ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR KODAP OIL STRATEGIC RESERVES DEPOT AT VASILIKOS, LARNACA

OCTOBER 2016

Non-Technical Executive Summary

Contents

1 INTRODUCTION

KODAP is the Cyprus Organisation for Storage and Management of Oil Stocks and is a public body establish by law. As per European Union Directives, KODAP has to maintain and administrate minimum strategic fuel reserves equal to at least 90 days consumption and under the EU accession agreement Cyprus has committed to maintain 60 days fuel reserves up to the end of 2007 and 90 days reserves thereafter.

Aeoliki Consulting was commissioned by KODAP to undertake an Environmental Impact Assessment (EIA) of the proposed Project. The EIA presents the findings of the impact assessment and identifies mitigation measures that will be implemented to address significant (adverse) impacts.

This Non-Technical Executive Summary (NTES) provides an overview of the findings of the EIA process as presented in full in the Environmental Study. The NTES has been prepared for a general audience including parties close to or potentially affected by the project.

2 OBJECTIVES

The main objective of the Environmental Impact Assessment is to evaluate the environmental impact of the construction and operation of the new KODAP Tank Farm in the area of Vasilikos and addresses the following aspects:

- public health;
- amenities of inhabitants and users of the affected area;
- the degree of influence;
- suggestions for avoidance;
- minimization;
- reclamation or replenishment of the negative impacts;
- the impacts which are not confronted and their degree of minimization.

3 FUEL FARM BASIC DATA

The construction of a new complex of fuel storage tanks (Fuel Farm) is currently under development. The new Fuel Farm will be situated on the north/east of the Vasilikos Cement Company, and it will consist of the following:

- 11 (above ground) tanks;

- product pumping and filtering station with manifolds;
- fire water tank (4,000 m^3),
- set of 3 product lines (about 1 km long) connecting the terminal with the import lines from Vasilikos Port and the storage terminals of other oil companies in the area;
- transfer-pipeline receiving station;
- intake pipeline from the sea/ port (some 1.5km long) complete with its own pumping station by the sea/ port;
- mobile truck loading system;
- office block;
- guard house;
- fire / foam pumping station;
- technical building including power transforming station;
- high security fence complete with truck entrance / exit gates and emergency exits;
- road network and walkways;
- parking lots;
- associated lighting and closed circuit television (CCTV)

The erection of the tanks is anticipated to be carried out in phases according to the storage requirements of KODAP.

Four (4) tanks of CLASS A (Mogas) products, and seven (7) tanks of CLASS B (Jet fuel, and Diesel) products will be erected, of total storage capacity of approximately 430,000 m^3. The tank sizes are identical and are of 45m in diameter and 22m height. During this phase an Administration Building, filling pipelines, a Fire pump house and Fire Fighting Storage Tank and all other infrastructure will be constructed.

Table 1 below indicates the tanks sizes and volumes.

Table 1: Tankages and fuel quantities

TANKS	DIA. (m)	HEIGHT (m)	TANK VOL. (m^3)	ROOF	FUEL	Total Vol. (m^3)
Tk1-Tk4	45	22	43,000	Internal Float. Roof	CLASS A	172,000
Tk5-Tk11	45	22	43,000	Fixed Roof	CLASS B	258,000
					TOTAL	**430,000**

4 PROJECT DESCRIPTION

The proposed plot of land to be developed is located on the north-west side of Vasilikos Cement Factory in the south coast of Cyprus approximately 25 km to the east of Limassol and 30 km to the South-west of Larnaka.

The boundaries of this area run along Vasilopotamos river to the West and follow the existing road towards the North. Its west boundary runs parallel the existing Vasilikos road. To the South there is a common boundary with Vasilikos Cement Works plant and a small agricultural property.

At short distance there are a number of fuel tanks owned by VTTV and Petrolina companies to the south-west. The nearest residential development is Mari Village 1.7 km northwest of the site.

The area surrounding the proposed location for the construction of the fuel farm is characterised by industrial development along its east, west and south boundary. Finally, a pumping station of South Stream is located to the south of the study area.

5 BIOPHYSICAL and SOCIO-ECONOMIC BASELINE

5.1 Key Biophysical Baseline Aspects

Climate: Vassilikos area has a Mediterranean climate and receives approximately 390mm of rain per year. The rainfall values for Vassilikos per month are lowest in July (0mm) and highest in December (108mm). The monthly distribution of average daily maximum temperatures shows that the average midday temperatures for Vassilikos area range from 40°C in June to 1°C in February. The data show that the most predominant wind in the area is from the south easterly direction. The second predominant wind is from the southwest-to-northwest direction.

Air Quality: The industrial air quality monitoring station, located at Zygi village, Larnaca, which is less that 1km away from the site, records pollutant levels as a result of the industrial activity in the greater Vasilikos area (EAC power stations, VCW plant etc). The station has been placed downwind of these sources in the nearest residential area. Background atmospheric pollution levels in the Vassilikos Bay area record short term peak pollution levels caused from the nearby industrial activities (Vassilikos Power Station, Vassilikos Cement Works). In broad terms, the monitoring programme indicated that for most of the time, concentrations of pollutants are low, approaching the natural background levels, and well within the EU Limit Values. However, peak concentrations are higher and this is an indicator of dominant industrial sources.

Topography: The site is situated at the southwestern edge of the Vassilikos river catchment area, approximately 400 m east of the river estuary. The Vