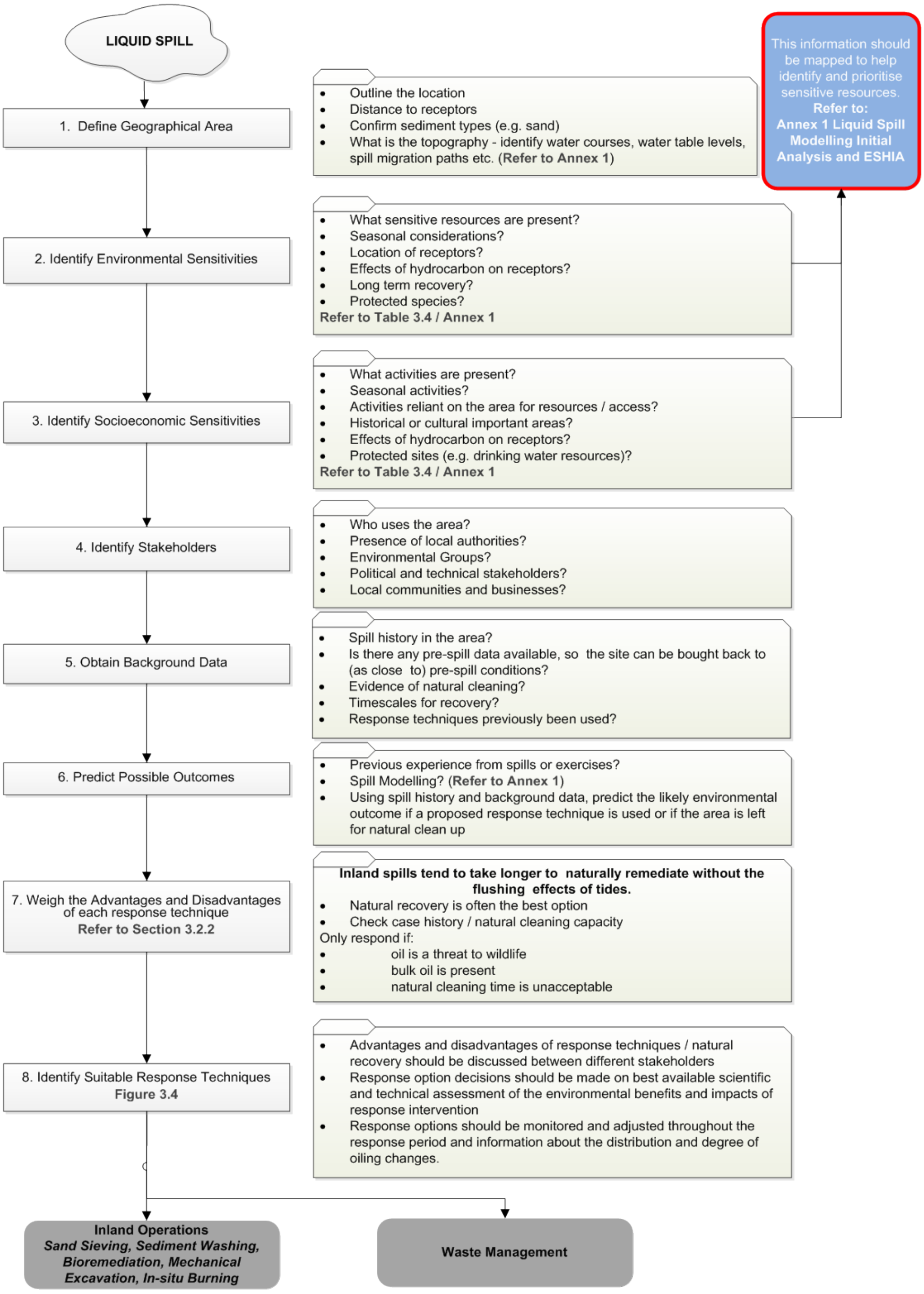


Table 3.2 Summary of spill simulation results

Concession Zone	Well Number	Summary Description of Area	Sensitive Receptors	Surface water / Channelised Flow	Key Observations regarding liquid release	Overland Flow Risk Level
South	1	Well pad 1 and the land within the 1km buffer around it are generally flat with approximate ground elevations ranging from 429 -435m AOD. There is however what appears to be a raised roadway running directly through the well pad area in a north west – south east direction. The road sits at an approximate ground elevation of 472 m AOD. Review of satellite imagery suggests the area is predominantly covered by Hamadas and regs characterised by bare areas made up of hardpans, gravels, bare rock, stones, and boulders.	An unnamed pipeline has been identified approximately 870m west of the proposed well pad location, running in a north west - south east direction. No other receptors were identified within the available datasets.	Based on well location, the closest point at which flow is simulated to enter a channel (based on the 10k stream segmentation analysis of the 30m DEM) is approximately 2 km north west of the well pad. The model simulation has picked out a high point in the DEM located in the south eastern area of this area. If a release were to take place within this area the flow is simulated to enter a channel feature located approximately 3.2km south of the well pad.	The simulated flow direction indicates that a release could affect both the road and pipeline. Assuming the observed raised ground continues along the length of the road, flow is likely to be diverted north and south as opposed to directly onto the road following surface topography. It is unclear whether the identified pipeline is located above or below ground level but given the distance of the well pad from this pipeline , it is considered unlikely that a release of condensate and/or produced water or a release of bulk fluids stored on the well pad would reach this far.	Low
South	2	Well pad 2 is generally flat and from review of satellite imagery appears to be predominantly covered in Regs and Hamadas, characterised by stony outcrops. The topography within the 1km grid around the well pad varies from an elevation of 420 - 435 m AOD.	No sensitive receptors have been identified (within available datasets) inside a 1km buffer of the well pad location. A pipeline has been identified approximately 2.1km east of the well location.	Based on the well location, the closest point at which flow is simulated to enter a channel (based on the 10k stream segmentation analysis of the 30m DEM) is approximately 1.7 km north east of the well pad. Review of available	No significant receptors susceptible to be impacted by overland flow have been identified in the vicinity of well pad 2. The flow simulation indicates that released liquid could flow north of the well pad following surface topography before reaching a	Low

Concession Zone	Well Number	Summary Description of Area	Sensitive Receptors	Surface water / Channelised Flow	Key Observations regarding liquid release	Overland Flow Risk Level
				satellite imagery does not indicate any features to suggest this is a permanent flowing water course and it is likely to be an ephemeral tributary of a larger oued which could potentially flow under prolonged rainfall or flash flood events. The oued does cross the 1km buffer zone approximately 1km east of the proposed well pad 2 location. The simulated flow direction is, however, north of the well pad, away from this potential surface water feature.	modelled surface channel feature 1.7km north east of the well pad. Given the worst case release volume, potential surface channel distance and the features described in the previous column, it is considered unlikely that a release of condensate and/or produced water or a release of bulk fluids stored on the well pad would reach this far.	
South	3	Well pad 3 is generally flat and from review of satellite imagery appears to be predominantly covered in Regs and Hamadas with occasional pockets of bare sand. The topography within the 1km buffer around the well is generally flat with approximate ground elevations ranging between 410 - 425 m AOD.	A potential surface channel feature has been identified within the south west corner of well pad 3. No other receptors were identified within the available datasets.	Based on well location, the closest point at which flow is simulated to enter a channel (based on the 10k stream segmentation analysis of the 30m DEM) is approximately 500m south west of well 3.The flow simulation also indicated a liquid release could potentially enter another surface water feature approximately 3.8km north west of well 3.	The flow simulation indicates a liquid release on well pad 3 will generally flow north or south following surface topography. Given the proximity of the potential modelled surface water channel to well 3, it is possible that a release of condensate and/or produced water or a release of bulk fluids stored on the well pad could reach this surface water if it were flowing	Medium/High

Concession Zone	Well Number	Summary Description of Area	Sensitive Receptors	Surface water / Channelised Flow	Key Observations regarding liquid release	Overland Flow Risk Level
				Based on review of the satellite imagery, both channels appear to be a tributary of a larger oued likely to flow in periods of prolonged or significant rainfall.	at the time of release.	
South	4	Well pad 4 is generally flat and from review of satellite imagery appears to be predominantly bare sand. The topography within the 1km buffer around the well is generally flat with approximate ground elevations ranging between 320 - 328 m AOD.	Two potential surface channel features have been identified within the 1km buffer zone of well pad 4. One approximately 70m north and the other 1km south west of well 4. No other receptors were identified within the available datasets.	Based on well location, the closest point at which flow is simulated to enter a channel (based on the 10k stream segmentation analysis of the 30m DEM) is approximately 70m north of well 4. Review of available satellite imagery does not identify any features suggesting permanent flow of either of these potential surface waters. However surface scaring does indicate that channels have been cut into the landscape suggesting these surface water features could be ephemeral and flow in periods of prolonged or significant rainfall.	The flow simulation indicates a liquid release on well pad 4 will generally flow north or south towards the two identified potential surface waters. Given the proximity of the potential modelled surface water feature to well 4, it is possible that a release of condensate and/or produced water or a release of bulk fluids stored on the well pad could reach this surface water if it were flowing at the time of release.	Medium/High
North	5	Well pad 5 is generally flat and from review of satellite imagery	Two potential surface channel features have been identified	Based on well location, the closest point at which flow is	The flow simulation indicates a liquid release on well	Medium/High

Concession Zone	Well Number	Summary Description of Area	Sensitive Receptors	Surface water / Channelised Flow	Key Observations regarding liquid release	Overland Flow Risk Level
		appears to be predominantly covered by bare sand. The topography within the 1km buffer around the well is generally flat with approximate ground elevations ranging between 328 - 336 m AOD.	within the 1km buffer zone of well pad 4. One flows directly through the well pad and is located approximately 195m west and the other 890m north east of well 5. No other receptors were identified within the available datasets.	simulated to enter a channel (based on the 10k stream segmentation analysis of the 30m DEM) is approximately 195m east of well 5. Review of available satellite imagery indicates that whilst this area is predominantly bare ground there are occasional patches of sparse scrubland suggesting potential surface water flow or shallow groundwater might be present.	pad 5 will flow north towards the identified potential surface channel feature. Given the proximity of the potential modelled surface channel feature to well 5, it is possible that a release of condensate and/or produced water or a release of bulk fluids stored on the well pad could reach this surface water if it were flowing at the time of release.	
North	6	Well pad 6 is located near an erg. The topography within the 1km buffer around the well is relatively flat with approximate ground elevations ranging between 324 - 330 m AOD. Review of satellite imagery indicates the area is predominantly covered by Regs and Hamadas with pockets of bare sand.	One surface channel feature has been identified within a 1km buffer of well pad 6. This is located approximately 1km south of the proposed well pad location. There is also a road located approximately 1.7km east of the well pad. No other sensitive receptors have been identified inside a 1km buffer of well 6.	Based on the proposed well location, the closest point at which flow is simulated to enter a channel (based on the 10k stream segmentation analysis of the 30m DEM) is approximately 1 km south of the well pad. The satellite imagery does not define any clear surface water features within the areas of those identified in the modelled outputs. There	The flow simulation indicates a liquid release on well pad 6 will flow south towards the identified potential surface water feature. It is considered unlikely that a release of condensate and/or produced water or a release of bulk fluids stored on the well pad could reach this far. Surface channel features are therefore considered unlikely to begin more rapid	Low

Concession Zone	Well Number	Summary Description of Area	Sensitive Receptors	Surface water / Channelised Flow	Key Observations regarding liquid release	Overland Flow Risk Level
				are, however, darker green patches visible in these areas indicating that vegetation is potentially present and therefore it is possible that this is supported by localised surface water or near surface groundwater features.	migration away from the point of release via these features	
North	7	The area around well pad 7 slopes from west to east beginning at approximately 360 mAOD and falling to around 325m AOD. The topography within the 1km buffer around well pad 7 is characterised by sand dunes to the north & west of the well and bare sand to the east & south.	No surface channel features have been identified within the 1km buffer zone around well pad 7. There are however surface water features identified approximately 1.6km south east of the proposed well location. There are two roadways within the wells 1km buffer zone. One runs directly through the well location and the other approximately 945m northwest of the well. No other sensitive receptors have been identified within the datasets available.	Based on well location, the closest point at which flow is simulated to enter a channel (based on the 10k stream segmentation analysis of the 30m DEM) is approximately 2.5km south east of the well location. Review of aerial imagery does not identify any visual evidence to suggest surface water flow in this area.	The flow simulation indicates a liquid release on well pad 7 will generally flow south east towards the potential surface water feature through low points in the Erg system. It is considered unlikely that a release of condensate and/or produced water or a release of bulk fluids stored on the well pad could reach this far. Surface water channel features are therefore considered unlikely to begin more rapid migration away from the point of release via these features	Low
North	8	Well pad 8 is located within a large erg and therefore the	No surface channel features have been identified	Based on the proposed well location, the closest point at	The flow simulation indicates a liquid release on well	Low

Concession Zone	Well Number	Summary Description of Area	Sensitive Receptors	Surface water / Channelised Flow	Key Observations regarding liquid release	Overland Flow Risk Level
		topography in the region varies considerably. The topography within the 1km buffer of the well pad also consists of sand dunes at an approximate elevation ranging between 320m-380m AOD.	within the 1km buffer zone around well pad 8. There is a surface channel feature identified approximately 2.5km north west of the well location. A roadway runs through the 1km buffer zone approximately 900m North of well 8. No other sensitive receptors have been identified.	which flow is simulated to enter a channel (based on the 10k stream segmentation analysis of the 30m DEM) is approximately 2.5km north west of the well location. Review of aerial imagery does not identify any visual evidence to suggest surface water flow in this area. In addition to this, the surface topography would suggest surface water flow in these locations would be unlikely.	pad 8 will flow north or south towards through low points in the Erg. Towards identified potential surface water features. It is considered unlikely that a release of condensate and/or produced water or a release of bulk fluids stored on the well pad could reach this far. Surface water channel features are therefore considered unlikely to begin more rapid migration away from the point of release via these features	

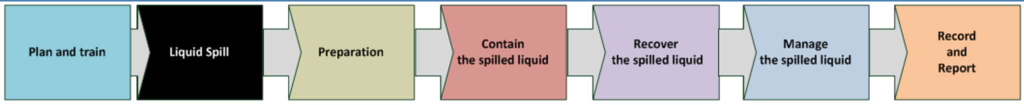
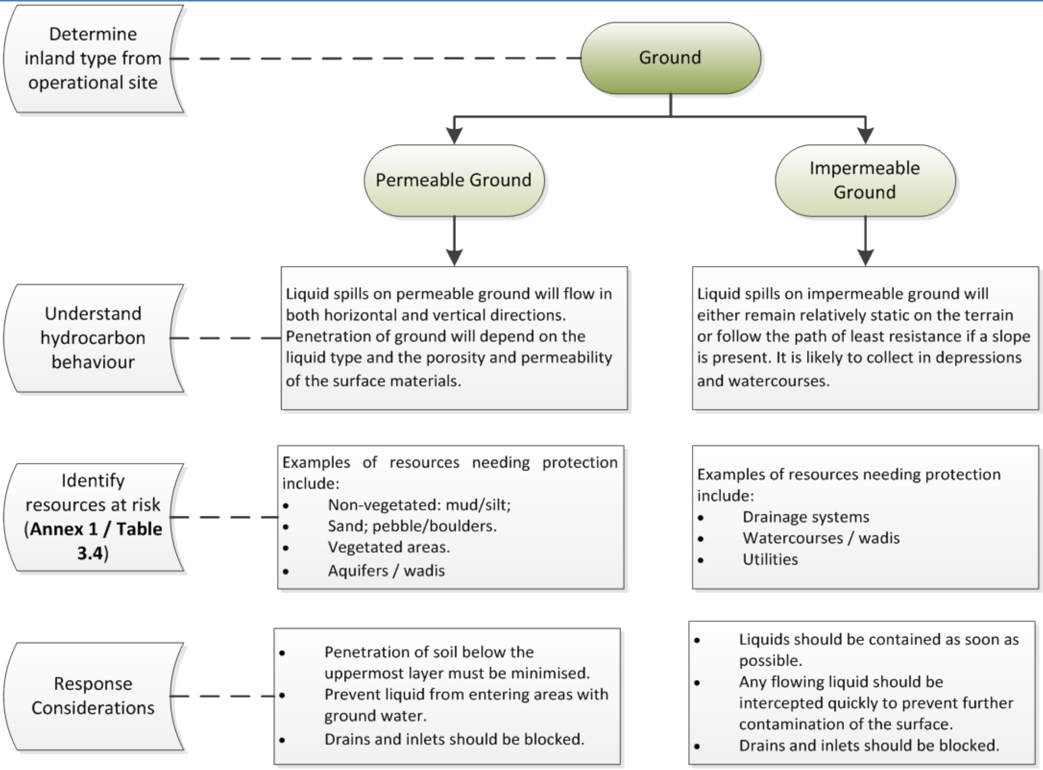
3.2.2 Discussion of Liquid Spill Modelling and Response Considerations

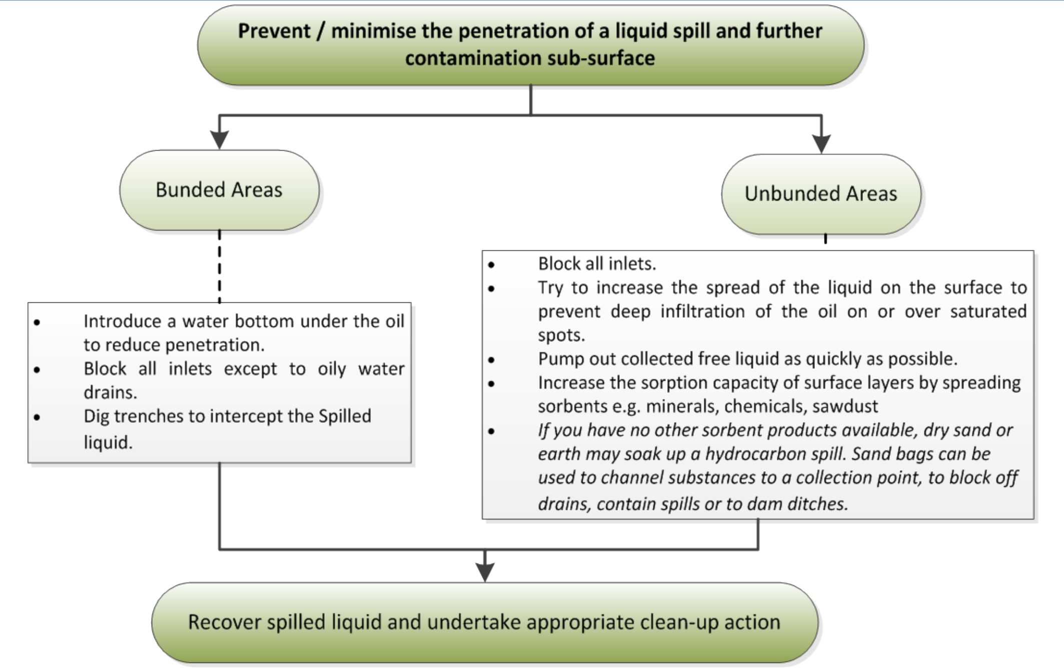
A summary of the *Timissit Oil Spill Modelling Initial Analysis* is included in Annex 1.

Key findings of the initial spill modelling are detailed below and should be considered in line with any spill response and NEBA process. The approach to response for these events is included within the response approaches described in Section 3.2.3.

- There is currently limited information on shallow groundwater, however, it is anticipated that there may be a shallow groundwater table (<5m below ground surface) in the area as observed elsewhere in the region.
- Shallow aquifers are considered to be of relatively minor significance overall due to their limited extent and the relatively small volumes of water which they store, however they have significant social and economic importance in those areas where they are the only fresh water source.
- These shallow aquifers become manifest in both *oueds* and *sabkhas*. These aquifers are usually less than 10 m thick. Where they do exist, these sediments are usually granular in nature and permeable and the water table generally appears at depths between 3 to 5 m bgl.
- Flow directions are influenced by the structure of the sediments and the topography. These shallow groundwater resources provide support to existing vegetation (where present), which tends to concentrate where the shallow aquifer is present.
- In terms of response planning the potential risks to shallow groundwater will need some degree of consideration – particularly if a release could affect users of this resource.
- The area that could potentially be affected by an oil spill contains a limited number of sensitive receptors that are likely to be at risk from an oil release. This is based on both a remote sensing assessment of the areas and field studies which have visited a number of the potential well locations. Notwithstanding this a final survey of receptors should be completed once well sites are finalised and this plan updated accordingly.
- The worst case potential liquid release volume is estimated by Statoil to be approximately 800m^3, it has been assumed that any sensitive receptor (excluding surface water features) located outside a 1km buffer zone is unlikely to be impacted via an overland flow route.
- Although the furthest the liquid release is predicted to travel overland (based on the worst case spill volume) is less than 1 km from the well site, some response strategies may seek to consider avoidance of all receptors in the immediate vicinity.
- The vicinity of the study site is subject to irregular rainfall and short intense storm events. During such events surface water run-off is likely to flow via the oueds until it reaches a low lying area or depression where it will pool and either evaporate or infiltrate into the sandy soils beneath it.
- Should a liquid release coincide with such an episodic event, oueds could potentially permit rapid transportation of released liquid via overland flow if the spill were to reach them. Entry of liquids into these channels from a spill is therefore considered to represent a potential risk and response should be tailored accordingly to minimise the potential for more extensive dispersal in the event of coincident rainfall events.
- With the exception of well pad 3, each of these depressions are located at distances greater than 2.5km from the proposed well locations. An unnamed sabkha appears from satellite imagery to be located on the edge of the 2.5km buffer zone around well pad 3. Modelled overland release flow paths at well pad 3 suggest this sabkha could potentially be impacted if the released liquid were to reach this far.
- Generally the risk to sensitive receptors from overland flow of spilled liquids is low with the potential exception of Well pads 3, 4 and 5. These pads are located within proximity of surface channels which, if flowing at the time of a bulk fluids spill, could be impacted by the spill and could result in more extensive distribution of the liquids within the environment.
- Under the case of sand, <u>condensate modelling</u> indicates impacts to groundwater with liquids taking approximately <u>5 days</u> to reach the water table – *this provides a window of opportunity and discussion between OSC, PSC and LSC for equipment and staging posts to be set up strategically.*
- Under the case of sand, <u>diesel modelling</u> indicates that LNAPL takes approximately <u>1 day</u> to reach the water table.
- The subsurface modelling indicates that the condensate will spread out up to 165 m for condensate and up to 20 m for diesel although the rate of spreading decreases significantly after the first 50 days of the release.
- Whilst the overall spread of the free phase liquid on the water table is relatively limited the dissolved phase constituents which will partition into groundwater will continue to migrate at a rate determined by the hydraulic gradient and permeability of the underlying sand deposits. In the worst case scenario the dissolved phase plume could reach up to 300 m from the spill location within 40 days and up to 500 m after approximately 4 months. These time frames and potential travel distances should be factored in to the response planning.

3.2.3 Inland Operational Techniques

<table>
<tr><td rowspan="2">Resources Available</td><td>Tier 1</td><td>Tier 2</td><td>Tier 3</td></tr>
<tr><td>Refer to Tier 1 and 2 Response Resource Inventory Section 3.1.3, p 15</td><td>Refer to Tier 1 and 2 Response Resource Inventory Section 3.1.3, p 15</td><td>OSRL
Refer to 3.1.4, p. 15</td></tr>
<tr><td>Safety</td><td colspan="3">
1. Wear the appropriate PPE (buoyancy vest may be required if slurry pools are created)
2. Identifying the risks through a comprehensive risk assessment process and implementing mitigation measures to reduce them where applicable.
3. Communicate the risks the risks and mitigation measures in place through a safety brief prior to any operations being carried out.
4. Pay attention to fire hazards.</td></tr>
<tr><td>Key Steps</td><td colspan="3">
</td></tr>
<tr><td>Step 1
Determine inland environment type</td><td colspan="3">
</td></tr>
<tr><td></td><td colspan="3">When responding to spills on permeable surfaces, it is important to minimise the amount of liquid that can penetrate below the surface; this may require the liquid to be spread over a large surface area in the attempt to reduce head pressure on the surface to prevent penetration. This may well be the preferable option compared to long-term operations of subsoil and groundwater clean-up.</td></tr>
</table>



Liquid Retention Capacities in <u>Permeable</u> Surfaces

Surface Type	Example	Capacity (ltrs/m3)
Stones / Coarse Gravel (pebbles)		5
Gravel / Coarse Sand		8
Coarse Sand / Medium Sand		15
Medium Sand / Fine Sand		25
Fine Sand / Silt		40

- Each type of permeable surface will allow liquids to permeate at different rates and will retain a liquid spill at varying capacities. Although the pore spaces in coarser soils are larger, liquids will flow through more readily (due to gravity) thus giving a lower retention capacity.
- Finely packed sediments retain the spilled liquids in two ways; firstly the liquid molecules cannot pass so easily between the particles due to their size and secondly because the forces associated with capillary action hold the liquid in the pore spaces.
- Surface area is also a factor in retention capacities; small grain sediments have a higher surface area and therefore hold more liquid on the surface of the grains than larger grained sediments.

Liquid Retention Capacities in <u>Impermeable</u> Surfaces

If liquids are released on to impermeable ground, the response should first prevent the spilled liquid from further spreading and potentially contaminating other surface areas. Where possible the spill should be diverted onto a low permeability membrane to minimise penetration into the ground, reduce waste generation and facilitate collection. Once contained, the spill will then need to be recovered through either manual or mechanical

<table>
<tr>
<td></td>
<td>
methods.

Prevent spread of a liquid spill and further contamination of the surface area

Bunded Areas
• Ensure all spilled liquid is contained within the bunded area.
• Block all inlets except to oily water drains.
• Consider adding a water bottom to protect against any breaches in the bund floor.

Unbunded Areas
• Construct a bund around the liquid spill using resources available such as water filled booms soils or sandbags.
• Use sorbents as a means of controlling any secondary contamination.
• Concentrate the spill so that it can be collected into containers.
• Pump out collected free liquid as quickly as possible.

Recover liquid spill and undertake appropriate clean-up action
</td>
</tr>
<tr>
<td>Clean-Up Methods</td>
<td>
Manual Clean Up
Manual recovery is a labour intensive strategy that utilises large numbers of people collecting stranded oil with the necessary tools; shovels etc


Use of Water Low pressure flushing
Flooding can cause the liquid to float on the water, this allows it to be recovered later by pumps and skimmers. Flushing can be used to re-mobilise the spilled liquid from the soil and/or wash it from the surface. Both techniques should be used carefully, and containment boom in place to prevent further spread.

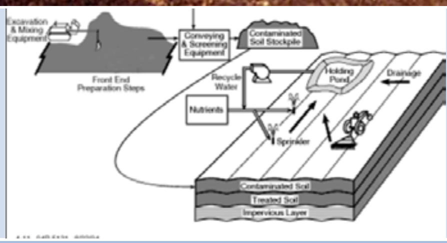

Sorbents
Sorbents, made of oleophilic materials; natural (straw) and synthetic (polypropene), can be introduced to the area to selectively absorb the spilled liquid whilst repelling water.


Mechanical Recovery
A spilled liquid can be removed from the surface using a multitude of machinery, including (specialist) pumps and vacuum equipment, scrapers, graders and oleophilic skimmers.


In-situ Burning
In-situ burning may be considered when physical recovery is not feasible. It is best used in remote areas, especially where roots are protected by high water levels. Some environments may recover from burning more readily than if left oiled without treatment.

</td>
</tr>
</table>

Manual Clean up	Operational Information for Timissit Project
Response Objective	• To contain the spill as quickly as possible using resources on site. • Protect sensitive areas from further impact from liquid spill, contain and recover spill. • Prioritise areas to protect with the most appropriate strategies and techniques
Response Considerations	• Waste management of oiled products from the liquid spill. • Pre clean sites out with immediate spill site and check availability of suitable storage. • Complete the Net Environmental Benefit Analysis (NEBA) process and identify and prioritise sensitive locations.
Safety Awareness	Hazardous materials / Exposure to Volatile Organic Compounds (VOCs) and potentially also Hydrogen Sulphide (H_2S) from the liquid spill being recovered / Slips, trips and falls; Manual Handling
Minimum PPE Requirements	Gloves / Ear defenders / Oil resistant suit (Tyvek) / Gas monitors Safety glasses / Sturdy footwear
Major Communication lines	Spill Observer / DSS / OBR / Drilling Supervisor ⟷ Incident Commander ⟷ L1ERT Leader Incident Management Team (L2IMT)
Response Efficiency	• Manual recovery is the most common method of spill response cleanup and involves teams of workers using rakes, shovels, and other tools to remove oil and debris. • Manual cleanup is a slow process; it generates less waste than other techniques. • Good organisation of the workforce is essential to ensure that operations are directed to the right areas
Resources	Tier 1 onsite equipment    
Supporting Information and Tools	• Section 3.1.3 Tier 1 and 2 Response Resource Inventory • http://www.oilspillprevention.org/oil-spill-cleanup/oil-spill-cleanup-toolkit/manual-recovery • The Project Waste Management Plan (WMP) presents an overview of the existing and relevant waste management facilities located near the Study area, particularly in the In Amenas, Illizi and Djanet areas

Bioremediation	Operational Information for Timissit Project	
Response Objective	Microorganisms break down the contaminants and reduce the liquid spill (oil) loading in the soil.	
Response Considerations	**Bioremediation** The addition of microbes to oily waste to break down contaminants. This can be conducted either in-situ or ex-situ where the oil waste is removed to be treated elsewhere. For example: land farming (where liquid spill and microorganisms are added to the soil where the microorganisms break down the contaminants and reduce the oil loading in the soil. • Produces an inert substance which can be disposed of at landfill, if oil loading is within permitted levels. This process should be carried out in a controlled environment	
Resources	Tier 1 onsite equipment	 
Supporting Information and Tools	Section 3.1.3 Tier 1 and 2 Response Resource Inventory http://www.oilspillprevention.org/oil-spill-cleanup/oil-spill-cleanup-toolkit/bioremediation	

<table>
<tr><th>Low Pressure Flushing / Surface Oil Collection</th><th colspan="5">Operational Information for Timissit Project</th></tr>
<tr><td>Response Objective</td><td colspan="5">

- A technique that uses high volumes of low-pressure water to wash stranded or buried spilled liquid (oil)
- To recover the liquid spill as quickly as possible using resources on site.

Sediment washing

Involves the cleaning of sand, pebbles and cobbles in-situ at the treatment site. Lightly oiled substrate can be moved to designated lined areas / pits and low pressure water can be used to remobilise spilled liquids collected in containment booms.

It is not always easy to identify when pebbles are oil free. This technique can produce large quantities of oily water waste that will require treating, it is costly and time consuming.</td></tr>
<tr><td>Response Considerations</td><td colspan="5">Waste management of oiled products from the liquid spill.</td></tr>
<tr><td>Safety Awareness</td><td>Hazardous materials</td><td colspan="3">Exposure to Volatile Organic Compounds (VOCs) and potentially also Hydrogen Sulphide (H_2S) from the liquid spill being recovered</td><td>Slips, trips and falls</td></tr>
<tr><td rowspan="2">Minimum PPE Requirements</td><td>Lifejackets</td><td>Ear defenders</td><td colspan="2">Oil resistant suit (Tyvek)</td><td>Gas monitors</td></tr>
<tr><td>Gloves</td><td>Safety glasses</td><td colspan="2">Sturdy footwear</td><td>Personal flotation devices (dependent on depth of water)</td></tr>
<tr><td>Major Communication lines</td><td>Spill Observer / DSS / OBR / Drilling Supervisor</td><td colspan="3">Incident Commander</td><td>L1ERT Leader Incident Management Team (L2IMT)</td></tr>
<tr><td>Response Efficiency</td><td colspan="5">The quicker the spill is contained, the easier it will be to clean up and reduce secondary contamination.
Combined with the use of vacuum trucks, pumps and skimmers may be useful on pooled areas of spilled liquid following remobilisation</td></tr>
<tr><td>Resources

Tier 1 and Tier 2 equipment</td><td colspan="2"></td><td colspan="2"></td><td></td></tr>
<tr><td>Range of Use</td><td colspan="2">Flushing out oil buried in a sand beach using low pressure water supplied through lances and perforated pipes.</td><td colspan="2">Raise the water level and allow surface oil to be retained for collection.</td><td>Algeria considerations: Waste management (solid and liquid wastes)</td></tr>
<tr><td>Supporting Information and Tools</td><td colspan="5">

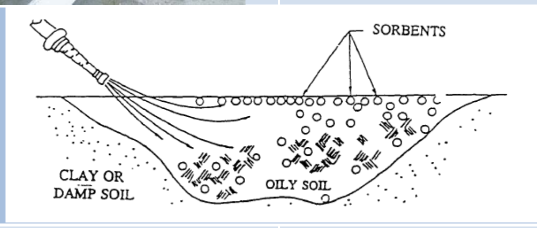
- Section 3.1.3 Tier 1 and 2 Response Resource Inventory
- The Project Waste Management Plan (WMP) presents an overview of the existing and relevant waste management facilities located near the study area, particularly in the In Amenas, Illizi and Djanet areas</td></tr>
</table>

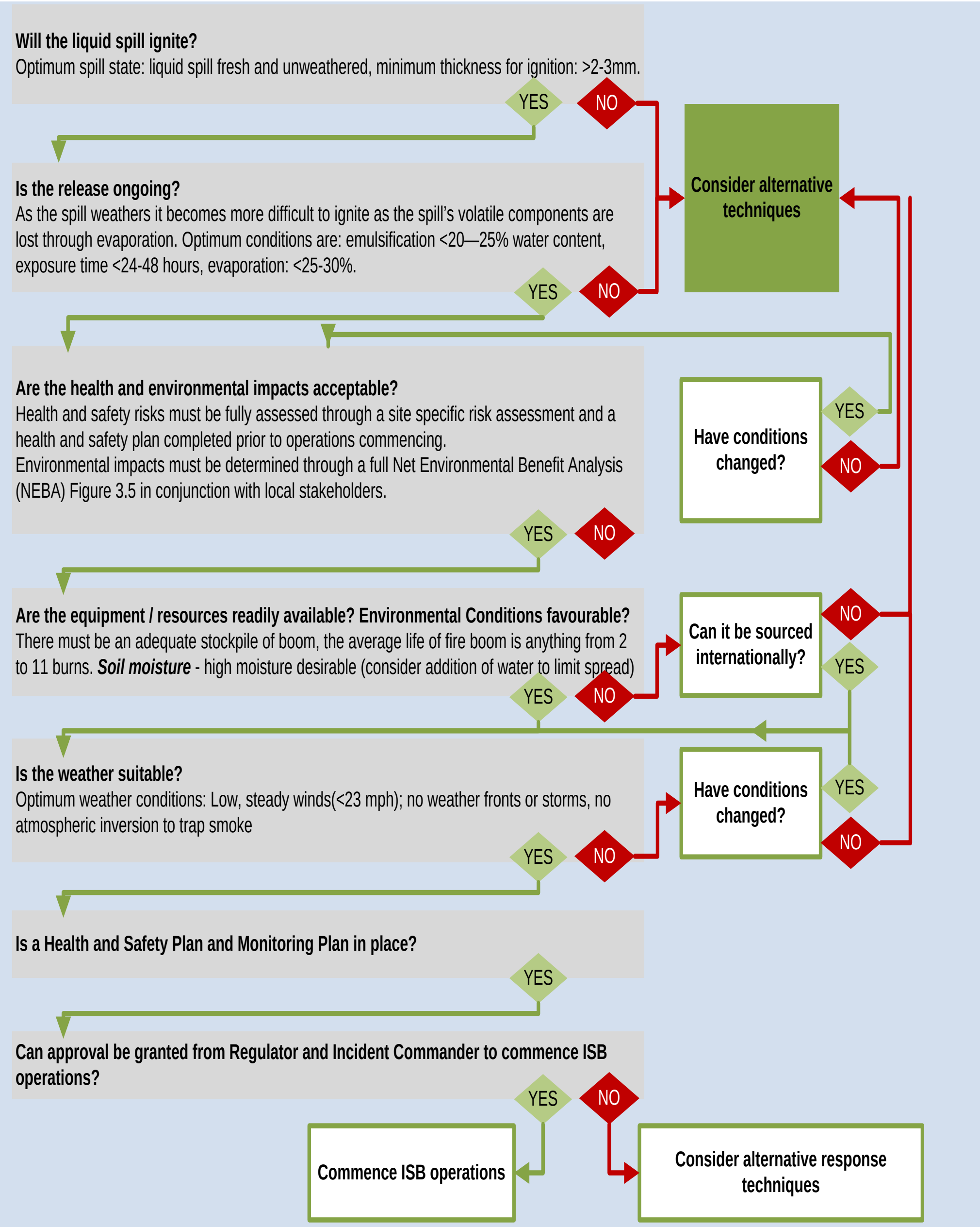
Sorbents	Operational Information for Timissit Project			
Response Objective	To contain the spill as quickly as possible using resources on site.			
Response Considerations	Waste management of oiled products from the liquid spill. Products include: sorbent pads, rolls, sorbent booms, pom-poms and snare booms and loose or granulated sorbent materials. These items may be placed in wadis and depressions to minimise the potential for loss of oil in the event of rainfall as a precautionary measure.			
Safety Awareness	Hazardous materials	Exposure to Volatile Organic Compounds (VOCs) and potentially also Hydrogen Sulphide (H_2S) from the liquid spill being recovered		Slips, trips and falls
Minimum PPE Requirements	Gloves	Ear defenders	Overalls	Gas monitors
	Safety glasses	Sturdy footwear		
Major Communication lines	Spill Observer / DSS / OBR / Drilling Supervisor	Incident Commander		L1ERT Leader Incident Management Team (L2IMT)
Response Efficiency	The quicker the spill is contained, the easier it will be to clean up and reduce secondary contamination.			
Example Resources	**Tier 1** Spill Kits 	 	 	
Range of Use	**Liquid spill types** Sorbent products can be used on a range of oil types.	**Sorbents**	**Algeria considerations** Waste management	
Supporting Information and Tools	Section 3.1.3 Tier 1 and 2 Response Resource Inventory http://oilspillresponseproject.org/sites/default/files/uploads/Inland%20Response%20GPG.pdf			

<table>
<tr><th>Mechanical Recovery (skimmers)</th><th colspan="4">Operational Information for Timissit Project</th></tr>
<tr><td>Response Objective</td><td colspan="4">• To recover the spill as quickly as possible using resources on site.
• Used to physically remove floating spills from an impacted area.</td></tr>
<tr><td>Response Considerations</td><td colspan="4">Sand Sieving
Sand and oil can be separated using specialist mechanical sand cleaners which sieve the contaminated sand.
Consider NEBA (Refer to Section 3.2.1) to ensure the area is not further damaged by over cleaning or sterilisation.</td></tr>
<tr><td>Safety Awareness</td><td>Hazardous materials

Rotating machinery and hydraulic hose failure</td><td colspan="2">Exposure to Volatile Organic Compounds (VOCs) and potentially also Hydrogen Sulphide (H_2S) from the liquid spill being recovered</td><td>Slips, trips and falls

Manual Handling

Noise</td></tr>
<tr><td rowspan="2">Minimum PPE Requirements</td><td>Ear defenders</td><td>Safety glasses</td><td>Oil resistant suit (Tyvek)</td><td>Gas monitors</td></tr>
<tr><td>Gloves</td><td>Sturdy footwear</td><td>Noise protection (pumps)</td><td></td></tr>
<tr><td>Major Communication lines</td><td>Spill Observer / DSS / OBR / Drilling Supervisor</td><td colspan="2">Incident Commander</td><td>L1ERT Leader
Incident Management Team (L2IMT)</td></tr>
<tr><td>Response Efficiency</td><td colspan="4">• The quicker the spill is contained, the easier it will be to clean up and reduce secondary contamination.
• Dependent on in-country resources and logistics.
• Recovery of spilled oil can be as simple as using vacuum trucks.
• Vacuum trucks are best used when connected to an skimmer / recovery device</td></tr>
<tr><td rowspan="2">Resources</td><td rowspan="2">Tier 1 / Tier 2 equipment</td><td colspan="2"></td><td></td></tr>
<tr><td colspan="3">
</td></tr>
<tr><td>Range of Use</td><td>Suction head skimmers that lay flat can be used to limit the amount of water recovered.</td><td colspan="2">Often combined with sorbents for improved efficiency</td><td>Algeria considerations
Waste management (soil and liquid waste)</td></tr>
<tr><td>Supporting Information and Tools</td><td colspan="4">Section 3.1.3 Tier 1 and 2 Response Resource Inventory
National Service Center for Environmental Publications (NSCEP)</td></tr>
</table>

In-situ burning	Operational Information for Timissit Project			
Response Objective	To limit the extent of the spill as quickly as possible using Tier 2 / Tier 3 resources			
Response Considerations				
Safety Awareness	Hazardous materials Recovery and disposal of the burn residue	Exposure to heat from fire. Exposure to Volatile Organic Compounds (VOCs) and potentially also Hydrogen Sulphide (H_2S) from the liquid spill being burnt. Potential black smoke plumes.		Slips, trips and falls Risk of fire spreading
Minimum PPE Requirements	Ear defenders	Anti-static NOMEX-coated coveralls (fire resistant)	Gas monitors	Respiratory Protective Equipment (RPE)
	Gloves	Safety glasses	Sturdy footwear	
Major Communication lines	Spill Observer / DSS / OBR / Drilling Supervisor	Incident Commander		L1ERT Leader Incident Management Team (L2IMT)

Resources and considerations	*Refer to* Tier 1 and 2 Response Resource Inventory Section 3.1.3, p 15 and OSRL *Refer to 3.1.4, p. 15*	 Potential black smoke plumes	 Burn Residue
			 Residue pick-up (sorbents)
Range of Use	Oil types The liquid (condensate / diesel) is classified suitable for ISB.	In Situ Burning requires approval from regulator (CNOSS)	Algeria considerations Waste management (burn residue)
Supporting Information and Tools	Section 3.1.3 Tier 1 and 2 Response Resource Inventory Ensure response teams are integrated into the communication decision to burn http://www.oilspillprevention.org/oil-spill-cleanup/oil-spill-cleanup-toolkit/in-situ-burning		

Groundwater Recovery	Operational Information for Timissit Project			
Response Objective	• If ground penetration occurs there is the potential for groundwater to become contaminated with free product and which could then generate a dissolved phase plume which could migrate away from the release area. • The objective is to identify the direction of flow and to commence recovery operations as quickly as possible to minimise the area requiring remediation.			
Response Considerations	Movement of contaminants on or in groundwater is relatively slow compared to the above ground migration and therefore the initial response should focus on the surface release as a priority. Once the release has been brought under control it is recommended that shallow trenches be dug down to groundwater around the perimeter of the main spill area to assess whether free product has migrated vertically through the soil. If it has then excavations in the source area should be undertaken to remove the oil from the groundwater and/or the trenches should be pumped to recover the oil. Low permeability liners along the down gradient side of the trenches should help to contain the product. A series of trenches may be required extending away from the spill area until a clean edge is encountered. Subsequent monitoring and remediation may require installation of wells to facilitate sample collection and further remediation – particularly if it is not practical to extend excavations to the water table. If during excavation contaminated soils are encountered then these should be managed in accordance with the WMP. Recovered soils should be segregated based on degree of contamination and should be stockpiled on a low permeability liner. Any liquid generated from the waste should be collected and disposed of.			
Safety Awareness	Hazardous materials Rotating machinery and hydraulic hose failure	Exposure to Volatile Organic Compounds (VOCs) and potentially also Hydrogen Sulphide (H_2S) from the liquid spill being recovered		Slips, trips and falls Manual Handling Noise
Minimum PPE Requirements	Ear defenders	Safety glasses	Oil resistant suit (Tyvek)	Gas monitors
	Gloves	Sturdy footwear	Noise protection (pumps)	
Major Communication lines	Spill Observer / DSS / OBR / Drilling Supervisor	Incident Commander		L1ERT Leader Incident Management Team (L2IMT)
Response Efficiency	• Excavation of trenches can be done quickly using back-hoe excavators and should help to identify and contain subsurface migration of oil. • If groundwater is deeper than 5m then drilling rigs may be required to install wells to facilitate oil recovery. These may then be used to treat groundwater.			
Resources	**Tier 1** / Tier 2 equipment			

	 
Range of Remediation Approaches	Depending on the extent of the spill and the depth/direction of groundwater flow it may be necessary to employ more advanced remedial approaches to minimise environmental impact to or via groundwater. Initial installation of wells to monitor conditions, establish flow directions, etc will be used to plan a more detailed analysis of potential remedial options.

3.2.4 Waste Management

<table>
<tr><td rowspan="2">Resources Available</td><td>Tier 1</td><td>Tier 2</td><td>Tier 3</td></tr>
<tr><td colspan="3">Local waste management contractors
Waste Management Plan</td></tr>
<tr><td>Overview</td><td colspan="3">In accordance with the Algerian Environmental Laws and International Codes and Regulations.
Main waste management aspects are the following:
• Handling and segregation as per class of hazard, from the non-hazardous wastes such as bulk packages and highly hazardous waste such as used oil;
• Collection and storage;
• Suitable housekeeping measures; and
• Transportation</td></tr>
<tr><td rowspan="2">Safety</td><td colspan="3"></td></tr>
<tr><td colspan="3">• Wear the appropriate PPE (buoyancy vest may be required if slurry pools are created)
• Identify risks and mitigate them where possible
• Communicate the risks and controls in place through a pre-operation safety brief</td></tr>
<tr><td>Key Steps</td><td colspan="3">Liquid Spill → Preparation → Generate Waste → Segregate Waste → Store Waste → Transport Waste → Final Disposal</td></tr>
<tr><td>Step 1
Preparation: Minimise Waste Generation</td><td colspan="3">Action to take: Follow the steps below to minimise waste generation.
• Pre clean area before it becomes oiled.
• Cover containment sites to prevent rainwater adding to the waste volume.
• Clean and re-use recovery equipment rather than discarding.
• Handle waste where possible in-situ, e.g. bioremediation, surf washing, burning, sand sieving. This will reduce the amount of waste that needs to be transported and treated.
• Minimise the use of sorbents.
• Re-use PPE where possible.</td></tr>
<tr><td>Step 2
Preparation: Prevent Secondary Contamination</td><td colspan="3">Guidance: Secondary contamination is the spread of oil via transport, people and equipment to other unpopulated areas.
Action to take: Follow the steps below to prevent secondary contamination.
• Regularly check pumps and hose connections for leaks.
• Ensure all storage is water tight to prevent leakage.
• Line and decontaminate all waste transportation vehicles before they leave the site.
• Establish a traffic circulation plan for vehicles.
• Locate waste storage sites close to recovery equipment.
• Establish a suitable site set up which includes a decontamination zone.
• Hot Zone: Dirty / work area, all oil stays in this zone.</td></tr>
</table>

<table>
<tr><td></td><td>

Warm Zone (Decontamination Zone): Clean down area, there is one entrance / exit channel. Anyone leaving must pass through an organised series of decontamination phases in the ‘warm zone’.
Cold Zone: Waste removal vehicles can collect full containers from this clean area so that they do not spread oil onto the roads.

</td></tr>
<tr><td>Step 3

Segregate Waste</td><td>
Guidance: Waste should be classified, segregated and labelled.

Action to take: Follow the steps below to segregate waste.
<table>
<tr><td colspan="2">Separate oil from soil, vegetation, plastics and sorbents.

Note: Awareness training may be required. Incorrectly segregating waste can rapidly increase the waste volume and cause it to be disposed of incorrectly, with financial implications.</td></tr>
<tr><td rowspan="2">Liquid</td><td>Oily

Additional segregation is required before reaching its final disposal</td></tr>
<tr><td>Non-oily

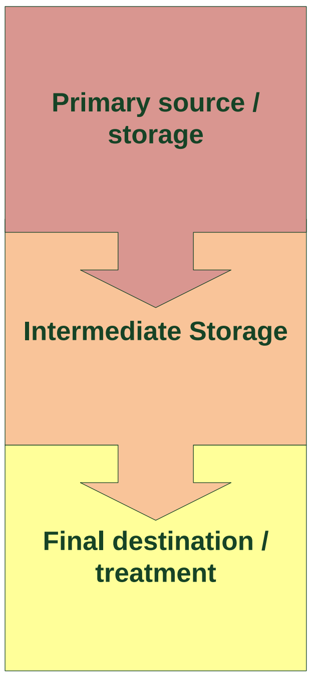
Use a municipal plant or other approved method to process waste.</td></tr>
<tr><td rowspan="2">Solid</td><td>Oily

Waste should be transported to central waste processing centre. Additional segregation is required before reaching its final disposal.</td></tr>
<tr><td>Non-oily

Waste to be transported to local landfill sites for disposal.</td></tr>
</table>
</td></tr>
<tr><td>Step 4

Store Waste</td><td>
Guidance: Using temporary storage facilities will:

Prevent delays from many vehicles trying to access one site
Allow sufficient time to organise final disposal sites or methods whilst the response effort continues
Assist in appropriate waste segregation

</td></tr>
<tr><td></td><td>


Local, regional and national legal regulations must be met
</td></tr>
</table>

	Waste should be labelled with type and source of waste Waste sites should: 1. Be fenced off with controlled site access 2. Have good access and egress 3. Have suitable site set up to ensure that waste is separated and secondary contamination is minimised 4. Have useful and appropriate signage to reflect the site set up 5. Storage containers should: 6. Be suitable for the waste type 7. Be water tight and lined with polyethylene sheeting to prevent oil leaching
Step 5 Transport Waste	**Guidance:** Initial transportation will involve small vehicles such as dump trucks and front end loaders. Subsequent transportation to intermediate or final disposal sites includes tankers for liquid waste and sealed trucks for solid waste. **Note:** Only waste contractors that can demonstrate to have the necessary authorisation from the Ministry of Environment (MATET) as per the Ministerial Order of 2nd September 2013 will be considered for the transport of the waste. **Action to take:** Follow the steps below to transport waste. • Ensure trucks have covered or sealed top • Decontaminate trucks before leaving the site. • Ensure the shipment for transporting wastes meets requirements / regulations.
Step 6 Final Disposal	**Action to take:** Follow the steps below to dispose of waste. Consider the final disposal destinations for the following waste types. **Treatment of oiled sediment** **Sand Sieving** Sand and oil can be separated using specialist mechanical sand cleaners which sieve the contaminated sand. Consider NEBA (*Refer to Section 3.2.1*) to ensure the beach is not further damaged by over cleaning or sterilisation **Sediment washing** Involves the cleaning of sand, pebbles and cobbles in-situ at the treatment site. Lightly oiled substrate can be moved to designated lined areas / pits and low pressure water can be used to remobilise spilled liquids collected in containment booms. It is not always easy to identify when pebbles are oil free. This technique can produce large quantities of oily water waste that will require treating, it is costly and time consuming **Bioremediation** The addition of microbes to oily waste to break down contaminants. This can be conducted either in-situ or ex-situ where the oil waste is removed to be treated elsewhere. For example: land farming (where oil and microorganisms are added to the soil where the microorganisms break down the contaminants and reduce the oil loading in the soil. Produces an inert substance which can be disposed of at landfill, if oil loading is within permitted levels. This process should be carried out in a controlled environment **Treatment of other oily waste** Treatment of oiled debris / PPE

	There are limited methods of treating oiled debris. Once debris is oiled final disposal methods include incineration and landfill.
The Project Waste Management Plan (WMP) presents an overview of the existing and relevant waste management facilities located near the in the Study area of the Block Timissit, particularly in the In Amenas, Illizi and Djanet areas	

4. Response Organisation

Statoil will adopt the Incident Command System (ICS) as the preferred response management system. The management organisation is described below.

4.1 Response Organisation

4.1.1 Line 1 Emergency Response Team (L1ERT)

4.1.1.1 L1ERT Responsibilities

The L1ERT manages the practical first response to the incident. The L1ERT's primary tasks are to:

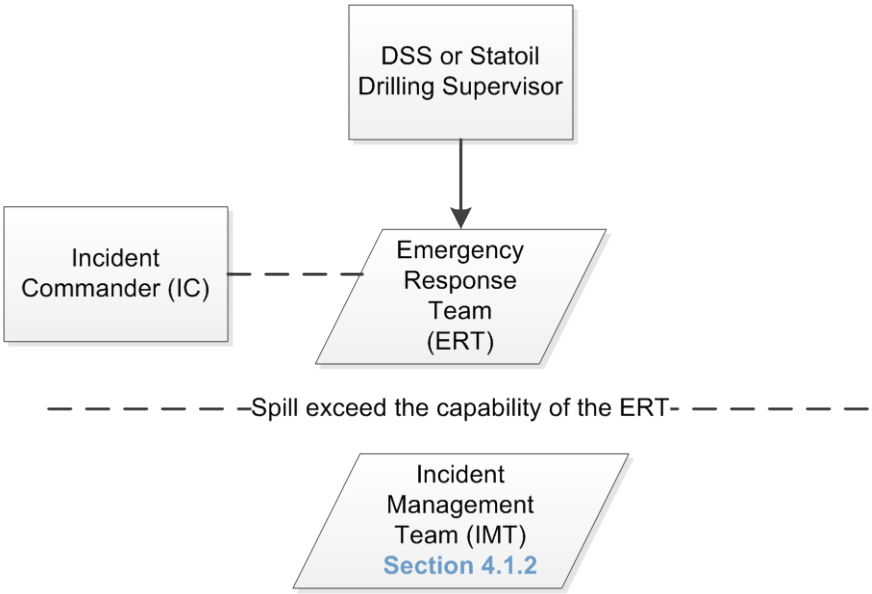
- Ensure the safety of all workers in the area of the spill
- Assess the situation (incident size, severity, likely impacts)
- Notify the Shift Supervisor immediately to activate the response organisation
- Take appropriate action to mitigate the negative impacts to people, environment and assets in a safe manner

On larger incidents, the L1ERT would be incorporated into the Operations Section of the Incident Command Team organisation.

4.1.1.2 L1ERT Structure

The L1ERT is led by either the Drill Site Supervisor during drilling operations (DSS) or the Senior Statoil representative on site (Statoil Drilling Supervisor). The L1ERT Leader is responsible for notifying the Incident Commander (IC) based in Alger

Figure 4.1 L1ERT Functional Lines of Authority



4.1.2 *Level 2 Incident Management Team (L2IMT)*

If the spill exceeds the capability of the L1ERT, the L2IMT will be established.

4.1.2.1 Responsibilities

The L2IMT's primary responsibilities are to:

- Develop and execute appropriate strategies to protect people, environment, assets and reputation.
- Manage all aspects of the response
- Work in cooperation with all agencies, authorities and governments involved in the response

4.1.2.2 Team Structure

The L2IMT is structured in line with the ICS model. The L2IMT structure permits:

- Clear definition of roles and responsibilities amongst response personnel
- Procedures for controlling personnel, facilities, equipment and communications
- Manageable span of control and lines of authority during a response
- Integration of the L2IMT with response teams from other companies or authorities that have adopted the ICS model

The L2IMT is led by the IC who is responsible for directing and coordinating the response to the incident. The critical response functions are broken down into four sections:

- Operations *(Operations Section Chief)*
- Planning *(Planning Section Chief)*
- Logistics *(Logistics Section Chief)*
- Finance / Administration *(Finance/Admin Section Chief)*

"Quick-Start' checklists have been developed for each of these key positions and will be included in the final version of the LSRP

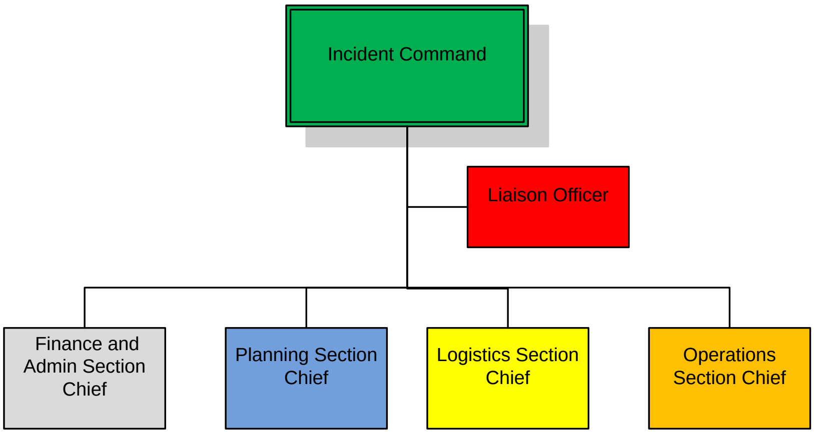
More than one function can be covered by one person but the different roles shall at all times be separated.

Tier 1

For Tier 1 spills, one person may be able to cover multiple roles. In this case, it is recommended to combine:

- The IC and OSC
- The PSC, LSC and F/ASC

Figure 4.2 Example Management Organisation of Tier 1 Response



Tier 2 and Tier 3

The ICS organisation for a Tier 2 and Tier 3 incident will be expanded as appropriate. Responsibilities and check-lists are defined and developed for roles, and will be included in the final version of the LSRP.

Table 4.1 L2IMT Escalation Practical Considerations

	Tasks	Actions
Incident Command Centre	Ensure Incident Command Centre (ICC) facilities are adequate to meet size and demands of enlarged ICS structure for incident scope	• Secure suitable building and resource with a minimum of perimeter and entry security teams 24/7 • Large central room to house Command Staff and Section Chiefs at stations • Central room to have multiple status boards with markers • Each station should contain a phone, laptop, multiple notepads, pens and pencils • Additional rooms to house support functions such as medical, canteen, IT, technical specialists, admin etc. • Building to have A/C and washroom facilities • Building to have sufficient printers, faxes and copiers • Building to have 'break-out' rooms for people to take refreshments and relax when off duty • Building to have sufficient parking space • Building able to provide or receive sufficient food and water for staff
IT Support	Ensure adequate IT support throughout incident	• IT support contractors to be pre-identified • Internet access is high speed (Wi-Fi included) • Laptops, projectors are available in sufficient numbers • Ensure Documentation Unit, *Crises Manager*, is established for record keeping
Media	Ensure media management is of high priority	• Establish media centre close to but not on site of the ICP; must have security team and rear exit doors speakers • Issue timely and regular media statements Issue media line for people to make enquiries
Unified Command	Ensure all relevant national authorities with jurisdiction and authority are identified and included	• Establish Unified Command with sufficient representation including Safety Officer • Cooperate Committee National (TELBAHR) – competent National Authority
ICS	Ensure ICS management and structure is commensurate with the incident scale	• Evaluate to contract an ICS specialist(s) to set up and oversee incident to ensure compliance, smooth running and ongoing staff training
	Larger number of personnel will be required to manage and carry out spill response operations on a protracted time period	• Expand ICS' span of control to suit e.g. create geographical branches and divisions as appropriate; • source local labour for inland clean-up operations
	Identify priority specialist support functions e.g. wildlife response , waste management, aerial	• Mobilise resources from pre-established contractor network pool and OSRL / Statoil resources

	Tasks	Actions
	surveillance and inshore operations etc.	
Contractor Management	Overseas contractor management	• Ensure sufficient housing is secured - block book multiple security cleared hotels • Contract transport providers • Customs and visa process is expedited for multi nationality personnel • Confirm medical care and Medivac contracts procedures include sub-contractors
Response Resources	Inshore spill response - identify and mobilise sufficient resources for scale of incident	• Liaise with OSRL and mobilise • Liaise with Wild Well Control (WWC), Boots & Coots (B&C) or similar company and mobilise if applicable • Aerial surveillance capability if deemed required • Containment and recovery capability (inland specific resources) • Waste management response capability • Wildlife response capability
Vehicles	Vehicles / Excavators / Haulage vehicles	• Mobilise from pre-determined sources suitable for each type of operation
Well Blowout	Well blow out incidents	• Integrate Wild Well Control response functions to ICS alongside oil spill response activities
Volunteers	Volunteers	• Establish a volunteer programme for including into various operations such as, wildlife response, staging post assistance • Dedicated volunteer management may be required
Community	Community Relationships	• Establish a community support programme to ensure good working relationships and communications with adjacent settlements if applicable • Ensure early engagement manage expectations (financial or otherwise); manage claims and compensation requests

APPENDICES

A OPERATIONAL REPORTING FORMS

A.1 Statoil Spill Notification Form

Company Name	_____	Incident Location:	
Incident Date	_____	Time of Incident:	_____
Name of Injured (if incident includes an injury)		_____	

Incident Category (check one – see attached for definitions)					
☐	Accident	☐	Near Miss	☐	Condition

Incident Type (check one)					
☐	Injury	☐	Spill	☐	Security Breach
☐	Work Related Illness	☐	Oil/Gas Leak	☐	Reputation
☐	Fire/ Explosion	☐	Loss of Production	☐	Other (describe below)
☐	Material Damage	☐	Impairment/Failure Safety System		

Incident Severity (check one - see attached incident classification matrix for detail)										
Actual	1	☐	2	☐	3	☐	4	☐	5	☐
Potential	1	☐	2	☐	3	☐	4	☐	5	☐

Incident Description

Immediate Actions Taken

What Actions Will Be Taken to Prevent Recurrence?

Report Completed By:

Name:	Company:

Investigation Report – Triggering Factors – Direct Causes

Substandard Condition or Act	Sub Category

A.2 Oil Spill Response Notification Form

The latest version of the Notification form can be accessed through http://www.oilspillresponse.com/activate-us/activation-procedures

Warning! Please telephone the Duty Manager before e-mailing or faxing this completed form

To	Duty Manager		
OSRL Base	Southampton, UK	Loyang, Singapore	Fort Lauderdale, USA
Telephone	+44 (0)23 8033 1551	+65 6266 1566	+1 954 983 9880
Emergency Fax	+44 (0)23 8072 4314	+65 6266 2312	+1 954 987 3001
Email	dutymanagers@oilspillresponse.com		

Safety and Security: Oil Spill Response Limited's safety policy requires us to work closely with the mobilising party to ensure all aspects of safety and security are addressed for our personnel.

Guidance: Please ensure the information given on this form is accurate at the time of completion. This information will be used to develop and recommend the most appropriate response strategy. If new information should become available, or the situation changes, please inform the Duty Manager as soon as possible.

Section 1 – Contact Details	**Mandatory Information Required**
Member Company	
Name of Person Notifying OSRL	
Position in Incident	
Direct Phone Number	
Mobile Number	
Fax Number	
Email Address	
Command Centre Address	
Date and Time of Notification	
Section 2 – Location	
Country / Region of Spill	
Latitude / Longitude of Spill Position	
Area Affected	☐Inland ☐River ☐Estuary ☐Shoreline ☐Port ☐Harbour ☐Offshore ☐Subsea ☐Other
Depth of Water (if applicable)	
Section 3 – Spill Details	

Date and Time (of spill – GMT)						
Source of Spill						
Cause of Spill						
Status of Spill	☐ Secured	☐ Uncontrolled	☐ Unknown			
Product Properties	Product Name / Type					State Units Alternatively, provide an Assay sheet ☐ Assay sheet provided
	SG or API					
	Pour Point					
	Wax Content					
	Asphaltene					
	Sulphur Content					
	Viscosity					
Release Rate	Instantaneous Release					State Units
	OR					
	Continuous Release		per hour for		☐ Hours ☐ Days	

Section 3 – Spill Details cont.		Mandatory Information Required	
Description of Observed Spill	Estimated Quantity		**State Units**
	Size		
	Appearance		
	Direction of Travel		

Section 4 – Weather		
Wind Direction (wind direction given **from**)		**State Units** **Alternatively provide a local weather forecast** ☐ **Weather forecast provided**
Wind Speed		
Air Temperature		
Sea Temperature		
Sea State		
Visibility		
Cloud Base		

Section 5 – Oil Spill Model Request			
Information you supply in Section 3 (Spill Details) and 4 (Weather) will be used for the modelling			
Do you require Oil Spill Trajectory Modelling?	☐ Surface 2D	☐ Sub-surface 3D*	☐ Not at this time
Additional Information (please include start date and time)			

*Separate model request form required. Sub-surface models require additional time and costs.		
Section 6 – Safety and Security		
Highlight any known Safety or Security Risks		☐N/A
Describe Security arrangements for OSRL staff (if applicable)		☐N/A

Additional information if available

Section 7 – Resources at Risk	
Environmental or Socio-economic sensitivities that may be impacted (If possible provide the relevant oil spill contingency plan)	
Section 8 – Equipment	
Equipment already deployed or being mobilised (other than OSRL resources)	

A.3 Oil Spill Response Mobilisation Form

The latest version of the Mobilisation Authorisation form can be access through http://www.oilspillresponse.com/activate-us/activation-procedures

Mobilisation Authorisation Form

Warning! Please Telephone the Duty Manager before e-mailing or faxing this completed form

Safety and Security

Oil Spill Response Limited's safety policy requires us to work closely with the mobilising party to ensure all aspects of safety and security are addressed for our personnel.

To	Duty Manager		
OSRL Base	Southampton, UK	Loyang, Singapore	Fort Lauderdale, USA
Telephone	+44 (0)23 8033 1551	+65 6266 1566	+1 954 983 9880
Emergency Fax	+44 (0)23 8072 4314	+65 6266 2312	+1 954 987 3001
Email	dutymanagers@oilspillresponse.com		

Details of Authorised Contact	
Subject	
Incident Name	
Mobilising Company	
Name of Person Authorising OSRL	
Position in Incident	
Direct Phone Number	
Mobile Number	
Fax Number	
Email Address	

Invoice Address	
Purchase Order Number	

I, authorise the activation of Oil Spill Response Limited and its resources in connection with the above incident under the terms of the Agreement in place between above stated Company and Oil Spill Response Limited.				
Signature:		Date / Time:		

If Oil Spill Response Limited personnel are to work under another party's direction please complete details below;

Additional Details	
Company	
Contact Name	
Position in Incident	
Direct Phone Number	
Mobile Number	
Fax Number	
Email Address	

B Preliminary Contacts Directory – TO BE UPDATED PRIOR TO OPERATIONS

Response Position/Function	Normal Job Title or Position	Name	Contact Numbers/Information	
			Primary	**Email/Fax/Alt.**
1. Facility/Local Response Personnel (Tier 1 Team)				
2. Statoil Management Personnel				
Main alarm & notification centre, Forus (Norway)			+47 51990002	

Organisation	Normal Job Title or Position	Name	**Contact Numbers/Information**	
			Primary	Fax / Email / Other
3. Mandatory Regulatory Agency Notifications				
Centre National des operations de surveillance et de sauvetage en Mer	Not Provided	Not Provided	+213(21)430178	+213(21)437108 mrccalgiers@mdn.dz
4. Oil Spill Response Organisations (OSROs)				
Oil Spill Response Limited	Duty Manager	Various shifts	+44(0)2380331551	+44(0)2380724314 dutymanagers@oilspillresponse.com
REMPEC Prevention Focal Point	Directeur de la marine marchande et des Ports, Direction de la marine marchande et des Ports, Ministère des transports	M Ibn El Boushaki Mohamed	+213 21 92 92 81	Cell: +213 556 886 638 Fax: +213 21 92 60 96F Address: 1, Chemin Ibn-Badis El Mouiz (ex Poirson) El Biar 16000 Alger
REMPEC OPRC Focal Point REMPEC Mutual Assistance Focal	OPRC Focal Point	M Salim DERRAR	+213 21 432 867	Cell: +213 662 116 405 Fax: +213 21 432 867 Address: Attaché du Cabinet, Ministère de l'aménagement du territoire et de l'environnement, Rue des Quatre Canons – Alger Centre, Alger 1600

Point				
5. Regulatory/Government Agency Notifications				
Competent National Authority Comite National (TELBAHR) for Oil & HNS	Not Provided	Not Provided	+213(21)432867	+213(21)432867 derrar73@yahoo.fr

Response Position/Function	Normal Job Title or Position	Name	Contact Numbers/Information	
			Primary	**Email/Fax/Alt.**
6. Regional/Corporate Response Personnel (Tier 2 Team)				
7. Other Organisations (neighbouring facilities, sensitive area managers, hospitals, emergency services etc.)				

B.1 Additional and Specialist Resource Contact Information – TO BE UPDATED PRIOR TO OPERATIONS

Company or Organisation	Primary Contact Name	Location	24 hr Number	Secondary Number
Company Owned Resources				
Primary Oil Spill Response Organisations (OSROs)				
Aerial Surveillance				
Natural Resource Damage Assessment Subject Matter Experts				
Other Resource or Subject Matter Expert Types/Categories				

Annex 1: Liquid Spill Modelling Initial Analysis

Introduction

To help analyse the potential response requirements Statoil has completed an oil spill modelling exercise for a range of scenarios. The results from this modelling have been used to assess potential flow directions both over the land surface and within the subsurface to help inform areas for response. In addition the potential for impact on potentially sensitive receptors has been assessed. The key findings from the well sites are provided in the LSRP. This annex provides a brief excerpt covering the results of the work completed. Further information is available in the stand-alone Oil Spill Modelling Report.

Results

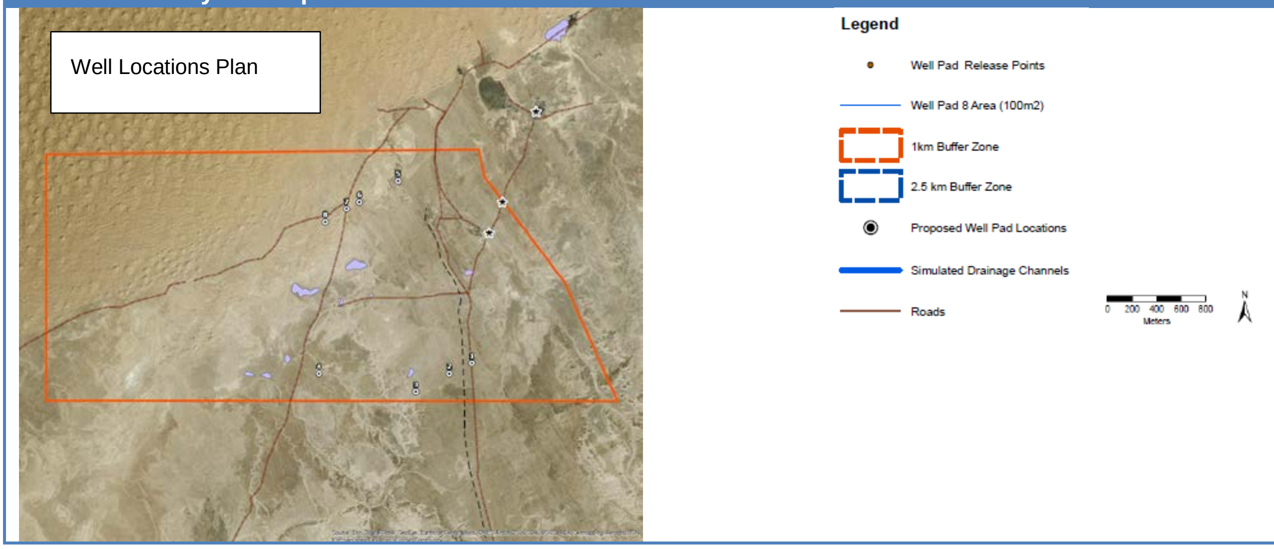
The principal overland flow pathway identified for linking the release of liquids from the different scenarios to potentially sensitive receptors is likely to be the nearby surface channel features – particularly if coincident with a storm event. The modelling results give an indication of the time element for transmitting the source to the receptors via this overland pathway.

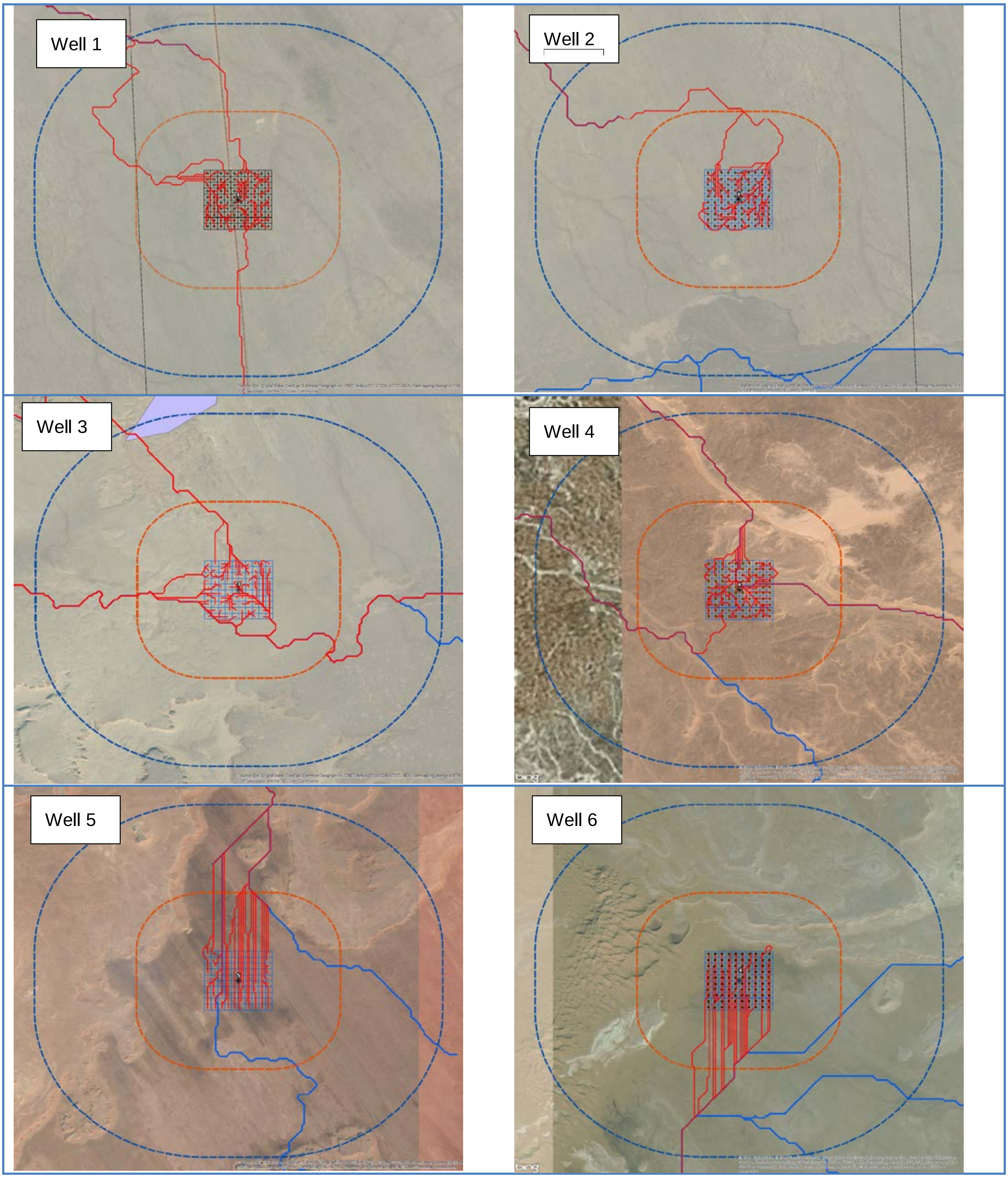
Most of the receptors identified in the area are likely to be affected through direct contact pathways whereby the oil coats the surface of the receptor. Field surveys have not, however, identified significant receptors at risk other than some examples of Neolithic tools which are common in the area. The pathway aspect of the pollutant linkage is an important aspect as it will affect the emergency response strategy and appropriate mitigation measures.

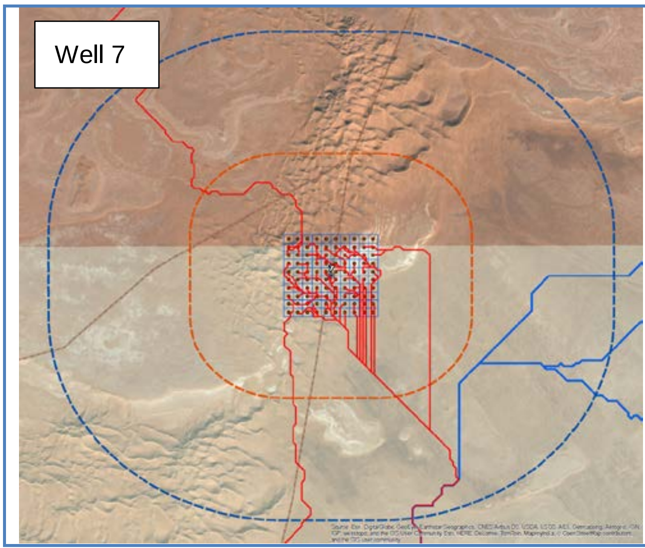
The results from the modelling are best presented in the form of graphical outputs showing the potential spill location and the flow paths via which the oil is simulated to travel. For each well site two sets of results have been generated. These include a non-quantitative analysis of likely fluid migration routes. This is completed to identify the most sensitive areas around which an assessment of plausible receptors is required. The second is a quantitative analysis of the potential extent of a spill based on an assumed 1,000m^3 liquid release. In all of the quantitative analyses the extent of flow is limited with none of the simulations extending further than approximately 1km from the point of release.

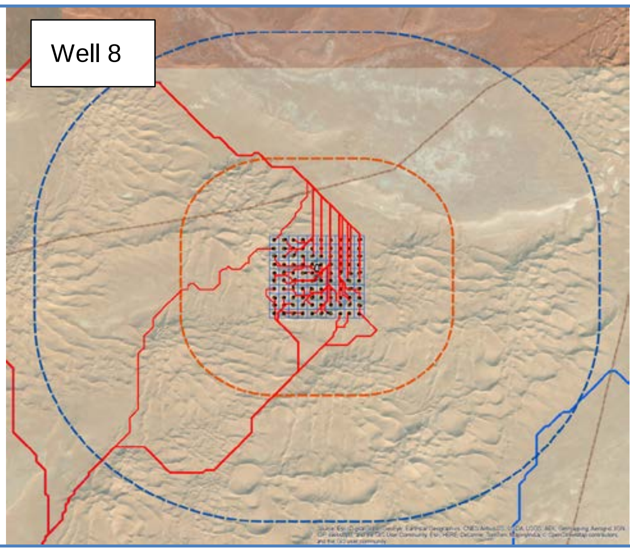
The following figures present the results for each of the 8 well pad locations.

Flow Path Analysis Output




Well 1
Well 2
Well 3
Well 4
Well 5
Well 6





Qunatiative Spill Analysis Output

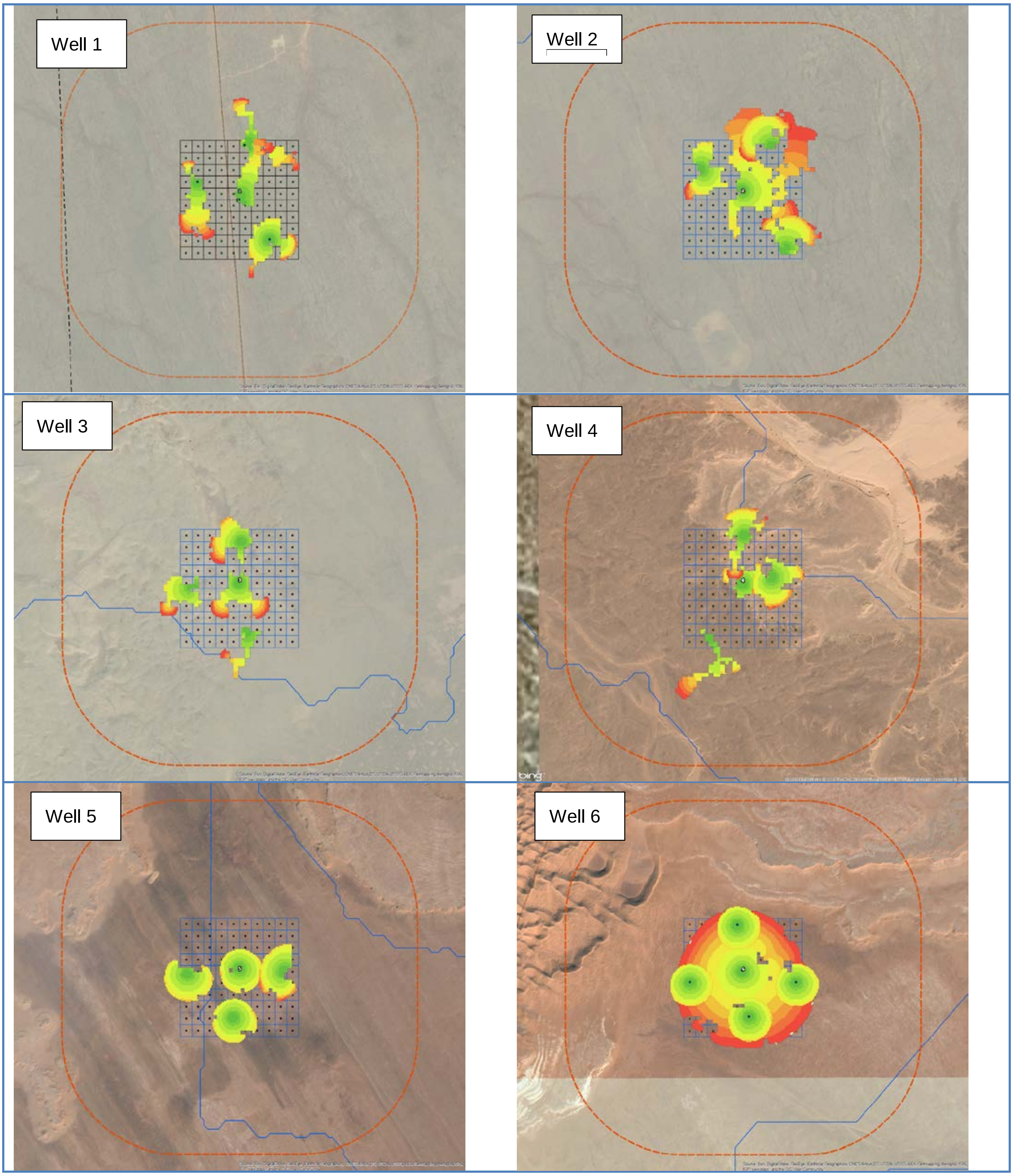
Legend

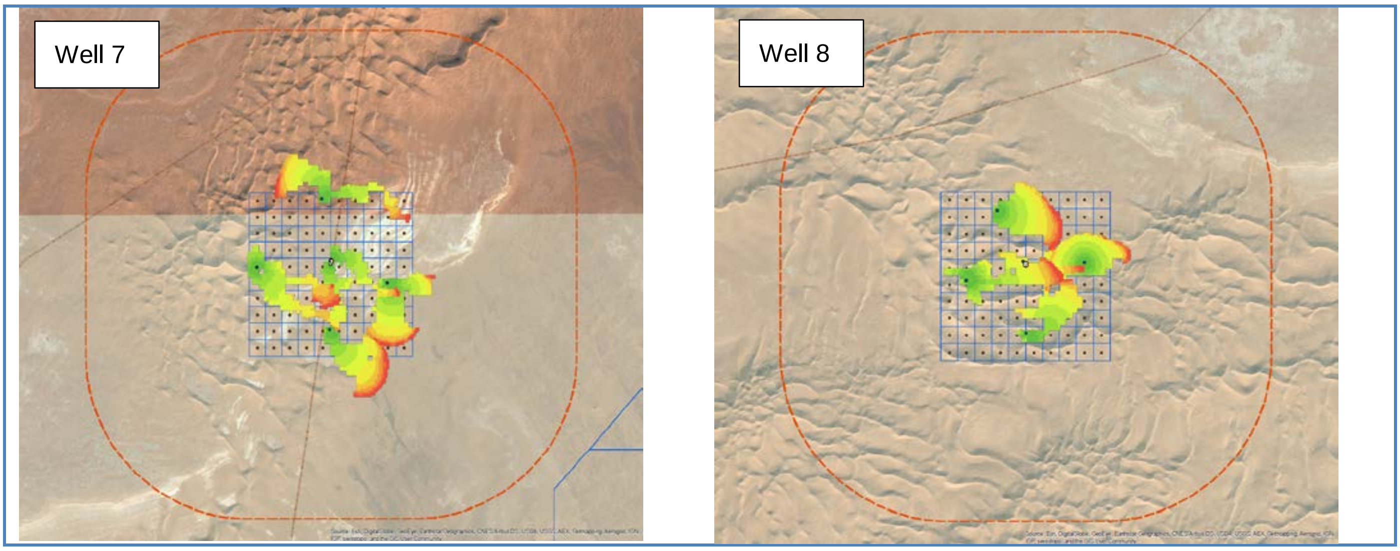
Modelled Liquid Release (1000m3)

Time since Release

- <30 Minutes After Release
- 30 Minutes - 1 Hour After Release
- 1 - 2 Hours After Release
- 2- 4 Hours After Release
- 4- 8 Hours After Release
- 8 - 16 Hours After Release
- 16 - 24 Hours After Release
- 24 - 32 Hours After Release
- 32 - 40 Hours After Release
- 40 - 48 Hours After Release
- Simulated Drainage Channels
- Well Pad 1 Area (100m2)
- Well Pad 1 Potential Release Points
- 1km Buffer Zone
- Unknown Pipeline
- Roads

0 0.2 0.4 0.6
Kilometers
N


Well 1
Well 2
Well 3
Well 4
Well 5
Well 6



Subsurface modelling indicates that the condensate could reach the water table within 5 or 6 days (sand or loamy sand conditions, respectively) more quickly than the diesel (1 to 40 days, sand and loamy sand, respectively) but spreads out an order of magnitude further (140 – 165 m for condensate and 12-20 m for diesel). The time to reach the water table may seem counter-intuitive for the lower viscosity condensate however it is a reflection of the source flux term for each scenario. In the condensate scenarios a greater volume of fluid is spread out over a large area with a thin depth on the surface before infiltration. In the diesel scenarios a smaller volume is held within a small area (the bund) with a relatively greater head of fluid and that head provides a greater downward force on the subsurface penetration of the fluid.

The order of magnitude difference in spreading on the water table between condensate and diesel is a factor of the order of magnitude difference in spill volumes.

The model indicates that under loamy sand conditions the diesel spill is held up considerably compared to sandy conditions. The trend observed is one of a relatively fast decent followed by a sharp tailing off after approximately 5 days at a depth of 2 m. This is likely to be related to a reduction in the flux from the release which is not evident in the sand conditions as the LNAPL reaches the water table within the time period when the flux is still being applied.

The dissolved constituent is simulated to move very quickly (under the very conservative conditions of no bio-degradation). A concentration of 0.01 mg/l is observed 150 m from the source area within 7 days in sand and 10 days in loamy sand in the condensate scenarios. The same concentration is observed at 150 m after 24 days in sand and 100 days in loamy sand in the diesel scenarios

Annex D.2 – Waste Management Plan

Table of contents

1 Introduction

1.1 Background and objectives

In 2014 Statoil, together with Sonatrach and Shell (Partners), was awarded the Timissit licence, an unconventional liquid-rich shale gas licence situated on the border of Libya at the edge of the Berkine basin. Statoil is the operator of the licence.

Project activities to be undertaken by Statoil in the project area include: seismic acquisition (2D/3D); civil works and camp construction; exploration drilling (water wells, exploration wells, and hydraulic stimulation of horizontal wells); transportation of personnel and equipment.

This Waste Management Plan (WMP) aims to set the framework for the procedures and the general requirements that will be considered during the operations in the Timissit Project (hereafter referred to as the Project) in relation with the generation and management of solid and liquid waste.

The present Framework WMP is therefore intended as a preliminary framework that will be transformed into an operational plan during the post-ESIA phase of project development (i.e., as further detailed project design information will be available, to more precisely reflect and incorporate the methods of handling, storage, treatment and disposal of the main typologies of waste streams).

The Framework WMP outlines how all the main typologies of waste generated during the Project will be managed in accordance with Statoil standards, Algerian laws and regulations, as well as recognised good international industry practices. Thus the WMP defines the Waste Management Policy, structure and related roles and responsibilities to ensure appropriate waste management practices during the proposed exploration activities.

In this context, the WMP is intended to facilitate the following objectives:

- Minimising the generation of wastes;
- Minimising the risks of causing harm to the environment that may arise due to waste management;
- Improving operational efficiency; and
- Ensuring compliance with all laws and regulations applicable to this WMP.

This plan covers all the main categories of waste, generated, handled, transported and disposed of resulting from Project activities.

1.2 Waste Principles

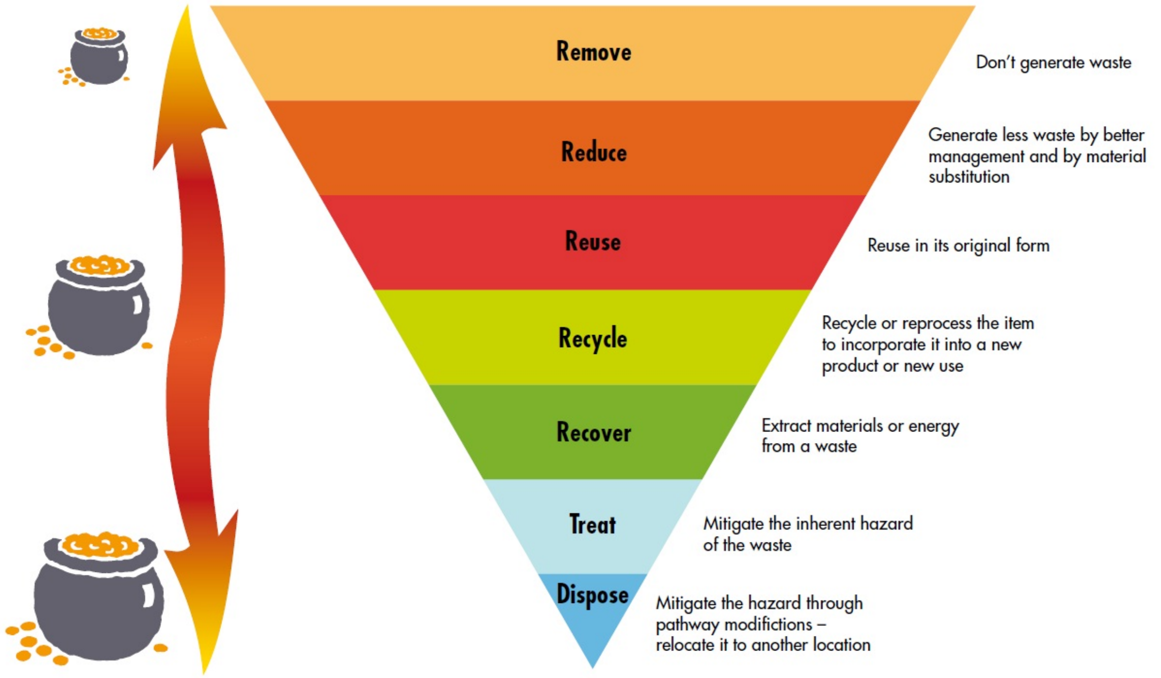
Current "state of the art" waste management principles are based primarily on the avoidance and reduction of waste generation. As such, waste management begins with prevention.

Prevention of waste generation refers to the avoidance or removal of waste by modifying the project design and operating practices. This principle has been incorporated, to the most practicable extent, into the construction and operation stages of the Project

In those cases when the generation of waste cannot be avoided, the principles of waste management include the incorporation of a hierarchy of management practices. This hierarchy is considered integral to the development of the strategy for dealing with waste and is frequently expressed in terms of reduction, reuse, recycling and finally waste treatment and disposal.

For the current project, where reasonable and appropriate, waste management activities will be performed in accordance with the internationally recognised waste management hierarchy indicated, which is also presented in Figure 1.1.

Figure 1.1 Waste hierarchy



Source: OGP Guidelines for waste management with special focus on areas with limited infrastructure – Report No. 413, rev.1.1, September 2008 (Updated March 2009)

In order of preference, the aim of the Waste Management Plan will be to:

- Reduce the amount of waste generated, collectively this is known as 'reduction at source' and may be achieved through modifications of equipment or technology, processes or procedures, the reformulation or redesign of products, substitution of raw materials, and improvements in housekeeping, maintenance, training or inventory control;
- Re-use of materials, where appropriate, in their original form, such as re-use of water or, for instance, chemical containers, that can be reused multiple times through an approved chemical vendor who refills chemical 'x' into the same used chemical 'x' container with the correct choice of container material and stock return procedures;
- Recycling of waste, where appropriate, such as scrap metal, plastic and/or tyres;
- Recovery of as many materials as practical from the remaining waste, in terms of conversion of waste into usable materials and/or extraction of energy or materials from waste;
- Treatment of waste where necessary to render it less hazardous and/or to make it suitable for reuse, through:
    - biological methods (composting, materials can be recycled where appropriate);
    - thermal methods (incineration);
    - chemical methods (neutralisation, stabilisation);

  - o physical methods (evaporation, filtration, centrifugation, compaction or shredding);

- Dispose of residual waste responsibly at authorised facilities, such as injection or deposition at landfills.

All typologies of solid and liquid waste will be managed in accordance with the principles of the Waste Hierarchy, the application of which will be addressed during the procurement of goods and services for the Project and will be taken into consideration when reviewing waste storage and disposal methods throughout the different phases of the Project. Furthermore, Project contracts will include the following requirements:

- Minimisation of waste generation at all stages of the contract;
- Preparation and implementation of a materials Reuse and Recycling Plan;
- All residual waste to be treated in order to reduce its toxicity and/or volume for subsequent disposal; and
- Treated waste to be disposed of at appropriate and authorised facilities.

1.3 Scope of Work

This Framework Waste Management Plan will set the basis for the future implementation of the procedures for the operational management of the wastes generated as a result of the exploration activities proposed by the Timissit Project, and detailed in the Project Description chapter of the ESIA.

These activities include a wide range of operations, including seismic acquisition (2D/3D), civil works, and exploration drilling activities (including hydraulic stimulation of horizontal wells, testing activities, abandonment and well site rehabilitation).

The scope of this framework WMP encompasses the management of waste from its generation, collection, segregation, storage, transport, treatment and/or disposal. The WMP will focus on those waste streams considered of major interest, such as drilling muds, cuttings and flowback waters, and will provide an overview of the best practicable management options to facilitate their further implementation once the final waste characteristics are identified.

In this context, the WMP identifies:

- Types of waste generated;
- Waste management processes and procedures;
- Waste transport requirements;
- Monitoring requirements;
- Audit and inspection requirements; and
- Record keeping and reporting requirements.

1.4 Structure of the Plan

The present plan is structured as follows:

- *Section 1* – Introduction: presentation of the purpose, objectives and general principles of the plan;
- *Section 2* – Definitions and abbreviations;
- *Section 3* – Waste regulations: regulations and guidelines on waste management, including Algerian legislation, international conventions and guidelines, and Statoil standards;

- *Section 4*- Roles and responsibilities;
- *Section 5* – Identification and classification of waste streams: a list and description of waste sources and a census of the main waste generated during the exploratory activities proposed in the Project, based on hazard classification;
- *Section 6* – Waste management and routes: identification and description of the different waste management streams and treatment opportunities for waste reduction, recycling and responsible disposal;
- *Section 7* – Waste monitoring, record keeping and reporting: overview of a monitoring programme for waste management, including the records to be kept and the associated reporting;
- *Annexes*
    - *Annex D.2.1* – Overview of relevant existing waste management facilities
    - *Annex D.2.2* – Waste management summary tables

2 Waste Regulatory Framework

The present WPM has been developed according to and is compliant with:

- Algerian laws and regulations;
- STATOIL standards in the field of waste management;
- Relevant international guidelines and conventions.

2.1 Algerian Laws and Regulations

Numerous environmental regulations have been adopted which aim to align Algerian legislation with international best practices, and, as a result, have set more stringent requirements and standards. These relate in particular to:

- Classification of waste;
- Approval of waste treatment facilities;
- Operating standards for industry in general and waste treatment in particular;
- Promotion of recycling; and
- Regulation of waste transport.

However, waste management in Algeria is particularly challenging due to limited disposal or treatment facilities (especially with regard to hazardous industrial wastes), and the fact that existing facilities are not always state of the art. Illegal dumping and burning of waste in the open air is still a common practice, and industrial waste is often stored on site without adequate control (D-Waste, 2014).

Algerian environmental legislation requires that all projects that may potentially have adverse effects on the environment obtain prior authorisation. Waste generated by the project needs to be treated in classified installations that have been appropriately approved by the MATE. Hazardous waste that is transported to facilities for treatment and disposal also needs to be carried by licensed carriers, in appropriate and correctly labelled containers. Along with any waste transportation is the requirement to complete waste tracking documentation.
Waste that cannot be treated in-country will be shipped to other countries for disposal and treatment. The transboundary movement of waste is subject to the prior approval of an authorisation, which in turn requires prior consent from the importing state and the existence of a contract between the exporter and the disposal company that certifies the sustainable management of waste.

Within this section the main laws and regulations relating to the management of waste in Algeria are briefly analysed, as are Statoil's relevant standards and international conventions.

2.1.1 Algerian Institutional Framework

In Algeria the management of waste (non-hazardous and hazardous) is followed-up and/or controlled by several institutions:

- The Ministry of Land Use and Environment (MATE) is responsible for the National strategy for solid waste management.
- The National Waste Agency (AND), created in 2002, is MATE's instrument for implementing the national waste policy. Its main mission comprises promoting activities related to integrated management of waste.
- The National Observatory for the Environment and Sustainable Development (ONEDD - *Observatoire National pour l'Environnement et le Développement Durable*) was created by Executive Decree in April 2003. Its mission is to build and manage networks of pollution observations and measurements, environmental monitoring, and data collection.
- The Environmental Directorate of each Wilaya (in the case of Timissit Project, the Illizi Wilaya Environmental Directorate) is empowered to find regulation violations and non-conformities. In practice, this directorate controls the environmental infrastructure and industrial activities (but not the collection and transportation of waste, due to limited resources).
- Nationally, there is an Urban Planning and Environmental Protection police force (dependent on the Ministry of the Interior) that can verbalise and penalise offences against the environment; in practice this police force has little involvement in the control of waste management, due to limited resources.
- The National Centre for Cleaner Technologies (CNTPP) is a public institution with both commercial and industrial goals, supervised by the MATE and created by Executive Decree 02-262. It assesses violations or non-conformities of environmental regulations in the industrial sector. As such it has performed environmental audits of some industrial facilities. The centre also contributes to the development of techniques for reducing and recycling waste and provides the necessary technical support to industrial companies with regard to green technologies.
- At the regional level, delegated Walis (regional governor) also have a hygiene office that can audit any deficiencies in waste management by an industry.

At a local level, the municipalities have a municipal health office that can take note of any deficiencies in the execution of services (collection and/or transportation of urban waste, dumps and so on).

2.1.2 Algerian Regulatory Framework

In terms of waste management and environmental protection, the framework documents applicable in Algeria are Law 03-10 on environmental protection, of July 19th, 2003, Law 01-19 on the regulation of waste management, control and disposal, and the Law 05-12 on water. An overview of the mentioned laws is presented in the following subsections.

In addition, the several decrees and regulations underlying the main framework established by the mentioned laws are also presented in Table 2.1.

2.1.2.1 Law no. 03-10 of 19th July, 2003, on the Protection of the Environment and Sustainable Development

This act sets out the general principles of rational environmental management and defines environmental protection rules in the context of sustainable development, which also apply to waste management, by setting the main management principles of the 'polluter pays principle' and sustainable development. According to this law, Environmental Impact

Assessments (EIAs) and notification processes are required for projects relating to development of an area, as well as infrastructure and projects that either directly or indirectly have an immediate or future impact on the environment (including impacts from waste production and management).

2.1.2.2 Law no.01-19 of 12th December, 2001, on the Regulation for Waste Management, Control and Disposal

Law 01-19 of 12/12/01 relating to the management, control and disposal of waste, defines the basic principles that lead to integrated waste management, from generation to disposal, and constitutes the main legal framework for solid wastes in Algeria.

This law mainly covers aspects related to the ownership of waste, responsibilities (requiring the waste producer to ensure the traceability of waste), waste treatment facilities and financial sanctions. The law introduces the concept of the duty of everyone to take the necessary measures to avoid, whenever possible, waste production at source. Any producer or owner of waste must ensure that produced waste is, whenever possible, reused, recycled or disposed of.

The main requirements of the law are as follows:

- Waste is to be reused or recycled, and only when this is not possible should be disposed of in an environmentally safe way.
- Hazardous waste (including hazardous industrial waste) can only be treated in installations approved of by the Ministry of the Environment.
- The mixing of dangerous hazardous waste with other waste is prohibited.
- Dangerous hazardous waste generators or owners must provide the Ministry of Environment with data on the nature, characteristics, and quantity of generated waste. Additionally, treatment and waste reduction measures must also be supplied.
- Waste transport, exportation and transport are subject to an authorisation granted by the Ministry of the Environment, after consultation with the Ministry of Transport.

This law therefore encourages the reuse or recycling of wastes allowing their disposal only in an environmentally safe way, in order to avoid:

- Causing damage to human health, soils, water resources, air, fauna and flora;
- Generating odours or noise;
- Altering the state of a landscape or a site of special interest.

The law requires a national waste inventory to allow the characterisation of specific waste categories, as above.

According to the law, domestic waste should be managed through a communal waste management plan in facilities authorised by the respective Wali (regional governor). All approvals for a proposed waste treatment or disposal facilities require a prior environmental impact assessment.

2.1.2.3 Law 05-12 of 24th August 2005, on Water

Law 05-12 of 24 August, 2005, on water defines the different protection zones of water courses and the associated requirements and prohibitions, also setting out the fact that all wastewater discharges are subject to authorisation.

In this context, industrial wastewater discharge effluents are required to comply with limit values established by regulation. The law also provides for and regulates the authorisation for surface water and groundwater use.

It also states that disposal of hazardous material likely to pollute groundwater, either through natural infiltration or artificial recharge, is prohibited. If disposal does not pose a toxicity or nuisance risk for the public water domain, it is then subject to authorisation.

This law has been modified and updated by laws 08-03, 06-07 and 08-13.

2.1.2.4 Additional Relevant Laws and Decrees

Table 2.1 presents additional Algerian legislation related to waste management.

Table 2.1 Waste management-related legislation in Algeria

Law/ Decree	Date	Subject	Comments
Exec Decree 84-378	15th December 1984	Urban waste	Sets out the conditions for removing and cleaning solid urban waste including: domestic waste, rubble, hospital waste, abattoir waste, carcasses of small animals, and waste produced by commercial activities (packaging waste, other general waste).
Presidential Decree 90-198 (modified by Presidential Decree 99-64)	30th June 1990	Explosive waste	Regulates the storage, transport and use of explosive substances and defines the requirement for an authorization for disposal of explosive material.
Exec Decree 93-161	10th July 1993	Regulates oil and lubricant discharge and spills into the natural environment	It prohibits the discharge of some type of oils (listed in Article 2 of the decree, including vehicle oils) into the natural environment and sewage system. For other type of oils it regulates the terms governing the authorised discharge of oil and lubricants into the natural environment. It also establishes procedures for handling and storing these oils / lubricants. *Note: This Decree has been revoked by Article 113 of Law 03-10. However, it is still used by the authorities as the replacement decree has not yet been published.*
Exec Decree 94-43	30th January 1994	Injection of water	Executive Decree 94-43 regulates the preservation of hydrocarbon reserves and the protection of aquifers. It relates to project activities during the drilling of upholes (e.g., use of drilling muds). It states that operators must take all possible measures to ensure the protection of the environment and shallow groundwater tables, in relation to drilling muds, wastes from production centres and all other activities. It also regulates the injection of freshwater or produced water into the reservoir to increase pressure. Article 21 establishes that the physical and chemical properties of the injected water must ensure a stable and durable injection and effective oil movement. Potential incompatibility problems between reservoir water and

			injected water have to be studied beforehand in the laboratory. Article 24 prohibits the injection of freshwater except by agreement with relevant authorities.
Presidential Decree 98-158	16th May 1998	Waste transport	It regulates the transboundary movement of waste
Exec Decree 02-372	11th November 2002	Packaging wastes	Executive Decree 02-372 relates to the management of packaging wastes.
Exec Decree 03-452	1st December 2003	Transport of dangerous substances	This regulates the transportation of dangerous substances by road (except those included in Law 01-19 – special wastes, inert waste and domestic waste). It also requires companies to establish accident prevention and response plans for the transport of dangerous substances.
Exec Decree 03-477	9th December 2003	National Waste Management Plan	It sets the modalities and procedures for the preparation, publication and revision of the National Management Plan for Hazardous wastes.
Exec Decree 03-478	9th December 2003	Medical waste	Defines the terms governing the management of healthcare waste.
Exec Decree 04-88		Oil waste treatment	The decree sets the obligations of facilities in charge of the treatment and regeneration of used oils. This is applicable only in the case the project treats waste oils on site, which would imply an authorisation for the treatment and regeneration of used oils and registration in the trade register.
Exec Decree 04-409	22nd March 2004	Regulates dangerous waste transportation	Executive Decree 04-409 specifies requirements for dangerous waste transportation, including labelling, conditioning waste selection, and measures to be implemented in case of accidental spills. Dangerous waste transport needs a prior authorisation from the MATE and the Ministry of Transport
Exec Decree 04-410	14th December 2004	Regulates waste acceptance into treatment facilities	Executive Decree 04-410 specifies the conditions of acceptance of waste into waste treatment facilities.
Presidential Decree 05-119	11th April 2005	Radioactive waste	Relates to the management of radioactive waste. Radioactive waste is defined as material containing radioelements with concentrations or activity over the exemption limits and for which there is no planned use. This exemption limit is not defined in the decree.
Exec Decree 05-314	10th September 2005	Special hazardous waste	Fixes the methods of approvals for groups of waste generators and/or holders of special waste.
Exec Decree 05-315	10th September 2005	Special hazardous waste	Establishes the terms governing the declaration of special hazardous waste (*All special wastes that by their constituents or the characteristics of the harmful substances they contain are likely to affect public health and / or the environment).*

			The declaration must be submitted to the department responsible in the Wilaya concerned, and must contain information on the waste characteristics and efforts taken to minimise waste production. For the Timissit Project, the reference Wilaya is Ilizi
Exec Decree 06-104	28th February 2006	Waste nomenclature	Executive Decree 06-104 establishes a nomenclature for waste, including special hazardous waste. This system classifies waste according to a coded number, the identification of the waste type and an indication of its hazardousness.
Exec Decree 06-138	15th April 2006	Regulates air emissions and defines limit values for air pollutants	Executive Decree 06-138 sets out limit values for emissions of pollutants to the air in its annex. Different values are defined for existing and new industrial facilities. This regulation includes values for nitrogen dioxide, sulphur dioxide, metals, VOCs, and particulate matter, amongst other things.
Exec Decree 06-141	19th April 2006	Defines liquid effluent (wastewater) discharge limit values	Executive Decree 06-141 sets out liquid effluent discharge limit values for industrial effluents defined as “any discharge, flow, jet and deposit of a direct or indirect liquid which comes from an industrial activity”. Effluent discharge limits for several parameters are defined in Annex 1 of the decree, including: metals, temperature, pH, BOD, COD, TSS, cyanides, oil and grease, and total hydrocarbons.
Exec Decree 07-300	27th September 2007	Penalties for industrial effluents.	Executive Decree 07-300 sets a list of penalties that the operator must pay if the effluents discharged exceed the limits set out by the law (executive decree 06-141).
Exec Decree 09-209	11th June 2009	Waste water	Executive Decree 09-209. Waste water discharges into the public sewer system or treatment plants are submitted to a discharge authorisation established by the administration in charge of water resources.
Exec Decree 09-19	20th January 2009	Waste	Executive Decree 09-19 describes the rules applicable to the collection of special waste. This activity is subject to the provision of an authorisation.
Exec Decree 10-23	12th January 2010	Wastewater treatment systems	Executive Decree 10-23 sets the technical characteristics of wastewater treatment systems (domestic wastewater).
Exec Decree 10-88	10 March 2010	Wastewater discharge	Executive Decree 10-88 regulates the terms governing the authorisation non-toxic effluent disposal into the public hydraulic domain.
Order of 6th January 2013	6 January 2013	Wastewater discharge limit values	Fixes the maximum limit values for effluent discharge, spillages and deposition of any type of materials that do not present a toxicity risk or nuisance in the hydraulic public domain, in terms of physical, chemical and bacteriological parameters.
Order 2nd September 2013	2 September 2013	Authorisation for transport of hazardous special waste	This order sets the content of the request of dangerous waste transportation authorisation, conditions of delivery and technical characteristics, including the technical characteristics of hazardous special waste labels.

Source: ERM, 2015

2.2 Statoil standards for Waste Management

Statoil internal requirements for handling waste issues are regulated by both corporate functional and technical requirements and in corporate work processes related to waste management. Below is a summary of Statoil's main applicable standards.

FR 11 (Sustainability Management)

"We will seek to minimise the generation of waste and to minimise health and environmental impacts at every stage of the production-consumption-disposal chain".

Drilling and hydraulic stimulation activities are considered the most relevant in the context of the exploration programme. Due to the lack of well-developed waste facilities the main focus should be on the minimisation and treatment of muds, cuttings and flowback water at source.

TR1009 (Environmental requirements for onshore facilities)

The technical requirements have the same approach as the functional requirements and state that "*Waste shall be minimised through the design and choice of materials and chemicals".* In addition they focus on establishing local waste management plans for relevant activities in accordance with working requirements.

SU602 Ensure safe and sustainable waste management

The working processes SU602-1/ focuses on which activities have to be undertaken to establish waste management plans that can be, at a later stage, used for the development of the Operational Management Plans. The SU602 reflects the company's approach to WMPs and requires that waste risks are identified through a process that involves:

- Establishing context:
    - External (laws, regulation, national classification, stakeholders etc.)
    - Internal (internal requirements, guidelines, goals, waste aspects etc.)
- Assessing risks:
    - Identifying waste risks
    - Analysing and ranking of waste risks according to known methods
    - Documenting of identified waste risks
- Recommending measures
    - Identifying and proposing mitigating measures
    - Prioritising of measures in accordance with the waste hierarchy

Through this plan, Statoil Algeria is committed to:

- Complying with the relevant legislation, Codes of Practice and good oil & gas field practices;
- Designing, constructing and operating equipment and facilities safely, to a level that meets the accepted standards of the hydrocarbon, exploration, production and processing industries;
- Consulting with employees and their representatives, as appropriate, on matters that may affect their health, safety and wellbeing;
- Identifying potential major hazards and risks arising from intended operations and ensuring appropriate controls are in place; and

- Having effective emergency response plans in place that are periodically tested for appropriateness and effectiveness to enable response to foreseeable emergencies arising from Statoil's operations.

In addition, Statoil will adhere to the state-of-the-art procedures in waste management as per the standards included in OGP, IPIECA and API waste management guidelines. The following section includes a summary of the main applicable, relevant guidelines for the project.

2.3 International Conventions and Guidelines

International legislation in terms of waste management is relevant mainly for waste that needs to be exported from Algeria. The main piece of international legislation that affects the exportation of wastes, in the case it is needed, is the *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.*

In the case of transboundary movement of wastes, additional regulations would apply depending on the country of destination. Therefore, if the waste is to be exported into the European Union, then Council Regulation (EEC) No 259/93 and the European Union's Hazardous Waste Directive (91/689/EEC) will also apply.

If any of the waste is exported to other African countries then the Bamako Convention may apply. The Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Waste within Africa details similar restrictions to the Basel Convention.

Algeria is also party to several international and regional conventions. Table 2.2 presents the international agreements signed by Algeria. These conventions are not specific to oil and gas activities, but are general guides for the management of environmental aspects in Algeria, as regards the exploration and production of oil and gas.

Table 2.2 International Agreements signed by Algeria - Waste Management

Date	Name of convention
1968	Convention to Create the Arab Centre for the Study of Dry Regions and Arid Lands
1969	Convention for the civil responsibility for oil pollution damage
1971	UNESCO Programme, Man and the Biosphere
1971	Wetlands of international importance especially as waterfowl habitat
1971	Establishment of an international fund for compensation for oil pollution damage
1972	Convention on the prevention of marine pollution through dumping of waste and other materials
1972	Protection of world cultural and natural heritage
1973	Convention on international commerce of threatened wild fauna and flora species
1974	SOLAS – Safety of life at sea
1976	Protocol on co-operation in combating pollution of the Mediterranean sea by oil and other harmful substances in cases of emergency
1976	Protocol for the prevention of pollution in the Mediterranean due to the immersion of ships and planes
1976	Convention on the Protection of the Mediterranean Sea Against Pollution
1977	Protocol on Co-operation among North African States on Desertification Control
1978	MARPOL 1973 and amendments 1978 (annex I and V) and amendments to Annex D of 1978 Protocol. Protocol relating to the international convention for the prevention of pollution from ships
1979	Convention on the Conservation of European Wildlife and Natural Habitats
1980	Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources
1982	UN Convention on the Law of the Sea

1982	Protocol concerning Mediterranean specially protected areas
1985	Convention for the Protection of the Ozone Layer
1987	Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol), and amendments
1988	Convention on the health and safety of workers at their working place
1989	Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (Basel Convention)
1990	Oil pollution preparedness, response and co-operation
1992	Framework Convention on Climate Change
1992	Convention on Biological Diversity
1992	Charter of the Maghreb on the environment
1992	Civil liability convention and fund convention
1994	International Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa
1994	Protocol for the protection of the Mediterranean sea against pollution resulting from exploration and exploitation of the continental shelf and the sea-bed and its underlying lithology
1995	Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean
1996	Understanding between Algeria and Mauritania for the protection of vegetation
1997	Convention on climate change: control and limitations of atmospheric discharges of greenhouse effect gases
1998	Modification of the International Convention of 1969 on civil liability for damages due to oil pollution
2001	Convention of the African commission of energy (AFREC), promoting cooperation for energy management in Africa
2002	Convention on persistent organic pollutants (Stockholm)
2002	Statutes of the International Union for the Conservation of Nature and its Resources (IUCN)

Source: ERM, 2015

The Basel convention, related to waste management, is described below. In addition, a summary of the key waste management procedures that Statoil adheres to (OGP, IPIECA, API is also provided.

2.3.1 Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal

This convention is an international treaty designed to reduce the movements of hazardous waste between nations, and specifically to prevent the transfer of hazardous waste from developed to less-developed countries (LDCs). The convention is also intended to minimise the amount and toxicity of wastes generated, to ensure their environmentally-friendly management as close as possible to the source of generation, and to assist LDCs in the environmentally-friendly management of the hazardous and other waste they generate. The convention was opened for signature on 22nd March, 1989, and entered into force on 5th May, 1992.

A waste falls under the scope of the convention if it is within the category of waste listed in Annex I of the convention and if it contains one of the hazardous characteristics listed in Annex III of the convention. Waste must contain a characteristic such as being explosive, flammable, toxic, or corrosive. The other way that a waste may fall under the scope of the convention is if it is defined as, or considered to be, a hazardous waste under the laws of the exporting country, the importing country, or of the countries of transit.

Annex II of the Basel Convention lists other waste such as domestic waste and residue that comes from the incineration of domestic waste and that needs special consideration when being exported or imported.

In addition to conditions on the import and export of waste, there are stringent requirements for notice, consent and tracking of the movement of waste across national boundaries. The exportation or importation of waste between parties and non-parties is prohibited. The exception to this rule is where the waste is subject to another treaty that is not less restrictive than the Basel Convention.

2.3.2 OGP – Waste Management Guidelines

OGP has a number of industry good practice standards and guidelines related to waste management in oil and gas exploration activities. Below is a list of those that are potentially relevant for the project activities:

- Guidelines for waste management with special focus on areas with limited infrastructure (OGP, 2008): these provide guidance on principles and practices of effective waste management, as well as information on waste streams and technologies typically applicable in exploration and production operations.
- Exploration and Production Waste Management Guidelines (E&P Forum, 1993): these provide general information on the waste management options available for wastes generated by exploration and production activities.
- Guidelines for the management of Naturally Occurring Radioactive Material (NORM) in the oil & gas industry (OGP, 2008): these determine best practices for managing NORM in oil and gas producing facilities.
- Environmental management in oil and gas exploration and production (E&P Forum, 1997): these provide an overview of the environmental issues in the oil and gas exploration and production industry, and the best approaches to achieving high environmental performance, including for waste management.

2.3.3 IPIECA – Waste Management Guidelines

The most important IPIECA guideline relevant for project waste management is that on petroleum refinery waste management and minimisation (IPIECA, 2014).

It describes a variety of design, operational, equipment and procedural elements that can be considered to help define a waste management system, identifies opportunities for improvement, and highlights waste management options for waste streams typically produced at a refinery.

2.3.4 API – Waste Management Guidelines

The most important API guideline relevant for project waste management is the API E5 Environmental Guidance Document: Waste Management in Exploration and Production Operations (API, 1997).

It includes a general overview of pollution-prevention practices and waste management options for exploration and production activities.

3 Identification and Classification of Waste Streams

This section presents the identification of the different waste sources expected as a result of Project activities followed by a classification of the main waste typologies of waste generated.

3.1 Waste Origins/Sources

As a result of Project activities, different sources of waste will be generated. The types of wastes vary from domestic waste generated mainly in the accommodation areas to special / hazardous waste generated during the drilling process.

The main types and sources of effluents and solid wastes for the different phases of the project are presented in Table 3.1 and Table 3.2 respectively.

Table 3.1 Waste effluent sources

Waste Source	Generated waste	Project Phases
Accommodation areas, other Project sites	Sewage (grey and black waters, wash-down water, hydrocarbon-free)	• Seismic Survey • Exploratory Drilling • Hydraulic stimulation
Parking and refuelling sites. Waste storage areas. Areas for equipment and vehicle washing, for contaminated container cleaning. Well pads.	Potentially contaminated wash down water	• Seismic Survey • Exploratory Drilling • Hydraulic stimulation
Wells	Well drilling fluids (water based muds and if used, oil based muds)	• Drilling
Wells	Produced water	• Well testing
Wells	Condensate	• Well testing
Wells	Flow-back water	• Hydraulic stimulation

Table 3.2 Solid waste sources

Waste Source	Generated waste	Project Phases
Sewage treatment process in accommodation camps	• Sewage sludge	• Seismic Survey • Exploratory Drilling • Hydraulic stimulation
Site clearance, wooden pallets from equipment shipments	• Wood or vegetation	• Seismic Survey • Exploratory Drilling • Hydraulic stimulation
Accommodation areas, offices	• Food waste; • Paper and cardboard; • Plastics; • Glass; • Miscellaneous combustibles; • Kitchen oil/grease; • Hazardous waste (e.g., small batteries, fluorescent lamps)	• Seismic Survey • Exploratory Drilling • Hydraulic stimulation
Construction activities (to create the accommodation camps, pits and ponds, waste storage areas, well pads, etc.)	• Inert waste (concrete rubble, grit); • Metals; • Solvents; • Welding rods (used); • Packaging wastes (plastics, metals, cardboard); • Contaminated soils (in case of spills)	• Seismic Survey • Exploratory Drilling
Drilling activities	• Cuttings	• Exploratory Drilling
Supply of materials	• Plastic and metal containers; • Packaging materials (plastics, metals, cardboard, pallets).	• Seismic Survey • Exploratory Drilling • Hydraulic stimulation

Vehicles and machinery	• Tyres (used); • Lead-acid batteries; • Waste oil and lubricants; • Air filters; • Oily rags. .	• Seismic Survey • Exploratory Drilling • Hydraulic stimulation
On-site incinerators	• Incinerator ash	• Seismic Survey • Exploratory Drilling • Hydraulic stimulation
Storage of oil and chemicals	• Tank bottoms; • Empty containers (in metal and plastic); • Unused chemicals.	• Seismic Survey • Exploratory Drilling • Hydraulic stimulation
Sedimentation	• Wastewater treatment tank bottoms	• Seismic Survey • Exploratory Drilling • Hydraulic stimulation
First aid/medical treatment centres	• Medical waste	• Seismic Survey • Exploratory Drilling • Hydraulic stimulation

Annex D.2.2 summarises the different main waste streams expected as a result of the planned Project activities. It also provides an indication of volumes to be generated, and the anticipated disposal methods.

3.2 Waste Classifications

All waste generated by the Project will be classified in accordance with the Algerian Regulation on Waste Management, Control and Disposal (Law 01-19) and the regulation that establishes the nomenclature for the different solid waste streams (Decree No. 06-104).

Essentially, this decree classifies waste into the following main categories:

- Domestic and Assimilated Waste (*Déchets ménagers et assimilés* – MA) ;
- Special Non-hazardous Waste (*Déchets spéciaux* – S);
- Special Hazardous Waste (*Déchets spéciaux dangereux* – SD); and
- Inert Waste (*Déchets Inertes* – I).

In addition, medical waste should be classified and managed according to the Regulation on Medical Waste Management, Executive Decree No 03-478.

3.2.1 Domestic and Assimilated Waste

Typically, domestic and assimilated waste includes wastes that are not considered hazardous and that are generated by domestic activities, in offices, etc. This includes a wide range of materials that may be recycled. Examples of domestic and assimilated type wastes include paper, disposable cups, food waste, packaging, and office refuse.

It should be noted that some products are considered domestic prior to their intended use (e.g., activated carbon or oil stained wood), however, they may become special or special hazardous waste once used and may contain a range of hazardous chemicals or contaminants. In contrast, some products are considered hazardous or special prior to their treatment, however, they become domestic (or special) waste once treated, and may be re-used, for example plastic or metal containers for storage of chemical substances. Once they are empty, they may be properly cleaned for re-use or recycling.

Table 3.3 presents a preliminary list of inert and domestic and assimilated waste expected to be generated during Project exploration activities.

Table 3.3 Domestic and assimilated waste

Types of Waste	Estimated quantity during seismic survey	Estimated quantity per vertical well drilled	Estimated quantity per horizontal well drilled
Food waste	2 kg/person and day	150 m^3	225 m^3
Litter			
Paper and cardboard			
Plastics (bottles, packaging, PET containers)	<700 kg		
Containers – metal (used and not contaminated)			
Containers – plastic (used and not contaminated)			
Glass			
Metals (cans, other)			
Wood or vegetation			
Packaging material - various			

3.2.2 *Special Waste (not hazardous)*

Special waste refers to those non-hazardous wastes that are not inert and cannot be assimilated into domestic waste. Typically, special wastes generated by a seismic and drilling exploratory project include oily rags, non-metallic oil filters, absorbent pads, plastic wraps, packaging materials, sludge and various small amounts of other flammable materials, discarded wire, scrap metal, plastic wraps, packing materials, glass items, cans, plastic, and various small amounts of other materials.

In Table 3.4 a preliminary list of special waste expected to be generated during the exploration activities of the Project is presented.

Table 3.4 Special waste

Types of Waste	Estimated quantity during seismic survey	Estimated quantity per vertical well drilled (80 days / 250 People)	Estimated quantity per horizontal well drilled (100 days / 250 People)
Incinerator ashes	< 50 Ton	< 50 Ton	< 50 Ton
Metallic drums	500 Kg	Unknown	Unknown
Scrap metal		15 m^3	20 m^3
Toner	< 1 Tn	< 1 Tn	< 1 Tn
Filters – air (used)	< 50 Units	< 50 Units	< 50 Units
Tyres	30 Units	30 Units	40 Units
Drill cuttings (water based muds)	none produced	500 m^3	600 m^3

Sludge from sewage treatment processes	Unknown	Unknown	Unknown

3.2.3 Special Hazardous waste

Algerian law defines hazardous waste as that which can potentially harm human health and/or could potentially damage the natural environment if not managed and disposed of in an appropriate way.

Within each special hazardous category, different hazardous sub-categories have been assigned as per Decree No. 06-104:

- explosive;
- flammable;
- extremely flammable;
- irritant;
- noxious;
- toxic;
- infectious;
- carcinogenic;
- corrosive; and
- hazardous for the environment.

Despite being hazardous, several types of hazardous waste can and should be reused or recycled, to the extent practical (e.g., waste oils).

In Table 3.5 a preliminary list of special hazardous wastes generated during the Project activities is presented.

Table 3.5 Special Hazardous waste

Types of Waste	Estimated quantity during seismic survey	Estimated quantity per vertical well drilled (80 days / 250 People)	Estimated quantity per horizontal well drilled (100 days / 250 People)
Chemicals (solvents, others)	< 0.1 Tonnes	< 0.1 Tonnes	< 0.1 Tonnes
Batteries (dry and acid-based)	400 Units (flashlights)	400 Units (flashlights)	500 Units (flashlights)
Aerosol cans	< 0.1 Tonnes	< 0.1 Tonnes	< 0.1 Tonnes
Contaminated packaging	< 5 Tonnes	< 5 Tonnes	< 5 Tonnes
Contaminated soil	Not expected	Not expected	Not expected
Electrical and electronic equipment	< 2 Tonnes	< 2 Tonnes	< 2 Tonnes
Fluorescent lamps	< 0.1 Tonnes	< 0.1 Tonnes	< 0.1 Tonnes
Used oil	0.15 Tonnes	0.15 Tonnes	0.25 Tonnes
Oil filters	0.1 Tonnes	0.1 Tonnes	0.1 Tonnes
Oily rags	0.1 Tonnes	0.1 Tonnes	0.1 Tonnes
Refrigerants	< 1 Tonnes	< 1 Tonnes	< 1 Tonnes
Cement slurries	none produced	approx. 20 m^3 (From cement returns to pits)	Approx. 30m^3 (From cement returns to pits)
Drill cuttings (Oil-based muds)	none produced	not expected	not expected

NORM	none produced	not expected	not expected
Sludge from contaminated evaporation ponds	Not expected	<20 m3	< 250 Tonnes

In addition to the waste reported in the table above, the exploration activities, and in particular drilling and well stimulation and testing, will generate potentially contaminated wastewater that will need to be treated.

The preliminary estimate of generated wastewater quantities prior to treatment is reported in Table 3.6

Table 3.6 Hazardous wastewater

Types of waste	Estimated quantity during seismic survey	Estimated quantity per vertical well drilled	Estimated quantity per horizontal well drilled
Potentially waste water from cleaning areas (e.g. rig)	<150m3	<150m3	<150m3
Sewage: grey water	135 m^3	135 m^3	200 m^3
Sewage: black water	90 m^3	90 m^3	135 m^3
Water-based muds	none	795 m^3	950 m^3
Oil-based muds	none	not expected	not expected
Condensate	none	400 m^3	800 m^3
Flowback water	none	800 m^3	10000 m^3

3.2.4 Inert Waste

Inert waste is waste which is neither chemically nor biologically reactive and will not decompose. Examples of this are sand, drywall and concrete. These residues are generally the result of construction activities. The main production of this type of waste in the Project will be generated during the construction of the well pads, wastewater pits, ponds and accommodation camps.

Table 3.8 presents a preliminary list of inert waste generated during the Project activities.

Table 3.7 Inert waste

Types of waste	Estimated quantity during seismic survey	Estimated quantity per vertical well drilled	Estimated quantity per horizontal well drilled
Construction debris – Inert waste	<50Tonnes	<50Tonnes	<50Tonnes

3.2.5 Medical waste

Algerian law defines medical waste as waste resulting from human medical and veterinary activities involving diagnosis, treatment and research, such as the waste that would originate from the Project's clinic(s) which will be classified and managed according to the Regulation on Medical Waste Management, Executive Decree No 03-478. This decree indicates how biomedical waste should be separated, identified, stored, removed, transported and disposed of/treated.

Specifically, in accordance with the decree, medical waste will be separated into the following types:

- infectious waste;

- anatomic waste; and
- toxic waste.

Table 3.8 presents a preliminary list of medical waste generated during the Project activities.

Table 3.8 Medical waste

Types of waste	Estimated quantity during seismic survey	Estimated quantity per vertical well drilled	Estimated quantity per horizontal well drilled
Medical waste	<100kg	<100kg	<100kg

3.2.6 Unidentified Waste

Unidentified wastes are those that are generated from an unidentified source; if an unidentified waste is discovered, it will be treated as hazardous (taking a precautionary approach) until an investigation is carried out to enable its correct characterisation and handling, and a suitable management route identified.

The correct characterisation will be conducted based on the hazard classification established by Decree 06-104.

Furthermore, in order to characterise an unidentified waste, if necessary, the following options can be employed:

a) Material Safety Data Sheet (MSDS) information (e.g., spent chemicals, and lubricant oils usually preserve their original hazardous characteristics, or their degradation is described on relevant MSDS).
b) Process knowledge (e.g., a continuous waste source constituted by spent drilling mud containing the already analysed synthetic base).
c) Laboratory analysis to be carried out by the waste contractor upon Statoil's request.

4 Roles and Responsibilities

4.1 Responsibilities for Waste Management

Table 4.1 summarises the responsibilities of different organisations with respect to the management of wastes generated by the Project.

Table 4.1 Waste Management Responsibilities

Organization	Responsibilities
Statoil	Overall responsibility for the management of environmental aspects during Project activities. This includes ensuring Project waste is managed in a manner consistent with Algerian laws and the framework set within this WMP, including: • Development and implementation of the final WMP following the framework established within this document, including: o collection, compilation and analysis of waste management performance statistics to ensure compliance; o assessment of compliance and adoption of continual improvements; o ensuring required monitoring is undertaken; o ensuring reporting is developed as required by the WMP and

	ESIA report; o overseeing of any updates of the WMP and subsequent communication of changes to Statoil staff, contractors and the Algerian authorities; and o communication of waste management procedures to site personnel and contractors including provision of waste awareness training to site staff and contractors. • Preparation of contracts that include requirements for managing Project waste in accordance to the WMP; • Monitoring the waste management performance of Project contractors by undertaking audits. o Ensuring all Project waste management facilities (Statoil owned or third party owned) are operated in accordance with the relevant licences ; and o Evaluation of new waste treatment / disposal facilities as part of Statoil's commitment to continual improvement.
General Contractors (drilling contractors; seismic contractors)	Ensuring all wastes are managed in accordance with the WMP and contract requirements including. • Compliance with Algerian laws and any other relevant legislative requirements and best practices; • Appropriate segregation, labelling, storage, transport and disposal; • Provision of assurance to Statoil proving that Project wastes are being properly managed and disposed of through provision of waste generation and waste management data, including records and official documents (i.e., waste transport manifests and waste tracking logs); and • Provision of training to staff in Project waste management procedures and the requirements of this WMP.
Waste Management Contractors	• Management of wastes in accordance with Contract and WMP requirements; • Management of all Project wastes in accordance with site authorisation or licence and Algerian laws; • Completion of waste transport manifests and returning of a copy to Statoil as evidence of reception/transfer/disposal of Project wastes; • Provision of information and data to Statoil regarding Project wastes managed; and • Allowing Statoil access to waste management facilities and operations for auditing purposes.

Source: Statoil, 2015

4.2 Liabilities

Statoil recognises that it has a duty to ensure that any waste produced by the project is handled safely and in accordance with legal requirements and international standards as described in section 3.3. This means that in practice, Statoil is responsible for ensuring the safe and proper recovery, treatment or disposal of waste produced as a result of Project activities. This responsibility applies during the whole waste management process, from its generation until it is appropriately disposed of, including those cases when the waste is transferred to a third party, such as a waste contractor, for its transport and/or treatment.

As a result, Statoil will take measures to ensure that all waste is stored and disposed of responsibly, and in particular will:

- Prevent anyone keeping, depositing, disposing or removing Statoil waste without a waste management licence ensuring that waste is only handled or dealt with by individuals or businesses that are approved to do so.
- Ensure that waste management licences are kept current.
- Ensure materials are properly packaged for transportation and that all waste containers are appropriately labelled for storage and transportation purposes.
- Ensure records of all wastes received or transferred are kept through a system of signed waste transport manifests and waste tracking logs. This will allow all the wastes to be traced and will provide a written description enabling anyone receiving the waste to dispose of it or handle it appropriately.
- Ensure material safety data sheet (MSDS) records are kept for all hazardous wastes and that they accompany the waste during its transportation.

In this context waste transport manifests and waste tracking logs are fundamental for ensuring that wastes are transferred from the producer, through a transportation chain, to the final disposer, providing a record of due diligence and chain of custody that will allow the waste to be traced. The waste transport manifest tracks the waste stream from the point of origin to the deposition location as it accompanies all waste consignments (along with the cargo manifest) originating from Project activities, and will be duly completed with the details required and the appropriate signatories.

4.3 Training

Waste management awareness training, as part of the Project induction process, will be provided to all Project personnel (including contractors and subcontractors). Toolbox talks, team briefings, safety meetings and periodic poster campaigns will also be used to ensure ongoing awareness of and compliance with correct waste management procedures as outlined in this framework WMP.

Apart from general waste management training, the personnel directly involved in waste treatment or waste disposal will also receive additional training provided by waste equipment suppliers, including training in incinerator operation.

4.4 Management of Change

As part of the WMP's philosophy and Statoil's SU602 standard, Statoil will periodically review and modify the plan if risks are identified or changed due to:

- Changes to Algerian laws and regulations;
- Changes in Statoil policies and reporting procedures;
- Changes in Statoil operations (changes in the project design or activities); and/or
- Changes as a result of deficiencies identified from incidents or audits.

5 Waste Management and Routes

Within this section the different waste management options are described and the waste treatment opportunities for waste reduction, recycling and responsible disposal are defined based on the waste hierarchy principles and the analysis carried out via the waste classification in Section 3.

5.1 Waste minimisation

As indicated in Section 1.2 on the prevailing waste management principles, the first priority will be to minimise the amount of wastes generated as well as their toxicity.

Waste reduction can be achieved by careful Project planning and design, as well as by ensuring the implementation of good site practices. Reducing the volume and toxicity of waste generated will reduce the potential impacts associated with the handling, storage, transport, treatment and disposal of the waste as well as reducing the amount of raw materials consumed.

Measures that will be implemented to reduce the amount and toxicity of waste that is generated include the following:

- Contractors will be required to verify that they have taken into consideration waste reduction techniques and strategies as part of their bid for purchasing and management.
- Contractors will be required to have a Reuse/Recycle Plan for their portion of the Project work.
- All waste will be segregated so as to minimise the volume of toxic waste by avoiding waste mixing.
- Containers should be labelled, covered, and sealed to prevent accidental mixing of wastes or contamination by water. For example, if one litre of paint thinner is poured into a 500 litre tank of used motor oil, the result is 501 litres of hazardous waste. Normally, paint thinner and used motor oil are able to be recycled.
- Where practicable, all materials will be ordered in bulk in reusable packaging that can be returned to the suppliers.
- Useful materials should be segregated from the waste and identified. Containers should be labelled with the name of the material.
- Only the amount of material needed should be ordered. Personnel should refrain from over-ordering or stockpiling materials.
- The appropriate size container should be ordered based upon the quantity of product needed. The entire product in one container should be consumed prior to opening another. For example, when two litres of a material are needed, ordering two-one litre containers is more beneficial than ordering a five litre bucket.
- Waste transportation should be arranged as soon as enough waste has been generated to justify a shipment and in order to prevent a hazardous situation in the area where the waste is stockpiled.
- Prior to transporting waste, it should be verified that the manifest or other transfer form identifies the type and volume of the material and the number/size of containers.
- Paint and solvents should be used completely. Empty containers should be allowed to dry and placed in the general trash unless the paint is lead based. Lead-based paint requires disposal as hazardous waste, and as such will only be used if no other option is possible.
- Non-hazardous materials should be used in place of hazardous materials wherever possible.
- Every effort should be made to completely empty vendor-supplied containers. This reduces the potential expense and liability of hazardous waste transportation.

5.2 Waste collection/handling

The most important aspect of good practice for waste collection is to ensure that wastes are segregated at source and kept segregated during collection and transportation to the waste treatment/disposal facility. Statoil is working towards implementing a segregation system and addressing the issue of maintaining segregation throughout collection and transportation.

After proper segregation, most of the waste generated will be temporarily stored in the Project site in a series of selected waste storage areas, until it is suitably managed (by means of reuse, recycle, treatment or disposal) according to the applicable legislation, guidelines and best practices.

In this context, waste handling must be carried out in compliance with the minimum requirements listed here below.

- Routes to and from waste storage areas shall be chosen in such a way as to avoid:
    - Uneven terrain where there could be a high risk of spills;
    - Interference with other concurrent complex operations;
    - Crossing areas where activities incompatible with the type of substance handled are carried out (e.g., when handling flammable substances, avoid crossing areas where welding activities occur);
    - Crossing areas where water wells are located;
- Where required, the proper PPEs (Personal Protective Equipment) must be worn for handling waste , including:
    - Gloves (i.e., leather or chemically resistant, as warranted);
    - Safety glasses, goggles or face shield;
    - Hard hat;
    - Steel-toed shoes or boots; and
    - Coveralls or other suitable work clothes.
- Containers where the substances are stored shall be maintained and provided with devices to prevent overflow;
- Transportation equipment shall be adequate to the quantity of substance to be handled and provided with proper devices (e.g., close-boarded platforms, fasteners etc.) to prevent potential roll-over of the containers;
- Traffic signals to manage transportation shall be placed inside the construction and operating areas;
- Safety measures for handling flammable and hazardous substances shall be implemented where applicable;
- Decanting shall be carried out on paved areas or using devices to prevent soil contamination in case of spills;
- A permit-to-work system shall be applied in the case of waste handling activities considered critical.

Personnel involved in the handling of wastes must recognise and understand the potential hazards associated with waste management. To achieve this, all personnel will be trained to a level commensurate with their duties.

With regard to special hazardous wastes, it is essential that they are identified at the source and registered in the waste declaration form for hazardous waste, included in the Annex of Executive Decree 05-315 and provided in Figure 5.1. It is the obligation of the waste generator to fill out and submit this form to the *Wilaya*. At the same time it serves as an instrument for waste identification, monitoring and control, which should be used for hazardous as well as non-hazardous waste.

Figure 5.1 Model waste declaration form

REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE

DECLARATION DES DECHETS SPECIAUX DANGEREUX

Année .... Date de transmission ....

Identification du générateur et/ou du détenteur

Statut de l'entreprise
....

Dénomination de l'entreprise
....

Siège social
....

Domaine d'activité
....

Certification éventuelle de l'entreprise
....

Nom de la personne chargée de la gestion des déchets
....

A/ Nature, quantité et caractéristiques des différents types de déchets spéciaux dangereux générés

1 - nature des déchets spéciaux dangereux générés

Matière première utilisée
....

Dénomination du déchet
....

Code du déchet
....

Consistance du déchet

Solide ☐ liquide ☐ gazeux ☐ pâteux ☐

Autres précisions en cas de mélanges éventuels
....
....

2– Quantité des déchets spéciaux dangereux générés : (t/an)
....
....

3– Caractéristiques des déchets spéciaux dangereux générés :

Composition chimique
....
....

Critère de dangerosité
....
....

4 – Stockage des déchets spéciaux dangereux

Types de stockage

Temporaire ☐ Quantité ....t/an

Permanent ☐ Quantité ....t/an

Modalités de stockage
....
....

Source: Annex of Executive Decree 05-315 (http://www.joradp.dz/FTP/jo-francais/2005/F2005062.pdf

In this context the creation of a waste inventory (both hazardous and non-hazardous) is considered necessary for the appropriate handling of wastes. This inventory must include, at least, the type and nature of waste generated, its storage location, date of storage and quantity of waste.

5.2.1 Waste storage areas

Domestic waste and special non-hazardous waste, special hazardous, inert and medical waste will be stored separately in designated storage areas and incompatible waste will be segregated so as to prevent inadvertent contact in the event of leakage from a container.

A dedicated layout reporting the location of all waste storage areas will be prepared and made available to all personnel concerned.

5.2.1.1 General Characteristics

Storage areas will be located far from any sensitive receptors, such as vegetated areas, water wells, and generally down current from campsites.

The selected storage areas, including those destined for liquid wastes, will be:

- Fenced and locked, in order to avoid thefts and scavenging by animals, pests and rodents;
- Signposted to clearly reflect the nature of the materials stored inside.
- Either paved or protected from direct contact between wastes and the soil.
- In the case of liquid waste stored in tanks or drums, these must be provided with secondary containment.
- Waste storage areas must be protected from potential bad weather conditions (episodic torrential rain or high winds).
- Each storage area must include segregated sectors to allow the separate storage of different waste streams according to their hazard class, and waste compatibility.
- Properly maintained (e.g., all damages, such as cracks, that could allow leakage of contaminants to soil will be timely identified and eliminated) and kept clean.
- Provided with corrosion-resistant inner surfaces in case of hazardous waste storage area.
- Provided with fire-fighting systems/equipment where applicable with respect to waste flammability.

5.2.1.2 Waste storage areas on the Project site

At this stage of project design it is proposed that waste storage areas are constructed for each seismic base camp and adjacent to each well to be drilled. This assumption may change at a more advanced and detailed phase of project design. Final locations and dimensions of each waste storage areas will be defined in an advanced stage of the Project when detailed data, including the type and the amount of generated waste, is available.

All waste will be carefully segregated in separate sectors based on its hazard classification and waste compatibility.

Accommodation camps and well site areas will be equipped with separate containers or bags for proper and temporary collection of domestic and assimilated waste, special (non-hazardous) waste, special hazardous waste (including specific containers to collect and store medical waste) and inert waste that will be periodically transferred to the waste storage areas. A regular collection schedule, with sufficient frequency to avoid accumulation of waste, will be implemented.

Waste storage areas will be provided with a paved and impermeable floor, in order to prevent soil and groundwater contamination in the case of accidental spillages, and these will be equipped with a fixed cover on top to protect the waste and containers from bad weather conditions. They will have adequate ventilation and enough space will be left to easily and safely allow stacking of containers and loading, unloading and maintenance activities.

Furthermore the slope and orientation of waste storage areas will be designed and maintained in such a way that free drainage of leachate, generated by accidental spillages, will be directed into a collection drain and then added to the potentially contaminated runoff water, which will be properly treated.

As previously indicated, the waste storage areas will be divided in sectors for each type of waste according to hazardousness. Within each sector, waste containers will be located in rows and, if feasible, stacked to optimise the space available for waste storage. It will be important to leave enough aisle space between sectors and rows of containers (minimum 15 cm) in order to safely allow loading, unloading and maintenance activities and so that the labels and conditions of each container can be easily observed.

Storage of waste will also be carried out in accordance with the MSDS for each waste type. MSDS records will be kept at waste storage areas for all hazardous waste being stored on site. This is extremely important in order to avoid mixing incompatible waste.

5.2.1.3 Storage areas for recyclable wastes

Within the storage area associated to each well/campsite an area should be prepared for the storage of recyclable wastes. Bales of plastics, paper/cardboard and aluminium can be stored in this area as well as other recyclables (scrap metal or tyres) as long as they are not categorised as special dangerous waste.

5.2.1.4 Storage areas for domestic and special non-hazardous waste

Domestic and special non-hazardous waste will be stored as follows:

- Wastes will be stored in containers that are in good condition and compatible with the characteristics of the materials in question.
- Containers must be kept closed at all times.
- Empty gas cylinders will be deposited in a safe standing position and separately by typology “r” in a clearly labelled section of the covered storage area.
- Suitable containers will be used for storing kitchen oil and grease.
- Empty containers (metal and plastic) will be placed separately and stacked on pallets. Even if the storage area will be covered, empty containers will be stored on their sides with bungs or lids in place. This storage method prevents any accumulation of precipitation or other liquids in the drums and eliminates the need to deal with such liquids (e.g., rainwater mixed with residual material in drums increases the volume of waste and thus increases the disposal cost).

5.2.1.5 Storage areas for special hazardous waste

It is important to designate specific areas/locations for the intermediate storage of hazardous waste generated at source and ensure that the waste is only stored in those areas, marked as hazardous waste storage areas, prior to being transported to the final waste storage area. All containers/receptacles in those areas should be properly marked, identifying the wastes stored and any associated hazards according to the indications of the relevant MSDS (material safety data sheets).

Waste entering the storage area should be recorded in the inventory, so that it is known which wastes are stored, where, and how long they have been there.

As with domestic wastes, prime recyclables should be identified so that the possibilities for recovery/recycling are maximised. Careful segregation at source should be enforced. Containers must be marked consistently, showing their contents and also indicating if the contents are destined for recovery/recycling. A large number of contaminated plastic containers, including tubs and drums may be generated and these are potentially good candidates for recycling. Statoil or its contractors should communicate with recycling companies to identify the types of plastics that are recyclable.

Wastes which are periodically generated in large quantities (e.g., bottom tank sludge) can be placed in empty drums and stored in the intermediate storage area for hazardous wastes. At the same time, this measure includes the reuse and elimination of the drums.

Special hazardous waste will be handled and stored so as to avoid potentially dangerous incidents due to escape of the waste or mixing of incompatible wastes, and to ensure that hazardous waste does not enter the non-hazardous waste stream. The storage methods for the main hazardous waste classes are listed below.

- Solid waste, such as oil filters, or incinerator ash (if classified as special hazardous) will be stored in proper, closed containers.
- Suitable containers will be used for storing special hazardous waste, such as batteries and lamps.
- Contaminated containers (metal and plastic) will be placed separately and stacked on pallets. Even if the storage area will be covered, empty containers will be stored on their sides with bungs or lids in place. This storage method prevents any accumulation of precipitation or other liquids in the drum and eliminates the need to deal with such liquids (e.g., rainwater mixed with residual material in drums increases the volume of waste and thus increases the cost for disposal).
- Liquid waste such as paint, solvents, waste oil and sewage treatment sludge (from sedimentation) will be stored in closed containers, inside a secondary containment.
- All containers and waste types will be appropriately labelled for recognition.
- Containers for special hazardous wastes must be sealable containers.
- OBM cuttings, if generated, will be placed in skips or cuttings boxes and stored onsite for a limited time, pending transport.

5.2.1.6 Medical waste

Medical waste will be separated based on its hazard level as follows:

a) Infectious waste
b) Cutting and / or perforative waste.
c) Anatomic waste.
d) Toxic waste.

The following measures will be adopted for the storage of medical waste

- All infectious waste bins will be identified by a yellow colour, as well as other related identification labels;
- Infectious waste will be separated into yellow plastic bags, or if not possible, any other yellow impermeable plastic bags or containers labelled with the wording “infectious waste”;
- Waste medicine must be stored in containers stamped with the wording “waste medicine” to be dumped in a safe site.

5.2.1.7 Storage areas for inert wastes

An inert waste storage area should be created at an appropriate site with easy access. Construction and demolition waste should be collected and stored in this area. Recycling options can then be evaluated, and the material can be used for road construction or other purposes

5.2.2 Containers and labelling

All typologies of waste will be collected in proper containers with the following characteristics:

- Non-absorbent, water tight, insect resistant, durable, easily cleanable, and designed for safe handling;
- Free of leaks, corrosion, gouges, bulges and creases. If a container becomes severely rusted, bulging, structurally unsound, or leaky, etc., it will be replaced, or placed into an over-pack drum;
- Compatible with the waste they contain (e.g., corrosives should be packaged in plastic drums; liquids should be packaged in non-removable head drums);
- Sufficiently sized to prevent overflow;
- Clearly labelled to indicate the type of waste;
- Maintained in a clean, sound condition and free from offensive odours;
- Provided with covers and kept closed except when filling;
- Acceptable for shipment to avoid the need for changing containers prior to shipping (i.e., complying with applicable legislation on transport of dangerous goods).
- Not completely full, if used to store liquids. Sufficient space will be provided so that the container is not full of liquid and can withstand the vapour pressure of the liquid it contains (at temperatures of up to approximately 60°C).
- The secondary containment volume (for liquid waste storage) will be sufficient to hold all the liquid stored in the container or, in case of multiple containers in the same containment basin, to store at least 1/3 of the total amount and, in any case, 110% of the content of the largest container.
- With regard to hazardous waste, containers will be suitable for the substance they are holding, resistant to corrosion, maintained in a good condition, securely closed and sealable, and display the appropriate hazard warning symbol.
- With regard to medical waste,
    - all infectious waste containers will be clearly identified through the label “Infectious Waste” and stamped with the international infectious waste logo;
    - Cutting and/or perforative waste will be stored in strong and rigid-walled containers and the wording “Cutting and/or perforative waste” is to be printed on one of the easiest to see sides and, if this is not possible, stamped with a yellow label with the wording “Infectious Waste”. The container will also display the international infectious waste log;
- Cutting and /or perforative waste containers may be produced from recycled plastic pharmaceutical containers or any other rigid fixed containers painted in yellow or displaying the wording “Cutting and/or perforative waste” in yellow.

5.2.2.1 Containers for non-hazardous waste

This section refers to wastes of a non-hazardous nature, corresponding to the categories of domestic and assimilated waste, inert wastes, and non-hazardous special and medical wastes.

With regard to storage containers for non-hazardous waste, it is considered that lined receptacles with colour-coded bags and lids simplify collection and the maintenance of segregation during transportation. Waste collectors would remove the bag and contents from the waste bin/receptacle and replace with an empty bag of the same colour.

Possible receptacles are 240 l and 120 l plastic bins with wheels. For the different fractions, lids of different colours can be used and special slots for cans and for paper could be installed, if preferable.

If preferable, metal containers (typically 5 m^3 capacity) can be used for certain waste streams, including plastics, scrap metals, and metallic non-contaminated packaging wastes.

Figure 5.2 Example of 120 l bins for separate collection

Source: Statoil, 2015

Figure 5.3 Example of 240 l bins with openings for cans or bottles

Source: Statoil, 2015

There is no international standard colour coding system for waste bags and bins, except for medical waste, which is packaged in yellow bags, and mixed urban waste, which is generally packaged in black bags and bins. Statoil Timissit should adopt its own classification system, including yellow bags for medical waste and black bags for mixed domestic waste. A potential suggestion is indicated in the figure below.

Figure 5.4 Possible Colour Coding System (Recycling Oriented)

Bag colour	Contents
clear	PET drinking bottles (transparent)
orange	All other packaging materials, but no paper/cardboard (yoghurt cups, tubs etc.)
green	Paper/cardboard
blue	Metals (e.g. drink cans, tins)
yellow	Healthcare Wastes (NO SHARPS)
Strong recipient (can be yellow)	SHARPS (healthcare waste)
black	Mixed household wastes

The colour-coded classification proposed above is a system focusing on the recyclable fraction. The expected large quantity of PET drinking bottles justifies collecting these as a separately uniform waste stream, to be gathered in transparent plastic bags, or no bags at all, only in the bins. Other separately collected waste streams for recycling are paper/cardboard and metals.

Using a flexible system with colour coded lids is recommended. Lids could be exchanged between bins as needed. The reason is that the final use and requirements of recycling companies accepting the material might change, e.g., a company might only accept aluminium cans, but not mixed with tin plate, because they have no separation possibilities. If a company is only interested in white office paper, this should be separately collected and not mixed with paper and cardboard.

In the case of waste incineration, a simpler segregation system could be applied. Figure 5.5 shows the system assuming that organic waste will still be separated at source and metals will be recycled. Medical wastes must be handled separately inside the facilities even if they could be incinerated together with other wastes, assuming the availability of an appropriate incinerator. The details of waste segregation depend on the type of incinerator. In the example in Figure 5.5, orange-, yellow- and black-coded waste would be incinerated.

Figure 5.5 Possible Colour Coding System (Incineration Oriented)

Bag colour	Contents
orange	All packaging materials (plastics, cardboard etc.)
blue	Metals (e.g. drink cans, tins)
yellow	Healthcare Wastes (NO SHARPS)
Strong recipient (can be yellow)	SHARPS (healthcare waste)
black	Mixed household wastes

5.2.2.2 Containers and labelling for hazardous wastes

This section refers to wastes of a hazardous nature, corresponding to the categories of hazardous special wastes and hazardous medical wastes.

Collection containers should be marked in a consistent manner to clearly indicate the presence of hazardous wastes.

The special hazardous waste containers will comply with the following:

- They must be in good condition, clean and free of cracks. Once full, they must be hermetically sealed to ensure that there are no leaks.
- They must be conceived and produced to avoid any loss of content, and built with materials that are not susceptible to attack by their content, and which do not form dangerous combinations with that material.
- They must be solid and resistant for appropriate handling.
- The packing and storage of hazardous waste shall be carried out in a way that avoids generating heat, explosions, combustion, the formation of toxic substances or any effect that may increase the hazard level of the waste or make it difficult to manage.
- The content of waste containers will be identified in a clear, legible and indelible way, using a visible label according to the ministerial Order of 2nd September, 2013, i.e., according to the model (Figure 5.6) and with a minimum size of 10% of the container surface.
- The label must include the following information:
  - Special Hazardous Waste ("*Déchet Spéciaux Dangereux*") must be clearly mentioned
  - Name of the waste contained
  - Identification code (as per Executive Decree 06-104 of February the 28th)
  - Hazardous criteria for that specific waste (as per Executive Decree 06-104)
  - Indication of the risks and orientation regarding prudent actions
  - Quantity of waste
  - Name, address and phone number of waste holder and generator.

- o Destination of the waste in the case it is transported.

Figure 5.6 Model Special Hazardous Waste label

Modèle d'étiquetage

* النفايات الخاصة الخطرة

Déchets spéciaux dangereux *

النفاية : ....

Déchet : ....

الرمز : .... النفاية رقم ....

Code : .... Déchet n° ....

* معيار تحديد مدى خطر النفايات ....

* Critère de dangerosité : ....

الكميّة : كغ

Quantité : kg

الاسم : المنتج و/أو الحائز / المرسل إليه

Nom : générateur et/ou détenteur/destinataire

العنوان : المنتج و/أو الحائز / المرسل إليه

Adresse : générateur et/ou détenteur/destinataire

Source: Annex of Executive Decree 05-315 (http://www.joradp.dz/FTP/jo-francais/2005/F2005062.pdf

The following containers are suggested for the different special hazardous wastes expected

Table 5.1 Containers for Special Hazardous waste

Types of waste	Storage on site
Cuttings contaminated with OBM	Cutting Boxes DNV 2.7-1 Certified / Evaporation ponds
Contaminated absorbents	Drum (200 litre) with locking ring
Used aerosols	Drum (200 litre) with locking ring
Contaminated packaging	5 m^3 metal container
Used oils	Waste Oil Tanks. 2700 l capacity
Paint and solvents	Drum (200 litre) with locking ring
Fluorescent lights	Drum (200 litre) with locking ring
Batteries	Drum (200 litre) with locking ring
Medical waste	Medical waste containers with rigid walls and adequately thick plastic bags.

5.3 Waste reuse and recycling

For materials that have served their purpose and are, unavoidably, destined to be waste, the priority will be their proper segregation, containment, and storage until their reuse or recycling. The assessment of waste types and quantities shows that there are relevant waste streams of reusable or recyclable fractions that can be separated and recycled. Statoil will continually evaluate possibilities for reuse and recycling of products and materials based on practical feasible solutions and economic viability.

5.3.1 Plastics

Plastics may be recovered if there is availability in the market for recovery/recycling.

At least, one recycling company for compacted PET bottles and plastic drums is located in Hassi Messaoud. Other options might be available if further companies are identified.

Options would be to attempt to segregate the plastics into individual types at source or segregate all acceptable plastics into one mixed-plastics container at source and, if necessary, segregate this into individual types. It is assumed that water bottles can be separated easily in order to have one type of clean plastic already separated (PET).

Non-recyclable and contaminated plastics (or all plastics if recycling proves impracticable to implement) could be incinerated in an environmentally sound manner in a modern incinerator unit. Another option is compacting and balling these materials together with the mixed waste stream before final disposal.

5.3.2 Metals and glass (domestic-type)

Given the small quantity and the high specific weight of glass and the long distance transportation requirements, it is not considered a recyclable waste stream. Glass can be dumped at a landfill for inert wastes, if any is located nearby, with the exception of glass from fluorescent tubes and other lamp bulbs containing hazardous materials that need to be managed as special hazardous wastes.

Metal is an important domestic and special waste stream. Aluminium drinking cans are a significant source of waste that could be sold to recycling companies in Hassi Messaoud.

The collection of cans can be carried out using 120 l or 240 l bins with or without special can slots. As collected aluminium cans have a very low density, they should be compacted prior to transportation.

Metal parts generated during Project activities (scrap metal) as special wastes are already separated from the waste stream and stored separately. This metal can also be sold in Hassi Messaoud.

5.3.3 Paper and Cardboard

Paper and cardboard can also be stored and transported for recycling. However if quantities are not enough to make the transport profitable, they may also be incinerated on site. For small quantities, incineration at site will be the best environmental option.

Recycling companies are located in Hassi Messaoud and in the north of Algeria; it should be discussed with them if white paper is to be submitted separately or together with a mixed paper/cardboard fraction. The material should be compacted by a baling press.

5.3.4 Oily wastes

Waste oil recycling exists, and specialised firms like NAFTAL in Hassi Messaoud, have recycling facilities available. Statoil will evaluate the possibility of waste oil recycling based on environmental performance of the waste oil recycler and economical viability. Transportation costs are to be considered and relevant quantities must be accumulated in order to reduce transportation costs as far as possible.

Used oils should be stored in a controlled hazardous waste storage area, provided with secondary containment. A waste contractor or transport company licensed for hazardous waste transportation should collect the used oil. Another possible option is recovery using centrifuge or filtration equipment, and exportation of the recovered oils.

If reuse or recycle is not possible, incineration could be the final treatment.

5.3.5 Organic wastes / food wastes

A significant proportion of domestic-type wastes generated are food wastes, mainly from the accommodation camps. Other organic wastes include garden and yard wastes (although the nature of Timissit Base Camp and other facilities are such that large quantities of the latter are not expected).

Given the limitation of a remote location, the only option considered feasible has been incineration of organic domestic wastes at site.

5.3.6 Construction and demolition waste

Construction and demolition waste can be easily reused provided it has not been contaminated by oil spills or other chemical / toxic substances. The best option is to crush demolition waste to gravel and reuse it as filling material, for instance for road construction. This type of waste will also be disposed of in a municipal landfill (provided it lacks hazardous materials, in which case these should be extracted and separated).

5.3.7 Waste from electronic and electrical equipment (WEEE)

Electronic waste, like computers, washing machines, fridges etc. has to be treated, recycled and disposed of by authorised competent recycling companies using appropriated methods. Electronic waste has to be properly decontaminated by removing toxic components.

For this specific project it is recommended that all waste from electronic and electrical equipment be stored at one site (e.g., in a container) and then transferred to a recycling firm once sufficient quantities have been gathered.

5.4 Waste treatment and disposal

The waste management hierarchy gives preference to *avoidance* and *minimisation* and then *reuse*, *recovery* and *recycling.* However, there will always be a proportion of wastes which cannot be avoided and which cannot be practicably reused, recovered or recycled. The hierarchy then, as a general principle, states that waste should be treated before disposal to reduce the hazards and quantities of waste for final disposal. Exact waste treatment and disposal methods will be determined as the project design progresses and following an evaluation of different waste management options. The specific arrangements for the transport and disposal of the different waste types will be detailed out in the final Waste Management Plan (WMP) to be prepared when the final project design is available.

As a first option, if feasible, non-hazardous, special hazardous and medical waste will be treated on-site (through wastewater treatment, incinerators, etc.). Residual waste and incinerator ash may be transferred outside the project site and disposed in a landfill by a third party contractor. If this is not feasible, another option to be considered is the construction of an on-site landfill for non-hazardous waste.

The main wastes potentially requiring treatment are:

- Non-recoverable /non-recyclable domestic wastes;
- Special and hazardous waste;
- Non-recoverable / non-recyclable oily wastes including oil sludge;
- Drilling Wastes;
- Flowback water and produced water;
- Contaminated soil;
- Small quantities of solvent and chemical wastes;
- Oil and air filters;
- Contaminated receptacles; and
- Medical waste.

Key criteria when considering/selecting technologies for application are robustness, flexibility, performance and reliability. The following sub-sections consider the options for domestic-type wastes, special and hazardous wastes, and then medical wastes. Technological options fall into three broad categories:

- Physical/chemical;
- Thermal incineration or thermal desorption methods ;
- Biological.

5.4.1 Domestic-type wastes

Domestic-type wastes are generally treated by thermal or biological means. Thermal processes include incineration (with or without heat recovery), pyrolysis and gasification. The only widely-used biological process is composting (aerobic and anaerobic).

Incineration is a mature, highly flexible, and robust technology. Modern incinerator packages are capable of processing mixed domestic-type wastes to strict international performance standards. The more sophisticated of these units can also generally handle a proportion of industrial and hazardous wastes, including healthcare wastes, simultaneously.

Thermal processes are highly effective from the point of view of reducing volumes of landfill waste, incineration typically results in ash equivalent to 20% to 30% of the waste feed weight, and to 10% to 15% of the waste feed volume. If domestic waste is incinerated together with hazardous solid and liquid wastes and medical waste, higher environmental standards must be applied.

The bottom ash from the incinerators will be analysed to determine whether it falls within the Algerian definition of special hazardous waste. If it is non-hazardous, it can either be deposited in an onsite landfill, if constructed, or taken to a third party landfill.

If it is classified as hazardous it will be disposed off at a properly authorised third party hazardous waste disposal facility (i.e., Statoil will evaluate the possibility of negotiating an agreement with In Amenas Joint Venture, of which is a shareholder, to share the use of certain facilities of the Central Waste Accumulation Area, located in In Amenas).

Landfilling

Landfilling is considered the last option for the domestic-type wastes. The quantity of non-recyclable waste should be low enough that simple landfilling would become feasible, if waste recovery is strictly applied and materials are stored and commercialised (reused, recycled).

In order to optimise environmental protection, a “dry landfill” system is preferred. This means that wastes are compacted, baled before landfilling. Options considered are an authorised domestic waste landfill or a construction of an on-site landfill for non-hazardous waste. If the latter alternative is chosen, the construction will be carried out so it will minimize the generation of leachate. After the project site is closed, a decommissioning plan will secure closure of the waste site and restoration of the area back to its original state.

5.4.2 Liquid domestic Waste

Aqueous emissions will be generated throughout the duration of the seismic surveying activities, drilling and stimulation activities, and will include sanitary waste, water used for cleaning purposes and operational water.

Black and grey water (sewage, wastewater from laundry, kitchen washings and showers) are considered non-hazardous and therefore will be disposed of *in situ* using a contained treatment and disposal system designed to meet both Algerian legal requirements and Statoil standards. This system is likely to involve filtration, both anaerobic and aerobic bacterial treatment, chlorination, and final disposal through sprinkler systems or lined evaporation ponds.

The sewage system and evaporation ponds will be sited to avoid flooding in case of heavy rainfall, and downstream and down gradient of the camp itself. Prior to siting the facilities, a risk assessment will be undertaken to determine risks to contamination of groundwater. Liners will be used if any risk of contamination to groundwater resources is identified.

If evaporation ponds are to be used, they will be designed to accommodate wastewater generated during the total duration of the operations, and it will be ensured that surface runoff cannot enter.

Water discharge areas would be located on absorbent soil, at least 300 m away from local water wells or any perennial surface water source.

If fly camps were in operation, the sewage produced would be stored in a septic tank and transferred to sewage facilities at the base camp for treatment.

The resultant sludge from the treatment of wastewaters, the sewage sludge, should be dried and disposed of at a dump site / sanitary landfill.

5.4.3 Special wastes

Special waste is waste that is not classified as hazardous but that needs particular treatment. The main special waste streams expected in Timissit are scrap metal, tyres and expired non-hazardous drilling mud additives.

The best option for treating the scrap metal is to sell it allowing it to be recycled and reused as described in section 5.3.2.

With regard to tyres, the best option is to have it collected by a recycling company which can sell the material to cement factories in order to be used either as alternative fuel or as a construction material in roads, where it is used to limit noise emissions from the road itself.

Expired non-hazardous mud additives such as starch, bentonite or others are typically generated by drilling activities. Additives generally come in sacks and become waste once they expire. Non-hazardous mud additives can be disposed of in landfills. However, it is recommended to liaise with suppliers and ask them to recover these materials and recycle them if possible.

5.4.3.1 Water based drilling fluids and cuttings

Drill cuttings associated with water-based mud are expected to be one of the highest volume waste streams that will have to be either stored and treated on-site, transported to an approved waste facility for disposal, or disposed off on-site in state approved reserve pits.

Generally, muds and cuttings, once recovered from the well during drilling, are separated in order to return the mud to the recirculating mud system and make the solids easier to handle. This will allow the water used to prepare the muds to be reused, minimising waste generation.

Drill sites will be designed to include shale shakers and a pit or pond for treating the resulting effluents. These pits must be in accordance with Statoil HSE management standards:

- Be lined to eliminate leaching, leakage or unauthorised discharge of content into the surrounding environment.
- Be located a safe distance from oases, surface water, water wells and *foggaras* (>300m);
- Be located a safe distance from human settlements (>300m);
- Be of sufficient size to ensure they will not overflow in periods of heavy rainfall;
- The closure process shall be planned to minimise potential environmental impacts;
- A closure plan and monitoring plans will be developed, based on a risk assessment.

The treatment in the pits is via evaporation or chemical stabilization. After drying and/or stabilization, the dried sediments will be disposed off in the landfill at site or in the lined pit as a part off the decommissioning plan for the site. The cuttings will be buried together with the used lining or. Water-based muds that have been determined to be benign will be left to evaporate and then be mixed with the excavated soil and left in the pit and covered over with top soil.

Before the operation can take place the operation will have to comply with both Algerian legal requirements and Statoil standards**.**

5.4.4 Special hazardous wastes

Main special hazardous wastes requiring treatment are oily wastes and oil/water wastes, including flowback water, condensate, oil based drilling muds and associated cuttings. A variety of other wastes are generated in smaller quantities, such as used solvents and chemicals, and expired hazardous mud additives. Used containers that have housed hazardous substances are also counted as hazardous wastes.

Recovery processes have already been discussed briefly in the context of oil recovering. Acids from lead acid batteries can be decanted into plastic containers then lime slurry can be added manually. The resulting sludge can be dried and solid residues disposed of in the landfill.

5.4.4.1 Oil based drilling fluids and cuttings

The use of oil-based muds will be avoided wherever possible and only used if justified by a technical assessment. Oil-based muds shall be managed separately to water-based muds, and will be recycled and reused on subsequent wells (i.e., not left with water based muds in the pit) as far as practically possible. The OBM wastes, including the associated cuttings, cannot be disposed of onsite.

If oil-based mud is used, the management of OBM cuttings at the drilling site will be the following:

- OBM-contaminated cuttings will be separated with a dedicated high-power shale shaker and transferred by a screw conveyor to a lined pit;
- As an option, OBM cuttings can also pass through a vertical dryer/centrifuge. This will normally reduce the oil content to below 2.5%.
- In order to be able to treat OBM cuttings as non-hazardous waste to enable their final disposal in a landfill, they must be subjected to thermal desorption treatment to reduce the oil content to below 1%.

It must be noted that Algerian legislation does not establish minimum oil content in the cuttings for them to be considered special hazardous waste, though common practices in other countries establish these limits between 1% and 3%. Algerian legislation (Law 01-19) does not allow on-site disposal of any hazardous waste.

As a result the recommended practice is to apply best industry practices, which aim to transport cuttings to appropriate facilities unless the oil content in cuttings is below 1%. These levels can only be achieved by means of a thermal treatment. Dependant on the amount of OBM waste that have to be treated, Statoil will evaluate whether to apply thermal desorption technology on site with the aim to reduce the oil content in the cuttings to below 1%. This treatment will enable for disposal of treated cuttings locally.

If smaller amounts of OBM cuttings is produced Statoil will aim to transport cuttings to centralised treatment sites and perform thermal desorption treatment there. A last option would be to incinerate OBM in cement kilns or in incinerations plants specializing on hazardous waste.

5.4.4.2 Fluid flowback and produced fluids

Fluids produced during flowback will be handled in accordance with Algerian legislation, Statoil requirements and International standards. A separation system will be utilised to separate the three fluid streams from the well: condensate/oil, liquid water, and gas.

Recovered fluids will be recycled or disposed of through flaring, sale, evaporation or removal to an approved disposal site consistent with regulatory conditions.

Fracturing fluids and produced water will be stored on site in either lined earthen storage pits or above ground storage tanks. Fluids will be allowed to evaporate on-site. Remaining dried oily sludge will be collected and incinerated in incineration plants for hazardous waste.

If relevant and technically feasible some produced water will be monitored throughout the project and the technical capability for reuse of water in subsequent drilling and stimulation phases will be considered.

Condensate will be collected and stored in tanks. Then it will be transported offsite to an oil processing facility by a licensed waste management contractor. Optionally, it may be burned on site using an effluent burner.

Reinjecting produced hydraulic stimulation fluids into a suitable formation isolated from production aquifers may also be considered in accordance with regulatory requirements and noting that disposal wells are prohibited by Algerian Law (water code, Law 05-12), except by express agreement of the Ministry of Energy and Mining and the Ministry of Water Resources, after the submission of a technical dossier including justification.

5.4.4.3 Other

Other special hazardous wastes, if feasible, will be treated directly on the Project site. For this reason, incineration will be considered for a series of special hazardous waste streams, including medical waste, oil filters, solvents, paints and sewage sludge.

Table 5.2 Special Hazardous Waste to be treated in the Project incinerators

Waste
Medical waste
Oil filters
Paint, solvents
Sewage sludge
Tank bottoms
Contaminated oily rags
Contaminated empty drums (plastic)
Contaminated soil
Chemical waste

The incinerators will be procured from specialist manufacturers and will meet appropriate international environmental performance standards. In particular, they are likely to have a two stage combustion system to ensure efficient destruction of the waste and minimal emissions to air and compliance with Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste. Their purpose will be to reduce the volume and weight of waste and burn nearly all of the organic compounds in the waste.

They will be selected to be capable of processing mixed residual domestic-type waste and small quantities of hazardous waste including oil filters, sludges, spill kits, paint cans and medical waste. Incinerators will be specifically chosen to provide as much flexibility as possible in terms of the range of typologies of waste that can be burnt.

The incinerators will be operated in accordance with the manufacturer's procedures and will be maintained in accordance with the manufacturer's recommended maintenance schedules. All staff involved in operating the incinerators will be suitably qualified and appropriately trained. The incinerators will comply with current international best practice and any ministry permitting and emissions performance standards.

Waste will be incinerated, separated by typology, based on hazard classification.

Special hazardous wastes that are not incinerated onsite will be properly stored and labelled until they are transported to the appropriate facilities.

5.4.5 Facilities outside the project site

Third party facilities for waste treatment and disposal will be evaluated and mapped in case of there being no possibilities for reusing, recycling, treating and disposal of waste inside the Project site.

Local facilities/contractors which are able to manage and treat waste shall be mapped and qualified. Such mapping will be carried out considering the best options resulting from a combination of both treatment capabilities/cost and distance from the Project construction site, in order to ensure that, in addition to selecting the most appropriate technical and economical option, transport risks and the carbon footprint will be minimised.

Any waste management contractor employed by Statoil will be required to keep records of the Project waste consignments that they have transported, treated or disposed for at least five years.

Audits will be conducted of all the waste contractors and waste disposal facilities:

- Prior the first use – to ensure that they meet the Project's standards and expectations in terms of their environmental controls and health and safety standards; and
- At regular intervals thereafter – the frequency depending on the nature of waste being handled and the results of previous audits.

A preliminary identification of waste treatment and disposal facilities in Algeria is presented in Annex D.2.1 of the present document.

5.5 Waste transportation

Once the treatment and disposal solution has been selected from the available options, transfer and conveyance of waste from the storage sites to the treatment/disposal sites will be organised in accordance with applicable legal requirements (national and international).

With regard to special hazardous waste, a transportation permit is required by Algerian legislation as indicated by Law 01-19, Executive Decree 04-409 and Ministerial Order of 2nd September, 2013.

In all cases when waste is transferred to a third party, the Statoil Well Site Supervisor (WSS) and the Statoil Logistics Coordinator (LC) shall ensure that the waste transporter is aware of the waste management requirements contained in the plan and the waste management procedures. It should be noted that the transboundary movement of waste is regulated both by Algerian (Presidential Decree 98-158) and international regulations (Basel Convention). Presidential Decree 98-158 establishes that the transboundary movement of waste is subject to the prior approval of an authorisation and approval from the exporting and importing states.

5.5.1 Waste transfer

Waste will be transferred from the generation site to the treatment/disposal site safely and in an environmentally sound manner, and routes will be selected based on logistical and economic aspects.

All waste will be collected and transferred:

- Only by persons or entities that are duly authorised by the MATE (Executive Decree 04-409 and Ministerial Order of 2nd September, 2013).
- In a manner that ensures materials are properly packaged and secured for transportation and that all waste containers are appropriately labelled (special hazardous waste according to Ministerial Order of 2nd September, 2013) for storage and transportation purposes.
- Using a system of signed waste transport manifest (see below) to document the details of each individual load of waste. Each manifest will provide a written description of the waste load that will enable anyone receiving the load to dispose of or handle it safely.

- Relevant MSDS sheets will accompany the waste during transportation.

The waste transport manifest is divided into three sections:

- The first part is completed by the waste generator;
- The second part is completed by the waste transporter; and
- The third part is completed by the waste receiver.

The information to be included in the waste transport manifest includes, at least the:

- Type of waste;
- Quantity or volume of waste;
- Final disposal location;
- Date of waste dispatch, transfer or disposal;
- Waste generator details;
- Waste transport contractor details;
- Waste destination contractor details;
- Archiving and retention of waste tracking records.

In this context, the special hazardous waste declaration form required by Algerian legislation in its executive Decree 05-315, (refer to Figure 5.1) can be used as the instrument for waste identification, monitoring and control if also used for non-hazardous waste categories.

An example model of the waste transport manifest, already used by Statoil in other countries, is provided in Figure 5.7.

For each load of waste that leaves the site, the manifest will be completed detailing exactly what the waste comprises in terms of type and quantity of waste. A copy of the manifest will be retained at the Project site and the manifest will accompany the consignment of waste as it is transported. At each handing over point, from one authorised handler to another, the person receiving the waste must sign the form to acknowledge safe receipt and the person handing over the waste will retain a copy. At the point of final treatment/disposal the form will be signed by an authorised person at the licensed facility and a copy of the form returned to the Project site as evidence of the safe receipt of the consignment at the intended final location.

Figure 5.7 Example Waste Transport Manifest

Section A, GENERATOR (Generator completes all of Section A)

1. Generator Name: ______
2. Address: ______
3. Phone No.: ______

If owner of the generating facility differs from the generator, provide:

4. Owner's Name: ______
5. Assigned Waste Code: ______
6. Container: ______

Quantity	Units	Type
	P - Pounds	DM - Metal Drum
	Y - Yards	DP - Plastic Drum
	M³ - Cubic Meters	B - Bag or Wrap
	Y³ - Cubic Yards	T - Truck
	O - Other	O - Other

7. Generating Location: ______
8. Address: ______
9. Phone No.: ______
10. Owner's Phone No.: ______
11. Description of Waste: ______

GENERATOR'S CERTIFICATION: I hereby certify that the above named material has been properly described, classified and packaged and is in proper condition for transportation according to applicable regulations:

Generator Authorized Agent Name ______ Signature ______ Shipment Date ______

Section B, TRANSPORTER (Transporter I completes 1-7; Transporter II completes 8-14)

1. Name: ______
2. Address: ______
3. Phone No.: ______
4. Driver Name / Title: ______
5. Truck No: ______
6. Truck Lic. No./ State: ______
7. ______ Driver's Signature ______ Shipment Date

8. Name: ______
9. Address: ______
10. Phone No.: ______
11. Driver Name / Title: ______
12. Truck No: ______
13. Truck Lic. No./ State: ______
14. ______ Driver's Signature ______ Shipment Date

Section C, DESTINATION (Generator completes 1-4; Transporter completes 5-6; Destination Site completes 7-8)

1. Site Name: ______
2. Physical Address: ______
3. Phone No.: ______
4. Mailing Address: ______
5. Discrepancy Indication Space: ______

TRANSPORTOR'S CERTIFICATION: I hereby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate:

6. ______ Name of Authorized Agent ______ Signature ______ Receipt Date

SHIPPER'S CERTIFICATION: I hereby certify that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged marked and labeled / placarded and in all respects in proper condition for transport according to applicable section and national governmental rules:

7. ______ Shipper's Name & Title ______ Signature ______ Receipt Date

8. ______ Name and Address of Responsible Agency

Source: Statoil, 2015

5.5.2 Vehicles and contractors

Only waste contractors that can demonstrate the necessary authorisation from the Ministry of the Environment (MATE) as per the Ministerial Order of 2nd September, 2013, will be considered for transporting the Project waste. The capability and track record of waste collectors will be assessed and confirmed with the regulatory agencies (*Agence Nationale des Déchets- AND*) prior to the appointment of any contractors.

When a contractor collects waste from the Project construction site, the collection vehicle will be checked to ensure that it is appropriately designed for the type of waste and containers to be transported (i.e., it is 'fit for purpose'), that it is carrying any necessary emergency equipment (e.g., spill containment kits) and that it is roadworthy and legally compliant (e.g., tyres in good condition and lights functioning). If not, waste will not be loaded onto the vehicle. All waste will be suitably covered during transport to avoid windblown litter.

Contractors will be required to ensure that only qualified and trained drivers operate collection vehicles and that drivers have suitable documentation as evidence of their training. The driver's documentation will be checked when they collect the waste from the Project site and if there is any doubt about their qualifications or training, the driver will not be allowed to take the waste.

5.5.3 Containers

Containers for waste transport will be chosen to conform with legal requirements and transport methods.

Each waste container leaving the Project site will be:

- clearly labelled to describe the waste it contains. Any old labels or markings on the container (e.g., from its original use) will be completely removed or totally obscured to avoid confusion as to the contents of the container;
- in good condition and not leaking;
- appropriate to the waste it contains;
- appropriately sealed (e.g., with a lid or bung); and
- not emitting any harmful gases or generating heat.

Documentation on material properties and precautions to be taken in case of spillage (for example, the information on a material safety data sheet – (MSDS)) will be provided and will accompany the waste.

5.5.4 Waste register

A detailed record (waste tracking log) of the origin, quantity and type of waste handled, transported, treated, recovered or disposed of will be kept by Statoil. This log will be fed from the tracking logs maintained at each waste storage area and constitute the basis for reviewing the waste inventory and waste identification for waste reduction efforts.

The waste tracking log will include at least the following information:

- Location name: Name of facility generating waste (e.g., Project drilling rig);
- Quantity of waste;
- Carrier name: for all offshore transfers, include the name of the vessel transporting waste;
- Disposal location: location where waste will be disposed;
- Waste transport manifest number; and
- Initials: initials of the person filling out the log.

A waste tracking log template is included in Figure 5.8.

In accordance with Executive Decree 05-315, special hazardous waste must be declared as such (as per the template included in the decree). The declaration must be sent to the environmental administration within 3 months of the end of the declared year.

The waste register database or tracking log is to be maintained by the field Statoil EHS Advisor and communicated to the Senior EHS advisor on a weekly basis.

Figure 5.8 Model Waste Tracking Log

WASTE TRACKING LOG							
FACILITY NAME:							
	Date	Waste Type	Quantity (m^3, Drums, Tanks)	Vessel/Vehicle ID	Disposal Method	Disposal Location	Initials
1							
2							
3							
4							
5							
Name of Supervisor:							
Signature:							
Date:							

Source: Statoil, 2015

6 Waste Monitoring

6.1 Waste Monitoring Programme

A monitoring programme for waste management will be implemented to ensure that all waste management actions are conducted in compliance with Algerian legislation, international guidelines and Statoil standards as well as adhering to the WMP, and in order to avoid and minimise the risk of pollution due to waste storage, transfer, treatment and final disposal activities.

Three kinds of waste-monitoring activities will be conducted, as reported below:

- A measurement of weight/volume of waste, separated by type and final disposal, at source, onsite storage areas, transport vehicles and receptor facilities, using portable or fixed scales. Measurements will be taken every time waste is generated, collected and stored to be delivered onsite or to third party contractors for subsequent use, treatment or final disposal. These data will be inserted into the Statoil's environmental accounting system;
- The values to be specifically monitored and recorded are at least:
  - General waste volumes and type;
  - Recycled waste volumes and type;
  - Hazardous (solid & liquid) waste volumes and type;
  - Drilling fluid volumes generated, stored, treated and/or transferred offsite;
  - Drill cutting volumes generated, stored, treated and/or transferred offsite;
  - Flowback water and condensate generated, stored, treated and/or transferred off site;
  - Scrap metal volumes;
  - Organic food waste volumes; and
  - Black and grey water volumes.
- All waste storage areas will be audited / inspected regularly (every week) checking their quality status, in order to ensure that all the requirements listed in Section 5.2.1 are met, including the good condition of containers and

proper labelling. A check list will be completed for every inspection, and, for any criticalities that are found, corrective action will be planned and implemented, in order to control and minimise any risk of pollution. Furthermore each month a supervisor will check that the waste register is correctly compiled;
Environmental monitoring will be performed in order to address all activities that have been identified to have potentially significant impacts on the environment. Production of waste and its management are most likely to potentially impact air, soil, water and biological resources.

6.2 Record keeping

Records will be generated as a result of the monitoring actions, especially during the audits / inspections carried out at the waste storage areas, on treatment equipment (e.g., drilling solids control equipment) or on the evaporation ponds and pits used to treat waste effluents and cuttings.

The main records will correspond to the waste tracking log, as per Section 6.5.4, which will include all details of all wastes generated, their origin and destination.

6.3 Reporting

Recording and reporting of all HSE events relating to this WMP shall be implemented, especially with regard to non-conformance situations. All potentially serious events shall be investigated and analysed, and lessons learned from these investigations will be communicated and corrective actions implemented, including the necessary modifications of the WMP to ensure the same event will not occur again.

In case such an event takes place, the Statoil representative should be informed immediately.

As a result, a common information system will be used for recording incidents including at least the following:

- fuel and/or other hydrocarbon releases;
- leaks from any waste container
- leaks from effluent waste pits and/or ponds;
- incorrect handling and/or mixing of waste; and
- unauthorised disposal of trash or liquid waste material.

7 Acronyms and Abbreviations

2D	Two dimensions
3D	Three dimensions
AFREC	African Energy Commission
AND	National Waste Agency (in French, *Agence Nationale des Déchets*)
API	American Petroleum Institute
BOD	Biological Oxygen Demand
CNTPP	National Centre for Cleaner Technologies (in French, *Centre National des Technologies de la Production Propre*).
COD	Chemical Oxygen Demand
EEC	European Economic Community
EIA	Environmental Impact Assessment
ESIA	Environmental and social impact assessment
e&p	Exploration and production
HSE	Health, Safety and Environment
IPIECA	International Petroleum Industry Environmental Conservation Association
IUCN	International Union for the Conservation of Nature
LC	Logistics Coordinator
LDC	less-developed countries
MARPOL	International Convention for the Prevention of Pollution from Ships
MATE	Ministry of Land-Use Planning and Environment (in French, *Ministère de l'Aménagement du Territoire et de l'Environnement*)
MSDS	Material safety data sheet
NORM	Naturally Occurring Radioactive Material
OBM	Oil-based muds
OGP	International Association of Oil & Gas Producers
ONEDD	National Observatory for the Environment and Sustainable Development (in French, *Observatoire National pour l'Environnement et le Développement Durable*)
PET	Polyethylene Terephthalate
PPE	Personal protective equipment
SOLAS	International Convention for the Safety of Life At Sea
TSS	Total Suspended Solids
VOC	Volatile Organic Compounds
WEEE	Waste Electrical and Electronic Equipment
WMP	Waste management plan
WSS	Well Site Supervisor

Annexes

Annex D.2.1 - Overview of relevant existing waste management facilities

This section presents an overview of the existing and relevant waste management facilities located near the in the Study area of the Block Timissit, particularly in the In Amenas, Illizi and Djanet areas (presented in the Table below). The information currently available regarding the waste management facilities in the study area is very limited.

Table 1 Relevant waste facilities

Location	Facility name/type	Infrastructure/Activity	Classification	Type	Disposal Method	Comments
In Amenas	Central Waste Accumulation Area	Covered area with process equipment	Solid waste – non-hazardous and hazardous material	Tyres, can and glass, drum, bulbs, bailing	N/A	Managed by CIEPTAL, the subsidiary of CIS group. In principle, this is a private waste management facility that treates wastes generated by the In Amenas JV (of which Statoil is one of the partners). However, we have included it in the list in case Statoil decide to reach an agreement with In Amenas to share the treatment facilities.
		Open Storage area with ISO containers		Metals, bails of cardboard or aluminium cans, other		
		Oil and chemicals storage area Incinerators		Used oil, corrosion inhibitors, amines, other.		
		Storage area		Car batteries, catalyst		
		Incinerators		Food, wood, electronic waste, other non - recyclable items		
		Landfill		Ash from the incinerator		
Annaba, Sétif, Biskra, Touggourt	ERE – Entreprise de Récupération de l'Est	Recovery.	Solid waste – special or hazardous waste	Ferrous metals and non-ferrous metals	N/A	http://www.transolb.com/ere.htm
Ouled Moussa	SPA Future World Oil (SPA FWO)	Recovery and regeneration of used oils.	Liquid waste - special or hazardous waste	Used oils: Petroleum based fuels, fluids, industrial oils, lubricants, greases and gases.	N/A	www.rebexoil.com
Oran, Alger and Annaba	NAFTAL	Recovery of waste oil facilities.	Liquid waste - special or hazardous waste	Used oil	Intended for recycling abroad	http://www.naftal.dz/fr/

Location	Facility name/type	Infrastructure/Activity	Classification	Type	Disposal Method	Comments
N/A	Scomi Oiltools EURL	Drilling waste management solutions: fluids and cuttings.	Liquid waste Solid waste - special or hazardous waste	Drilling waste	N/A	http://scomigroup.com.my/
Alger	Green Sky	Recovery, treatment, landfill or thermal destruction.	Solid waste special or hazardous waste	Pharmaceutical, medical waste and industrial waste.	N/A	http://www.greensky.dz/index.php
Oran	ERO – URF (Unité de récupération de ferraille)	Recovery and treatment of mainly ferrous waste, waste disposal, supply of steel mills, demolition.	Solid waste	Ferrous metals	N/A	http://www.ero-algerie.com/
Setif	ENPC - TRECYPLAST	Recovery, sorting and grinding of plastic waste.	Solid waste	Plastics	Recycled to other materials	http://www.enpc-dz.com http://www.enpc-trecyplast.com/index.php
Baba-Ali	GIPEC – PAPIREC	Recovery, sorting, selection, conditioning of recyclable paper	Solid waste	Paper and cardboard	Sales	http://www.sgp-gephac.dz/fiche_id/gipec.htm
Constantine	SARL Stidest	Recovery, treatment and incineration of waste.	Solid waste - special or hazardous waste	Pharmaceutical, medical waste and industrial waste	N/A	http://stid-est.com/
Setif	Groupe ENPEC – Entreprise Nationale de Produits de	Refining unit of lead and recycling of used batteries.	Solid waste - special or hazardous waste	Batteries and lead	N/A	www.enpc-dz.com/

Location	Facility name/type	Infrastructure/Activity	Classification	Type	Disposal Method	Comments
	l'Electricité					
Aïn Ouassara	Groupe Recyclex - Eco Recyclage	Recovery and recycling of used batteries (20000 t).	Solid waste - special or hazardous waste	Batteries	N/A	http://www.djelfa.info/fr/index.php?news=19
Sétif	Douib Recyclage Caoutchou	Recovery and treatment of used tyres	Solid waste – non hazardous	Used tyres	Granulated rubber	http://www.drc.dz/article.php?id=21
In Amenas	Local government in charge of environmental services	Decantation pools (2000 m3).	Liquid waste – non hazardous	Used water	N/A	To be confirmed if the facility is currently in operation.
Illizi	Centre d'enfouissement technique (CET)	Sorting area Storage area Landfill (6 ha).	Domestic waste -non hazardous	N/A	N/A	To be confirmed if the facility is currently in operation.
In Amenas	Centre d'enfouissement technique (CET)	Sorting area Storage area Landfill (6 ha).	Domestic waste -non hazardous	N/A	N/A	To be confirmed if the facility is currently in operation.
Djanet	Centre d'enfouissement technique (CET)	Sorting area Storage area Landfill (3 ha).	Domestic waste -non hazardous	N/A	N/A	To be confirmed if the facility is currently in operation.

Annex D.2.2 – Waste Management Summary Tables

Waste Stream	Waste type	Generator Responsibility	On-site storage and collection	Algerian Waste Category (06-104)	Algerian Waste Code (06-104)	Hazard Criteria (06-104)	Main Sources	Suggested disposal method (by priority of lowest impact)
Chemical Waste	Solvents	Return to supplier wherever possible	Evaporate in own container. Store residue in sealed containers	SD	7.1.2	Harmful	Maintenance and drilling operations	Return to supplier Recycle Incinerate if applicable
	Other chemicals	Return to supplier wherever possible	Store in container	SD	7.1.3	Harmful	Maintenance and drilling operations	Return to supplier Recycle Incinerate if applicable Depending on chemicals, they can be neutralized and evaporated
	Drums of unknown content	Return to supplier wherever possible Drum crusher*	Store in hazardous waste area	-	7.1.99	Harmful	Maintenance and drilling operations	Return to supplier Incinerate Dispose of in hazardous landfill
Batteries	Lead batteries (wet-cell batteries)		Place in recycling container (battery bank)	SD	16.6.1	Toxic	Maintenance, offices, accommodation camps, vehicles and machinery	Storage and recycle by specialized companies Dispose of in hazardous landfill
	Ni-Cd Batteries (dry-cell batteries)	Do not incinerate	Place in recycling container	SD	16.6.2	Toxic	Maintenance, offices, accommodation camps, vehicles and machinery	Storage and recycle by specialized companies Dispose of in hazardous landfill
	Others		Place in recycling container	S	16.6.5	-	Maintenance, offices, accommodation camps, vehicles and machinery	Storage and recycle by specialized companies Dispose of in non-hazardous

Waste Stream	Waste type	Generator Responsibility	On-site storage and collection	Algerian Waste Category (06-104)	Algerian Waste Code (06-104)	Hazard Criteria (06-104)	Main Sources	Suggested disposal method (by priority of lowest impact)
								landfill
Scrap Metal	Aluminum	To be cleaned of any oil/lubricant before placing in bin	Store at metal bin	S	17.4.2	-	Construction and Maintenance operations (drilling)	Recycle (sell as scrap)
	Copper, Bronze	To be cleaned of any oil/lubricant before placing in bin	Store at metal bin	S	17.4.1	-	Construction and Maintenance operations (drilling)	Recycle (sell as scrap)
	Steel, Iron	To be cleaned of any oil/lubricant before placing in bin	Store at metal bin	S	17.4.1	-	Construction and Maintenance operations (drilling)	Recycle (sell as scrap)
Metal containers	Empty and damaged metal drums	Ensure all drums are empty (< 1% product), clearly labelled and accompanied with an MSDS Drum crusher*	Return to supplier or store on a pallet	SD	17.4.8	Environmental risk	Drilling, well testing, seismic survey.	Re-use (if good condition) Recycle (selling) – to be decontaminated by recycler
	Drink cans (Aluminum)	Empty of fluids and crushed Can crusher* Bailing machine*	Crush, bale and store in yellow container	MA	15.1.4	-	Accommodation camps	Recycle
	Aerosol cans	Ensure aerosol cans are empty –	Store at metal bin	MA	15.1.4	Explosive Toxic	Accommodation camps	Recycle metals Dispose of in hazardous

Waste Stream	Waste type	Generator Responsibility	On-site storage and collection	Algerian Waste Category (06-104)	Algerian Waste Code (06-104)	Hazard Criteria (06-104)	Main Sources	Suggested disposal method (by priority of lowest impact)
		Do not crush Aerosol piercer*						landfill
Contaminated packaging (drums, containers)	Various, mainly metals and plastic	Ensure drums are cleaned appropriately and chemical labels are removed for reuse Drum crusher*	Store separately from non-contaminated drums on pallets or on a container within waste storage area	MA	15.1.1	Environmental Risk	Construction and maintenance (Drilling and seismic). Accommodation camps	Recycle Incinerate Dispose of in hazardous landfill
Non-contaminated Packaging (plastic drums)	Empty plastic drums / containers	Ensure drums are cleaned appropriately and labels are removed for reuse Bailing machine* Drum crusher*	Reuse as possible. Return directly to supplier where possible. Those for recycling should be crushed and baled. Ensure remaining drums are empty and placed on pallets	MA	15.1.3	-	Construction and maintenance (Drilling and seismic). Accommodation camps	Wash and Reuse Recycle incinerate Dispose of in non-hazardous landfill
Contaminated soil	Contaminated soil – Hydrocarbon	Contact EHS for advice	Case dependent. Store in drums or lined area.	SD	1.4.1	Flammable Toxic	Construction and maintenance on Seismic, Drilling, Stimulation and Testing	Case dependent. Consider treatment (bioremediation) or incineration
	Contaminated soil – Other	Contact EHS for advice	Case dependent. Store in drums or lined area.	SD	1.4.1	Flammable Toxic	Construction and maintenance on Seismic, Drilling, Stimulation and Testing	Case dependent. Consider treatment (bioremediation) or incineration

Waste Stream	Waste type	Generator Responsibility	On-site storage and collection	Algerian Waste Category (06-104)	Algerian Waste Code (06-104)	Hazard Criteria (06-104)	Main Sources	Suggested disposal method (by priority of lowest impact)
Electrical and electronic equipment	Various	Ensure waste electrical equipment is collected from site	Recycling container	SD	16.2.5	Environmental Risk	Accommodation camps and offices	Re-use Decontamination and recycle (if possible, decontamination by recycling company)
	Toner and print cartridges	Place in toner recycling bin	Recycling container	SD	8.3.8	Environmental Risk	Accommodation camps and offices	Recycle by specialized companies
Glass	Fluorescent lamps (glass contaminated with mercury)	Place intact tubes in fluorescent specific container	Fluorescent container	SD	20.1.6	Toxic Environmental Risk	Accommodation camps and offices	Recycle by specialized companies including mercury extraction Dispose of in hazardous landfill
	Glass- general	Ensure glass/jars/bottles are rinsed of contents	Glass recycling container glass crusher* Bulb crusher*	MA	16.1.2	-	Accommodation camps and offices	If feasible, recycle Landfill (inert wastes)
Oils	Used oil and lubricants	Ensure waste oil is contained before placing into designated storage tank	Oil storage tank Store in waste oil tanks (double skinned). Oil may be collected in smaller containers and tipped into waste oil drum for ad hoc emptying.	SD	13.2.5	Toxic	Construction and maintenance (Drilling and Seismic)	Re-use Recycle Incinerate
	Oil filters	Drain filters prior	Oily waste tanks	SD	16.1.4	Harmful	Construction and	Incinerate

Waste Stream	Waste type	Generator Responsibility	On-site storage and collection	Algerian Waste Category (06-104)	Algerian Waste Code (06-104)	Hazard Criteria (06-104)	Main Sources	Suggested disposal method (by priority of lowest impact)
		to disposal	(double skinned)				maintenance (Drilling and Seismic)	
	Oily rags and absorbents	Ensure dirty rags are not mixed with clean ones	Oily waste tanks (double skinned)	SD	15.2.1	Flammable, noxious.	Construction and maintenance (Drilling and Seismic)	Incinerate
Domestic waste	Cardboard	Ensure cardboard is clean and does not contain plastic or other contaminants	Store in recycling paper bins (Blue bins)	MA	19.12.1	-	Accommodation camps and offices	Recycle
	Litter	Ensure placed in appropriate bin	Store in general waste bins (Green bins)	MA	20.3.1	-	Accommodation camps and offices	Incinerate Dispose of in non-hazardous landfill
	Paper	Ensure it is segregated and placed in recycle bins	Store in recycling bins (Blue bins)	MA	19.12.1	-	Accommodation camps and offices	Recycle
	Paper food packaging	Ensure it is placed into general waste bins, unless packaging includes the recycling symbol	Store in recycling bins (Blue bins) or General waste bins (Green bins)	MA	20.1.1	-	Accommodation camps and offices	Recycle Incinerate Dispose of in non-hazardous landfill
	Food scraps	Bins for food scarp with lids, closed at all times.	To be deposited in a composting container or in the	MA	2.2 / 2.3	-		Recycle (compost) Incineration Dispose of in non-hazardous

Waste Stream	Waste type	Generator Responsibility	On-site storage and collection	Algerian Waste Category (06-104)	Algerian Waste Code (06-104)	Hazard Criteria (06-104)	Main Sources	Suggested disposal method (by priority of lowest impact)
			general waste bin (Green bins).					landfill
	Packaging Plastic (other than drums)	Segregate recyclable and non -recyclable (check recycle symbol) Bailing machine*	Shred, bale and store in Recycling bins (Yellow bins) General waste bins (Green bins)	MA	20.1.7	-		Recycle Dispose of in non-hazardous landfill
	PET containers	Segregate recyclable and non-recyclable Bailing machine*	Shred, bale and store in Recycling bins (Yellow bins) General waste bins (Green bins)	MA	20.1.7	-		Recycle Dispose of in non-hazardous landfill
Filters	Air filters	Air filters vehicles are to be cleaned out using an air pressure hose so that they may be re-oiled and refitted into the vehicle	Return directly to supplier where possible or storage in container	SD	16.1.7	-	Vehicles and machinery (Drilling and Seismic phases)	Re-use Incinerate Dispose of in non-hazardous landfill
	Filters with activated		Place in container	SD	6.12.2	Flammable Toxic	Vehicles and machinery (Drilling and Seismic	Incinerate Dispose of in hazardous

Waste Stream	Waste type	Generator Responsibility	On-site storage and collection	Algerian Waste Category (06-104)	Algerian Waste Code (06-104)	Hazard Criteria (06-104)	Main Sources	Suggested disposal method (by priority of lowest impact)
	carbon						phases)	landfill
Wood	Wood waste (pallets, others)		Denail and store in open container for reuse	MA	17.2.1	-	Accommodation camps	Reuse (Statoil or supplied to local communities) Use for incineration booster fuel (self-ignition following diesel pre-ignition) Dispose of in non- hazardous landfill
Rubber	Tyres and tubes	Ensure that unusable tyres are taken to retailer tyre shredder*	Return directly to supplier where possible. Remaining tyres to be placed on pallets at the waste storage area	S	16.1.1	-	Vehicles and machinery (Drilling and Seismic phases)	Re-use Recycle Incineration Dispose of in appropriate landfill
Medical Waste	Medical waste (dressings, clinical and cleaning materials, blood samples)		Storage in appropriate containers with biohazard labelling	SD/S	20.1.14 / 20.1.15	Toxic Carcinogenic	Medical facilities, Accommodation camps	Incineration Dispose ashes in landfill
Refrigerants			Storage in appropriate containers to be sent to specialized companies for recycling	SD	16.02.03	Environmental risk	Accommodation camps	Recycle

Waste Stream	Waste type	Generator Responsibility	On-site storage and collection	Algerian Waste Category (06-104)	Algerian Waste Code (06-104)	Hazard Criteria (06-104)	Main Sources	Suggested disposal method (by priority of lowest impact)
Ashes	Ashes from incineration of waste			S SD	10.1.1 10.1.4	Toxic	Waste management	Dispose of in appropriate landfill
Cement	Cement slurries	Do not wash into sewerage or streams/surface water	Temporary storage	SD / I depending if they include hazardous substances	17.1.1	Environmental risk	Drilling; construction.	Store and recycle by specialized companies Dispose of in appropriate landfill
Inert Construction and demolition waste	Construction waste		Storage area for inert waste in waste storage area	I	17.1.4		Construction and decommissioning phases in seismic and drilling (camps, well pads, etc…)	Reuse as backfill material Dispose of in landfill for inert material
Drilling Wastes	Produced Water		Lined evaporation pits. Store sludge in drums	SD	5.1.8	Environmental Risk	Well testing	Evaporation of water Incineration of sludge
	Produced Sand		Storage in containers	SD	1.4.1	Flammable Toxic	Drilling Stimulation Testing	Incinerate or bioremediation
	Drill Cuttings (oil based)		Contained in lined pits or storage tanks	SD	1.4.2	Environmental Risk Flammable Toxic	Drilling	Reuse of drilling fluid Lined Pit. As an option, vertical dryer/centrifuge to normally reduce oil content to < 2.5%; Thermal desorption to reduce oil content (<1%).

Waste Stream	Waste type	Generator Responsibility	On-site storage and collection	Algerian Waste Category (06-104)	Algerian Waste Code (06-104)	Hazard Criteria (06-104)	Main Sources	Suggested disposal method (by priority of lowest impact)
								See section 5.4.4 for details
	Drill Cuttings (Water based)		Contained in lined pits	S	1.4.3	Environmental Risk	Drilling	Reuse of drilling fluid. Non-hazardous waste landfill
	Flowback water		Lined pits or storage tanks	SD	1.4.2	Environmental Risk	Stimulation	Reuse water if possible Evaporation See section 5.4.4 for details
	Drill fluids (Water based)		Lined pits	S	1.4.3	Environmental Risk	Drilling	Evaporation in lined pits
	Drill fluids (Oil based)		Lined pits or storage tanks	SD	1.4.1	Environmental Risk Flammable Toxic	Drilling	Reuse See section 5.4.4 for details
Textiles	Clothing and PPE	correct segregation and not mixing with textiles contaminated with hazardous substances	Store in recycling containers	MA	4.2.2 / 4.2.3	-	Accommodation camps	Reuse Recycle Incineration
Sludge	Sludge from evaporation ponds		Storage tanks appropriately labelled	S/SD	----	Harmful Toxic	Evaporation ponds	Dispose at appropriate landfill (if available) Thermal treatment
	Sludge from sewage treatment		Lined pit	S	2.2.4	-	Accommodation camps and sewage treatment process	Sun-dry and then compost or dispose at non-hazardous landfill

Waste Stream	Waste type	Generator Responsibility	On-site storage and collection	Algerian Waste Category (06-104)	Algerian Waste Code (06-104)	Hazard Criteria (06-104)	Main Sources	Suggested disposal method (by priority of lowest impact)
	process							
Water	Drum-cleaning wastewater		Storage tanks / Lined pits	SD	7.7.1	Harmful Toxic		Water treatment or evaporation ponds
	Oily run-off water		Storage tanks / Lined pits	SD	7.7.1	Harmful Toxic		Evaporation pond. Remaining solids treated as hazardous waste
	Domestic sewage		Evaporation pond or stored in sealed tanks	-	-	-	Accommodation camps	Re-use of grey water Evaporation ponds. Remaning solids composted or disposed of as non-hazardous waste.

** Waste minimization equipment will be installed and used if feasible*

Annex D3 - Plan for Oversight and Monitoring of Environmental Impacts

Introduction

This Annex summarizes the monitoring plans and auditing actions associated with the identified potential impacts and mitigation measures of the Project (see Section 5 Impact Assessment and the main text and other Annexes of Section 6 Environmental Management Plan for further details). In order to avoid duplication of information, cross-references are made regularly throughout this Annex to the original sections/impacts and Annexes where more detailed information about impacts, mitigation and monitoring can be found.

Table 2.1, presented below, summarizes the monitoring and auditing activities defined in the Impact Assessment Chapter and provides indication of who should perform the activity as well as the corresponding timings. The table keeps the division between the Seismic and the Drilling/Stimulation activities presented in the impact assessment chapter but the impacts have been reorganized by receptor (e.g. impacts on the same receptor are all grouped together).

Statoil has assigned ownership of and accountability for all commitments made in Section 5 and 6 (Impact assessment and EMP), whereas the "responsible for implementation" column of the Table below refers to the party/ies which are better placed to actually implement the measures. Recognizing that the implementation of the Project comprises the collaborative effort of Statoil and its contractors, Statoil will ensure that roles and responsibilities are clearly defined, and communicated in the EMP. Statoil is committed to ensuring that Project-related staff are familiar with proposed mitigation measures and environmental protection procedures, in accordance with **"Annex D.5 - Plan for environmental information and awareness**".

Furthermore, monitoring programs will be implemented in general via Statoil's HSE Management System and guided by Timissit-driven operational documents, even where in some circumstances the actual monitoring operations may be contracted to external entities.

The Timissit project will also have a verification and critical analysis process in place (i.e., audits and process assessments) to ensure that the EMP is continuously monitored and revised accordingly, consistent with **"Annex D.7 - Environmental Audit plan"**.

With regards to the monitoring, the results of the monitoring measures will be recorded, stored and communicated to the authorities with a schedule and reporting procedure to be developed and agreed upon with them. All the monitoring results (and non-routine events register) will be recorded and kept on site and available for the relevant authorities' inspection, in accordance with the recording and reporting procedure to be developed.

Table 1.1 Project Monitoring Operations

Monitoring Actions	Responsible for implementation	Timing
AQ1 Impact on Air Quality during Seismic Exploration Phase		
Logs of preventative/corrective maintenance of vehicles. HSE audits and inspections (Annex D 7: Environmental Audit plan).	Statoil/Geophysical contractor	During operations
AQ2 Impact on Air Quality during Drilling and Hydraulic Stimulation Phases		
HSE audits and inspections (Annex D 7: Environmental Audit plan). Logs of preventative/corrective maintenance of vehicles and equipment, equipment testing logs. Logs of volume of hydrocarbons flared during well testing. Logs of volume of fuel used by drilling unit. Monitoring of drilling processes (fugitive emissions). Logs of Performance of well integrity tests (fugitive emissions).	Statoil/Drilling/HS contractor	During operations
N1 Impact on Noise during Seismic Exploration Phase		
HSE audits and inspections (Annex D 7: Environmental Audit plan). Logs of preventative/corrective maintenance of vehicles.	Statoil/Geophysical contractor	During operations
N2 Impact on Noise during Drilling and Hydraulic Stimulation Phases		
Logs of preventative/corrective maintenance of vehicles and equipment, equipment testing logs. HSE audits and inspections (Annex D 7: Environmental Audit plan). Noise monitoring should a receptor be found within 2 km of the drilling/hydraulic stimulation sites.	Statoil/Drilling/HS contractor	Before and During operations
SW1 Impact on Surface water during Seismic Exploration Phase		
HSE audits and inspections (Annex D 7: Environmental Audit plan). Records of ephemeral streams/oueds/sabkhas and other hydrological features (found during the seismic survey). Photographic records of applied procedures.	Statoil/Geophysical contractor	During operations
SW2 Impact on Surface water during Drilling and Hydraulic Stimulation Phases		
HSE audits and inspections (Annex D 7: Environmental Audit plan), including specifically. • Inspection of contents of pits for overflow or leakage, and level in pit • Inspection of liners for rips and tears. • Inspections of all waste storage areas Measurement /calculation of evaporation rates. Monitoring of water quality in pits. Waste registers and monitoring described in Annex D.2, Waste	Statoil/Drilling/HS contractor	During operations

Monitoring Actions	Responsible for implementation	Timing
Management Plan including specifically: • Monitoring, logs and records of quantity and chemical properties of flow back water Other logs and records of: • General waste volumes and type; • Recycled waste volumes and type; • Hazardous (solid & liquid) waste volumes and type; • Drilling fluid volumes generated, stored, treated and/or transferred offsite; • Drill cutting volumes generated, stored, treated and/or transferred offsite; • Black and grey water volumes.		
GW1 Impact on Groundwater during Seismic Exploration Phase		
HSE audits and inspections (Annex D 7: Environmental Audit plan). Groundwater Monitoring, described in detail in Annex D.4 Water Management Plan and in impact GW2, below.	Statoil/Geophysical contractor	During operations
GW2 Potential Overexploitation of Groundwater aquifer		
Monitoring and logs of water consumption (daily). Implementation of the Groundwater Monitoring, described in detail in Annex D.4 Water Management Plan and summarised in AE 2.1, related to measuring water levels in monitoring wells. Flowback water monitoring to assess possibility of re-use.	Statoil/Drilling/HS contractor	During operations
GM1 Impact on geology, geomorphology and landscape during Seismic Exploration Phase		
HSE audits and inspections (Annex D 7: Environmental Audit plan). Records of landscape features found during the seismic survey. Photographic records of applied procedures.	Statoil/Geophysical contractor	During operations
GM2 Impact on geology, geomorphology and landscape during Drilling and Hydraulic Stimulation Phases		
Impacts from drilling site preparation/operation (GM2.1) HSE audits and inspections (Annex D 7: Environmental Audit plan). Records of Management of Change procedure in terms of new or updated drilling locations.	Statoil/Drilling/HS	Before and during drilling operations
Potential increase of micro seismicity during hydraulic stimulation (GM2.2) A Seismicity Monitoring Plan will be drawn up, including induced seismicity monitoring with a system which could be similar to the type of "Traffic Light System, involving the installation of a network of seismographs (accelerometers) on the sites, and the definition of operational levels based on the intensity measured by the seismographs.	Statoil/Drilling/ contractor	Before and During HS operations
Potential mobilisation of NORM materials from exploration wells (GM2.3)	Statoil/Drilling/HS contractor	During drilling operations

Monitoring Actions	Responsible for implementation	Timing
NORM Monitoring Plan will be implemented, including gamma spectrometry tests on well core samples extracted from the Frasnian shale formation during the drilling of the first well, in order to verify their properties.		
S1 Impact on soil during Seismic Exploration Phase		
Same proposed for GM2, SW1 and GW1.	Statoil/Geophysical contractor	During operations
S2 Impact on Soil during Drilling and Hydraulic Stimulation Phases		
Same as proposed for GM2, SW2 and AE 2.1.	Statoil/Drilling/HS contractor	During drilling/HS operations
FL1 Impact on Flora and Vegetation during Seismic Exploration Phase		
HSE audits and inspections (Annex D 7: Environmental Audit plan). Records of flora and vegetation features found during the seismic survey. Photographic records of applied procedures. Record of relevant locations in terms of vegetation density to allow future assessment of regeneration if required.	Statoil/Geophysical contractor	During operations
FL2 Impact on Flora and Vegetation during Drilling and Hydraulic Stimulation Phases		
HSE audits and inspections (Annex D 7: Environmental Audit plan). Photographic records of applied procedures. Record of relevant locations in terms of vegetation density to allow future assessment of regeneration if required. Records of Management of Change procedure in terms of new or updated drilling locations. Field identification of additional sensitive areas Before to the commencement of drilling operations.	Statoil/Drilling/HS contractor	Before and during operations
FA1 Impact on fauna during Seismic Exploration Phase		
Same as FL1, CD1 and logs of backfilling of upholes.	Statoil/Geophysical contractor	During operations
FA2 Impact on fauna during Drilling and Hydraulic Stimulation Phases		
HSE audits and inspections (Annex D 7: Environmental Audit plan) mostly related to waste management. Same as for N2, FL1 and FA 1. Records of Management of Change procedure in terms of new or updated drilling locations.	Statoil/Drilling/HS contractor	During operations
EC1 Impact on economy, employment and livelihoods during Seismic Exploration Phase		
HSE audits and inspections (Annex D 7: Environmental Audit plan). Record keeping of local content and local sourcing data. Grievance mechanism records. Monitoring of implementation of the grievance mechanism (timing to	Statoil/Geophysical contractor	Before and during operations

Monitoring Actions	Responsible for implementation	Timing
respond to the grievances and implementation of commitments). Stakeholder Engagement Logs and Commitments Tracker. Same as in FL1.		
EC2 Impact on economy, employment and livelihoods during drilling and Hydraulic Stimulation Phase		
Same as for EC1 and FL2.	Statoil/Drilling/HS contractor	Before and during operations
IF1 Impact on infrastructure during Seismic Exploration Phase		
Same as for GW 2 (water infrastructure) and in EC1. Logs of waste management alternatives selection procedures. Third party Waste Management Audits.	Statoil/Geophysical contractor	Before and during operations
IF2 Impact on infrastructure during Drilling and Hydraulic Stimulation Phases		
Same as for impact IF1 and EC1. Monitoring of degradation of unpaved accesses.	Statoil/Drilling/HS contractor	Before and during operations,
PH1 Impact on community health and safety during Seismic Exploration Phase		
Same as AQ1 and N1. HSE audits and inspections (Annex D 7: Environmental Audit plan). Grievance mechanism records. Monitoring of implementation of the grievance mechanism (timing to respond to the grievances and implementation of commitments). Stakeholder Engagement Logs and Commitments Tracker. Project security providers commitments, adoption of required measures and behavior.	Statoil/Geophysical contractor	Before and during operations
PH2 Impact on community health and safety during Drilling and Hydraulic Stimulation Phases		
Same as PH1 above. Records of Management of Change procedure in terms of new or updated drilling locations.	Statoil/Drilling/HS contractor	Before and during operations
CH1 Impact on cultural heritage during Seismic Exploration Phase		
Records of Chance Find Procedure. HSE audits and inspections (Annex D 7: Environmental Audit plan). Records of cultural heritage features found during the seismic survey. Photographic records of applied procedures.	Statoil/Geophysical contractor	During operations
CH2 Impact on cultural heritage during Drilling and Hydraulic Stimulation Phases		
Same as in CH1 above Records of Management of Change procedure in terms of new or updated drilling locations.	Statoil/Drilling/HS contractor	Before and during operations,

Monitoring Actions	Responsible for implementation	Timing
CD1 Impacts from closure and decommissioning after Seismic Phase		
HSE audits and inspections (Annex D 7: Environmental Audit plan), in particular related to the Plan for the Shutting Down and Restoration of Sites, and if applicable to Plan for Management of Contaminated Sites and Soil. Photograph recording of the locations before operations in the area and after decommissioning to ensure that the areas have been properly cleaned and treated during decommissioning.	Statoil/Geophysical contractror	Before and after operations
CD2 Impacts from closure and decommissioning		
Same as CD1, with particular emphasis on water/waste pits associated to the well pads to be cleaned out and covered.	Statoil/Drilling/HS contractor	Before and after operations
AE1 Impacts from accidental/non-routine events. Blow out		
On line monitoring of well parameters, including BOP and pressures. Records of preventative and corrective maintenance. Blow Out Contingency Plan, Emergency Management Plan and if applicable Liquid Spill Management Plan records and registers in case of an accidental event.	Statoil/Drilling/HS contractor	During operations, after event (if applicable)
AE 2 Impacts from accidental/non-routine events. Groundwater Contamination.		
<u>AE 2.1 - Accidental spillage of raw materials (fuels, oils and additives) and waste on the well site</u> Same as in SW2, and: Groundwater Monitoring, described in detail in Annex D.4 Water Management Plan. Main elements will include: • Drilling of minimum of two water wells, one in the North and one in the South that will be the main points of the groundwater monitoring. • Desktop evaluation of the closest relevant existing water wells and their water quality • Selection of which water wells to be sampled during the Statoil operations Sampling of water wells will be as follows: • Before to the Statoil operations (1 sampling event, results reported to ARH) • During operations : Frequency and reporting schedule to be determined, in principle annually • After operations (1 sampling event, results reported to ARH). Analytical program as defined in Annex D.4 Water Management Plan.	Statoil/Drilling/HS contractor	Before, during and after drilling and HS operations See details in Monitoring column
<u>Groundwater Contamination Contact of drilling fluids with aquifers due to well construction and integrity issues during drilling (AE 2.2)</u> Same as in AE 2,1 above, and: Monitoring of drilling processes (mud weight, pressure on the mill, and drilling rate)	Statoil/Drilling/HS contractor	Before, during and after drilling operations

Monitoring Actions	Responsible for implementation	Timing
Logs of Performance of well integrity and leakage tests Cement evaluation logs. Logs of mud use and recycling.		
AE 2.3 - Groundwater Contamination Contact of stimulation fluids with aquifers due to loss of well integrity during hydraulic stimulation Same as in AE2.1 and AE 2.2. above ,and On line monitoring of pressure inside the wells during hydraulic stimulation. Logs of use of chemicals according to the Chemical Management Plan.	Statoil/Drilling/HS contractor	Before, during and after HS operations
AE 2.4 - Groundwater Contamination Contact of stimulation fluids with aquifers due to induced fractures Same as in AE 2.1 , AE 2.2 and AE 2.3 above and Analyses of petrological characteristics of target formation materials after drilling to calibrate the Geomechanical Model Subsurface mapping in the area of interest identifying large geologic faults, which can then be avoided.	Statoil/Drilling/HS contractor	Before, during and after HS operations

Annex D.4 - Water Management Plan

Table of contents

Executive Summary

In 2014 Statoil, together with Sonatrach and Shell (Partners) was awarded the Timissit License (Block 210), an unconventional liquid-rich shale gas license. Statoil intends to complete an exploration program in Timissit, including seismic acquisition and six exploration wells. This Water Management Plan was developed to assess the water sourcing options and water requirements for the planned operations and details Statoil's approach to water use for the project.

Due to the location of the Timissit License in central eastern Algeria, groundwater is the primary source of water in this area. The most significant groundwater resource in the region is the North-Western Sahara Aquifer System (NWSAS), better known by its acronym in French: SASS (*Système d'Aquifères du Sahara Septentrional*). This aquifer is the primary source of groundwater for the countries it underlies, including Algeria, Tunisia and Libya. Within the Study Area the Continental Intercalaire (part of the SASS), including both the Albian (Lower Cretaceous) and TAGI (Triassic) formations, is the aquifer with the freshest water and the most significant yield.

The Ministry of Water Resources is the primary body governing water management in Algeria. The Ministry is consulted during the EIA approval process and other water related authorisations while the decentralised directorates within each Wilaya, the Directorates of Water Resources (Directions des resources en eau), are responsible for granting water resource-related permits. The use of surface or groundwater resources in Algeria requires an authorisation or concession according to Article 71 of *Law 05-12* on water resources and the approval procedure for such a concession is established by Executive Decree 10-318. The concession, when granted, defines the aquifer from which the water will be abstracted, the volume of water or water flow that can be abstracted, the authorised use(s) of the abstracted water and the measures necessary for registering water abstraction. The concession is granted for the total amount of water to be abstracted from an aquifer (i.e. one single concession can be requested for all the water wells needed).

The SASS is used as a water source by Algeria, Libya and Tunisia. Given the lack of fresh surface water in these desert and semi-arid regions, this aquifer is of great importance for the economic and social development of these countries. The SASS is essentially a "fossil" aquifer because it receives nominal recharge and estimates indicate that annual abstractions from this aquifer have exceeded the recharge since the 1980s. In the Study Area shallow, hand-dug wells are used to provide water for camels and to a lessor extent irrigation. However, the town of Debdeb and other local settlements abstract groundwater from the Continental Intercalaire as the primary source of both drinking and irrigation water. According to the data provided by the local Directorate of Water Resources for the Illizi Wilaya, Debdeb abstracts a reported 4,079,240 m^3/year of groundwater.

The project water requirements are estimated at approximately 798,000 m^3 over the exploration period with an annual demand between 124,000 and 275,000 m^3. The project activities with the highest demand include road maintenance (57%), camp water (22%) and road surfacing (12%). Hydraulic stimulation becomes a more significant component during completion of horizontal wells, when it accounts for between 8 and 14% of the total annual demand. It is initially anticipated that water sourcing for the project will include trucking of potable water from Debdeb and the installation of abstraction wells during the exploration activities (one water abstraction well per exploration well).

An evaluation of the available water resources as potential water sources for the project was completed using specific guiding principles developed by Statoil, including environmental, social and economic dimensions. The evaluation focused on the two principal water supply options considered feasible for the exploration activities, (1) the Albian (Cretaceous) aquifer of the Continental Intercalaire (CI) and the TAGI (Triassic sandstone) aquifer (also part of the CI). Based upon the results of this evaluation the Albian aquifer is considered a reasonable target as a groundwater source for the exploration phase. However for large-scale development activities the use of the TAGI aquifer should be considered as it will have less environmental and social impacts in comparison to use of the Albian aquifer. Further evaluation should be made during the planning phase of the project to try and limit water use where possible and

geographically locate the abstraction wells such as to limit the potential impact of the planned water use on local populations using the same aquifer.

The exploration well design and stimulation design for the Timissit exploration program were developed with the protection of groundwater aquifers as a priority. In order to provide further confidence that the planned operations are not impacting groundwater, Statoil will implement a groundwater monitoring program to monitor both groundwater quality, extent of drawdown (and hence quantity impacts on other users) and operational water use (i.e. steps to minimise the volume of water required for operational use).

1 Introduction

In 2014 Statoil, together with Sonatrach and Shell (Partners) was awarded the Timissit License (Block 210), an unconventional liquid-rich shale gas license. The Timissit License is located in eastern Algeria, at the border with Libya. This Water Management Plan (WMP) was developed to assess the water sourcing options and water requirements for the planned operations and detail Statoil's approach to water use for the project. Water supply represents a key strategic component of the exploration program and protection of local groundwater resources is a priority for the planned operations.

1.1 Project Context

Statoil intends to carry out an exploration program in the Timissit license area. This program will include 350 km^2 of 3D seismic acquisition followed by an additional 200 km^2 during phases 2 and 3. Phase I will include the completion of two vertical wells and an additional four wells (vertical and horizontal) will possibly be completed in phases 2 and 3. This WMP covers the planned seismic activities and the first 6 exploration wells. The drilling and hydraulic stimulation of the exploration wells is scheduled for the period between 2016 and 2021 and the seismic acquisition is scheduled to commence in 2017.

1.2 Project Objectives and Assumptions

The overall objective of this WMP is to minimize the risks associated with water use for the Timissit Project and specific objectives include:

- Identify and characterize the available water resources;
- Summarize the Algerian legislation regulating water use;
- Identify other water users in and around the License Area;
- Define the water requirements (with respect to both quantity and quality) for the different project activities;
- Evaluate the potential water sources to determine which may be the most feasible option for the project water supply;
- Summarize operational considerations; and
- Develop a Monitoring Program.

The following assumptions were made in development of this WMP:

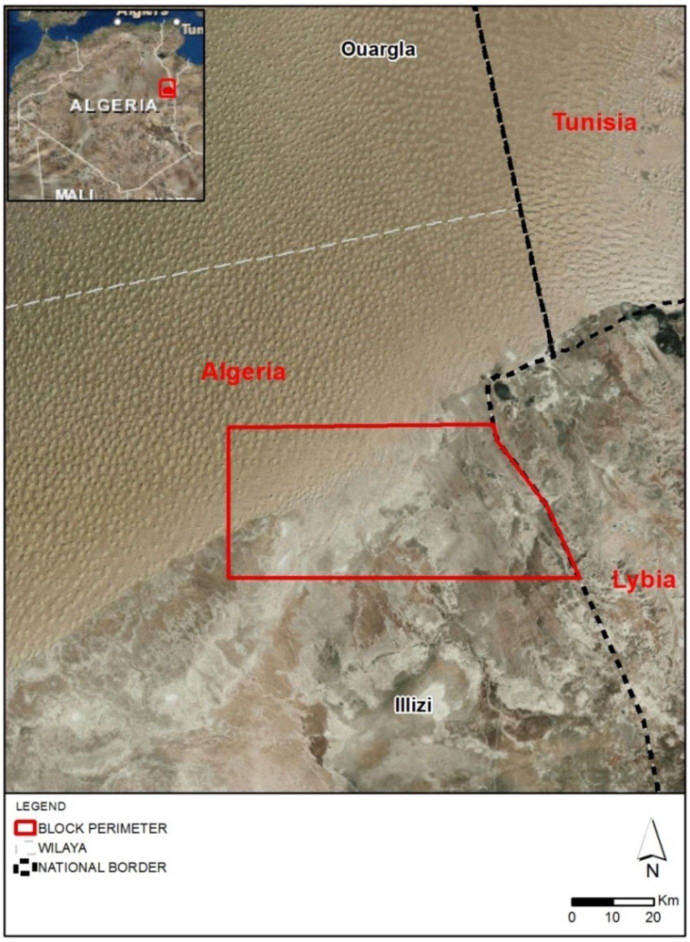
- Given the location of the License Area, groundwater is the primary target water source for project activities;
- Regional hydrogeological data was assumed to be representative of the water resources in the License Area and local data (specifically from ONT-1) was used, where available.
- Local water use was based on well inventory data provided by the DHW;
- Project water requirements are consistent with the Project Description developed by Statoil; and
- The monitoring program assumes use of well to be installed by Statoil during the exploration activities.

1.3 Project Area of Interest

The Timissit License Area is located at the border with Libya, just south of the border with Tunisia. It has an area of approximately 2,732 km^2 and the boundary of the license area is approximately 900 km southeast of Algiers, 300 km southeast of Hassi Messoud and 10 km southwest of Ghadames, Libya. It contains one town, Debdeb, located to the east.

Figure 1.1 provides a location map of the Timissit License Area. For the purpose of this Study, investigation of the available groundwater resources focused on an area within approximately 50 km north, south, east and west of the License Area boundaries. Information was also gathered on a more regional scale to inform the overall understanding of the regional hydrogeological systems, including qualitative and quantitative data to describe their form and function and their various inter-relationships.

Figure 1.1 Timissit License Area



Source: ERM Iberia

Note: ONT-1 is an exploration well discussed further below, in Section 3.

2 Methodology and Report Structure

2.1 Methodology

The information included in this report was compiled from a number of sources which are summarized below.

- Several bibliographical sources relating to the regional geology and hydrogeology. The different sources include studies related to the wider Sahara region, Algeria and the Ghadames Basin.
- Visits/data requests made to local government and scientific offices and review of government databases, including:
  - Algerian Ministry of Water Resources (MRE) : Ministère des Ressources de Eau ;
  - Algerian Water Agency (ANRH) : Nationale des Ressources Hydrauliques ;
  - The DRE (Direction des Ressources en Eau) office in the Illizi Wilaya; and
  - The Sahara and Sahel Observatory database (L'Observatoire du Sahara et du Sahel - OSS).
- Resources available from the Statoil Subsurface teams.

These resources are cited in full in *Chapter 8*, References.

2.2 Report Structure

The remainder of this report is structured as follows:

- Section 3 – Presents a summary of the water resources in Algeria and the Study Area;
- Section 4 – Presents a summary of local water use and water management;
- Section 5 – Provides a summary of project water requirements and an evaluation of the potential water resources;
- Section 6 – Presents an Evalaution of the Water Supply Options
- Section 7 – Presents the Monitoring Program;
- Section 7 – Conclusions;
- Section 8 – References; and
- Section 9 – List of Acronyms.

In addition, the following Annexes are attached to this document:

Annex A – List of Identified Water Wells.

Annex B – Water Forecast Assumptions.

Annex C – Groundwater Sampling Methodology

3 Water Resources in the Timissit License Area

This section of the report was prepared using information obtained through a desktop review of available documentation on the regional hydrogeology, detailed hydrogeological and hydrological information for the Timissit License Area (hereinafter, Study Area), where available, and consultation with the local water Authorities and local experts in Algeria.

3.1 Hydrogeology Resources

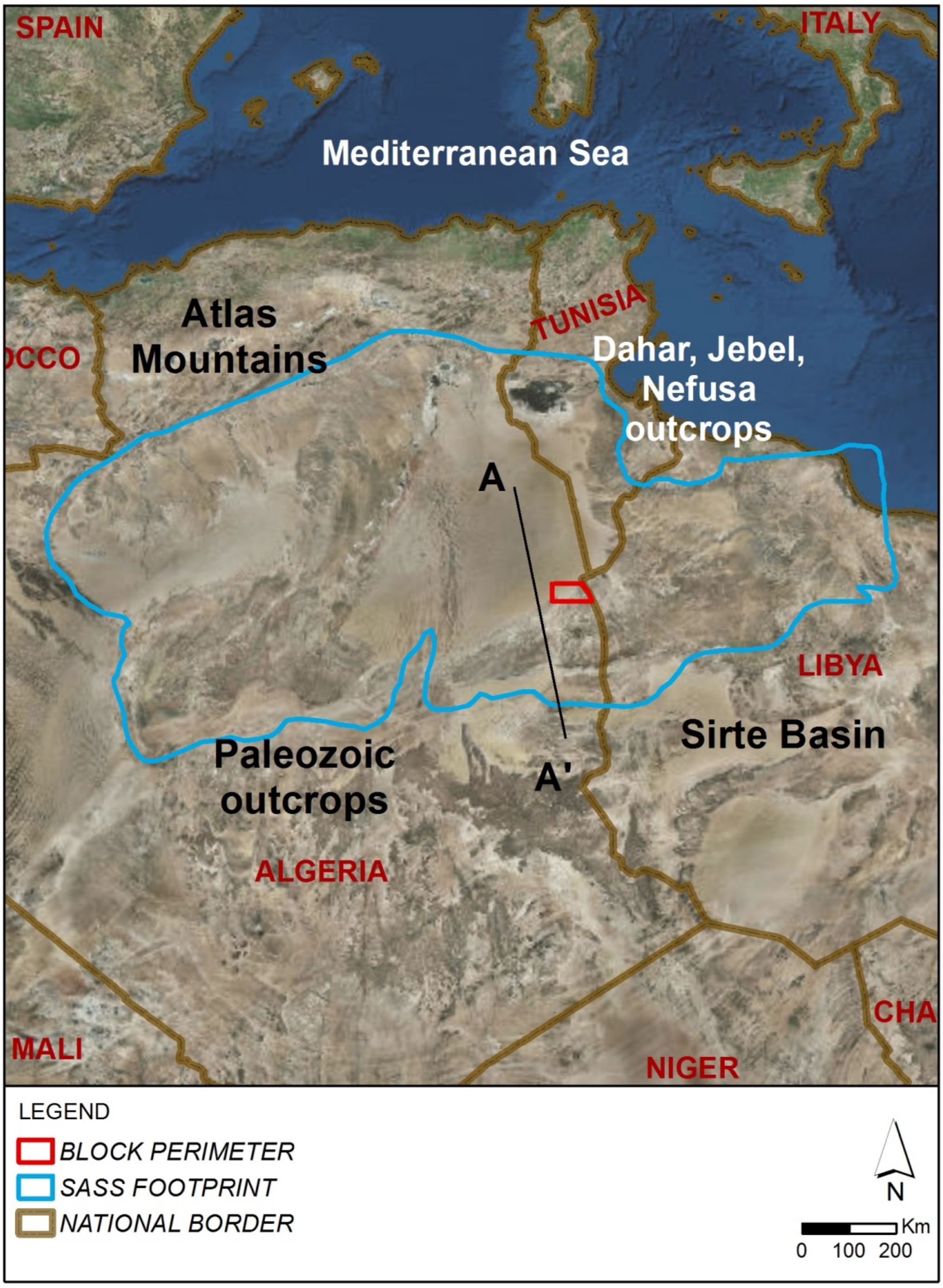
The Study Area is located in eastern Algeria, in the northern Sahara Desert (*Figure 3.1*), near the border with Libya and Tunisia. The most significant groundwater resource in the region is the North-Western Sahara Aquifer System (NWSAS), better known by its acronym in French: SASS (*Système d'Aquifères du Sahara Septentrional*). It is a large aquifer system that extends over an area of more than 1,000,000 km^2, comprising approximately 700,000 km^2 in Algeria, 80,000 km^2 in Tunisia and 250,000 km^2 in Libya. The SASS is bordered to the northwest by the Saharan Atlas Mountains, to the west-southwest by Palaeozoic outcrops, to the northeast by the southern Mediterranean, to the northeast by the Dahar and Jebel Nefusa outcrops and the east by the brackish water of the Sirte Basin. The general footprint of the SASS is shown in *Figure 3.1*.

The SASS is a multi-layer aquifer found in Mio-Pliocene through to Triassic formations, although its vertical extent varies across its geographical location. It is principally comprised of three overlapping aquifers (from top to bottom):

- The Terminal Complex (CT, from the French name *Complexe Terminal*).
- The Turonian aquifer.
- The Continental Intercalaire (CI).

A simplified hydrogeological schematic of the SASS, showing the three overlapping aquifers is included in *Figure 3.2*. It can be observed that the three aquifers are present across Algeria, Tunisia and Libya. Different names may be used locally in every country to refer to a given aquifer. In this document, the terms most frequently used in the Algerian bibliography were applied.

Figure 3.1 Map illustrating the geographic distribution of the SASS



Source: ERM, 2015

Note: Cross-Section A-A' is provided below as Figure 3.4.

Figure 3.2 SASS hydrogeological scheme across Algeria, Tunisia and Libya

Algeria	Tunisia	Lybia
Aquiclude		
Sands	*Djerid sands*	*Inferior Miocene sands and limestones*
Complexe Terminal		
Limestones	*Nefzaoua Limestones*	*Mizddeh Superior Cretaceous*
Aquitard		
Turonian aquifer		
Aquitard		
Continentale Intercalaire		
Inferior Cretaceous, Jurassic and Trias	*Inferior Cretaceous, Superior Jurassic*	*Inferior Cretaceous, Jurassic and Trias*
Aquiclude		

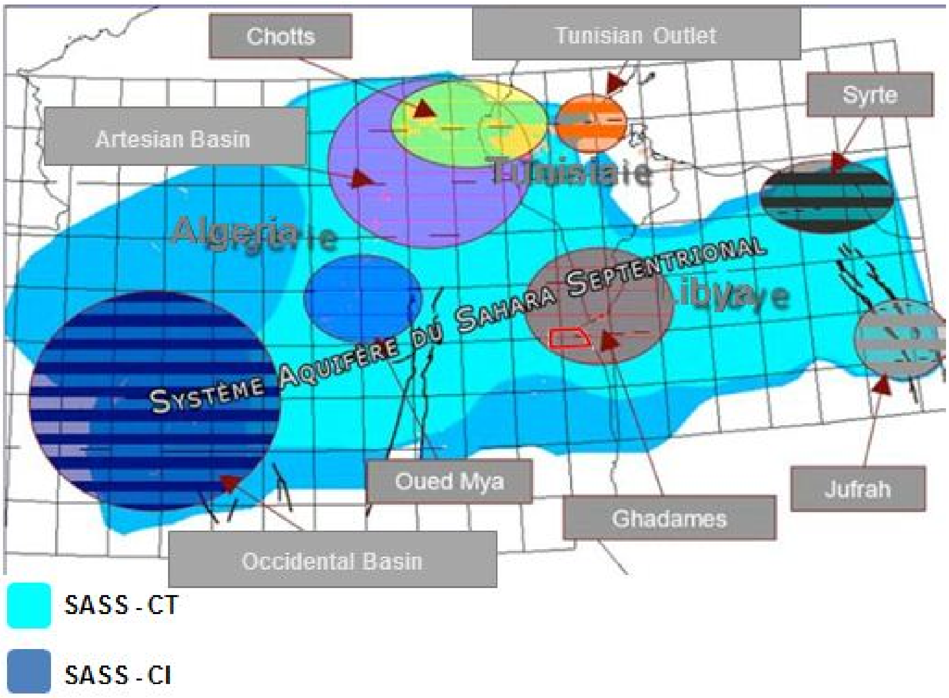
Source: Sappa G. & Rossi M., 2012

A recent study from the OSS (*Observatoire du Sahara et du Sahel –* Sahara and Sahel Observatory) proposed a hydrogeological zoning of the SASS by basins, as shown in *Figure 3.3*. As indicated in *Figure 3.3*, the Study Area is located within the Ghadames Basin, which extends across parts of Algeria, Tunisia and Libya[1].

The Ghadames Basin is one of the primary sedimentary basins in the region. It is a wide synclinal basin and its lithology is comprised of two distinct deposits. The upper part, extending to the base of the Upper Cretaceous, is composed of limestone, dolomites, dolomitic limestone, marl and argillaceous sediments with some thin sandy, shaley, silty and gypsiferous beds (El Baruni, 2000). Some of these layers are frequently fractured and cavernous. These formations comprise the CT and Turonian aquifers, discussed further in *Sections 3.3* and *3.4*. The second, deeper part of the lithology (from the Lower Cretaceous downward) is comprised of thick layers of granular sediments including Mesozoic and Palaeozoic sandstones with interbedded shale, clay and silt. Thin layers of limestone and gypsum (Triassic and Jurassic) are also present. The Lower Cretaceous-Jurassic-Triassic formations constitute the CI aquifer system, discussed further in *Section 3.5*. *Figure 3.4* presents a stratigraphic cross section through the Ghadames and Illizi Basins.

[1] Therefore, studies conducted in the three countries about SASS - Ghadames basin, can be considered an appropriate bibliography source for this project.

Figure 3.3 SASS hydrogeological basins



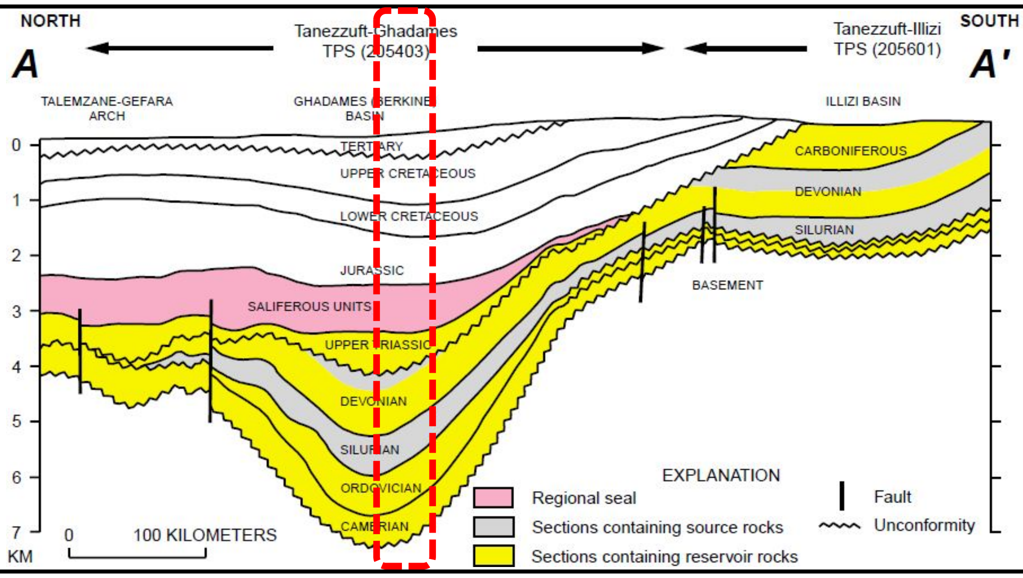
Source: OSS, 2003 (modified by Sappa & Rossi, 2010)
Note: Principal basins within the overall extent of the SASS and their common name are shown in the grey highlighted boxes.

The permeable and less permeable layers found in the Ghadames Basin are generally common to the whole of Eastern Libya, Algeria and Tunisia. It is difficult to define the aquifer layers based on a single geological formation given that the formations in the region are not always identical in lithological content, and variations of lateral and vertical facies are observed.

In addition to the SASS there are two other aquifers systems found within the Ghadames Basin:

- Shallower aquifers, found primarily in Quaternary deposits. They are of lesser significance, in comparison with the SASS due to their limited extent within the Ghadames Basin and their lower quality.
- Deeper aquifers, represented by the Palaeozoic formations. They are also of lesser significance, in comparison with the SASS due to their depth within the Ghadames Basin.

Figure 3.4 Stratigraphic cross section through the Ghadames and Illizi Basins



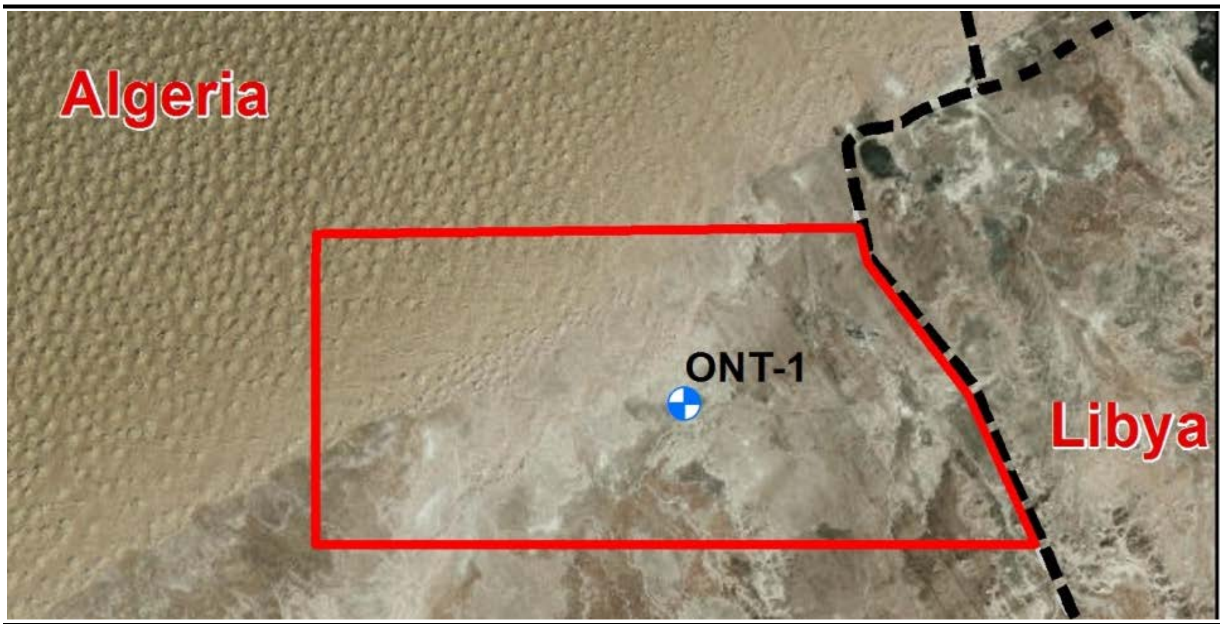
Source: Klett, 2000.

Note: (1) Red intermittent line represents the approximate Study Area location. (2) Approximate location of cross section A-A´is shown in Figure 3.1.

This overview is complemented by the specific information provided by Statoil for an exploration well completed inside the Study Area (*ONT-1. Postwell Geologic Summary. October, 2000*). Well ONT-1 (Ouan Tessabakot #1) is located near the center of the Study Area, as shown in *Figure 3.5*. The detailed geological profile available for ONT-1 allowed for the development of a hydrogeological conceptual scheme for the License Area, provided as

Figure 3.6.

Figure 3.5 Location of ONT-1



Source: Alnaft (no date)

Depths included in
Figure 3.6 **are estimated based on the lithological log for ONT-1. The estimation was done by considering 25 m as the minimum depth unit. This enables the simplification of the hydrogeological scheme. In addition, it should be noted that variations of the estimated depths will occur both in the Ghadames Basin and the Study Area, resulting from the non-parallel disposition of geological units, as shown in *Figure 3.4.***

The following sections, as listed below, provide further details about the different aquifers located in the Study Area:

- *Section 3.2*: Shallow aquifers.
- *Section 3.3*: CT aquifer system.
- *Section 3.4:* Turonian aquifer.
- *Section 3.5:* CI aquifer system.
- *Section 3.6*: Palaeozoic aquifer system.

Figure 3.6 Hydrogeological scheme in the Study Area

Age	Formation	Hydrogeological unit	Estimated depth (m)
Createaceous	Mio-pliocene & Upper Senonian*	SASS - CT aquifer	0 - 50
	Senonian*	Senonian aquitard	50 -250
	Turonian	Turonian aquifer	250-350
	Cenomanian	Cenomanian aquitard	350-550
	Albian	SASS - CI aquifer (Lower Cretaceous)	550 - 1,000
	Aptian		
	Barremian		
	Neocomian		
Jurassic	Malm	SASS - CI aquifer (Jurassic)	1,000 - 1350
	Dogger		
	Lias	Semipermeable level	1,350 - 1,650
Triassic	Upper Triassic		
	Medium Triassic		
	Lower Triassic	SASS - CI aquifer Triassic aquifer (TAGI)	1,650 - 1,675
Carboniferous	Avonian (Visean & Tournesian)	Paleozoic aquifer: Upper Devonian - Carboniferous complex	1,675 - 3,250
Devonian	Upper Devonian		
	Medium Devonian	Semipermeable level	3,250 - 3,650
	Lower Devonian	Paleozoic aquifer: Lower Devonian complex	3,650 - 4,150
Silurian	Silurian	Semipermeable level	4,150 - N/A
Ordovician	Ordovician	Paleozoic aquifer: Lower Devonian complex	N/A
Cambrian	Cambrian		

Source: ERM, 2015

Notes:

** = Based on regional information only*

The details provided in the following sections include:

- **Regional information: collected from the available bibliography, and applicable to the whole Ghadames Basin.**
- **Local information: information specific to the Study Area provided by Statoil (i.e.: from well ONT-1 stratigraphic column), local well inventory data or data collected during the field survey.**

In case of deviations between regional and local data, local data was considered more representative of the conditions expected for the Study Area.

3.2 Shallow Aquifers

Shallow aquifers are considered minor because of their limited extent and the relatively small amount of water they store, however they have significant social and economic importance in those areas where they are the only fresh water source (Pallas, 1978). Shallow aquifers are associated with Quaternary deposits, which provide favourable media for local groundwater storage, particularly where unconsolidated granular sediments overlie lower permeability clays and silts.

These shallow aquifers become manifest in both oueds and sabkhas. These aquifers are usually less than 10 m thick and their distribution is limited due principally to the irregular distribution of the Quaternary deposits and associated landforms and erosion. Where they do exist, these sediments are usually granular in nature and permeable and the water table generally appears at depths between 3 to 5 m bgl. Flow directions are influenced by the structure of the sediments and the topography. These shallow groundwater resources provide support to the existing vegetation, which tends to concentrate where the shallow aquifer is present.

Where exploitation does occur it tends to be either in the form of abstraction from shallow exposed groundwater within depressions along the plateau surfaces (gararahs) or via shallow hand dug wells. This shallow groundwater appears to be used by local communities for agricultural and grazing animals rather than as a potable supply. During the field survey shallow, hang dug wells were identified within the Study Area and it was confirmed that the water from these wells was used primarily for camels and to a lessor extent for irrigation.

3.3 Terminal Complex (CT) Aquifer System

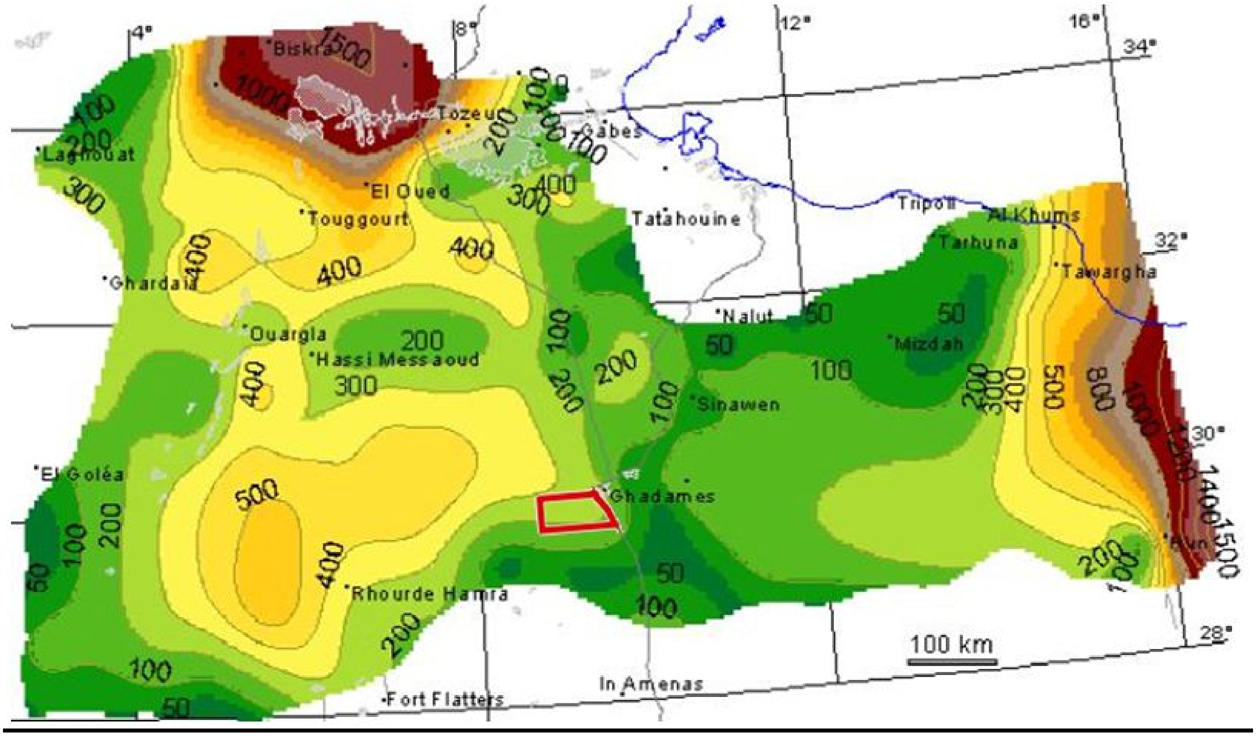
As described above, the CT aquifer unit forms the upper most part of the SASS system and it extends over an area of approximately 670,000 km^2. At a regional level the depth and average thickness of the CT aquifer system is highly variable as can be seen in *Figure 3.7*, however based on the information available for well ONT-1, the CT aquifers are relatively shallow within the Study Area, approximately 0-50 m deep, and in some areas may not be present (
Figure 3.6).

Two regional aquifers can be defined within the CT aquifer system, separated by a semipermeable layer:

- Mio-Pliocene aquifer.
- Calcareous aquifer of the Upper Cretaceous.

The **Mio-Pliocene aquifer** corresponds to Tertiary fractured limestone and sands and there is limited information in the available literature about this aquifer. These materials have limited extent and thickness with in the Study Area.

Figure 3.7 Regional thickness - CT aquifer system



Source: Ould Baba, 2005

The **Calcareous aquifer** is comprised of materials deposited in two main periods: Palaeocene and Upper Cretaceous. These formations have a limited extent and thickness within the Study Area, however the available data for the Ghadames area is included below.The **Palaeocene formation** is composed of highly heterogeneous sediments such as limestone, marly limestone, dolomite, sandy limestone, siltstone, unconsolidated deposits of sand, silt and gravel with clay, gypsum and anhydrite intercalations (El Baruni, 2000).

Data is available for two wells in the Palaeocene formation, located in the city of Ghadames (Libya). This city is located approximately 10 km northeast from the Study Area. The physical and chemical characteristics available for these wells are summarized in *Table 3.1* and *Table 3.2* (El Baruni, 2000).

Table 3.1 Palaeocene wells physical characteristics

Well	Depth (m)	Static water level (m)	Yield (m^3/h)	Transmissivity (m^3/s)
WG-1	110	72.7	38.16	$2.6E^{-4}$
WG-7	100	51.7	8.28	$2.7E^{-5}$

Source: El Baruni, 2000

Table 3.2 Palaeocene wells chemical characteristics

Well	EC (m mhos/cm)	TDS – sal. (g/l)	pH	Cations (mg/l)				Anions (mg/l)			
				Ca	Mg	Na	K	HCO_3	SO_4	Cl	NO_3
WG-1	2,500	1.8	7.8	287	92	224	7	250	1,085	298	20
WG-7	2,890	2.3	7.8	292	139	220	12	204	1,085	310	-

Source: El Baruni, 2000

Due to the heterogeneous nature of the formation and its permeability, the discharge of individual wells varies from one place to another. The yield of the wells reported above is considered low to moderate, ranging between 8 and 38 m^3/h.

The water quality is also highly variable. It is typically highly mineralized, with a salinity showing a variation from 1.8 to 2.3 g/l (wells near the city of Ghadames, *Table 3.2*). For context, the general salinity limit for drinking water is 1 g/L (USEPA) and the salinity of sea water is approximately 35 g/L.

Good yield and good water quality may result from areas of greater fracturing and the potential for direct recharge from surface runoff or vertical flow of groundwater from the Mesozoic and Palaeozoic aquifers.

The **Upper Cretaceous formation** within the Calcareous aquifer unit consists of fractured and cavernous dolomitic limestone, limestone, and dolomite interbedded with marl, shale, clay, and gypsum (El Baruni, 2000). Further detailed information on the groundwater in this formation is also provided in data from wells located in the city of Ghadames. The physical and chemical characteristics available for these wells are summarized in *Table* 3.3 and *Table 3.4*.

Table 3.3 Upper Cretaceous wells physical characteristics

Well	Depth (m)	Static water level (m)	Yield (m^3/h)	Transmissivity (m^3/s)
WG-15	86	26.98	25.92	$1.0E^{-4}$
WG-17	100	26.7	6.48	$9.2E^{-6}$

Source: El Baruni, 2000

Table 3.4 Upper Cretaceous chemical characteristics

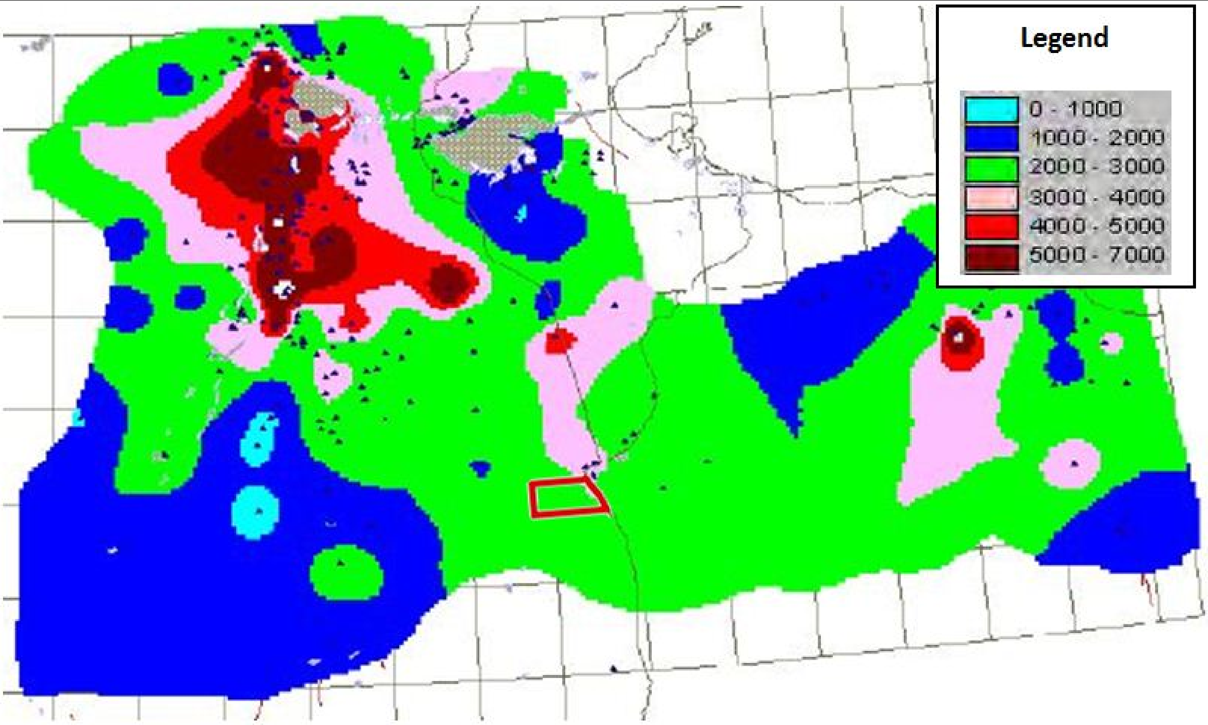
Well	EC (m mhos/cm)	TDS – sal. (g/l)	pH	Cations (mg/l)				Anions (mg/l)		
				Ca	Mg	Na	K	HCO_3	SO_4	Cl
WG-15	9,800	6.4	7.4	480	329	1,240	30	186	2,206	1,952
WG-17	5,830	2.8	7.4	208	249	660	10	204	1,345	1,054

Source: El Baruni, 2000

Reportedly the productivity associated with this formation is between 4 and 70 m^3/h, reaching more than 100 m^3/h, where the formation is highly fractured (El Baruni, 2000).

Water quality in the Upper Cretaceous formation is variable and in some cases is saline due to the presence of gypsum and anhydrite. According to the OSS Study (2003), there is generally good water quality north of the 31st parallel, due to the predominance of fresh water recharge in the outcrop areas of Jebel Nefusa. The water quality decreases to the south, where the Study Area is located, due to the slow movement of water from areas of recharge and the correspondingly high residence time in the formations, which typically have a high mineral content. The salinity reported in the samples analysed from WG-15 and WG-17 is 6.4 and 2.8 g/l, respectively. These data are consistent with regional salinity data reported by the OSS which indicate salinities between 2,000 – 3,000 mg/l (2 – 3 g/l or 2-3 parts per thousand) for the Study Area (see *Figure 3.8*).

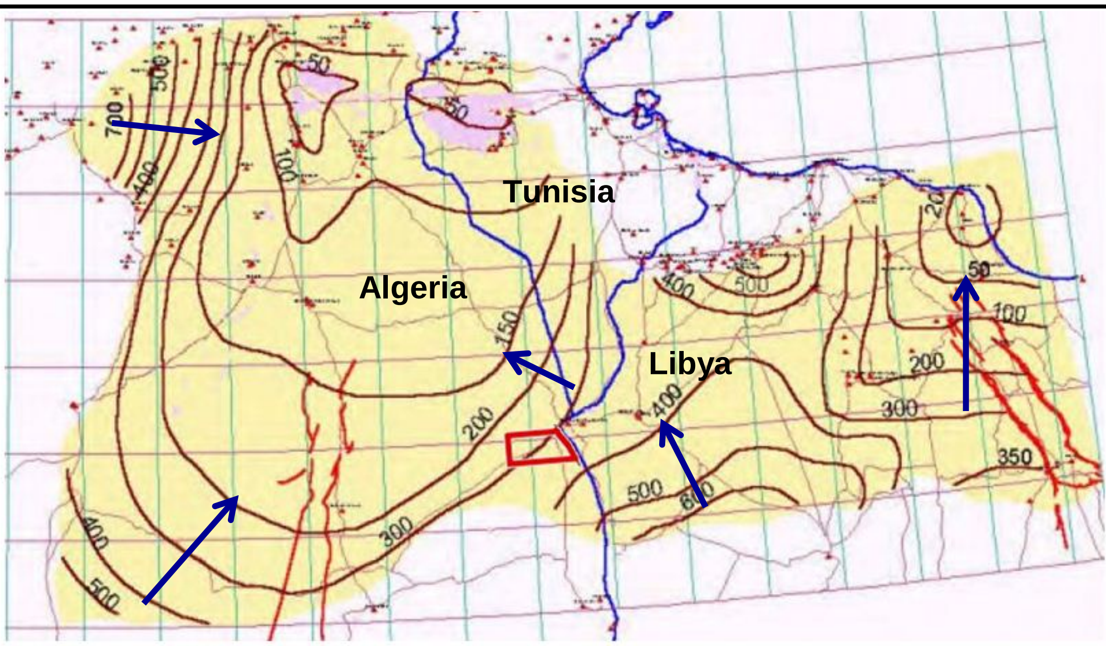
Figure 3.8 Regional salinity - CT aquifer system



Source: OSS, 2003

The inferred groundwater flow direction in the CT aquifer system is illustrated in *Figure 3.9*. It is observed that groundwater in the CT aquifer system flows from southeast to northwest in the Study Area.

Figure 3.9 Regional piezometric level - CT aquifer system



Source: Adapted from OSS, 2003

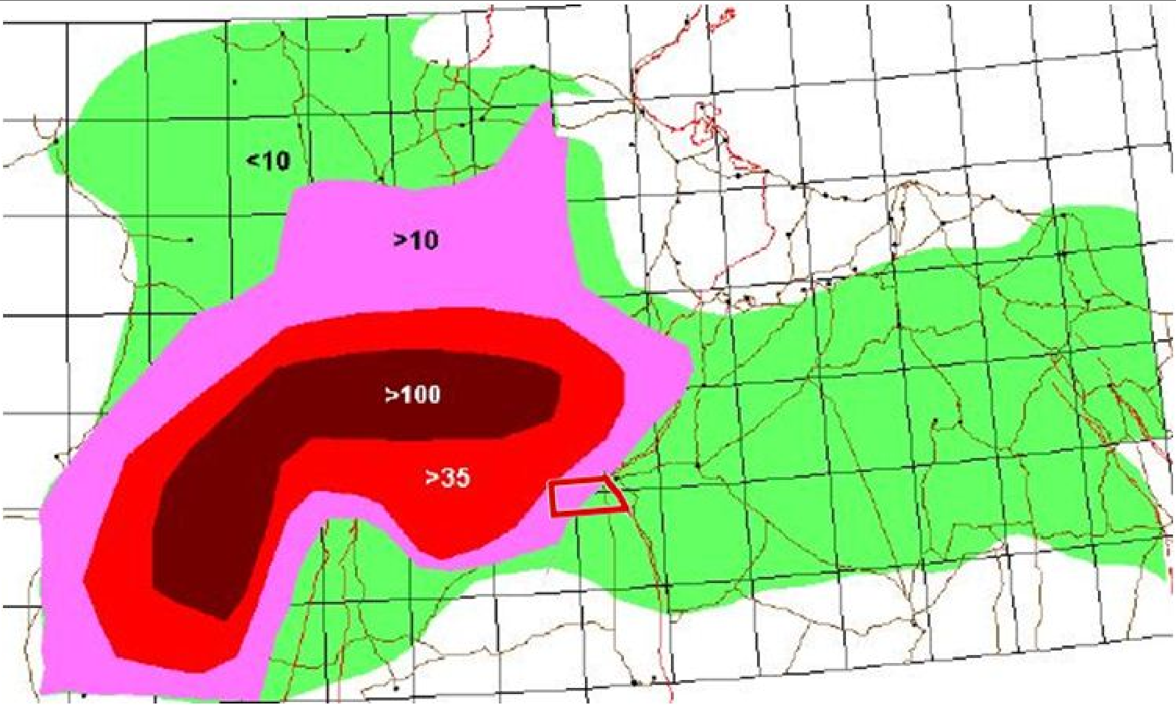
Note: Blue arrows represent the inferred groundwater flow direction from areas of higher head to lower head.

3.4 Turonian Aquifer

The Turonian aquifer is comprised primarily of limestone and dolomite deposits and based on the information from well ONT-1, the depth range for the Turonian formation is estimated at 250-350 m (*Figure* 3.6) in the Study Area. The following details are reported for this aquifer:

- The yield from this aquifer is generally low to medium, varying between 5 and 70 m^3/h, but can reach more than 100 m^3/h (El Baruni, 2000).
- The transmissivity of the Turonian aquifer is low, except in those areas where the formation is fractured. The average transmissivity computed from pumping tests conducted in Ghadames ranges between 2.1 x 10-5 and 2 x 10-3 m^2/s. The storage coefficient is high, in the order of 0.1 in the outcropping areas, where the aquifer is unconfined, and ranges from 1.7 x 10^{-3} to 2.6 x 10^{-4} in the confined areas. The porosity of the Turonian aquifer was reported to be in the range of 11 to 23% (El Baruni, 2000).
- The water quality in the Turonian aquifer is variable with the occurrence of saline water in some areas due to the presence of gypsum and anhydrite. At a regional level, the salinity ranges from 2.6 to more than 4.0 g/l, although areas with a higher level of salinity (> 35 and > 100 g/l) are found in central Algeria (Figure 3.10). The salinity reported for the Study Area is between <10 and >10 up to 35 g/L (*Figure 3.10*). Data available from chemical analysis show that the Turonian aquifer can be classified as a chloride and sulphate type water, mostly of mixed cation type (no dominant ions), although sometimes sodium appears as the predominant cation (El Baruni, 2000).

Figure 3.10 Regional salinity – Turonian aquifer



Source: OSS, 2003

3.5 Continental Intercalaire (CI) Aquifer System

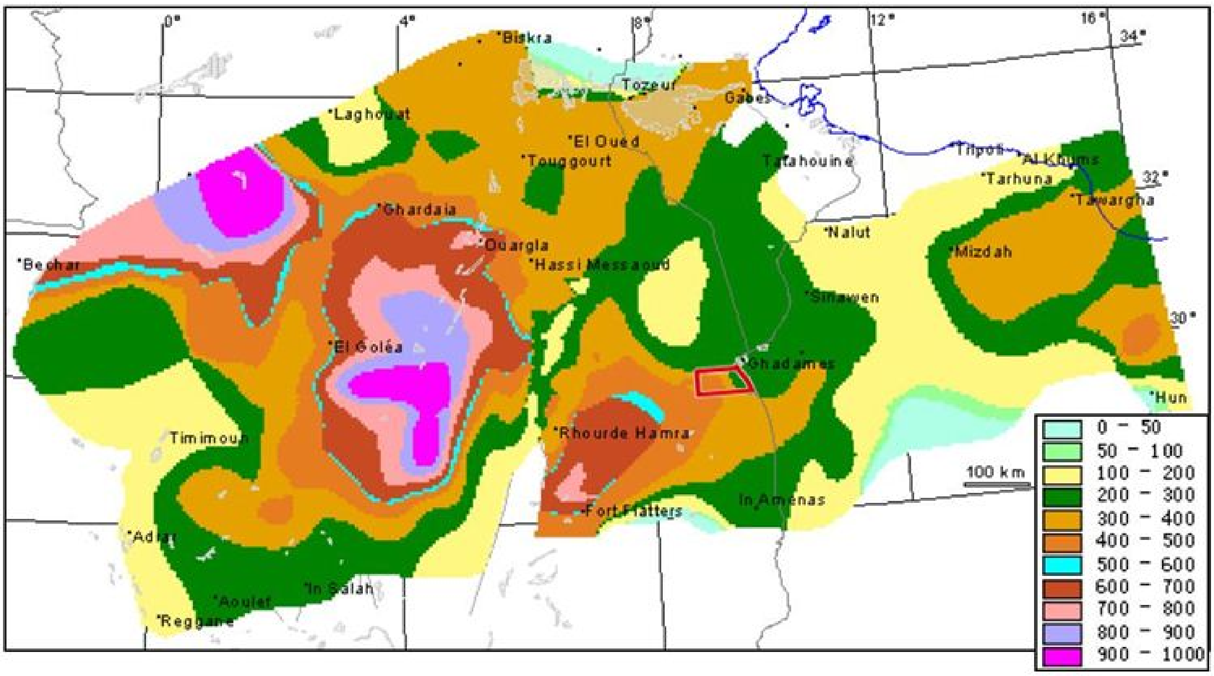
The CI aquifer system extends across three countries over a total area of approximately 1,000,000 km^2, constituting the highest quality aquifer in the Northwestern Sahara.

The French term "*Continental Intercalaire*" refers to the continental origin of the sediments that constitute the aquifer, which were formed in the continental and epi-continental environment between two marine sedimentation periods: the

Palaeozoic marine depositional period related to the Hercynian Orogeny and the Late Cretaceous marine depositional period related to the Cenomanian transgression. The CI aquifer system materials include layers of sandstone, clay, limestone, sand and gravel.

The depth and thickness of the CI aquifer system, as in the case of the CT aquifer system, shows a high degree of variability. The thickness in the Study Area, based on this map data is reportedly between 200 and 500 m (Figure 3.11).

Figure 3.11 Regional thickness - CI aquifer system



Source: Ould Baba, 2005

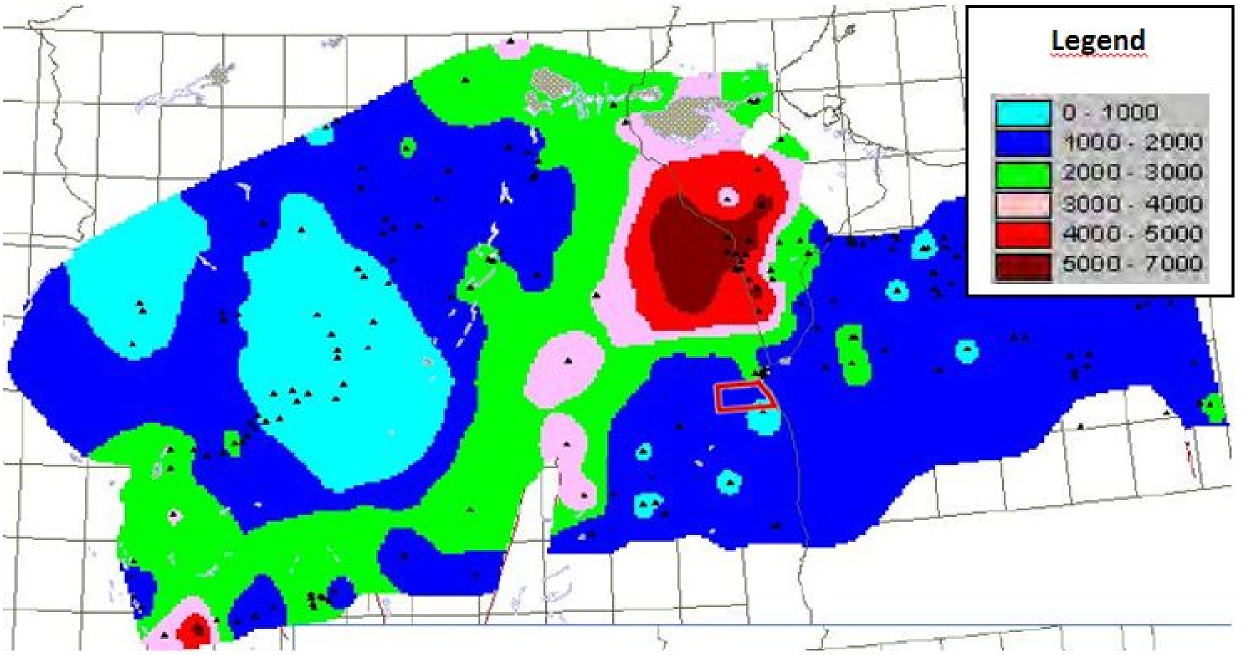
Two aquifers can be defined within the CI aquifer system, separated by a lower permeability formation:

- Lower Cretaceous-Jurassic aquifer.
- Triassic aquifer, also referred to as the TAGI.

The **Lower Cretaceous – Jurassic aquifer** is comprised of continental, unconsolidated to semi-consolidated sediments of principally Lower Cretaceous age, including quartzitic sandstone and gravel with intercalated silt, clay, shale and limestone. The following information is available for this aquifer:

- Based on data from well ONT-1 this aquifer unit is found between 550 and 1,350 m depth
- *Figure* 3.6).
- According to various sources (Pallas, El Baruni, Pizzi) the transmissivity of the Lower Cretaceous – Jurassic aquifer is reported between 400 and 8,600 m^2/d in the Ghadames Basin primarily due to the changes in aquifer thickness and lithological variations. The storage coefficient calculated via pumping tests was between 10^{-4} and 10^{-5} where the aquifer is confined and 10^{-1} near the outcrops areas where the aquifer is unconfined. The porosity was estimated to be between 20 and 38% (El Baruni, 2000).
- The production rates range from 50 to 400 m^3/h.
- The Lower Cretaceous – Jurassic formation is of relatively good quality (El Baruni, 2000), with an average salinity concentration between 1 and 1.5 g/l. Salinity is lower in recharge areas and higher in central and western part of the Ghadames Basin, where the Study Area is located. Regional salinity values for the CI aquifer system are shown below in *Figure 3.12* (1,000 – 2,000 mg/l).

Figure 3.12 Regional salinity - CI aquifer system



Source: OSS, 2003

The Lower Cretaceous – Jurassic aquifer is considered the freshest source of groundwater within the context of the SASS. It is frequently used as a potable drinking water source, although its salinity is frequently near or above the limit of what can be considered fresh water (2 g/l according to IPIECA but more typically 1 g/l for drinking water standards (ref: USEPA).

The Lower Cretaceous – Jurassic aquifer includes the Albian sandstones, which are considered to be the main fresh water bearing strata within this aquifer in the Study Area. The Albian sandstone is expected within a depth range of 650-750 m in the north of the Study Area between 500-600 m in the south. As reported by the Statoil subsurface team, at these depths water delivery rates are expected to be high, tentatively 50-150 m^3/h, also aligned with the reported production rates included for the Lower Cretaceous – Jurassic formation (50 – 400 m^3/h). According to the Statoil subsurface team there are sandstones below the Albian that are likely to produce water with a similar low salinity (< 2 g/L) to a depth of approximately 1,000 m.

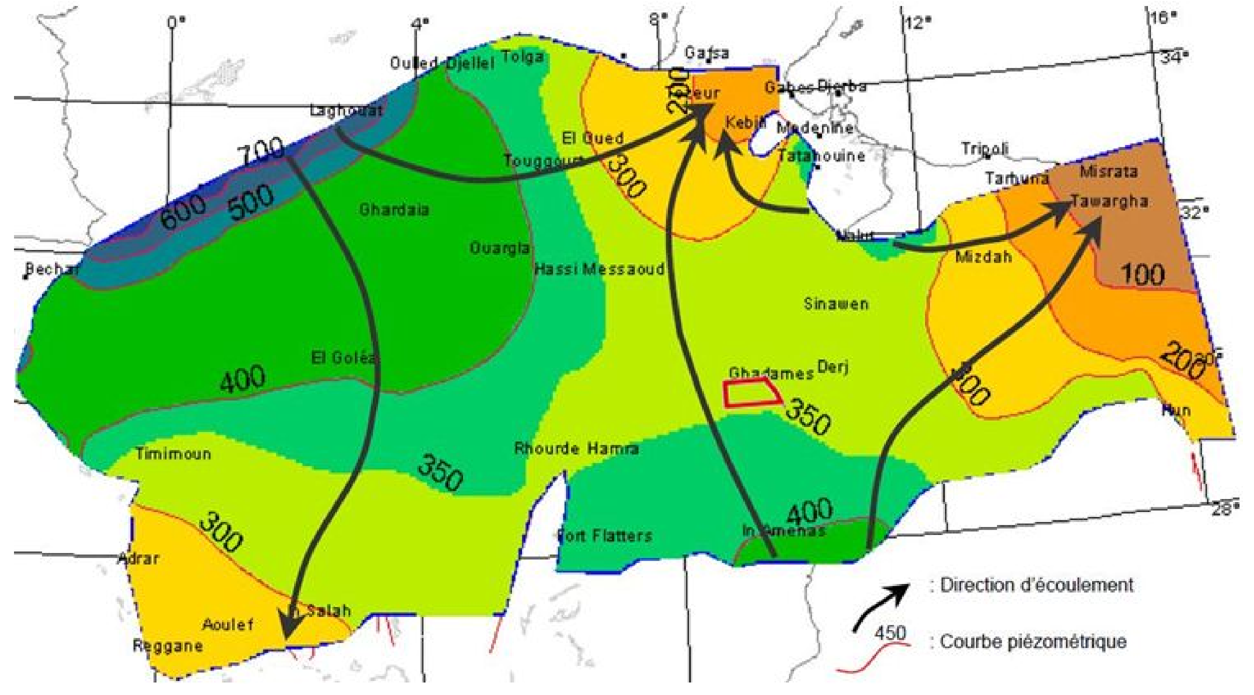
There is limited information available on the characteristics of the **Triassic aquifer**, due to the fact that it is found at considerable depth in the Study Area: between 1,650 and 1,675 m according to well ONT-1 *Figure 3.6*). According to the Statoil subsurface team the sandstone within this aquifer unit is expected to be best developed (best flow capacity / permeability) within the northern part of the Timissit License Area and it is not likely to be present in the southern part of the Timissit Licence Area.

The Triassic aquifer is formed by the sands and dolomitic limestones of the Middle Triassic. Sandy deposits in this aquifer may reach a thickness ranging from 140 to 290 m. The top of this aquifer includes a thick series of marl and marly limestone, whereas the bottom is composed of marly limestone and shale of the Carboniferous and Upper Devonian formation (BRL, 1997).

This aquifer has a variable salinity, with values reported at 1-2 g/L in the Illizi Basin (Everdigen, 1962) to highly mineralized to the north (Askri et al. 1995). The Statoil subsurface team reported that salinity values of 10 g/L are expected for the Triassic aquifer in the Timissit License Area.

The inferred groundwater flow direction in the CI aquifer system is shown in *Figure* 3.13. It is observed that groundwater in the CI aquifer system flows from south to north along the Study Area.

Figure 3.13 Groundwater flow direction - CI aquifer system



Source: OSS, 2003

3.6 Palaeozoic Aquifer System

The Palaeozoic aquifer system is the deepest groundwater present in the Ghadames Basin. The Palaeozoic formations cover the basement rocks (Precambrian basement) unconformably and consists mainly of clastic rocks of Cambrian to Carboniferous age (El Baruni, 2000).

The Palaeozoic aquifer system occurs at depths of over 1,800 m in the Ghadames Basin. Due to this considerable depth, it is not used as a water source in the Study Area.

The Palaeozoic aquifer system consists of the following formations:

- Upper Devonian – Carboniferous formation, characterised by groundwater composed of chlorinated brines (Askri et al. 1995). This formation is found at depths between 1,650- 3,100 m in the Study Area.
- Lower Devonian formation: characterised by a succession of high and low pressures, corresponding to topographic highs or depressions. Groundwater is characterised by a high mineral load and a high degree of metamorphism. This formation is located at an estimated depth of 3,650 – 4,150 m in the Study Area.
- Cambro-Ordovician formation: characterised by formation pressures close to hydrostatic pressures. In general, the mineral content increases with depth. This formation is located at an estimated depth of over 4,150 m in the Study Area.

Based on the interpretation of data collected from oil wells and water wells the reported yield from the Palaeozoic formations ranges from 100 to 400 m^3/h. The transmissivity is reported to be between 86 and 2,500 m^2/day. Groundwater flow in the Palaeozoic aquifers in the Ghadames Basin is indicated to be from south to north, flowing away from the Palaeozoic outcrops where these aquifers are recharged (El Baruni, 2000).

The Statoil subsurface team has reported that the salinity expected for the Palaeozoic aquifers in the Timissit License Area is relatively high, approximately 100 g/L. The groundwater is of higher quality to the south where the Palaeozoic aquifers are recharged.

3.7 Summary of Aquifers Characteristics

The information provided above for the different aquifers found within the Study Area is summarized below in *Table 3.5*.

Table 3.5 Summary of aquifers characteristics in License Block Area

Aquifer	Depth (m bgl)	Thickness (m)	Lithology	Yield (m^3/h)	Salinity (g/l)
Shallow aquifers	3-30	< 10	Quaternary deposits (granular sediments)	N/A	N/A
Terminal Complex (CT) aquifer system	Regional: 20-700	Regional: 50-1,200 Ghadames Area: 50-200 (reg. data)	Variable, see below	Variable, see below	Regional: 0–7 Ghadames Area: 2–3 (reg. data)
Mio-Pliocene aquifer	Ghadames Area: 150–180 (reg. data) License Area: 0-50	N/A	Fractured Limestone and sands	N/A	Ghadames Area: 1.9
Palaeocene formation (Calcareous aquifer)	License Area: 10-90	Regional : 0-100	Limestone, marly limestone, dolomite, sandy limestone, siltstone, unconsolidated deposits of sand, silt and gravel with clay, gypsum and anhydrite	Ghadames Area: 8–38	Ghadames Area: 1.8-2.3
Upper Cretaceous formation (Calcareous aquifer)	Regional: 260-380 License Area: 40-250	Regional: 0-100	Fractured and cavernous dolomitic limestone, limestone, and dolomite interbedded with marl, shale, clay, and gypsum	Regional: 4–70 (> 100, if fractures occur)	Ghadames Area: 2.8–6.4
Turonian aquifer	Regional: 200–450 License Area: 250-350	Regional: 50->100	Limestone and dolomite deposits	Regional : 5-70 (>100)	Regional: 2.6-> 4 (>100)
Continental Intercalaire (CI) aquifer system	Regional: 50-700 Ghadames Area: 300-350	Regional: 0-1,000 Ghadames Area: 200-500	Variable, see below	Variable, see below	Regional: 0–7 Ghadames Area: 1–2
Lower Cretaceous-Jurassic aquifer	Regional: 460-670 License Area: 550-1,350 *Albian formation: 650-750 (north of Study Area – local data).*	Regional: 580	Continental, unconsolidated to semi-consolidated sediments of principally Lower Cretaceous age, including quartzitic sandstone and gravel with intercalated silt, clay, shale and	Regional: 50-400	Regional: 1-1.5 (subject to variations depending on areas)

Aquifer	Depth (m bgl)	Thickness (m)	Lithology	Yield (m^3/h)	Salinity (g/l)
	Albian formation: 500-600 (south of Study Area – local data)		limestone		
Triassic aquifer	Regional: 1,800-2,000 License Area: 1,650 – 1,675	Regional: 140-290	Sands and dolomitic limestones of the Middle Triassic	N/A	Regional: <1 to 2 License Area: 10 g/L
Palaeozoic aquifer system	Regional: > 1,800 License Area: Upper Devonian-Carboniferous formation: 1,650-3,100 Lower Devonian formation: 3,650-4,150 Cambro-Ordovician formation: >4,150	N/A	Clastic rocks from Cambrian to Carboniferous	Regional: 100-400	Regional: Southern Ghadames Basin: 1.1-1.8 License Area: 100 g/L

Source: ERM, 2015 (based on information included within this document)

Notes:

N/A: not available

Data for the Ghadames Area are from wells WG-1, WG-7, WG-15, WG-17.

Data for the License Area are from well ONT-1 .

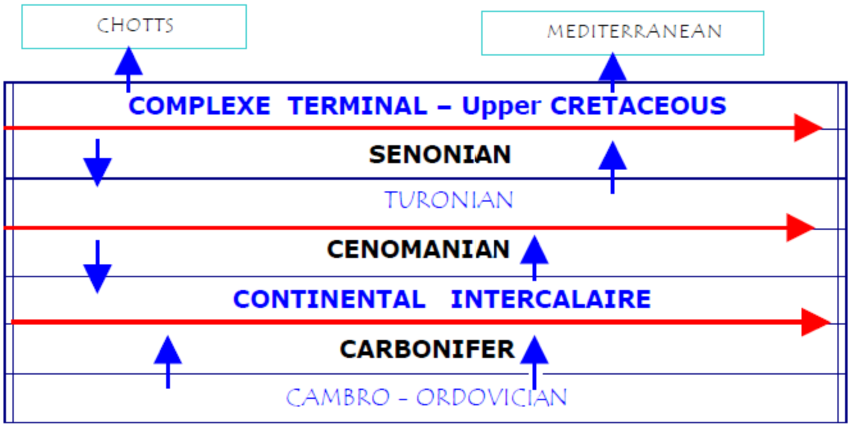
3.8 Aquifers Connectivity

The different aquifers described in the sections above are generally separated by low permeability or semi-permeable layers (referred to as aquitards). However, there are variations in the lateral and vertical extent of these aquitards which results in more or less hydraulic connectivity between the different aquifers across their extent (BRL, 1997).

Figure 3.14 Groundwater flow direction - CI aquifer system represents in a simplified schematic the potential hydraulic connections which may exist between the aquifers described above, where the aquifers are indicated in blue and the separating low permeability or semi-permeable layers in black. There are three principal aquitards:

- Senonian: Compact limestones, clay, marl and gypsum.
- Cenomanian: Limestone, marl, dolomite, gypsum and clays.
- Carboniferous: Shale or mudstone.

Figure 3.14 Groundwater flow direction - CI aquifer system



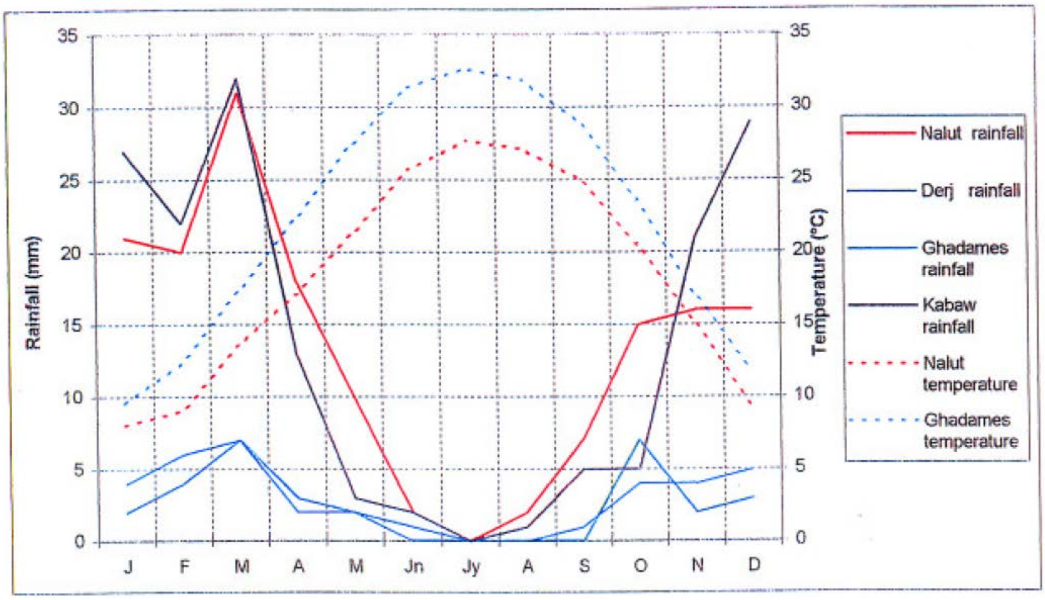
Source: OSS, 2003

Figure 3.14 Groundwater flow direction - CI aquifer system shows that horizontal flow occurs in the aquifers (red arrows), and vertical flow occurs across the aquitards (blue arrows).

3.9 Recharge and Discharge

Given the arid climate of the Study Area the aquifers in this region receive nominal amounts of recharge via the infiltration of rainfall. The annual average rainfall for the Ghadames area is reported to be 36 mm (BRL, 1997). *Figure 3.15* shows the monthly mean rainfall and temperatures reported by the Ghadames and Nalut meteorological stations. The Ghadames meteorological station (in Libya) is the closest meteorological station to the Study Area at an approximate distance of 10 km northeast of the Study Area.

Figure 3.15 Mean monthly rainfall and temperature in the Study Area



Source: BRL, 1997

Due to the low levels of annual precipitation, direct recharge to groundwater is very limited. High day time temperatures and strong winds combined with low relative humidity cause the quick evaporation of a large portion of the rainfall (Everdigen, 1962). Only in the case of heavy rains, runoff may reach the aquifers, providing a hydrological link to recharge (Ould Baba, 2005).

The average age of the groundwater in the SASS system is estimated at between 35,000 and 40,000 years, which are characteristics of a non-renewable resource (Sappa et al, 2010). The SASS is often considered a “fossil” aquifer, meaning there is a lack of meteoric water recharge, although studies have shown that some areas of the aquifer do receive direct recharge by rainfall. A total annual recharge of approximately 1 billion m^3/year has been calculated for the SASS (an annual recharge rate of 0.0017% of the total storage, (Ould Baba, 2005).

Groundwater discharges from the shallower aquifers of the SASS occur naturally in the Ghadames Basin in the form of sabkhas and springs. Several sabkhas are located in the Ghadames Basin and form the primary source of natural loss of groundwater via evaporation (El Baruni, 2000).

One of the largest sabkhas in the proximity of the Study Area is called Mezezzem, located approximately 35 km northeast of Ghadames (in Libya) or 45 km from the Study Area. Analysis of water samples from the Mezezzem Sabkha and the SASS – CI indicated a similar proportion in essential ions, suggesting that the Mezezzem sabkha is supplied by the SASS - CI. A view of the Mezezzem sabkha is included in *Figure 3.16*.

Elsewhere the principal zones of discharge tend to be towards the coast with no significant contribution from any of the aquifers expected into terrestrial surface water courses.

Figure 3.16 View of the Mezezzem sabkha

Source: Photo extracted from Google Earth Pro 7.0, Paronamio, 2015.

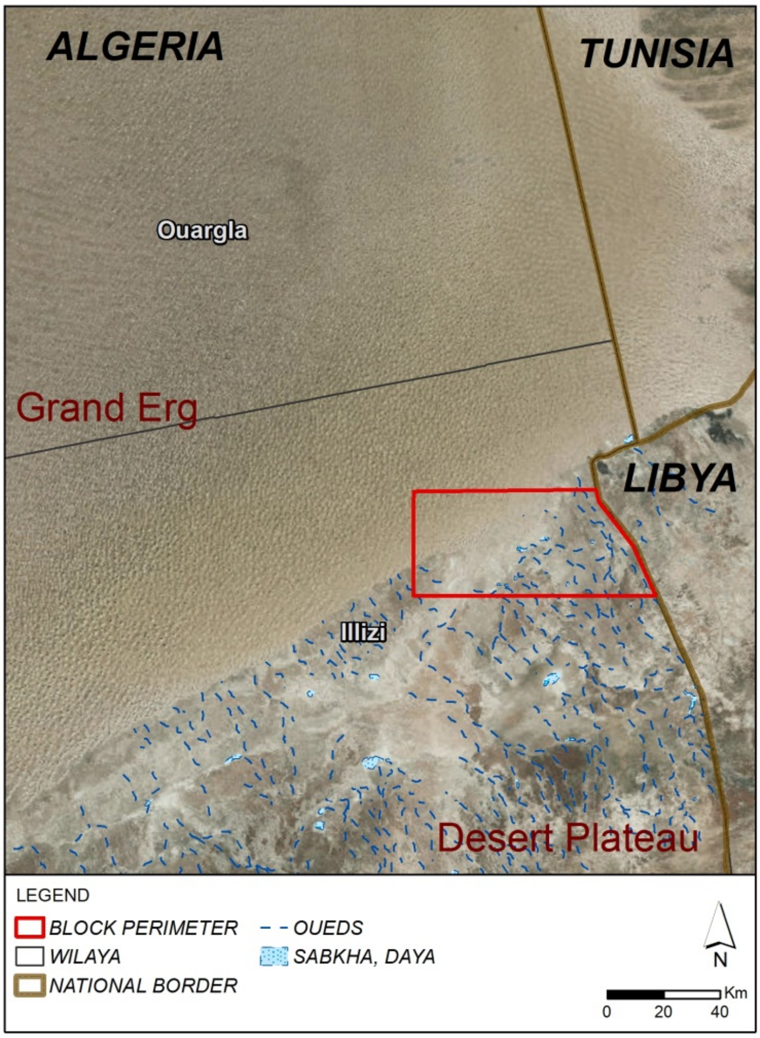
3.10 Surface Water Resources

Rainfall in the Study Area is scarce (see *Figure 3.15*) and there are no permanent surface water bodies. Only oueds can be described as surface water features, although they are ephemeral stream beds, and water is only present after heavy rainfall. There may be sudden but brief storms, which can trigger surface flows, but their importance is limited.

Figure 3.17 shows that there are some oueds in the southeast of the Study Area, in the desert plateau, south of the sand dunes (*Grand Erg Oriental*). These oueds are oriented southeast – northwest, following the relief in the area.

Oueds typically terminate in low lying areas giving rise to evaporite-rich pans (known as “evaporites”). The oueds and pans support some sparse vegetation.

Figure 3.17 Hydrological features within the Study Area



Source: ERM, 2015

4 Local Water use and Management

To understand local water use and management in Algeria, the following elements are described in this Section:

- Algerian organizations and legislation regulating water use.
- The current understanding of water use in Algeria and in the Study Area, including both groundwater and surface water.
- SASS management, based on the importance of the SASS in providing water to local communities.
- Local water use in the Debdeb area.

4.1 Algerian Organisations and Legislation Regulating Water Use

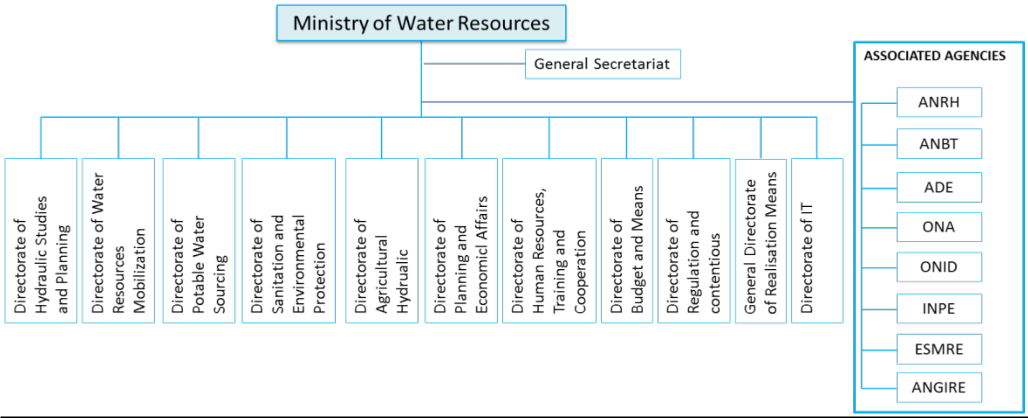
4.1.1 Ministry of Water Resources

The organisation of the Ministry of Water Resources was established by *Executive Decree 2000-325 of 25 October 2000*. It is organised into several directorates and agencies as shown in *Figure* 4.1.

The main responsibilities of the Ministry of Water Resources are:

- Managing and evaluating water resources. In particular, it is responsible for public water service infrastructure management.
- Participating in the development of national policy on water resources.
- Monitoring and controlling the implementation of national policies in accordance with the laws and regulations.
- Ensuring the rational use of water resources and their economy.
- Implementing maintenance and prevention measures with respect to hydraulic assets.

Figure 4.1 Organisation of the Ministry of Water Resources



Notes:

ANRH – National Agency of Hydraulic Resources (*Agence Nationale des Ressources Hydrauliques*)

ANBT – National Agency of Dams and Transfers (*Agence Nationale des Barrages et Transfert*)

ADE – Algerian Water Company (*Algerienne Des Eaux*)

ONA – National Office of Sanitation (*Office National de l'Assainissement*)

ONID – National Office of Irrigation and Drainage (*Office National de l' Irrigation et de Drainage*)

INPE – National Institute of Equipment Development (*Institut National de Perfectionnement de l' Equipement*)

ESMRE – School of Management of Water Resources (*Ecole Supérieure de Management des Ressources en Eau*)

ANGIRE – National Agency of Integrated Management of Water Resources (*Agence Nationale de Gestion intégrée des Ressources en Eau*)

Source: ERM, 2015 from http://www.mate.gov.dz/ (last visited on 04 May 2015).

The Ministry of Water Resources is consulted during the EIA approval process and other water related authorisations while the decentralised directorates within each Wilaya, the Directorates of Water Resources (*Directions des resources en eau*), are responsible for granting water resource-related permits. Further details on the responsibilities of the Directorates of Water Resources are provided below. In addition, the Agency of the Sahara Hydrographic Basin (Algerian organisation responsible for ensuring integrated water management within a basin) is also involved in the authorisation process for the use of water from the Sahara Basin (*Executive Decree 06-126*).

Furthermore, decentralised directorates operate within each Wilaya, the Regional Water Resources Directorates (Directions de Ressources en eau de la Wilaya). These regional governing bodies are responsible for:

- Ensuring the protection and preservation of public water resources and their rational use.
- Contributing to the development of conventional (surface and groundwater resources) and non-conventional water resources (treated wastewater and desalinated water) and their mobilisation.
- Ensuring the implementation and monitoring of regulations in the field of infrastructure development, operation and maintenance for the drinking water supply, sanitation and agricultural water supply.
- Collecting and analysing data on research, exploitation, production, storage and distribution of water for domestic, agricultural or industrial purposes.
- Maintaining a record of water points in the Wilaya's territory and following up studies and surveys that contribute to a better understanding of surface and groundwater resources.
- Approving the use of water resources (e.g., authorisation for water extraction or water use concessions).

4.1.2 Legislation regulating water resources

The use of surface or groundwater resources in Algeria requires an authorisation or concession according to Article 71 of *Law 05-12* on water resources. The activities subject to authorisation are established in Article 75 and the activities subject to concession are established in Article 77 of *Law 05-12*. According to Article 77, the use of water reserves from fossil or weakly renewable aquifers, particularly in Saharan areas (as is the case of the proposed onshore shale gas exploration and development), is subject to a specific water-use concession.

The approval procedure for such a water-use concession is established by Executive Decree 10-318, and the approving authority is the Wilaya Directorate of Water Resources and the ALNAFT (*Agence Nationale pour la Valorisation des Resources en Hydrocarbures* - National Agency for the Valorisation of Hydrocarbons Resources) (the later only for unconventional resources projects, in accordance with Article 53 of Law 13-01 on Hydrocarbons). Other authorities involved may include:

- Consulted parties (Art. 4 of *Executive Decree 10-318*).
- National Agency of Hydraulic Resources (part of the Ministry of Water Resources).
- The relevant Hydrographic Basin Agency. In the case of the Illizi Wilaya (where the Study Area is located) the Sahara Basin Agency (Agence de Bassin Hydrographique Sahara).

As per the Article 3 of *Executive Decree 10-318* the request has to include:

- Details of the entity applying for the permit or concession (name, address, etc.).
- Justification for the occupation of the land.

- Nature, location and a map (scale 1/50,000 or 1/200,000) indicating the proposed abstraction wells.
- Hydrogeological and geological information on the area.
- Details of the drilling program.
- Details of the hydraulic testing you will perform on your abstraction wells.

In addition, the technical specifications form (cahier de charges) included in the Annex of the *Executive Decree 10-318* shall be presented with the application.

The concession, when granted, defines the aquifer from which the water will be abstracted, the volume of water or water flow that can be abstracted during the validity of the permit (also established by the concession), the authorised use (s) of the abstracted water and the equipment to be installed for measuring water abstraction. The concession is granted for the total amount of water to be abstracted from an aquifer (i.e., one single concession can be requested for all the water wells needed).

4.2 SASS Management

The SASS is used as a water source by Algeria, Libya and Tunisia. Given the lack of fresh surface water available in these desert and semi-arid regions, this aquifer is of great importance for the economic and social development of these countries. The future of this water source is dependent on the joint management of the aquifer by the three countries to find a withdrawal scenario that is sustainable (Sappa et al, 2010). Aligned with this statement, the three countries in the SASS have decided to create a permanent tripartite consultation mechanism for joint management of the aquifer. Each country has designated a focal point for SASS. This will develop the databases and the promotion of study, research and training (Djabri et al. 2010).

In order to optimize and correctly value water resources, to implement solutions and control results it is imperative that all stakeholders that are appropriate and relevant be involved. These can be public agencies such as ANRH, DHW (*Direction Hydraulique de la Wilaya – Wilaya Hydraulic Directorate)*, CDRAS (*Centre de Documentation et de Recherche Administratives* – Administration Documentation and Investigation Centre), and ITDAS (*Institut Technique de Développement de l'Agronomie Saharienne* – Saharian Agriculture Development Technical Institute), but also associations and the local population.

4.3 Current Understanding of Water Use

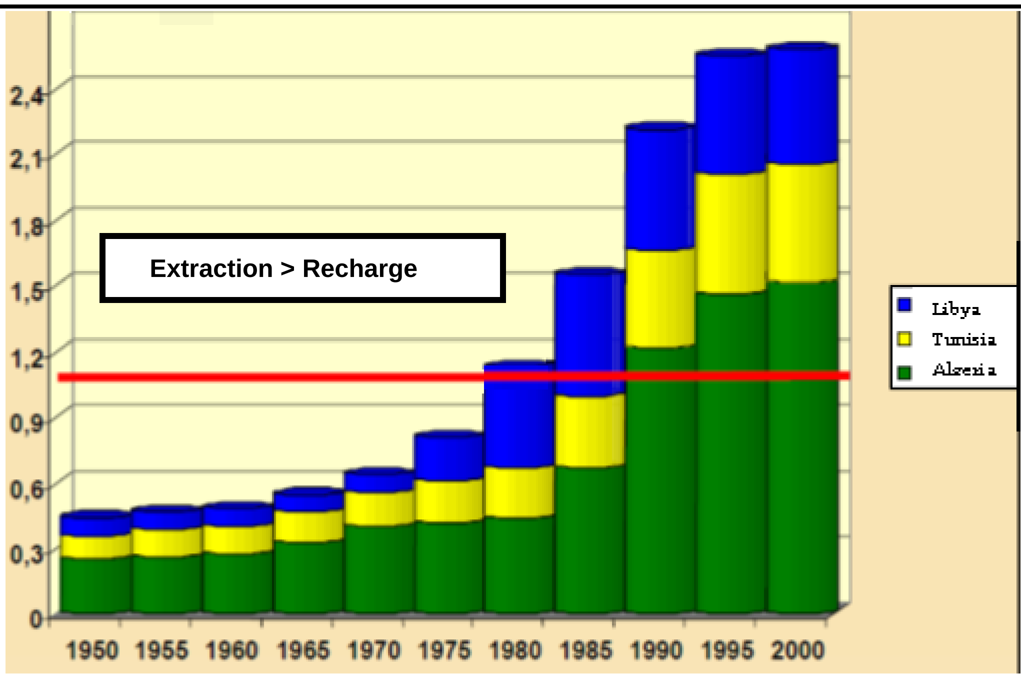
4.3.1 Regional use of groundwater

Groundwater is the principal source of water in the Ghadames Basin (El Baruni, 2000).Groundwater is used by the communities in the Study Area primarily for domestic and agricultural use. A majority of the groundwater abstraction wells in and around the Study Area are targeting the SASS, due to its water quality and supply capacity. Groundwater extracted for agricultural purposes is typically extracted from the SASS-CT, whereas groundwater extracted for drinking water purposes is typically extracted from the SASS-CI.

In 2008, a total of 6,500 reported water abstraction points existed in Algeria within the SASS footprint, associated with a total groundwater consumption of approximately 1.5 billion m^3/year. This figure increases up to 2.5 billion m^3/year, when considering the total SASS groundwater consumed by Algeria, Tunisia and Libya, as shown in *Figure 4.2*. As can be seen in *Figure 4.2*, groundwater consumption has exceeded the estimated recharge (approximately 1 billion m^3/year) of the SASS aquifer since 1980.

Table 4.1 includes a summary of the water consumption data available for the three countries, based on a study[1] undertaken by the OSS in 2008, in partnership with Algeria, Tunisia and Libya. *Figure 4.2* summarizes the total water consumption (including Algeria, Tunisia and Libya) by sectors in the year 2000 and in the year 2030 (estimation), based on data included in *Table 4.1*. The majority (over 75%) of the current and projected future water use is for agriculture. This table includes estimates of future water consumption in 2030, however based upon the available information it is not clear if these estimates consider the potential future development of unconventional resources in the region.

Figure 4.2 Total abstraction in the SASS (billion m³/year)



Source: OSS, 2002 (Modified by ERM, 2015)

Note: Red line indicates the estimated annual recharge of the SASS aquifer.

Table 4.1 Summary of Water Demand in Algeria, Tunisia and Libya

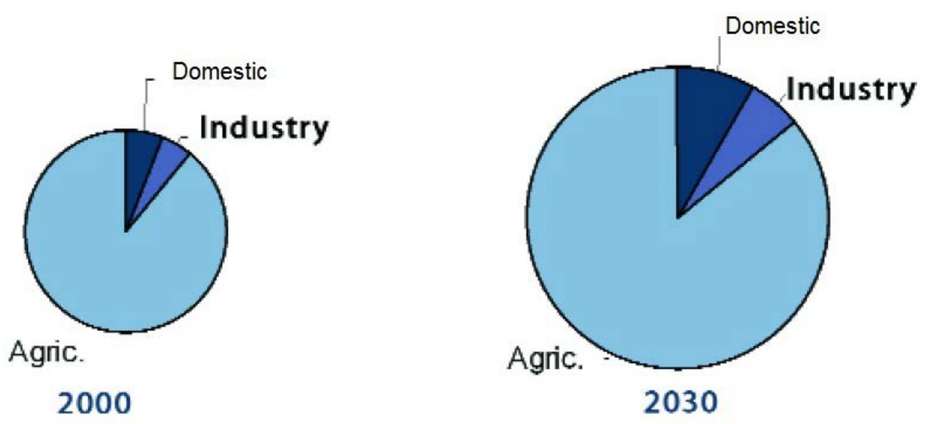
Water Demand	Country		
	Algeria	Tunisia	Libya
Domestic	155 l/day/inhabitant: 110 (urban areas); 80 (rural areas); 150 (tourism). 171 – 313 million m³ (year 2025).	Water consumption (based on 65 l/day/inhabitant – year 2003): 27 million m³ (year 2004). 39 million m³ (year 2016). 59 million m³ (year 2030). Water consumption (based on 200 l/day/inhabitant): 44 million m³ (year 2004). 95 million m³ (year 2015). 108 million m³ (year 2030).	Year 2008: Water consumption: 157 l/day/inhabitant. Total water consumption: 57 million m³. Year 2030: Water consumption: 200 l/day/inhabitant. Total water consumption: 170 million m³.

[1] The North-Western Sahara Aquifer System- Algeria, Tunisia, Libya. Concerted management of a transboundary water basin, 2008.

Water Demand	Country		
	Algeria	**Tunisia**	**Libya**
Industrial Sector	146 million m^3 (year 2000). 262 million m^3 (year 2025).	19.6 million m^3 (year 2002). 35 million m^3 (year 2015). 51 million m^3 (year 2030).	5 million m^3 (year 2002).
Farming	Average irrigation water consumption: 10,000 m^3 /ha/year. Irrigated land surface: 170,000 ha (year 2000). 300,000 ha (year 2020). 340,000 ha (year 2030). Water consumption: 1,700 million m^3 (year 2000). 3,000 million m^3 (year 2020). 3,400 million m^3 (year 2030).	Average irrigation water consumption: 15,000 m^3 /ha/year. Irrigated land surface: 40,000 ha (year 2000). 55,000 ha (year 2020). 77,000 ha (year 2030). Water consumption: 600 million m^3 (year 2000). 825 million m^3 (year 2020). 1,155 million m^3 (year 2030).	Average irrigation water consumption: 12,275 m^3 /ha/year. Irrigated land surface: 40,000 ha (year 2000). 77,000 ha (year 2020). 103,000 ha (year 2030). Water consumption: 491 million m^3 (year 2000). 945 million m^3 (year 2020). 1,264 million m^3 (year 2030).

Source: Observatory of the Sahel and the Sahara (OSS), 2008

Figure 4.3 Water demand from the SASS in 2000 and forecast for 2030 by sector (including Algeria, Tunisia and Libya)



Source: OSS, 2008

The intense development by the three countries in the past thirty years has exposed the SASS to a serious risk of groundwater drawdown, loss of artesian pressure, and salinization due to the increasing water demand.

4.3.2 Local use of groundwater

Based on the details provided by the DHW of the Illizi Wilaya, a total of 22 water wells are known to be present in and around the town of Debdeb (including wells located in Debdeb, Bordj-Messaouda, Fort Thiriet, Fort Saint, Mériksène and Timerouline). The complete list of the water wells is included in *Annex A*.

Table 4.2 summarizes the aquifers these water wells are pumping from and the associated water use.

Table 4.2 Water wells in the Study Area: aquifers and use

Water use	Aquifer		
	Turonian aquifer	CI aquifer system	*Not defined*
Potable water – exploitation by the AEP	0	10	0
Irrigation	0	1	0
Abandoned	3	3	2
Artesian / non defined use	0	3	0

Source: DHW Illizi Wilaya, 2015

Location of the identified water wells is included in *Figure 4.4*.

The main conclusions from the *Table 4.2* are listed below:

- None of the local wells appear to draw water from the Terminal Complex (TC). This may be because the TC is partially absent or does not provide sufficient quality or quantity of water in this area.
- Most of the wells draw from the CI aquifer. Only 3 wells are connected to the Turonian aquifer and they are reportedly abandoned.
- Most of the wells are used for potable water extraction. Only 1 well is used for irrigation purposes, 8 wells are abandoned, and in 3 artesian wells the water use is not known.

With respect to the reported yields of these wells, the flow rates range from 672 m^3/day to 6,048 m^3/day (average value: 1,794 m^3/day). A summary of the flow rates reported for the individual aquifers is provided below:

- Turonian aquifer:flow rates range from 1,296 to 2,400 m^3/day, with an average value of 1,808 m^3/day. These values are consistant with yield data described for the Turonian aquifer in *Table 3.5* (5-70 m^3/hour or 120 – 1,680 m^3/day).
- CI aquifer: flow rates range from 672 to 6,048 m^3/day, with an average value of 2,003 m^3/day. These values are consistant with yield data described for the CI aquifer system in *Table 3.5* (50-400 m^3/hour, that result in 1,200 – 9,600 m^3/day).

The total annual volume of groundwater abstracted from the CI aquifer in the Debdeb and surrounding areas is reported at approximately 10,062,320 m^3/year (from a total of 14 wells). Of this volume, the following breakdown can be made based upon the available data:

- Potable water – 7,292,700 m^3/year, or approximately 72% of the total.
- Irrigation use: 245,280 m^3/year, or approximately 3% of the total.
- Undefined use associated with artesian wells: 2,524,340 m^3/year, or approximately 25% of the total.
- The 5 operating wells reported for the town of Debdeb alone abstract a reported 4,079,240 m3/year or approximately 40% of the total.

During execution of the field survey several shallow, man-made wells were also identified in the Study Area. These wells reported had a maximum depth of 30 m and are used principally as a water source for camels or to a lessor extent for irrigation. These wells are likely drawing from shallow aquifers found in Quaternary or Mio-Pliocene materials.

4.3.3 Use of surface water

The absence of permanent surface water bodies (see *Section 3.10*) indicates that surface water is not a significant or consistent water source in the Study Area. Surface water body flows are scarce and unpredictable, and there is no information available on surface flow rates or flood water accumulation.

Figure 4.4 Location of water wells in the Study Area

Source: ERM, 2015

5 Project Water Requirements

5.1 Introduction

This chapter summarizes the current understanding of the water needs for the exploration phase, including a discussion of operational considerations with respect to the water supply. An evaluation of the available water sources (see also *Section 3*) with respect to their ability to meet the project needs is also provided.

5.2 Water Quantity Demand Assumptions and Estimates

A high-level water forecast was developed by ERM to summarize the estimated water needs during the exploration phase. Specific inputs were provided by Statoil with respect to the four primary operational needs: camp or potable water, drilling, hydraulic stimulation and civil works.

The following general assumptions were made in developing the water forecast:

- The first phase of exploration (2015/16-2018) will include 350 km^2 of 3D seismic acquisition and drilling and completion of 2 vertical exploration wells.
- The second phase of exploration (2018-2019) may include an additional 100 km^2 of 3D seismic acquisition and drilling and completion of 2 vertical and 1 horizontal exploration wells.
- The third phase of exploration (2020-2021) may include drilling and completion of 1 horizontal exploration well.

A summary of the specific assumptions used to calculate the water needs for specific operations is included in Annex B of this report.

Figure 5.1 provides a summary of the water forecast developed for the 5-year exploration phase and *Figure 5.2* provides a graphic summary of the breakdown in annual water needs for different activities.

As can be seen in *Figure 5.2*, road maintenance is the activity with the highest consistent water demand during the exploration phase, accounting for more than 57% of the water needed over a given year. Camp water and road surfacing demands follow, accounting for 22% and 12% of the total demand, respectively. The volume of water needed for hydraulic stimulation becomes significant when the horizontal wells are stimulated, accounting for between 8 and 14% of the total need.

The planned operations will not be executed simultaneously (i.e. some civil works will preceed drilling activities and hydraulic stimulation will follow drilling activities). However, as can be seen above, the activities with the highest water demand (road maintenance and camp water needs) will require a consistent volume of water over the exploration period. Therefore, the total estimated annual water demand was divided by 365 days to get an estimate of the daily water demand during exploration activities (see Figure 5.1). The daily water demand was calculated to be between 340 and 753 m^3/day. The higher demand arises when the horizontal wells are being stimulated.

A high level water balance was also developed to quantify the estimated water needs for the different project activities in comparison with the estimated volumes of wastewater that will be generated. This balance was developed for one year (2015/16) to illustrate the general water balance for the exploration phase based on the available data. The water quality of both the water needs and the wastewater was also considered. This water balance is illustrated below in *Figure 5.3*. As can be seen in this figure, civil works account for approximately

76% of the annual water demand, followed by camp water at 22%. A majority of the water required needs to be of fresh water quality (i.e. < 2 g/L salinity), with the exception of the water needed for hydraulic stimulation which in some cases can be slightly brackish (2< X <4 g/L salinity). Of the total required volume of water, 19% is estimated to be “returned” as wastewater. Of this wastewater, 95% is attributable to grey or black water that will be generated in the camp, 3% is flowback expected during hydraulic stimulation and 2% is produced water expected during drilling activities. The water quality in both cases is diminished as the flowback and produced water is expected to be a brine (> 40 g/L salinity) and the camp wastewater will be of variable quality. It is important to note the difference in water demand in a year when a vertical well is drilled and a year when a horizontal well is drilled. Although it is anticipated that the horizontal wells will be hydraulically stimulated 13 times in comparison with 1-2 times for a vertical well, the total water demand increases by less than 10% and the volume of water needed for hydraulic stimulation activities accounts for approximately 14% of the total water demand.

Figure 5.1 Water Forecast Summary

Exploration Water Needs Summary

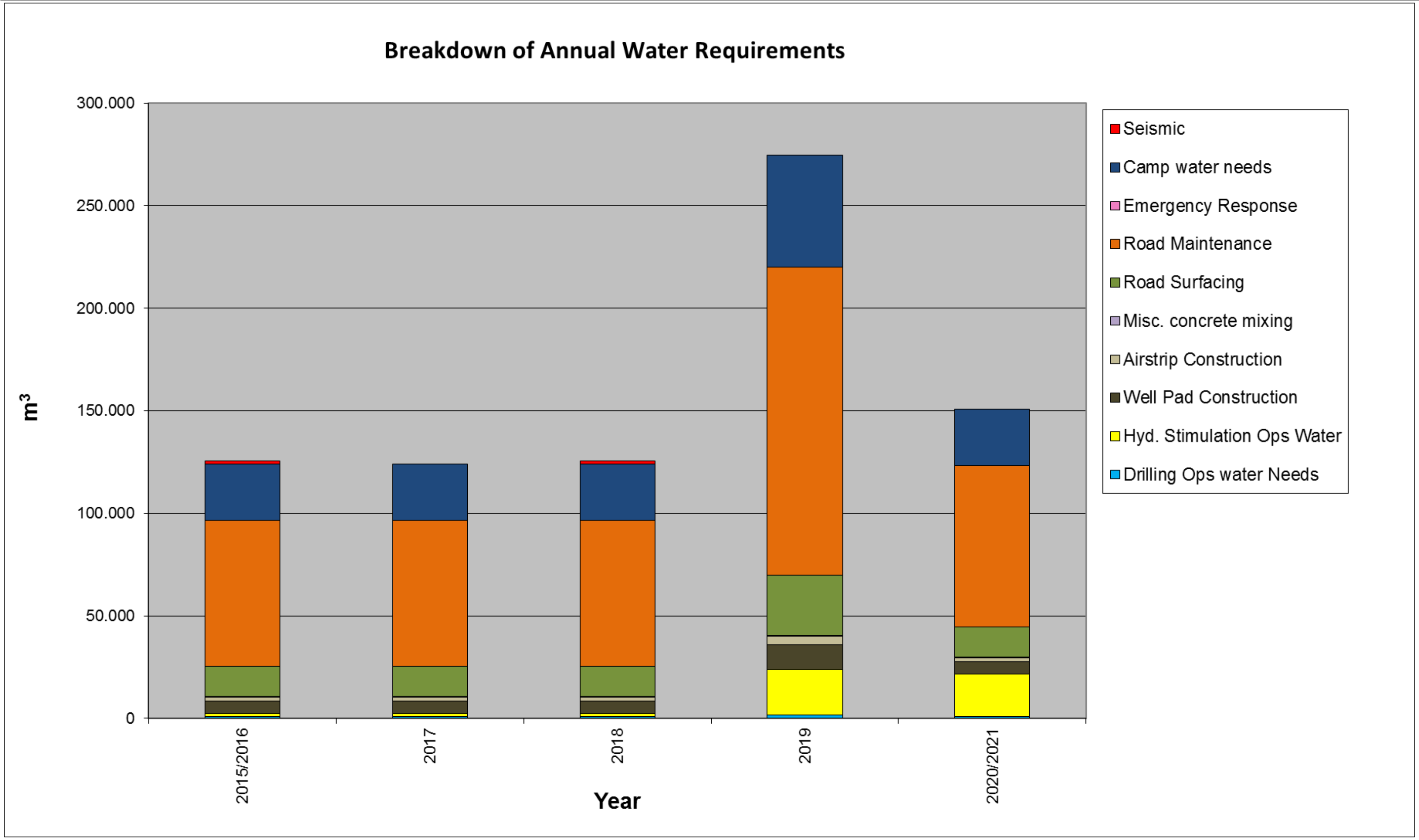
Length of Exploration Phase (years):	5
Total Number of Wells:	6
Total Water Usage (m3):	797.535

	Phase 1			Phase 2	Phase 3
	2015/2016	2017	2018	2019	2020/2021
Vertical Wells to be completed	1	1	1	1	
Horizontal Wells to be completed	0	0		1	1
Vertical stimulation to be completed	1	1	1	1	0
Horizontal stimulation to be completed	0	0	0	13	13
Number Rigs	1	1	1	1	1

	Activity	m3	Quality	Metric	2015/2016	2017	2018	2019	2020/2021
Seismic	All seismic water needs	25	Fresh	per day	1500		1500		
Drilling	Drilling Ops water Needs	795	Fresh	per vertical well	795	795	795	795	0
		954	Fresh	per horizontal well	0	0	0	954	954
				Total Drilling Ops Water	795	795	795	1.749	954
	Expected volume of produced water	500	Saline	per vertical well (600 per horizontal well)	500	500	500	1.100	600
Hydraulic Stimulation	Hyd. Stimulation Ops Water	1589,9	Fresh or Slightly brackish	per stimulation	1.590	1.590	1.590	22.259	20.669
	Expected volume of flowback water	794,95	Brine	per stimulation	795	795	795	11.129	10.334
Camp	Camp water needs	75	Fresh	per well/per day	27.375	27.375	27.375	54.750	27.375
	Estimated grey/black water return	60	Grey/ Black	per well/per day	21.900	21.900	21.900	43.800	21.900
Civil Works	Well Pad Construction	6000	Fresh	per wellsite	6.000	6.000	6.000	12.000	6.000
	Airstrip Construction	2000	Fresh	per airstrip	2.000	2.000	2.000	4.000	2.000
	Misc. concrete mixing	125	Fresh	per wellsite	125	125	125	250	125
	Road Surfacing	14825	Fresh	per wellsite	14.825	14.825	14.825	29.650	14.825
	Road Maintenance	375	Fresh	per day/per well	71.250	71.250	71.250	150.000	78.750
	Total Civil Work			per year	94.200	94.200	94.200	195.900	101.700
Emergency Resp (Storage)	Emergency Response	50	Fresh	per event	50	50	50	100	50
			Total	Total water demand per year (m3)	124.010	124.010	124.010	274.758	150.748
				Average Water Demand per day (m3)	340	340	340	753	413
				Total water generated per year (m3)	23.195	23.195	23.195	56.029	32.834

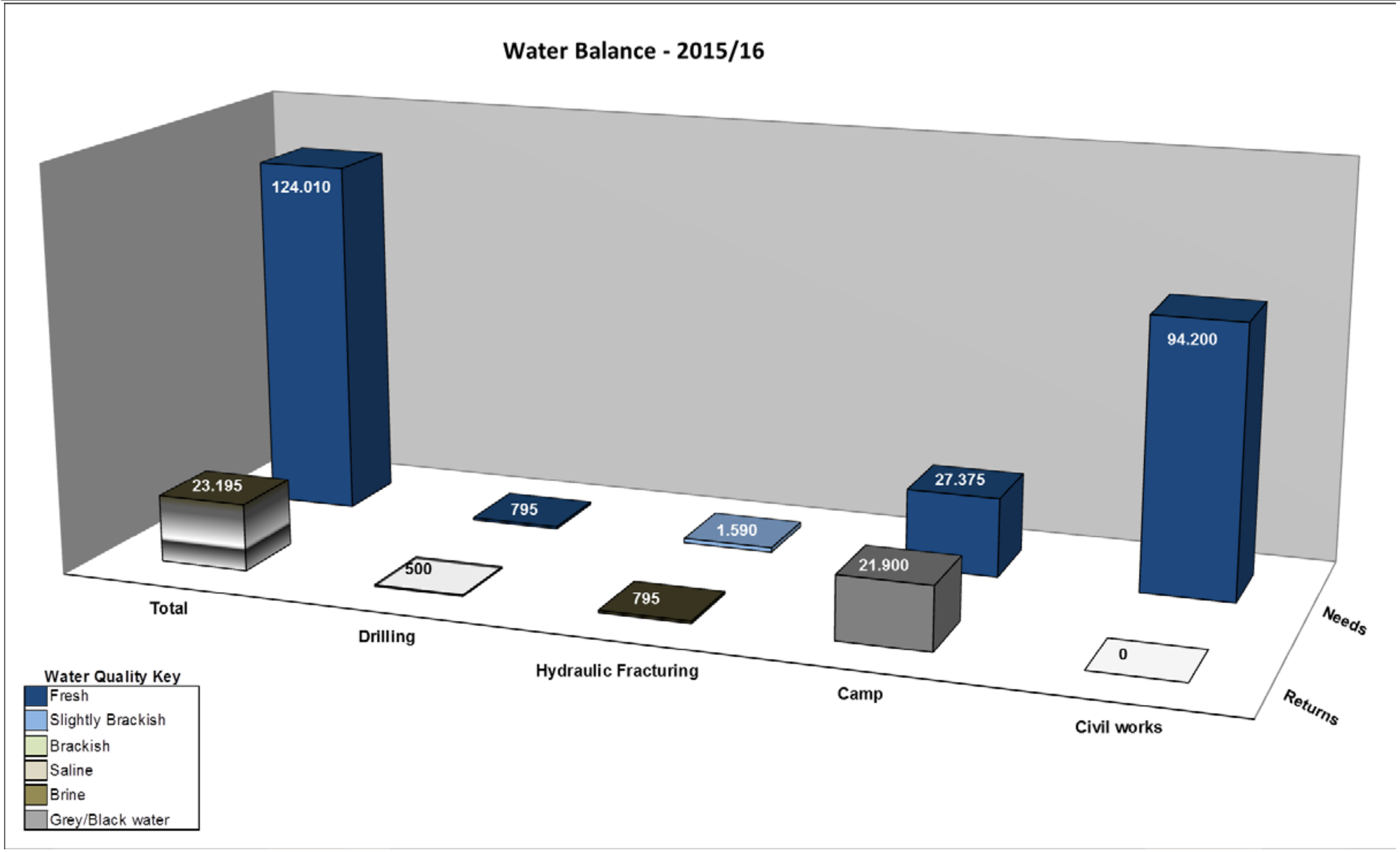
Source: ERM Iberia

Figure 5.2 Water Forecast Summary



Source:ERM Iberia

Figure 5.3 Water Balance Summary



Source: ERM Iberia

5.3 Operational Considerations

5.3.1 Location of Water Wells

The current plan for sourcing water during the exploration phase of the project is the installation of one to two water abstraction wells in the vicinity of each exploration well. One water well will be located near the well site and a second well may be drilled near the head of the access road to the well site. The need for a second well will be evaluated based on the length of the access road to be constructed for each well site. A total of 6 exploration wells are planned for the exploration phase of the project and therefore a total of 6 to 12 water abstraction wells will be installed. These wells will be used to source all of the water required during exploration activities, including civil works, drilling operations, stimulation, testing and camp water with the exception of potable camp water which will be transported from the nearest community, Debdeb.

For the first phase of exploration two vertical exploration wells will be drilled, one in the north and a second in the south of the License Area. Based upon the available information the currently assumed target aquifer for the groundwater abstraction wells is likely to be the Albian (Cretaceous) aquifer, which is the freshest groundwater source available in the Study Area. This unit is expected to have a depth of between 650-750 m in the north and 500-600 m in the south of the License Area.

5.3.2 Water Transport

The current plan is to drill the water supply wells in the vicinity of the explorations wells to limit the transport of the water needed for the planned activities. Water needed for drilling and stimulation activities will be piped via flexible hosing or poly pipe to operations while water needed for civil works or road maintenance activities will primarily be transported via water trucks. There is no plan to install a permanent water supply pipeline during execution of the exploration activities.

Based on the estimated volume of water needed for daily road maintenance (375 m^3) and assuming that 25 m^3-capacity water trucks will be used, this implies at least 15 daily trips using one truck. This scenario will need to be further evaluated when the exact distances to be travelled are confirmed in order to determine how many water trucks will be necessary for operations.

Water supply during the seismic activities will either be taken from the planned water wells or be trucked from Debdeb. The water needed during these activities is nominal (25 m^3/day over 2 months or approximately 1,500 m^3). Trucking in water from Debdeb may also be a secondary or contingency option for water supply during exploration activities should it be necessary. Debdeb is approximately 15 to 32 kilometers from the proposed exploration well sites and the transport and storage of water from this community would need to be further evaluated.

5.3.3 Water Storage

During Phase 1 of exploration water storage plans include the construction of one water reserve pit adjacent to each exploration well site, capable of storing approximately 1200 m^3 of water. The average total water consumption during drilling activities is estimated to be between 795 m^3 per well for vertical wells and 954 m^3 per well for horizontal wells.

During Phases 2 and 3 additional fresh water storage will likely be needed, especially during stimulation activities. Larger pits and/or additional pits will likely be constructed to accommodate the additional water supply as necessary. . If necessary, additional water storage tanks most likely will be used in combination with the water pits.

5.3.4 Emergency Water Supply

An emergency water reserve will be part of the drilling/completions layout and will be built during site construction. The emergency reserve pit will have a capacity of 50m^3. In some cases the emergency reserve may be constructed off-site near one of the water wells (where present).

5.3.5 Wastewater and Reuse Options

The principal wastewater streams anticipated during exploration activities are summarized below in Table 5.1.

Table 5.1 Wastewater Streams

Product	Estimated Volume (m3)	
	Vertical Vertical Well	HorizonHorizontal Well
	Drilling	
Water	500	600
Completions, Stimulation and Testing		
Completions	200	400
Flowback water	800	10,000
Camp		
Black water	60-90	90-135
Grey water	100-135	200

The approach for disposal of this waste water is described in further detail in the Waste Management Plan. During drilling activities water needed for water-based muds will be reused or recycled to minimize consumption. Other recycling or reuse options are not considered feasible during the exploration phase.

6 Evaluation of Water Supply Options

This chapter provides a summary of our current understanding of the available resources and a discussion of how these resources can meet the current and potential future water requirements for the Timissit License Area.

This evaluation was developed in accordance with Statoil's "*Proposal for Guiding Principles for Sustainable Use of Water*". This guidance establishes the principal criteria to be used in evaluating water sourcing options. These criteria or key issues are divided into three principal dimensions, environmental, social and economic, as follows:

- **Environmental Dimension**
  - Depletion of groundwater
  - Groundwater quality
  - Surface Water Quantity
  - Surface Water Quality
  - Freshwater biodiversity

- **Social Dimension**
  - o Non-renewable or limited water sources
  - o Water for basic human needs

- **Economic Dimension**
  - o True cost of water management included in the project costs.

The specific targets, indicators and guiding principles defined for each of these criteria are summarized below in *Table 6.1*.

The evaluation included herein focuses on the two principal water supply options considered feasible for the exploration activities (see Chapter 3 for more details on these aquifers):

1. The Albian (Cretaceous) aquifer of the Continental Intercalaire (CI).
2. The TAGI (Triassic sandstone) aquifer.

Table 6.1 provides a summary of the evaluation of these potential water sources. Based upon the results of this evaluation the Albian aquifer is considered a reasonable target as a groundwater source for the exploration phase. However for large-scale development activities the use of the TAGI aquifer should be considered as it will have less environmental and social impacts in comparison to use of the Albian aquifer.

The following observations are made based upon this evaluation:

- It is important to note that given the geographic location of the License Area, groundwater is considered to be the only viable water supply option for the planned operations. There are no surface water sources nearby and the Mediterranian Sea is located at a distance of approximately 400 km (through Libya) or 800 km (through Algeria). However, groundwater in this region is considered "fossil" and these resources are already being exploited beyond the estimated recharge rate by the regional demand.

- As discussed in Section 4, the use of either of the identified options would be contingent on obtaining a water permit or concession from the Algerian Government.

- With respect to local water use, data from the well inventory indicate that a total of approximately 4,100,000 m^3 of water is withdrawn annually from the town of Debdeb, principally for potable and irrigation water needs. According to the general water forecast developed (Section 5.2), the annual water needs estimated for the exploration phase is between 124,000 and 275,000 m^3. To provide some context for these volumes with respect to local water needs, the annual project water demand is equivalent to between 3 and 7% of the total annual water use for Debdeb in 2015.

- No data is currently available with regards to the water use for current or potential future unconvential concessions in this area. Future evaluation of the cumulative affect of the potential groundwater abstraction associated with these activities is recommended.

- A significant amount (approx. 57%) of the water demand for exploration activities is for road maintenance activities. Statoil will further evaluate this scenario during the planning phase of the Proejct to determine if any other logistical solutions are available to limit the amount of water needed for road maintenance.

- During the planning phase of the project it is recommended that Statoil evaluate placing the abstraction wells such that the potential impact on other water users in the area is minimized.

- It is currently anticipated that the potable water supply will be trucked in from Debdeb. The source of this water and its quality should be confirmed to determined if it is in fact different than the planned target aquifer, the Albian.

Table 6.1 Evaluation of Water Supply Options

Key Issues	Target	Indicators	Guiding principles	Results Option A Albian *CI Aquifer System* *(L.Creataceous-Jurassic aquifer)*	Results Option B TAGI *CI Aquifer System* *(Triassic aquifer)*
Environmental dimension					
Depletion of groundwater	No significant impact on groundwater availability due to water withdrawal	Groundwater level, groundwater flux, and river flow	Acceptable limits to be defined for the aquifer and the local watershed.	Approx. Depth : 500-750 m Approx. Yield: 50-150 m^3/h This aquifer receives limited recharge and is essentially a fossil aquifer. This aquifer provides a majority of the local and regional water supply, especially for potable water. Drawdown possible due to heavy regional exploitation. No direct communication with surface waters.	Approx. Depth: 1,600 – 2,000 m. Approx. Yield: Not available This aquifer receives limited recharge and is essentially a fossil aquifer. Due to its depth, the Triassic aquifer is not commonly exploited as a water source in the Study Area. No direct communication with surface waters.
Groundwater quality	No significant impact on groundwater quality due to water withdrawal and/or operational activities	Water quality parameters relevant to assess changes in aquifer properties and/ or environmental impacts	Compliance with local requirements Acceptable deviation from baseline	Regional Baseline: 1-2 g/L salinity Acceptable impact on groundwater quality expected. Risks for contamination deemed to be low. Baseline to be established. This is the freshest local and regional groundwater source. Quality to be monitored during exploration activities.	Regional Baseline: 1-2 g/L salinity, although understood to not be as fresh as Albian. Acceptable impact on groundwater quality expected. Risks for contamination deemed to be low. Baseline to be established. Water quality to be monitored during exploration activities.
Surface water quantity	No significant impact on water flow, water level	Water levels and water flow	Acceptable limits for water levels and water flow, to	No use of surface waters; the only surface water bodies are ephemeral oueds, flowing during flood periods.	No use of surface waters; the only surface water bodies are ephemeral oueds, flowing during flood periods.

Key Issues	Target	Indicators	Guiding principles	Results Option A Albian *CI Aquifer System* *(L.Createaceous-Jurassic aquifer)*	Results Option B TAGI *CI Aquifer System* *(Triassic aquifer)*
	and retention times due to water withdrawal		be defined for the local watershed		
Surface water quality	No significant impact on surface water quality due to water withdrawal and/or operational activities	Physical and chemical water quality parameters, based on local water quality parameters and IFC requirements	Compliance with local and IFC requirements Acceptable deviation from baseline	No surface discharge and no permanent surface water bodies. No potential for impacts on surface water quality.	No surface discharge and no permanent surface water bodies. No potential for impacts on surface water quality.
Freshwater biodiversity	No significant loss of freshwater biodiversity or ecosystem functions due to water withdrawal and/or operational activities	Aquatic flora and fauna, and wetland vegetation	No or slight change from baseline. Avoid withdrawal from a Ramsar listed wetland or a particularly sensitive water body	Only groundwater used; most ecosystems not supported by groundwater. No potential for impacts on freshwater biodiversity or ecosystem functions.	Only groundwater used; most ecosystems not supported by groundwater. No potential for impacts on freshwater biodiversity or ecosystem functions.
Social dimension					
Non-renewable or limited water sources	Enough water of freshwater quality for	Portion of water from non-renewable or limited water source (volume/total water withdrawal) 3	Limit or avoid using non-renewable or limited water sources	CI aquifer system is considered a non-renewable water source, due to its limited recharge capacity. This aquifer is already seeing signs of regional	CI aquifer system is considered a non-renewable water source, due to its limited recharge capacity. This aquifer is already seeing signs of regional stress due to over-

Key Issues	Target	Indicators	Guiding principles	Results Option A Albian *CI Aquifer System* *(L.Createaceous-Jurassic aquifer)*	Results Option B TAGI *CI Aquifer System* *(Triassic aquifer)*
	future generations			stress due to over-exploitation.	exploitation.
Water for basic human needs	No conflicts over water resources	Water deprivation for human users (deterioration or depletion of a water source) Cost increase for other water users	No significant decrease in water quality and availability Cost increase within acceptable limits for the local community (non-commercial and commercial users)	Groundwater is extracted from this aquifer for irrigation and for drinking water purposes. There is a local worry about impact on groundwater availability.	Groundwater is not commonly extracted from this aquifer, due to its depth. There is a local worry about impact on groundwater availability.
Economic dimension					
True costs of water management	At all times have an overview of true cost of water management	Cost of water sourcing, transport, infrastructure, treatment and disposal and Indirect costs related to oil/gas production regularity, environmental impact, social responsibility etc	Costs for water management shall be included in project economy	Economic costs for water use included in project budget	Economic costs for water use included in project budget

7 Monitoring Program Outline

7.1 Introduction

The exploration well design and stimulation design for the Timissit exploration program were developed with the protection of groundwater aquifers as a priority. The effective design of the exploration wells, including well casing and cementing design together with measures to verify well integrity significantly mitigates the risk of groundwater contamination. In order to provide further confidence that the planned operations are not impacting groundwater, Statoil will implement a groundwater monitoring program. In addition to the monitoring of groundwater quality, measures for the monitoring of operational water use are also included. This section provides the outline for the planned groundwater monitoring program.

7.2 Objectives

The objectives of the monitoring program are as follows:

- Establish baseline groundwater quality conditions in the License Area.
- Monitor for potential impacts to groundwater as a result of the planned project activities.
- Register water use and re-use practices during execution of the project activities.

7.3 Summary of Commitments

Statoil commits to carry out its operations in accordance with the below list of commitments made for groundwater monitoring.

Table 7.1 Summary of Commitments

Commitment		Organisation / Department	Evidence of Action
Pre Operations			
1	Statoil will drill a minimum of two water wells, one in the North and one in the South, that will be the main point of the ground water monitoring.	Statoil	Water bore reports.
2	Statoil will complete a Desktop evaluation of the closest relevant existing water bores and their water quality	Statoil	Presented in this program.
3	Selection of which water bores to be sampled during the Statoil operations	Statoil	Presented in this program.
4	Sampling of the water bores prior to the Statoil operations	Statoil	Presented in this program.
5	Distribution of the water samples to the appropriate laboratories for analyses	Statoil	Reporting to ANRH.
During Simulation, Testing & Abandonment			

6	Sampling of the water bores at the defined time with regards to the Statoil operations and send to laboratory for analyses	Statoil	Reporting to ANRH.
Post Operations			
7	Sampling of the water bores after the Statoil operations and send to laboratory for analyses,	Statoil	Reporting to ANRH.
8	Conduct a post operational evaluation of Statoil's activities impact on the ground water	Statoil	Reporting to ANRH.

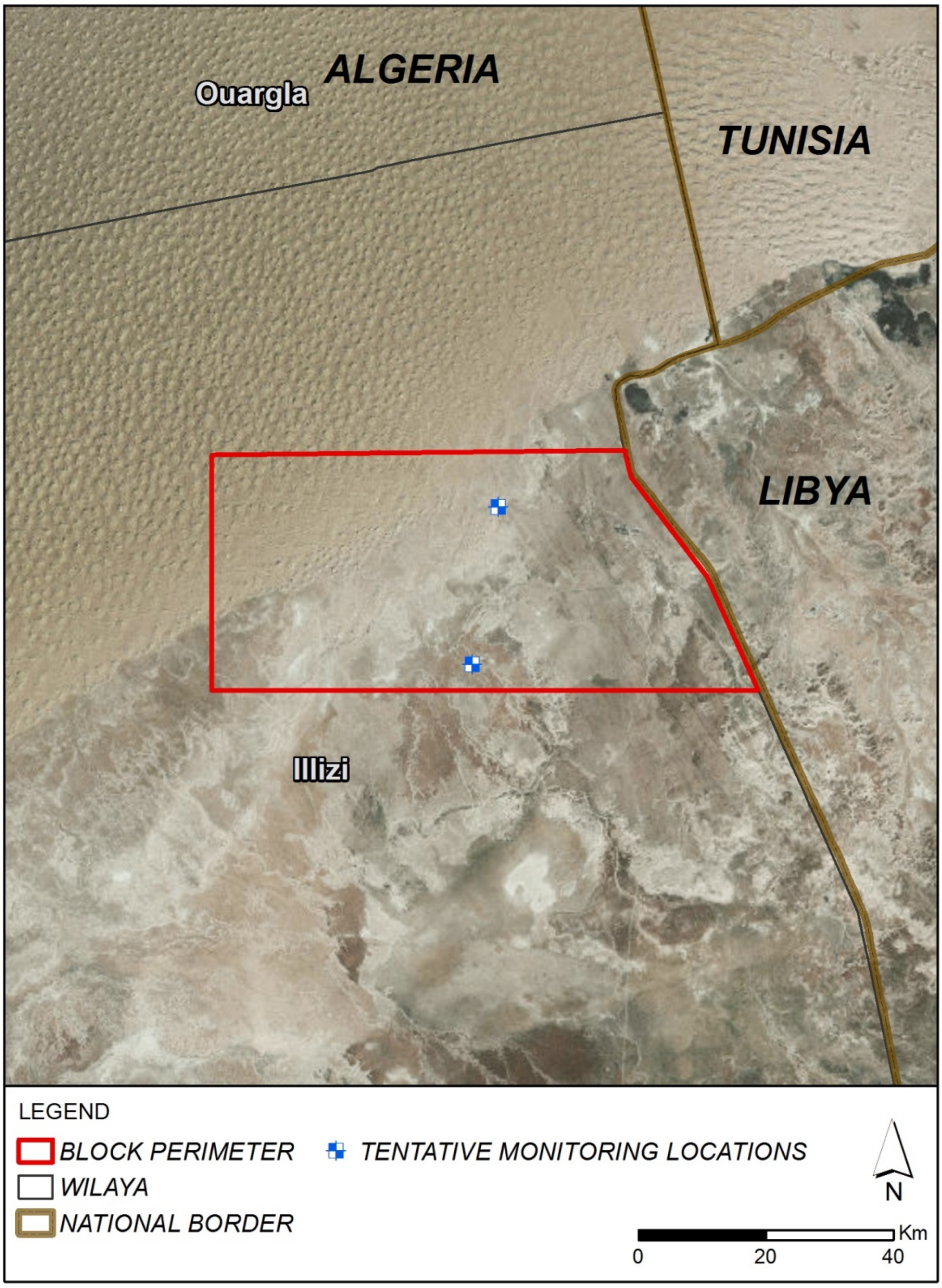
7.4 Approach

7.4.1 Groundwater Quality

Statoil will monitor groundwater for potential impacts from the proposed exploration activities by collected groundwater samples from selected abstraction wells in the license area.

The monitoring network will initially include the abstraction wells that will be installed in the vicinity of the planned exploration wells. In order for the wells to serve also as monitoring wells, they should be installed down-gradient of the planned exploration wells, if feasible. If additional wells that meet the criteria are identified in the License Area, they may be added to the monitoring network. It is initially anticipated that the monitoring network will include a minimum of two abstraction wells that Statoil plans to install, one in the North and one in the South. However, these wells will be installed as the exploration activities progress and the new monitoring wells may be added to the network as they become available. Based upon the tentative locations of the exploration wells, the tentative location of the abstraction/monitoring wells are indicated below in *Figure 7.1*.

Figure 7.1 Tentative Location of Monitoring Wells



Source:ERM Iberia

The proposed methodology for the groundwater monitoring program is included in Annex C.

Laboratory Analysis

The proposed analytical program is as follows:

Table 7.2 Analytical Program

ANALYTE	UNIT

ANALYTE	UNIT
Conventional Analyses	
Alkalinity	mg/L
Oil & Grease	mg/L
pH	SU
Specific Conductance	Uhmos/cm
Total dissolved solids	mg/L
Total suspended solids	mg/L
Chloride	mg/L
Sulfate	mg/L
Hardness	mg/L
Nitrate as Nitrogen	mg/L
MBAS/Surfactants/Foaming Agents	mg/L
Total Coliform	<1
E.Coli	<1
Turbidity	NTU
Hydrocarbons	
Dissolved methane	µg/L
Dissolved ethane	µg/L
Dissolved propane	µg/L
Volatile Organic Compounds	
Benzene	µg/L
Toluene	µg/L
Ethylbenzene	µg/L
Xylene	µg/L
Total Metals	
Arsenic	mg/L
Barium	mg/L
Calcium	mg/L
Chromium	mg/L
Lead	mg/L
Iron	mg/L
Magnesium	mg/L
Manganese	mg/L
Potassium	mg/L
Selenium	mg/L
Sodium	mg/L
Strontium	mg/L

7.4.2 Operational Water Monitoring

Identifying water efficiency opportunities requires an understanding of the water uses across operations, how these uses might change over time and the risks associated with using and disposing of this water. As a result, an operational water monitoring program will be established to facilitate the collection of reliable, good quality data across the planned operations.

Effective ongoing management of water use requires that these flows to be monitored and measured. As part of the planned operations Statoil will, as a minimum, measure and record the input and output flows used for different activities. The collected data will be reviewed so that performance of the water management system can be assessed, improvement goals set, and water efficiency options identified.

7.5 Sampling Frequency

Groundwater samples will be collected from these wells in one baseline sampling event and subsequently annually. In the event that a change in baseline conditions is detected the sampling frequency will be increased to semi-annually to document any possible new trends in groundwater quality. Operational water monitoring will be conducted daily during operations. The following table summarizing the sampling and monitoring frequencies.

Table 7.3 Sampling and Monitoring Frequency

Sampling	Frequency
Baseline groundwater sampling event	1 sampling event to occur prior to the start of exploration activities.
Groundwater sampling	Annually during the exploration phase.
Operational water monitoring	Daily

7.6 Reporting

Upon completion of each of the planned sampling events Statoil will submit a short summary report, including a copy of the analytical results, to the ANRH. The Operational water monitoring results will be submitted with the results of the annual groundwater sampling program.

7.7 Key Performance Indicators

Statoil has developed a set of key performance indicators to ensure that performance objectives are being met with respect to the groundwater monitoring program. These KPIs are indicated below in *Table 7.4*.

Table 7.4 Key Performance Indicators

Subject	Commitment
Protection of Groundwater	Well integrity shall be verified prior to proceeding with stimulation operations. Examples of operations that are used to verify well integrity include pressure testing of casing and performing cement evaluation logs.
Environmental performance to be monitored and recorded	Groundwater in the chosen water bores will be sampled, analysed and submitted to the ANRH during operations as per Reporting, outlined in Sction 7.6 of this document..

8 Conclusions

Based upon the information presented herein, the following conclusions can be made:

- There are two primary aquifers within the Study Area including the Albian (Lower Cretaceous) aquifer and the TAGI (Triassic) aquifer. These aquifers form part of a larger, regional aquifer that extends across Algeria, Tunisia and Libya called the Continental Intercalaire, part of the SASS aquifer system.
- Based upon the water forecast calculations, the estimated water demand for the project is 798,000 m^3 over the exploration period and between 124,000 and 275,000 m^3 annually. The project activities with the highest demand include road maintenance (57%), camp water (22%) and road surfacing (12%).
- Both the Albian and the TAGI were evaluated as possible water sources for the exploration project using Statiol's *Proposal for Guiding Principles for Sustainable Use of Water.* The Albian aquifer is considered a reasonable target as a groundwater source for the exploration phase. However, for large-scale development activities the use of the TAGI aquifer should be considered as it will have less environmental and social impacts in comparison to use of the Albian aquifer.
- Groundwater is the primary source of water both locally and regionally. Transboundary agreements are in place to facilitate the management of this regionally critical resource. Locally, the nearest town of Debdeb draws its water, a reported 4,100,000 m^3/year, from the Continental Intercalaire. To provide some context, the projected annual water demand for the project is equivalent to between 3 and 7% of the annual water use in Debdeb.
- Step should be taken during the planning stage of the project to limit water use and place abstraction wells geographically such that they would minimize the potential impact on other local users of the same resource.
- Prior to the installation of any abstraction well, Statoil would need to obtain a water permit or concession from the Algerian Government. The concession is granted for the total amount of water to be abstracted from an aquifer (i.e., one single concession can be requested for all the water wells needed).

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10 List of Acronyms

ALNAFT	National Agency for the Valorisation of Hydrocarbons Resources (from French, *Agence Nationale pour la Valorisation des Resources en Hydrocarbures*)
ADE	Algerian Water Company (from French, Algerienne Des Eaux)
ANBT	National Agency of Dams and Transfers (from French, Agence Nationale des Barrages et Transfert)
ANGIRE	National Agency of Integrated Management of Water Resources (from French, Agence Nationale de Gestion intégrée des Ressources en Eau)
ANRH	National Agency of Hydraulic Resources (from French, Agence Nationale des Ressources Hydrauliques)
ASTM	American Society of Testing and Materials
CDRAS	Administration Documentation and Investigation Centre (from French, Centre de Documentation et de Recherche Administratives)
CT	Terminal Complex (from French, Complexe Terminal)
CI	Intercalary Continental (from French, Continental Intercalaire)
DHW	Wilaya Hydraulic Directorate (from French, Direction Hydraulique de la Wilaya)
DO	Dissolved oxygen
EC	Electrical Conductivity
ERM	Environmental Resources Management
ESIA	Environmental and Social Impact Assessments
ESMRE	School of Management of Water Resources (from French, Ecole Supérieure de Management des Ressources en Eau)
ESP	Electrical Submsersible Pump
INPE	National Institute of Equipment Development (from French, Institut National de Perfectionnement de l' Equipement)
IPIECA	International Petroleum Industry Environmental Conservation Association
ITDAS	Saharian Agriculture Development Technical Institute (from French, Institut Technique de Développement de l'Agronomie Saharienne)
ISO	International Organization for Standardization
KPI	Key Performance Indicators
MMRA	Man Made River Authority
MRE	Algerian Ministry of Water Resources
NWSAS	North West Sahara Aquifer System
ONA	National Office of Sanitation (from French, Office National de l'Assainissement)
ONID	National Office of Irrigation and Drainage (from French, Office National de l' Irrigation et de Drainage)
ORP	Oxidation-reduction Potential
OSS	Sahara and Sahel Observatory (from French, L'Observatoire du Sahara et du Sahel)
QA/QC	Quality Assurance/Quality Control
SASS	Système d'Aquiferes du Sahara Septentrional (see NWSAS)
TAGI	Triassic Aquifer
TDS	Total Dissolved Solids
UNESCO	United Nations Educational, Scientific and Cultural Organization
USEPA	United States Environmental Protection Agency
WMP	Water Management Plan

ANNEXES

ANNEX 1

List of Identified Groundwater Wells

Table D.4.1.1 List of water wells

Well Location	Well ID	Depth (m)	SL (m)	DL (m)	Mob. Flow (m^3/day)	Exp. Flow (m^3/day)	Coordinates			Observations
							X	Y	Z	
Bordj-Messaouda	Bordj-Messaouda	900	0	0	2592	2592	9°25'27.42"E	30°12'3.60"N	327	Abstracts from the C.I. During the drilling the water rises with pressure and the static level is above ground level
Deb-Deb	DD I (Centre)	763	5,5	65	2596	1296	9°24'19.01"E	29°58'30.15"N	340	Abstracts from the C.I, operated by the AEP
Deb-Deb	DD II	770	0	32	2596	1296	9°23'32.15"E	29°58'12.33"N	337	Abstracts from the C.I, operated by the AEP
Deb-Deb	DD III	760	0	34	2596	1296	9°24'33.82"E	29°57'49.25"N	340	Abstracts from the C.I. During the drilling the water rises with pressure and the static level is above ground level
Deb-Deb	DD ZHUN	800	37	93	792	691	9°26'37.23"E	29°58'51.96"N	374	Abstracts from the C.I, operated by the AEP
Deb-Deb	N/P I	800	0	14	2596	0	9°26'23.25"E	29°57'17.24"N	350	Abstracted from the C.I, closed.
Deb-Deb	N/P II	835	0	16	2596	2596	9°26'54.86"E	29°56'51.12"N	354	Abstracts from the C.I, operated by the AEP
Deb-Deb	DD VII	800	0	18	1296	0	9°23'22.86"E	29°59'3.25"N	338	Abstracted from the C.I, closed.
Fort Thiriet	Fort Thiriet	750	0	0	1728	1728	9°22'46.58"E	30°10'54.73"N	317	Abstracts from the C.I. During the drilling the water rises with pressure and the static level is above ground level
Fort Saint	Fort-Saint I	313	0	0	1728	0	9°32'39.91"E	30°14'47.71"N	295	Abstracts from the Turonian, closed.

Well Location	Well ID	Depth (m)	SL (m)	DL (m)	Mob. Flow (m^3/day)	Exp. Flow (m^3/day)	Coordinates			Observations
Fort Saint	Fort-Saint II	330	0	0	2400	0	9°32'55.58"E	30°14'48.23"N	295	Abstracts from the Turonian, closed.
Fort Saint	Fort-Saint III	300	0	0	1296	0	9°32'55.28"E	30°14'59.63"N	296	Abstracts from the Turonian, closed.
Mérikséne	MKS I	800	0	42	2592	0	9°19'18.24"E	30° 8'44.89"N	312	Abstracts from the C.I, closed.
Mérikséne	MKS II	805	0	0	2592	1296	9°19'29.70"E	30° 8'30.04"N	313	Abstracts from the C.I, operated by the local AEP
Mérikséne	MKS III	886	0	0	6048	3024	9°22'47,7"E	30°10'34,9"N	320	Abstracts from the C.I, operated by the local AEP of the fire station
Timeroualine	Stah I	606	195	198	696	518	9°25'39.22"E	29°19'42.74"N	540	Abstracts from the C.I, operated by the local AEP
Timeroualine	Stah II	629	187	190	696	518	9°24'35.01"E	29°19'29.98"N	546	Abstracts from the C.I, operated by the local AEP
Timeroualine	TML 104	605	193	198	672	518	9°26'26.36"E	29°19'34.14"N	546	Abstracts from the C.I, operated by irrigation
Timeroualine	TML 105	210			0	0	9°26'43.74"E	29°19'56.25"N	546	During drilling, the probe had an accident requiring to abandon drilling
Timeroualine	TML 106	76			0	0	9°26'46.10"E	29°19'46.95"N	542	Drilling well as replacement of the TML 105 but has been abandoned.
Timeroualine	TML 107	600	198	204	672	672	9°24'33.48"E	29°19'44.68"N	542	Abstracts from the C.I, operated by the local AEP
Timeroualine	TML 108	603	198	204	696	696	9°24'25.00"E	29°19'55.00"N	542	Abstracts from the C.I, operated by the local AEP of the fire station

Notes :
SL : Static Level

Well Location	Well ID	Depth (m)	SL (m)	DL (m)	Mob. Flow (m^3/day)	Exp. Flow (m^3/day)	Coordinates	Observations
DL: Dynamic Level (during drilling) Mob. Flow: Mobilization Flow that is destined to drinking water or irrigation Exp. Flow: Exploitation Flow that depends on the productivity of the resource and the characteristics of the drilling. This value is calculated based on drilling tests.								

Source : DWR Illizi Wilaya (May, 2015)

ANNEX 2

Water Needs Summary
Water Forecast Assumptions

Water Needs Summary

			Vertical Wells (Well 1-4) Comments/Notes
Seismic Water Needs			
Volume of water needed for seismic survey:		m^3	
Quality of water needed for seismic survey:		Select	
Drilling Water			
Number of wells to be drilled:	1		Quantities per 1 well basis
Volume of water needed per well - including surface hole losses, cement jobs, drilling mud, liner cement work and completion:	795	m^3	
How many rigs will be operating at the same time:	1		
Time needed to complete 1 well:	2,3	Months	
Quality of water required for drilling fluids?	Fresh	Select	
Volume of produced water is expected during the exploration phase:	0	m^3	
Quality expected of produced water?	NA	Select	
Stimulation Water			
Number of stimulations planned per well:	2	each	single large stimulation, however ma be 2 smaller stimulations based on geology/petrophysical evaluation, thi is the max total volume independent stimulations per well
Water needed per stimulation:	1589,9	m^3	
Will wells be stimulated simultaneously?	N	Y/N	
Quality of water required for stimulation?	Fresh or slightly brackish	Select	
Volume of flowback water expected per stimulation?	794,95	m^3	Max case assumed as 50% of frac wa recovered (very high)
Quality expected of flow back water?	Brine	Select	worst case
Domestic/Camp Water			
How many camps will be operated?	1	each	1, includes miltary & operations on single well site
How many people estimated per camp?	100	each	50 military, 50 D&W operations
Will this change over time or can we assume consistent number of personnel over the period of exploration?	Consistent number		
Volume of water assumed per person/per day (drinking water, cooking, personal hygiene, laundry, and toilets)?	30000	L/day	Note: Standard is between 180-300 liters/person/day
Quality of water required for Domestic/camp use?	Fresh Water	Select	
Volume of domestic/camp water is expected to be "returned" (black water/grey water):	24000	L/day	Note: Generally on the order of 80%

Civil Works (Wells 1-6)

Construction Water			
Number of well pads to be constructed:	6	each	6 for entire ecploration phase, assume 1 well per pad
Volume of water needed for construction of 1 well pad:	6000	m^3	estimate by US civil construction leader
Volume of water needed for airstrip construction (if applicable):	2000	m^3	assume 1 air strip per well to be conservative, estimate by US civil construction leader
Other concrete needs? Estimated volume of water needed:	25	m^3/well	
Quality of water required for concrete mixing:	fresh	Select	
Road length	25	km/well	based on longest distance to phase 1 north and south wells, can be assumed for all wells in exp phase and this would be rather conservative as will reuse roads for each phase
Volume of water needed for road surfacing:	593	m^3/km	
Volume of water needed for road surfacing:	14825	m^3/well	
Quality of water required for road surfacing:	fresh	Select	Assumed this must be fresh based on environmental regulations
Will pipelines be constructed during this phase of work?	N	Y/N	
Volume of water required for hydrostatic testing of pipelines:	NA	m^3	
Quality of water needed for hydrostatic testing of pipelines:	NA	Select	
Volume of hydrotest water anticipated to be recovered:	NA	m^3	
Anticipated quality of recovered hydro test water:	NA	Select	
Other construction water needs?	100	m^3/well	Water required plane parking areas and other potential cementing.
Maintenance Water			
Volume of water needed for dust control?	15	m^3/km	roads and air strips
Volume of water needed for dust control?	375	m^3/day/well	roads and air strips assuming road length of 25km
Quality of water needed for dust control:	fresh	Select	
Volume of water needed for Emergency reserve?	50	m^3	On the well site the emergency reserve is part of the drilling/completions layout and built during site construction. There may be times where an emergency reserve is needed off site near the 2nd water well. This is what is assumed here for one well.
Quality of water needed for emergency reserve:	fresh	Select	
Will there be any process water requirements (e.g. desalters, cooling water, steam generation?	N	Y/N	Describe, including any specific volume and quality requirements
Any other water requirements not considered above?	N	Y/N	No large quantity of operational water has been missed.

	Horizontal Wells (Well 5-6)		Comments/Notes
Seismic Water Needs			
Volume of water needed for seismic survey:		m^3	
Quality of water needed for seismic survey:		Select	
Drilling Water			
Number of wells to be drilled:	1		Quantities per 1 well basis
Volume of water needed per well - including surface hole losses, cement jobs, drilling mud, liner cement work and completion:	954	m^3	
How many rigs will be operating at the same time:	1		
Time needed to complete 1 well:	3	Months	
Quality of water required for drilling fluids?	Fresh	Select	
Volume of produced water is expected during the exploration pha	0	m^3	
Quality expected of produced water?	NA	Select	
Stimulation Water			
Number of stimulations planned per well:	13	each	Lateral length of 1000m, stage spacing of 250' (75m)
Water needed per stimulation:	20657	m^3	Max volume 10,000bbl per frac stage
Will wells be stimulated simultaneously?	N	Y/N	
Quality of water required for stimulation?	Fresh or slightly brackish	Select	
Volume of flowback water expected per stimulation?	10328,5	m^3	Max case assumed as 50% of frac water recovered (very high)
Quality expected of flow back water?	Brine	Select	
Domestic/Camp Water			
How many camps will be operated?	1	each	1, includes miltary & operations on single well site
How many people estimated per camp?	100	each	50 military, 50 D&W operations
Will this change over time or can we assume consistent number of personnel over the period of exploration?	No		
Volume of water assumed per person/per day (drinking water, cooking, personal hygiene, laundry, and toilets)?	30000	L/day	Note: Standard is between 180-300 liters/person/day
Quality of water required for Domestic/camp use?	Fresh Water	Select	
Volume of domestic/camp water is expected to be "returned" (black water/grey water):	24000	L/day	Note: Generally on the order of 80%

Water Forecast Assumptions

Water Forecast Assumptions							Comments
Seismic	1	**60**	days (2 months)/per seismic survey				
Seismic	2	**25**	m3/day needed to cover all water needs during seismic survey				
Drilling	3	**6**	wells to be drilling over	**5**	years		
Drilling	4	**1**	Number of drilling rigs				
Drilling	5	**1**	full camp set-up for every	**1**	well to be drilled		This includes different camps for drill crew, militarily, etc. which can be rolled into one camp
Drilling	6	**70**	days to drill vertical well				2,3 months/30 days per month
Drilling	7	**90**	days to drill horizontal well				3 months/30 days per month
Drilling	8	**250**	personnel in drilling + stimulation camp (average including military)			**0,3**	m3 pp/pd
Drilling	9	**500**	m3 wastewater per vertical well				
Drilling	10	**600**	m3 wastewater per horizontal well				
Hyd. Stimulation	11	**1589,9**	m3/frac	**1**	frac per well vertical well		1-2 stimulations/vertical well, but volume is max indipendant of stimulations per well
Hyd. Stimulation	12	**13**	frac per well Horizontal well				
Hyd. Stimulation	13	**60**	days for completion of both vertical + horizontal wells				
Civils	14	**1**	Airstrip to be constructed prior to start of full production				Prior to start of drilling first well
Civils	15	**1**	Prepared pad for every	**1**	well		
Civils	16	**2000**	m3 of water needed per air strip				
Civils	17	**6**	number of well pads to be constructed				
Civils	18	**6000**	m3 of water needed per well pad for construction purposes				
Civils	19	**60**	days of civil works associated with each well				
Civils	20	**125**	m3 additional water needed per well				including add. Concrete mixing needs + plane parking areas
Civils	21	**25**	km of road needed per well				Concervative estimate b/c some roads will be reused
Civils	22	**593**	cu m water per	**1**	km		
Civils	23	**375**	m3/day/well for dust control				assuming 25 km of roadway + airstrips
Civils	24	**50**	m3 emergency reserve per well				

ANNEX 3

Groundwater Sampling Methodology

Methodology

This section provides the details of the groundwater sampling procedures which are to be used for any groundwater sample collection on behalf of Statoil as part of the Timissit exploration Project. The objective of this sampling protocol is to establish a uniform method for collecting samples from the sampling network or any other water supply well identified for sampling in order to reduce the potential variability associated with purging and sampling.

The sampling protocol detailed herein is consistent with the following international references:

- American Society of Testing and Materials (ASTM). 2012. Standard Guide for Planning and Preparation for a Groundwater Sampling Event (D5903-96).
- International Organization for Standardization (ISO). 2009. Water quality – Sampling – Part 18: Guidance on sampling of groundwater at contaminated sites. ISO 5667-11:2009.
- United States Environmental Protection Agency (USEPA), 2010. Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells. EQASOP-GW-001. Region 1. Revision No.3.

Monitoring Program

Access

If private wells are selected to form part of the monitoring network, a written access agreement will be signed by Statoil and the well owner prior to the sampling of these wells.

Equipment

The following equipment is necessary for execution of a groundwater sampling event:

- Water level meter (if possible);
- Total well depth meter (if possible);
- Purging/sampling pump and power source for pump (although it is assumed that an electrical submersible pump (ESP) will be installed in the water wells and that a generator will be present at the well site);
- Multi-parameter water quality meter (if possible, for measurement of temperature, pH, electrical conductivity [EC] oxidation-reduction potential [ORP] and dissolved oxygen [DO]);
- A clean recipient to be filled with a water sample from which field parameter measurements will be collected (if a flow-through cell is available this would be the recommended approach);
- Bucket for collection of purge water during sampling;
- Laboratory-provided sample bottles;
- Laboratory-provided labels;
- Laboratory-provided preservatives, if required;
- Chain of Custody record (according to Laboratory specification);

- Field filtration equipment, if required and provided by the laboratory;
- Cooler box and/or shipping container for safe storage and transport of sample bottles (ensure that preservation requirements are met, i.e. if it is required to keep the samples cool)

Water Level Measurements

Prior to purging or sampling the wells, if physically possible based on well construction, the static-water level will be measured and recorded. The measurements will be taken as depth-to-water from the top of the well casing or from a designated elevation marker on the casing and the values will be subtracted from the surveyed elevation of the casing (if available) to obtain the elevation of the water in the well.

Supply Well Purging and Sampling

It is assumed that the water wells will be operational when groundwater samples are collected. However, in the case that the well has not been active (not be pumped) for a more than 14 days, it is recommended that the well be purged prior to sampling. In this case the supply well discharge lines should be purged for 10 to 15 minutes before collection of water samples.

A valve close to the well should be used for purging and sampling in order to minimize the length of piping purged. In addition, the value should not draw water from an in-line filter or other treatment system. Purged water will be directed onto the ground in the general area of the well or to an area specified by the well owner. The sampling valve will be visually inspected prior to sample collection and the condition will be noted in the field log.

Sample collection will be completed, as follows:

1. While the pump is operating the sampling valve should be opened. Place a bucket under the sampling valve to collect any additional water discharged during sampling.
2. The recipient to be used to collect the field parameter measurements should be filled with water from the sample valve. Rinse the recipient 2 times with water from the sampling valve before filling the recipient. When the recipient is full the sampling valve can be closed.
3. Insert the pre-calibrated multi-parameter water quality meter into the recipient. Allow the measurements to stabilize and note the values on the field notes.
4. When the field parameter measurements have been noted the samples can be collected. Open the sampling valve and fill sample bottles directly from the discharge tube (note: if using a closed flow through cell, disconnect the pump discharge tube from the flow through cell to ensure that water samples are collected before water passes through the cell). The lip of the sample containers should not be allowed to touch the valve. In general, any vials for volatile compound (i.e. TPH) analysis should be collected first and filtered samples (i.e. metals) should be collected last. The sample valve should be adjusted to provide a laminar (non-turbulent) flow into the sample bottles to minimise aeration of the sample, and the water should be allowed to run smoothly down the side of the bottle. Additional notes for sample collection include:
    - When collecting samples in 40 mL vials, the vials must be filled with a meniscus above the rim of the vial to eliminate the formation of bubbles and headspace before capping (once the cap is screwed on, turn the vial upside down and gently tap the side of the bottle to see if any air bubbles are present. If they are, remove the cap, top off the vial and try again).

- Be careful not to let the water in acidified sample bottles overflow during sample collection as the acid preservative may be washed out.

5. Once all sample bottles have been filled, close the sampling valve.

6. The collected samples should be labelled with the appropriate information (Sample ID, date, Site name, initials of sampler), and placed immediately in an ice-cooled cooler box pending dispatch to the laboratory. Be careful not to overfill cooler box with sample bottles as they will be at greater risk of breaking during transport, and may be very heavy to lift once full.

7. An associated chain-of-custody should be prepared to accompany the samples to the selected laboratory.

Monitoring Well Purging and Sampling

Monitoring wells or wells that have not been in operation for more than 14 days will be purged prior to sample collection. The rationale is to ensure that all the stagnant water in the well and filter pack was removed and replaced with fresh formation water. The well should be purged of approximately three casing volumes or until measurements of the field parameters stabilize. Note: the destination of the purged water should be confirmed prior to commencing purging activities.

The purging procedure is as follows:

1. Before purging, the purge volume is calculated as three times the volume of standing water in the well and pore space of the filter pack, according to the following equation:

$$V_{tot} = V_{well} + V_{filter}$$
$$V_{well} = \pi\, r1^2\, h1; \text{ and}$$
$$V_{filter} = \pi\, (r3^2 - r2^2)\, h2\, n$$

Where:

Vtot = Total casing volume (L);
Vwell =Volume of water in well (L);
Vfilter = Volume of water in filter pack (L);
r1 = Inner radius of well casing and screen (m);
r2 = Outer radius of well casing and screen(m);
r3 = Radius of borehole(m);
h1 = Height of water column in well casing (calculated as the difference between the total well depth and the water level depth) (m);
h2 = Length of filter pack or height of water column in well (whichever is shorter) (m); and
n = porosity (use 0.25)

2. Proceed with the purging by turning the pump on. Discharge water should be directed to the previously agreed location.

3. Water samples should be collected for measurement of field parameters during purging. Also, it is important to note any changes to the visual clarity of the water during purging, as well as any unusual properties or odours. These measurements and observations should be noted every 15 min during purging.

4. Continue purging until the water quality parameters stabilises over three consecutive readings. The stabilisation criteria are as follows:

Table 1 Water quality parameter stabilisation criteria (US EPA)

Parameter	Stabilisation criteria
pH	**± 0.1 pH units**
EC	**± 3% (µS/cm or mS/cm)**
Temperature	**± 3%**
ORP	**± 10 mV**
DO	**± 10%**
Turbidity	**± 10% NTUs**

5. Following purging, samples are collected in the same manner described above from the sampling valve at the wellhead.

Sample Preservation and Shipment

Sample bottles will be supplied by a pre-approved laboratory and will include the appropriate preservatives and, as described above, the sample bottles will be filled to slightly more than full before being capped to ensure no free head space.

Immediately after sample collection, laboratory specified the sample bottles will be placed in sealed, insulated coolers packed with ice to cool the ambient temperature to approximately 4 degrees Celsius (ºC). The remaining sample bottles will be stored and transported without cooling. The coolers will be transported to the laboratory for delivery within 24 hours of sample shipment and within 5 days of sample collection (if possible).

Chain-of-custody procedures will be followed to ensure the integrity of groundwater samples and to trace the possession and handling of the samples from the time of their collection through laboratory analysis and reporting. A single chain of custody form will be used for each sample shipment and each person who handles one or more of the samples will sign the form upon relinquishing the samples.

Quality Assurance/Quality Control

The following quality assurance/quality control (QA/QC) measures are recommended to ensure the quality of the groundwater sampling results.

- Instrument Calibration. Prior to each sampling event the multi-parameter meter should be calibrated with the objective of verifying that it functions correctly and within the range of sensibility necessary for the specifications of the project.

- Decontamination of Sampling Equipment. All re-usable sampling equipment should be decontaminated between sampling points and disposable sampling materials should be used when possible (gloves, etc.). Decontamination of the sampling equipment should be completed using a non-phosphate detergent (e.g. Alconox) and potable water.

- Collection of Blanks and quality control samples. To assess the reproducibility and quality of the analytical results, collection of the following blanks and quality control samples are recommended:
- One trip blank (prepared in the field with deionized mineral water) for each sample shipment.
- One equipment blank during each sampling campaign.
- One duplicate sample during each sampling campaign.

Annex D.5
Plan for Environmental information and awareness

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1 Introduction

Statoil, as operator for Timissit project will ensure that personnel involved in the project will have sufficient information and environmental awareness training.

This document describes the plans for actions to be taken to inform and give the employees environmental awareness training in the Timissit project. Implementation of these actions will contribute to Timissit have its personnel adequately trained in environmental issues in accordance with requirements from the authorities and Statoil.

Dissemination of information will be provided in terms of meetings, workshops and specific courses.

2 Requirements

The requirements for the development, maintenance and further development of environmental competence is based on Statoil HSE policy described in the Statoil Book, as well as applicable legislation in regulations and guidelines. Requirements stipulated by the Algerian authorities must be considered as minimum requirements.

The project management is responsible for ensuring that all employees have the relevant environmental competence. Training plans must be drawn up for all employees to ensure that the necessary competence is attained, maintained and further developed. The plans shall specify concrete measures and the period at which they will be implemented.

3 Plan for information and environmental awareness training

Table 3.1 Preliminary training plan

Activities	Content - Measures	Target group	Estimated period	Responsible
Workshop	Environmental and Social Management in Timissit, see Plan for Workshop below	Project members, Staff on site	Workshop: Q1 2016 Continuous information meetings when needed	Project management
Course	Chemical management – risk assessment, procurement, transport, use, storage and waste handling of chemicals	Staff on site		Statoil Drilling supervisor
Induction training	Waste management awareness training, as part of the Project induction process, will be provided to all Project personnel (including contractors and subcontractors). Toolbox talks, team briefings, safety meetings and periodic poster campaigns will also be used Statoil Seismic supervisor to ensure ongoing awareness of and compliance with correct waste management procedures as outlined in the Waste Management Plan. Apart from general waste management training, the personnel directly involved in waste treatment or waste disposal will also	Staff on site	Q1 - Q2 2016	Statoil Drilling supervisor Statoil Seismic supervisor

	receive additional training provided by waste equipment suppliers, including training in incinerator operation.			
Exercises	Emergency response exercises, including liquid spill and/or gaseous emission scenarios - How to read and use the "Liquid response plan"	1st line and 2nd line	Q1 - Q2 2016	Statoil Drilling supervisor
Exercises	Emergency response exercises, including liquid spill and/or gaseous emission scenarios	1st line	Weekly during operation	Statoil Drilling supervisor

The purpose of the Environmental and Social Workshop is to communicate results from Timissit the ESIA and to give an overview of relevant environmental and social plans, programs and procedures:

- **Regulatory Framework:** Legal Responsibilities, Legislation, Enforcement
- **Project description:** Plans, Activities, Commitments
- **Baseline:** Physical, Biological, Archaeological, Socio-economical and past operations
- **Impact assessment:** Results from assessment, including training in Archaeological Chance Find and Protected/sensitive fauna and flora training
- **Environmental management plan:** Awareness training in plans, programs and procedures:
  - Plan for Prevention of pollution
  - Plan for Control of pollution
  - Liquid spill response plan
  - Plan for Intervention in case of pollution
  - Waste Management Plan
  - Plan for Management of contaminated sites and soil
  - Plan for Management of liquid and gaseous waste
  - Plan for Mitigation actions and monitoring
  - Water management Plan
  - Quarrying Management Plan
  - Plan for Chemical Management plan
  - Plan for Environmental information and awareness
  - Program for Environmental audit
  - Program for the shutting down and restoration of site
  - Procedure for Archaeological Chance Finds
  - Plan for Traffic/Journey Management Plan
  - Plan for Worker Management Plan
  - Public Consultation and Disclosure Plan
  - Plan for Local Content
  - Procedure for Management of Change
  - Internal and external communication

Annex D.6
Chemical management plan

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1 Objective

We need chemicals to operate safe. Chemicals prevent damage to equipment and prevent accidents. But chemical products that we use should be managed when it comes to selection, purchase, storage, handling and waste treated.

This Chemical Management Plan for Statoil's Timissit project in Algeria describes the requirements for the selection, management and documentation of chemical products, including HSE risk assessments and substitution assessments, as well as restrictions and requirements for dispensation processing both before and after use of chemical substances and products (chemicals). The purpose is to ensure a high level of protection for people, the environment and facilities in accordance with the company's risk management requirements.

This plan and principles apply to all chemicals used in the project and for all phases in the project (seismic, drilling and stimulation phases).

The target group for this document is personnel who requisition and/or use chemicals, personnel who work with procurement, purchasing or contracts, company representatives (CRs) for specific contracts, planners, project personnel (seismic, drilling & well) and HSE personnel.

2 Framework for use of chemicals and additives

2.1 Algerian requirements

Executive Decrees 03-451, modified by Decree 10-19, defines the safety rules applicable to hazardous chemical products and gas pressure containers. Article 4 of Executive Decree 03-451 establishes that performing professional activity involving mainly hazardous substances is subject to prior authorisation. However, when the use of hazardous materials is exceptional, circumstantial or accessory, as is the case of the Timissit exploration project, this authorisation is not required. However, the activity does remain subject to the provisions set by the decree. For instance, Article 7 of Executive Decrees 03-451, states that personnel involved in the storage of highly hazardous substances have to be qualified by the Wilaya's Directorate of Mining and Industry.

The import of hazardous material and chemicals included in the list published by the Ministry of Energy and Mining (List of 6th May 2015 available at: http://www.mem-algeria.org/francais/index.php?page=liste-des-matieres-et-produits-chimiques-dangereux.) is subject to an authorisation granted by the Ministry of Energy and Mining.

The conditions for the packaging and labelling of dangerous substances are set out in Executive Decree 05-08. For their transport, Executive Decree 03-452 states that an authorisation granted by the Ministry of Transport is required; and provides the conditions for transport (labelling, packaging, etc.). Specific transport conditions are set by Interministerial Order of 2nd November, 2000, on the transport of inflammable substances.

Ministerial instruction R1 of 22nd September, 2003, regulates the management of industrial risks related to hazardous substances. It is based on two principles: monitoring, and precaution through the establishment of an EIA, risk assessment, exploitation authorisation, Internal Operational Plan and an Emergency Response Plan.

2.1 Statoil's requirements

Facilities and systems shall be designed and operated to avoid, where practicable, or minimize the use of chemicals hazardous to the environment.

Chemical hazards shall be analysed based on disclosed health, safety and environmental hazard data.. For all chemicals, environmental hazard data shall be made available as GHS classification or as information sufficient to perform GHS classification.

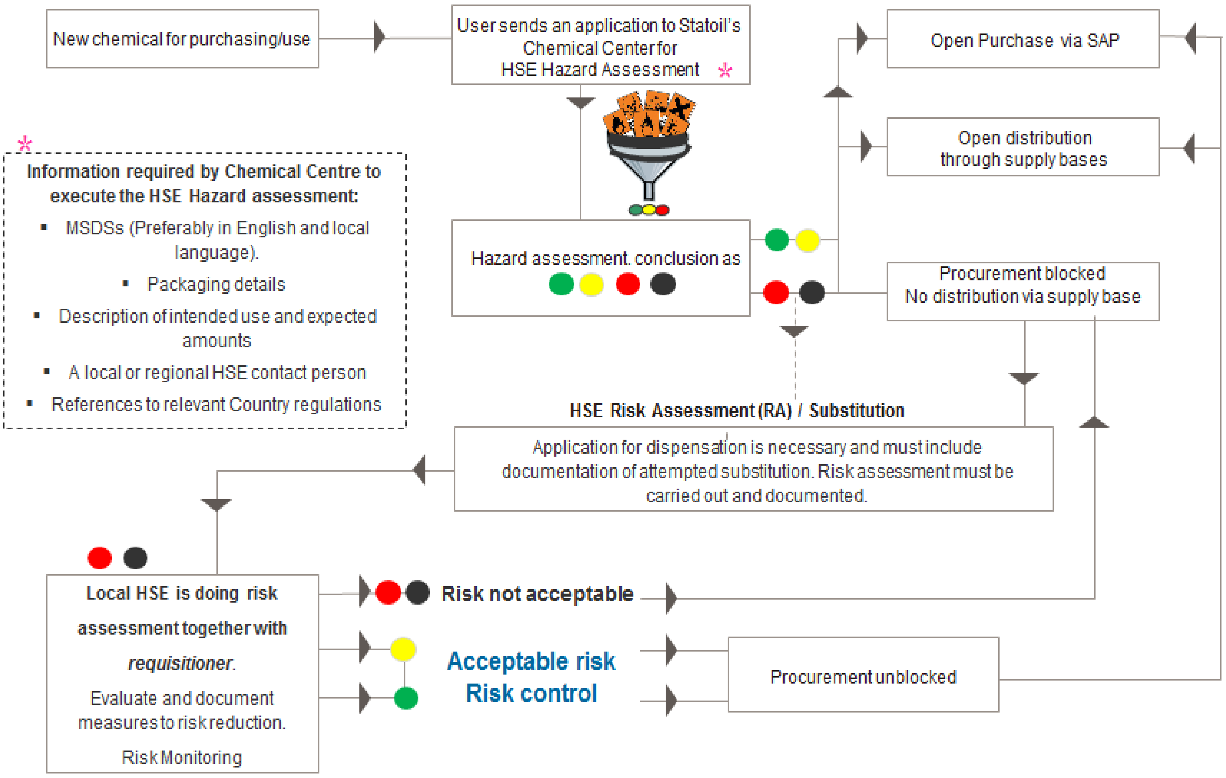
Chemicals shall be selected based on results of hazard and risk analyses, and availability of less hazardous substitutes.

Chemicals containing substances regarded as of very high concern, listed as prohibited substances in Restricted and prohibited substances (TR1668), shall not be used. All new systems shall be free of ozone depleting substances and fluorinated greenhouse gases. Existing systems shall be replaced with systems free of ozone depleting substances and fluorinated greenhouse gases if such systems are reasonably available.

Substances having PBT (Persistent, Bioaccumulative and Toxic), vPvB (very Persistent and very Bioaccumulative) or ED (Endocrine Disruptors) properties shall not be used, if not justified by analyses of risk and availability of substitutes. The justification shall be documented.

When chemicals enter the product stream, downstream health, environmental, and technical consequences shall be considered.

3 Statoil's process for purchasing and applying for new chemicals



In order to ensure quality and consistency in assessing hazardous properties of the chemicals, the following must be assessed:

- Inherent hazardous properties. The hazard must be described using hazard categories.
- Whether substitution assessments are required.
- Whether there are restrictions or bans resulting from extremely hazardous HSE properties that require dispensation processing.
- Whether the chemical is subject to any official requirements relating to emissions.
- The quality of suppliers' documentation (HSE data sheets and eco-toxic documentation).
- Whether risk assessments are required in connection with:
    - transport and storage
    - use and handling
    - waste handling
    - emissions to the environment

The Statoil Chemical Centre (CC) supports Timissit project in these assessments.
The CC is staffed by professional HSE personnel and has access to professional support. The Statoil Chemical Centre will support in quality control of HSE data sheets and eco-toxicological information and document and register hazard assessments in a joint electronic system.

The *general* rules for classifying hazardous properties are summarised in table 2.1 below. The table shows when a chemical requires risk assessment, assessment and documentation of substitution, and dispensation prior to procurement. The general basis for classifying chemicals is information in HSE data sheets. Where relevant, the classification of properties that are hazardous to the natural environment also includes additional information, as bioaccumulation, toxicity, biodegradation.

Table 2.1 General rules for classifying hazardous properties

HAZARD CATEGORY	HEALTH	ENVIRONMENT	SAFETY	Risk assessment requirement and consequences for procurements
6 Unacceptable	Statoil's prohibited substances list			Procurement blocked. Application for dispensation is necessary.
5 **Very serious**	**Very toxic (T+)** acutely toxic (R26, 27, 28) irreversibly toxic (R39) **Toxic (T)** Carc Cat 1 and Carc Cat 2 (R45, 49) Muta Cat 1 and Muta Cat 2 (R46) Repr Cat 1 Repr Cat 2 (R60, 61) **Hazardous to health (Xn)** Allergenic	**Environmentally hazardous (N) with hazard label** (R50+53) **Environmentally hazardous, ozone (N) with label** (R59) BLACK chemicals in HOCNF section 56b, except Statoil category 6	**Explosive** **(**R1,2,3,4,5,6,19,44)	Procurement blocked. Application for dispensation is necessary. Chemicals with environmental properties labelled R50 or R53 , and that do not require a HOCNF, are not subject to the requirement for dispensation processing when used on installations regulated by the Activities Regulation Dispensation applications must include documentation of attempted substitution. A thorough risk assessment is required in order to be granted

	(R42)			dispensation.
4 **Serious**	**Toxic (T)** acutely toxic (R23, R24, R25) chronically toxic (R48) **Corrosive (C)** (R35) **Hazardous to health (Xn)** Carc Cat 3 (R40) Muta Cat 3 (R68) Repr Cat 3 (R62, R63) **Irritant (Xi)** Allergenic (R43) Bioaccumulative (R33)	**Environmentally hazardous (N) with hazard label** (R50, R51+53, R54, 55, 57, 58) RED chemicals under HOCNF section 56b	**Extremely flammable (F+)** (R12) Low-volume chemicals that contain gas under pressure are exempt. **Oxidising (O)** (R7,8,6,14,16) Substances used in laboratories and gas under pressure are exempt.	Procurement blocked. Substitution must be assessed and documented for R40, R62, R63, R68 and for HOCNF chemicals*. *Alternative products must not be HSE category 4, 5 or 6 except where this is based on an overall assessment. Substitution should be assessed for other chemicals in category 4. A risk assessment must be carried out before use.
3 **Moderate**	**Corrosive (C)** (R34) **Hazardous to health (Xn)** acutely toxic (R20,21,22,65) **Irritant (Xi)** (R41)	**Environmentally hazardous without hazard code (N) or hazard label** (R52, 52/53, 53) "Other chemicals" in HOCNF	**Highly flammable (F)** (R11,15,17,30) Gas under pressure is exempt.	Procurement permitted. The need for a basic risk assessment must be considered. Must be stored/ handled in accordance with the instructions in the HSE data sheet.
2 **Minor**	**Irritant (Xi)** (R36,37,38,66,67) Avoid inhalation (S22,23) Avoid contact (S24,25) Use protective equipment (S36,37,38,39) Ventilation required (S51,52)	**Not classified as environmentally harmful** (Contains substances classified as environmentally harmful, but the product is not classified as such)	**Flammable** (R7,10,18) Gas under pressure is exempt.	Procurement permitted. Must be stored/ handled in accordance with the instructions in the HSE data sheet.
1 **Minor**	Not required to be classified. Subjective symptoms.	**Not classified as environmentally harmful** "PLONOR" chemicals under HOCNF section 56b		Procurement permitted. Must be stored/ handled in accordance with the instructions in the HSE data sheet.

The Statoil Chemical Centre may propose that chemicals be subject to stricter assessment than is required by official regulations or the supplier's/ manufacturer's documentation. Proposals must be considered by the relevant discipline entities.

If necessary, substitution and risk must be assessed locally.

Statoil has a central electronic system that documents HSE hazard assessments of the chemicals and that ensures that HSE data sheets can be easily accessed by everyone.

4 Chemical management in Timissit project

4.1 Purchase and risk assessment of chemicals

Screening, evaluation and selection of chemicals and suppliers for Timissit project will comply with Statoil's requirements described in previous section. After chemical suppliers have been chosen, the requisitioner, or the person who plans to use chemicals in the project, must submit an application on a separate form to the Statoil Chemical Centre.

The application requirement applies in the case of:

- New chemicals (see definition of "chemical")
- First-time registration of a chemical at a facility
- Requests for registration of new package sizes or new basic information about a chemical (does not require a new HSE assessment).

Both health, safety and environmental risks shall be assessed.
If the assessment of hazardous properties concludes that a risk assessment is required, the requisitioner/ planner must consult the HSE function in Timissit project.

The Statoil Chemical Centre will require dispensation processing if a chemical contains a substance that is restricted or prohibited (see table 1).

The user or requisitioner must contact the HSE function in Timissit project if a chemical is to be used in a materially new manner or by a new group of users (i.e. department, contractor, new personnel).

The Statoil Chemical Centre must document application processing in a separate log and by filing applications that have been processed.

The results of hazard assessments and any local risk assessments must be logged.

4.2 Chemicals to be used

The drilling and stimulation contractors will be contracted late 2015/early 2016.
The chemicals listed in Table 4.1 and 4.2 are most likely chemicals to be used in these operations.

Table 4.1 Typical Drilling chemicals

Chemical Additive Trade Name	Typical Purpose	Typical Concentration	
		Value	Unit
Fresh water	Base Fluid	90-99.9	Vol. % of total
Bentonite	Viscosifier	15	ppb
Xantham Gum	Viscosifier	0,25	ppb
Soda ash	Alkalinity Control	0,25	ppb
KCl	Shale stabilization	4	Vol. % of total
Sodium Acrylate	Dispersant	N/A	Vol. % of total
Lignate	Dispersant	1	ppb
Sodium Chloride	Weight Material	N/A	ppb
Barite	Weight Material	N/A	ppb
PAC	Fluid Loss Control Agent	0,5	ppb
Starch	Fluid Loss Control Agent	0,5	ppb
Zinc Oxide	H2S Scavanger	100	mg/gal
Organic LCM (Fibers and flakes)	Loss Circulation	10 - 20	ppb
SAPP	Bit Balling	10	ppb
Polycylate	Bit Balling	2	ppb
Soap Sticks	Bit Balling	Contingent	ppb
PHPA	Cuttings Encapsulation	1	ppb
Sulphonated asphalt	Shale stabilization	1	ppb
Class G Cement	Cement	50-90	Vol. % of total
Cellulose (halad)	Cement fluid control	0,5	Vol. % of total
Cellulose derivative	Cement free water control	0,05	Vol. % of total
Calcium Chloride	Cement accelerator	1,5	Vol. % of total

Table 4.2 Typical Hydraulic stimulation chemicals

Chemical Additive Trade Name	Typical Purpose	Typical Concentration Value	Unit
Fresh water	Base Fluid	90-99.9	Vol. % of total
KCl - Potassium Chloride	Clay Stabilization Agent	1	Vol. % of Total
FR-66	Friction Reducer	1	L/m^3
HAI OS	Hydrochloric Acid Inhibitor	10	L/m^3
BE-9	Bactericide	1	L/m^3
WG-36	Polysaccharide Fracturing Gelling Agent	3,59	kg/m^3
SP Breaker	Sodium Persulfate Breaker	0,6	kg/m^3
DCA-16001	Clay Stabilization Agent	2	L/m^3
100 Mesh Proppant	Proppant	1200	kg/m^3
30/50 Proppant	Proppant	1200	kg/m^3
20/40 Proppant	Proppant	1200	kg/m^3
DCA32002	Alcohol Based Surfactant	1	L/m^3
WG-11	Cross linker plus buffering agents	25	L/m^3
GasPerm 1000	Surfactant	10	L/m^3
Hydrochloric Acid	10-30% Hydrochloric Acid	500	L/m^3
Acetic Acid 60%	Iron Sequestrating Agent	20	L/m^3
FE-1A	Iron Sequestering Agent	20	L/m^3
FE-2A	Iron Sequestering Agent	5	L/m^3
Soda Ash	Acid neutralization, pH buffer	NA	NA

4.3 Transportation and receive control of chemicals

Transportation of chemicals will be conducted according to Algerian and International requirements and standards.

It is not legal to procure, transport or <u>receive</u> any chemicals at Timissit facilities that

- have been deemed unacceptable in a local risk assessment or for which the required risk and/or substitution assessment is lacking.
- are not registered in Statoil's IT tools SAP or Chess
- arrive without Safety Data Sheets (SDS) in English and French

If such a chemical arrives at Timissit facilities, the chemical shall be sent back to the base.

Checks can be carried out electronically in SAP by personnel at supply bases or goods receptions at onshore facilities or through random checks carried out by local HSE personnel.

All chemicals must be stored and handled according to the information in the SDSs.
Separate procedures will be established for the temporary storage of rejected chemicals and for the return of chemicals to suppliers

4.4 Chemical waste

Handling of chemical waste is described in *Annex D.2 Waste management plan*.

Following is a short summary of chemicals waste treatment and disposal.

4.4.1 Special chemical waste

Special waste is waste that is not classified as hazardous but that needs particular treatment. Chemical special waste streams expected in Timissit is expired non-hazardous drilling mud additives.

Expired non-hazardous mud additives such as starch, bentonite or others are typically generated by drilling activities. Additives generally come in sacks and become waste once they expire. Non-hazardous mud additives can be disposed of in landfills. However, it is recommended to liaise with suppliers and ask them to recover these materials and recycle them if possible.

Drill cuttings associated with water-based mud are expected to be one of the highest volume waste streams that will either have to be stored, treated on-site, transported to an approved waste facility for disposal, or disposed off-site in state approved reserve pits.

Generally, muds and cuttings, once recovered from the well during drilling, are separated in order to return the mud to the recirculating mud system and make the solids easier to handle. This will allow the water used to prepare the muds to be reused, minimising waste generation.

4.4.2 Special hazardous chemical waste

4.4.2.1 Oil-based mud

The use of oil-based muds will be avoided wherever possible and only used if justified by a technical assessment. Oil-based muds shall be managed separately to water-based muds, and will be recycled and reused on subsequent wells (i.e., not left with water based muds in the pit) as far as practically possible. The OBM wastes, including the associated cuttings, cannot be disposed of onsite.

If oil-based mud is used, the management of OBM cuttings at the drilling site will be the following:

- OBM-contaminated cuttings will be separated with a dedicated high-power shale shaker and transferred by a screw conveyor to a lined pit;
- As an option, OBM cuttings can also pass through a vertical dryer/centrifuge. This will normally reduce the oil content to below 2.5%.
- In order to be able to treat OBM cuttings as non-hazardous waste to enable their final disposal in a landfill, they must be subjected to thermal desorption treatment to reduce the oil content to below 1%.

4.4.2.2 Fluid flowback and produced fluids

Fluids produced during flowback will be handled in accordance with Algerian legislation, Statoil requirements and International standards. A separation system will be utilised to separate the three fluid streams from the well: condensate/oil, liquid water, and gas.

Flowback water from stimulation fluids and produced water will be stored on site in either lined earthen storage pits or above ground storage tanks. Fluids will be allowed to evaporate on-site. Remaining dried oily sludge will be collected and incinerated in incineration plants for hazardous waste.

4.4.2.3 Other

Other special hazardous wastes, if feasible, will be treated directly on the Project site. For this reason, incineration will be considered for a series of special hazardous waste streams, including medical waste, oil filters, solvents, paints and sewage sludge.

5 Dispensation from Statoil requirements

Significant changes in Drilling Muds Composition and the Stimulation fluids/additives will be managed according to the project's *Annex D.8 Procedure for Management of Change*.

The use of particularly dangerous chemicals or chemicals subject to particular restrictions or prohibitions requires dispensation processing.

Applications for dispensation must include descriptions of the grounds for the application and compensatory measures that ensure an acceptable level of risk.

Dispensation applications must include documentation of attempted substitution.

An application for dispensation from this plan may be submitted if regular case processing comes into conflict with an acute need or if the procurement is considered vital to operations.

6 Definitions and abbreviations

Chemical	A generic term for chemical substances and mixtures of substances. Medical products, cosmetics and food products are subject to separate regulations.
Codification	The establishment of basic data for goods and services.
CR	Company Representative. The person that has been appointed to act on behalf of Statoil and/or Statoil-operated license organisations in all matters relating to a contract.
Dispensation	Permission to deviate from the requirements in Statoil's governing documents. The publisher's case administrator or person authorised by him/ her must be involved in the process before final approval can be granted.
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
HOCNF	Harmonised Offshore Chemical Notification Format. Name of the eco-toxological (environmental) data sheet for offshore chemicals. Chemicals that require eco-toxological documentation (a HOCNF) are defined in the Activities Regulations.
HSE data sheets	Health, safety and the environment data sheets for hazardous chemicals
Purchaser	The person who is authorised to instigate procurement on the basis of approved requisitions.
Requisitioner	Person who has the right of disposal over budget funds and who issues requisitions for goods and services.
HSE	Health, Safety and Environment
Statoil's prohibited substances list	A list of chemical substances of particular concern.
Substitution	Replacing a chemical with a less hazardous chemical.

Annex D.7
Plan for Environmental Audits

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1 Introduction

This Plan for Environmental Audits is developed in accordance with Decree 08-312 and Instruction no 2.

The purpose of environmental audits is to identify potential gaps in relation to the regulatory requirements and Statoil's/Timissit's requirements and to verify the effectiveness of the implementation of proposed mitigation measures.

The plan should contribute to compliance and continuous improvement.

The audit reports, as well as the other records developed during the audit process, will be kept and stored by the HSE manager during the whole exploratory drilling/seismic process.

The audit results (nonconformities detected and opportunities for improvement) will be analysed and the corresponding corrective actions plan will be designed and implemented as appropriate to ensure that deviations are solved.

The audits will be carried out by specifically trained personnel independent to the areas subject of the review, but familiar with the site environmental requirements.

2 Environmental Audit Plan

A preliminary Environmental Audit plan has been developed; see Table D.7.1 below, reflecting necessary audits and verifications identified during the project planning and ESIA preparation.

This plan will be a dynamic document where necessary audits will be added prior to start operations and if it proves to be important also during and after the seismic and drilling activities.

Table 2.1: Preliminary Environmental Audit plan

No	Category	Audit Title and Objective	In scope	Timing
1	Ext. audit	Drilling Rig Contractor, • Standard / maintenance of rig, system and equipment. • Environmental mgt system.	Drilling	In the procurement process and during operation
2	Ext. audit	Chemical contractors	Project	In the procurement process and during operation
3	Ext. audit	Waste treatment companies • Availability, capacity, quality, type of treatment	Project	In the procurement process and during operation
4	Ext. audit	Hydraulic stimulation contractor • Environmental mgt system.	Drilling	In the procurement process and during operation
5	Ext. audit	Seismic contractor(s)	Seismic	In the procurement process and during operation
6	Int. audit	Verification of water sampling method	Project	Prior to activity
7	Int. audit	Verification of implementation of Waste mgt plan	Drilling and Seismic	During operations
8	Int. audit	Verification of implementation of Water mgt plan	Drilling and Seismic	During operations
9	Int. audit	Verification of implementation of Chemical mgt plan	Drilling	During operations
10	Int. audit	Verification of implementation plans, program, procedures and commitments/measures in Environmental mgt plan	Project	During operations
11	Int. audit	Verification of reporting to authorities	Project	During operations
12	Int. audit	Verification of implementation of Environmental Training program	Project	During operations
13	Int. audit	Verification of site restoration - Ensure that the site is inspected for the removal of all materials and surface returned back to original state after completion of drilling operations	Drilling	After drilling operations
14	Int. audit	Verification of site restoration - Ensure that the site is inspected for the removal of all materials and surface returned back to original state after completion of Seismic operations	Seismic	After seismic operations
15	Int. audit	Verification and inspection of implementation of Procedure for Archaeological Findings	Seismic	During operations

Annex D.8
Procedure for Management of Change (MOC)

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1 Objective

The objective of this document is to describe the structure, work requirements and approval hierarchy for change management in the Timissit projects by:

- Ensuring management control over project changes
- Identification and evaluation of potential consequences of a proposed change
- Ensuring that all affected parties and relevant stakeholders are involved and/or informed about the changes
- Establishing a record of the change, the impacts and mitigations, and reasons for the change

The primary target groups are Managers, Engineers, Superintendents, Site Supervisors and other stakeholders and decision-makers who are involved with operations.

This procedure is prepared for and applicable to drilling and well operations as per Statoil work requirements. It will be applicable for the seismic operations with small adaptations, including changing the Titles in the authority matrix, Table D.8.1.

This document is provided for in Drilling and Well Technology (FR03)

2 Work process requirements

Proposed program or design changes to an approved procedure and/or an AFE shall be properly evaluated, understood, approved and communicated to the appropriate authority level.

2.1 Procedure

The procedure to complete an MOC shall be as follows:

1. When a change is identified, the individual proposing the change shall initiate the MOC process by filling out the MOC template (Levels 2, 3, and 4).
2. The engineer shall communicate to the identified contributors in the Authority Matrix by meeting, phone or e-mail to evaluate the MOC.
3. The approver at the designated MOC level shall determine the need for a documented risk assessment.
4. Approval shall be in accordance with the relevant Authority Matrix.
5. Implementation shall occur, as appropriate, after all relevant parties are informed.
6. The MOC documentation shall be electronically stored at a location to be determined by the asset.

2.2 Levels of authority

Table 2.1 Authority Matrix for Management of Change (MOC)

LEVEL	DEFINITIONS AND EXAMPLES	CONTRIBUTORS	APPROVERS
1	**Daily operational decisions – verbal MOC only** The changes proposed will not change the design basis or well objectives but are necessary to manage everyday activities as circumstances change. These proposed changes do not require a written MOC but do require communication and joint decisions between the Contributors and Approvers. **Examples:** o Daily operational decisions necessary to carry out the approved procedures o Changes to approved procedures that are operationally driven, but do not change the well design or negatively impact the efficiency and HSE of the operations (e.g., changes to approved BHA) o Small changes to perforated intervals o Drilling with equipment in a diminished capacity o Change to casing design or setting depth without impacting well objectives	• Engineers • Site Supervisors	• Super-intendent or • Engineer
2	**Moderate changes to an approved program** Impact at this level could change a primary procedural step or cause a temporary deviation from the normal procedure. This change might not only affect costs but could create unintended circumstances. When operations must continue in order to ensure the safety of personnel and the project, a verbal approval shall be granted. Final MOC documentation shall be completed the next business day. **Examples:** o Inability to keep the hole full o Stuck drill string or casing resulting in fishing operation o Managing operations during and after an unintended kick o Collision with another well (no penetration) o Unplanned simultaneous operation o Change in perforating method o Deviation from well barrier requirements o Reduced footage in the lateral section greater than one (1) stage o Significant change to perforated interval resulting in complications to potential stimulation	• D&W Engineers • Subsurface Engineers • Site Supervisors • Superintendent • Regulatory • SSU	• D&W Manager, and/or • Subsurface Manager
3	**Significant changes that may impact the economic objective of the project** The immediate impact at this level could be a decision of whether to proceed in the current well with the proposed change or abandon the wellbore. At Level 3, an MOC shall be written, appropriate impacts identified, and approvals received before activities proceed. **Examples:** o Significant change to data acquisition or approved logging program (e.g., requiring logs when logs were not in the approved logging program) o Change in well objectives o Significant changes in the pore pressure or fracture gradient that require a change to the well design o Change to casing depth that may impact well objectives o Unexpected change to the lithology that may impact the well objectives	• As above, plus • Land • D&W Manager • Subsurface Manager	• Asset Manager
4	**Critical changes with the potential to impact UON** At this level the change could impact DPNA UON Onshore. At Level 4, an MOC shall be written, appropriate impacts identified, and approvals received before activities proceed. **Examples:** o Unplanned expenditures in excess of Asset Manager's approval level	• As above, plus • Asset Manager	• Sr. VP – DPNA UON

3 Acronyms and definitions

Authority Matrix	A document showing four (4) levels of change based on project impact with the corresponding levels of approvals.
Management of Change (MOC)	Process to manage changes in an approved procedure and/or AFE
AFE	Approval For Expenditure

4 Example of Request form to be used

REQUEST FORM
U.S. ONSHORE D&W
MANAGEMENT OF CHANGE (MOC)

DATE: ______________________ ASSET: ______________________

PROJECT / WELL NAME: ______________________ MOC#: ______

AUTHORITY LEVEL: ______ ATTACHMENTS: ______________________

SECTION A – DESCRIPTION OF CHANGE
Describe the change in this section. Do not describe the reason for the change – refer to Section B.

SECTION B – REASON FOR CHANGE
List or discuss the factors that are making this change necessary.

SECTION C – EVALUATION SUMMARY
List and/or describe all issues considered during the process of evaluating this change. Include a list of the personnel involved in the discussions as well as meeting minutes. Attach a copy of the Risk Register in which this change was evaluated. Include an evaluation of the value vs. cost of the change.

SECTION D – RECOMMENDATION / FORWARD PLAN
Summarize the steps that are recommended, followed by the steps to be taken as a result of this change.

APPROVALS *(Review Authority Matrix of the Change Management WR to determine the required level of approval for the given Authority Level)*			
TITLE	SIGNATURE / DATE	TITLE	SIGNATURE / DATE
Drilling/Completion Engineer		Drilling/Completion Superintendent	
D&W Manager		Subsurface Manager	
Asset Manager		SVP DPNA	

Annex D.9
Procedure for Archaeological Findings

Table of contents

1 Introduction

This document covers the general archaeological protection measures that seismic and drilling crews and their contractors will put into effect while working for Statoil in the Timissit license and any neighbouring blocks.

2 Policy

All archaeological sites and material in the Statoil concessions must be protected. No archaeological material shall be removed. All contractors, sub-contractors and their personnel must be made aware of their obligation to protect existing and new archaeological findings.

3 Objectives

It is Statoil's Objective that:

- The "footprint" left in our work area is as small as reasonably practicable
- Any man-made or natural occurrence shall, wherever practicable, be left in its original condition without interference from working units
- All archaeological remains lying within Statoil's Concession area are recorded and photographed

4 Responsibilities

All Statoil employed staff, contractors and subcontractors are responsible for complying with this procedure which will be made known to them through training, HSE induction, written information, safety meetings and daily toolbox meetings

The Site/Party manager has the overall responsibility for all work relating to the protection of archaeological within the seismic survey area. He is responsible for ensuring that all crew members and subcontractors are aware of and understand the relevant parts of this procedure.

Statoil's License Manager will ensure that there is an adequate Audit and Review process in place to ensure that the Objectives are met.

5 Principles

The protection of archaeological remains in Algeria is controlled by law. The destruction, damage, distortion, interference or change of any archaeological object or artefacts is strictly prohibited.

No archaeological object, remain or artefact shall be removed unless authorized by the Authorities. Authorized personnel shall supervise if removal is requested.

All archaeological items lying on the proposed location of seismic lines, up-hole locations, detours, accesses or campsites must be documented and suitable measures for their protection established.

A scouting team will be used to carry out identification and documentation. In areas of known high archaeological sensitivity the team may include officials from Authorities. In areas of less sensitivity the scout team will comprise of suitably competent seismic crew members (surveyors).

All sites of high archaeological sensitivity shall be documented by photography before and after operations.

6 Archaeological Site Recognition

Almost any concentration of coarse material visible on the desert sand is likely to have been brought by humans and therefore likely to be archaeology.

Pastoral sites (ca 10,000-3,000 years old) are most characteristically found close to the base of sand dunes. The sites have stone tools (flints), flat grinding stone, rounded rubbing stones for grinding wheat and thick pottery shards. They generally lie along the edges of former lakes, traces of which can be seen in patches of whitish-grey silt and flat whitish crusts.

Palaeolithic sites (1 million-70,000 years old) are characterized by hand-axes, large blades, arrowheads and spearheads. These are also frequently found on the lower slopes of sand dunes.

There are occasional traces of later sites, particularly close to the edge of the sand sea. These are characterized by the presence of metal artefacts and wheel-made pottery, which is denser and much harder than prehistoric pottery.

A manual with drawings of typical Libyan archaeological items that are likely to be found in the survey area has been prepared and shall be available to the seismic crew and be used by the survey team leader to identify findings in the concession area.

All rock outcrops shall be regarded as potential archaeological sites.

7 Impacts

Two main types of potential impact are foreseen:

- Direct impact of vehicles and other activity associated with the seismic survey and drilling operations (civil work, camp sites, clearing of lines, up holes etc.)
- Indirect impact from “souvenir-hunting” by members of the crews, or by increased accessibility of areas of the desert to tourists.

8 Mitigation

Without the presence of trained archaeologists it is the responsibility of the surveyors to identify archaeological sites when setting out seismic lines and offsets. When identified within 50 m and within sight of the planned lines, the boundaries of the sites should be marked out to avoid vehicles in the area.

The scout (Survey) will define the prospect area into the following areas:

Risk Level	Contents
Critical	Ruins of significance (usually existing & known)
High	Significant graves, large dwelling places or camp sites, building outline, old forts, temples, rock carvings etc
Medium	Small grave areas, small areas of dwelling, chipping areas, fireplaces

The first approach adopted in all areas will be to reposition both the vibrator and geophone lines so that intrusion into areas of archaeology is avoided, or to utilise offsets, skips and detours. The following guidelines apply for the relevant areas:

Critical
To be completely avoided by machines and personnel, with an exclusion distance of 50m within which no personnel or machines shall enter.

High
Personnel can pass, but vehicles are prohibited. A safety margin of 50m around the area of interest must be established, into which no vehicles can enter. Movement of sand or gravel and burial of geophones are not allowed within this zone.

Medium
Shot and cable lines shall be detoured past the site so as to cause minimal impact, with a safety zone of at least 10m. Where necessary shots will be skipped and the vibrators detoured. Movement of sand or gravel and burial of geophones within the safety zone are not allowed.

9 Crew Procedure

Suspected archaeological objects identified by the scout team shall be reported to the Site manager, with copy to HSE manager and Client Representative. Information shall be reported according to the Archaeological Survey Pro Forma (see Appendix 1) and include:

- Co-ordinates
- Site type and materials observed; chipping site, camp site, grinding stones etc.
- Size – likely extent (e.g. 20 x 10m)
- Description
- Photo

If within 50 m and within sight of the line, the site shall be marked.

Any suspected archaeological object not already identified by the scout team but found by a crew member must be reported and left in situ until it can be inspected.

For any significant archaeological findings associated detours & routes will be illustrated on the survey maps and distributed to all section heads.

The managers will make known to all their personnel what procedures need to be followed for each archaeological site. This can be conveyed via the daily toolbox meeting.

All sites shall be photographed after completion of the lines, which may be combined with removal of pegs marking the lines.

10 Documentation and reporting

Documented evidence of all archaeological sites found to be placed in a spreadsheet (see Appendix 3). Documentation shall include

- Co-ordinates
- Risk Level (Medium, High, Critical)
- Site type and material
- Size – a real extent e.g. 20m x 10m
- Description
- Photograph; before and after the completion of the job

A hard copy of the form and photographs will be filed and archived on the crew. An electronic copy of the form and photographs will be forwarded to the Statoil Algeria, Alger office.
All significant archaeological findings (Critical & High Levels) shall be reported to Statoil Algeria, Alger office according to reporting matrix. Statoil Algeria will contact relevant Authorities.
All archaeological findings will be reported in the weekly report.

11 Audit and Review

Random checking of findings will be conducted to check whether any theft or vandalism occurs to the site whilst the crew is still in the vicinity. During training of the crew a formal inspection, using a standard checklist (see Appendix 4), will be conducted by a Statoil representative, ref *Annex D.5 Plan for Environmental information and awareness* and *Annex D.7 Environmental Audit plan*.

Appendices

Appendix 1 Archaeological survey pro forma

Site Details:	
Survey Area:	Date:
GPS Waypoint:	Altitude:
Project Reference (eg seismic line no.):	

Photographic Record:	
Photo No(s).:	
Direction of View:	

Site Description:

Site Type (tick box ☑):

Cairn	☐	"Fireplaces"	☐	Lithics Scatter	☐	Pottery Scatter	☐
Cave	☐	Funerary Monuments	☐	Mosque	☐	Qasr/Qsur	☐
Cemetery	☐	Industrial Site	☐	Occupation	☐	Rock Art	☐
Enclosed Settlement	☐	Inscription	☐	"Occupation?"	☐	Trapping Stone	☐
Foggara	☐	Lithic Artefact	☐	Other Structure	☐	Well	☐
Other (specify):							

Description (topographic location/level of preservation/site extent etc):

Materials (tick box ☑):

Pottery	☐	Stone tools/flakes	☐	Grinding stones	☐	Shell	☐
Animal bone	☐	Metal	☐	Glass	☐		
Other (specify):							

Appendix 2 Site categories

Site categories
Cairn, cairns: the commonest form of Saharan burial is the cairn – a structure of piled stone over the body. In some areas it is clear that cairns were raised for other purposes, for instance, as navigation markers. Groups of cairns should be recorded under the broad category of cemetery. See also cemetery and funerary monument.
Cave: the term relates to both caves and rock shelters.
Cemetery: Any group of burials or suspected burials, whether highly nucleated or quite.
Enclosed settlement: A few minor settlements were provided with perimeter walls, which need not have been defensive.
Foggara: Underground water channel and associated series of vertical shafts excavated during construction of the channel.
'Fireplaces': Small piles of burnt stones are believed to be the hearths or traces of cooking pits of long-vanished prehistoric campsites.
Funerary monument: Isolated examples of funerary structures, recorded separately from neighbouring cemeteries.
Industrial site: Site with evidence of intensive manufacturing activity. These sites are associated with metallurgical and non-metallurgical slags, the latter perhaps connected to salt production.
Inscription : Inscriptions of varying date and in various languages, sometimes cut on portable artefacts (grave stele), at others on the living rock. The Libyan texts span the ancient language of the Garamantes to the Tifinagh script of the Tuareg.
Lithic artefact/artefacts: One or two stone tools found in isolation from more general lithics scatter or débitage.
Lithics scatter: Points in the landscape where distinct concentrations of lithics (stone tools, cores, débitage, etc.) were noted. Important to differentiate between Palaeolithic and Neolithic scatters.
Mosque: this category encompasses both permanent mosques in settlements and vestigial outlines used as places of worship on the desert tracks.
Occupation: Such sites include those with amorphous scatters of artefacts (e.g. pottery sherds, grindstones, lithics, ostrich eggshell in various combinations) but lacking visible structural remains other than occasional fireplaces. These are primarily prehistoric habitation sites of the Pastoral phase and can be extensive, especially in vicinity of palaeolake shorelines.
'**Occupation?**': Where few of the material elements are present or the site appears very small in area the designation should be with a '?'
Other structure: a catch-all term for miscellaneous stone structures of uncertain type – they may relate to funerary features or to settlements. Define shape – e.g. linear, circular, etc.
Pottery scatter: Many pottery scatters indicate human habitation and may contribute to the interpretative categories of 'occupation?' or 'settlement?'. Occasionally dense concentrations of pottery sherds may be recorded in isolation from any other features and these should be noted as pottery scatters.
Qasr, ***Qsur***: these are fortified sites, varying in size from simple towers to substantial fortresses and dating from ancient to Islamic periods.
Rock art: This may include a range of pecked, ground or incised designs. Describe subject matter ('cattle, camel, etc.)
Settlement: Habitation sites defined by artefactual and architectural traces – most commonly the traces of stone or mudbrick buildings. The term is used for all sizes of site and all vernacular architecture spanning the ancient to modern periods
Trapping stone: Figure-of-eight shaped stones - relate to Pastoral phase hunting practices.
Well: Wells are a characteristic feature of a desert farming landscape and changes to the morphology and technology of wells are important markers of hydrological and social change.

Appendix 3 Listing of Findings

	UTM (WGS-84)							
Ref	Area	N	E	Risk Level	Type	Size	Description	Photo Ref

Appendix 4 Checklist for archaeological inspection

Checklist for Archeological Inspection					
	Rating G = Good, S= Satisfactory, U = Unsatisfactory	G	S	U	Notes
1	Staff, contractors and subcontractors aware of archeological procedure.				
2	Client representatives and the seismic and drilling crew management are working together				
3	Seismic Crew Manager aware he is responsible for all crew work related to archeological protection				
5	Provisional classification of the survey area agreed between crew & Statoil?				
6	Scouting team utilized to check for archeology?				
7	Is the Scouting team leader aware of & understanding his responsibilities				
8	In areas of known Archeology are:				
	Lines reprogrammed where necessary				
	When archeologically sensitive areas need to be entered is it in line with the procedures?				
9	Documentation				
	Is a "Findings" Spreadsheet being compiled?				
	Are the necessary photographs being taken?				
10	Are findings reported to Statoil as required?				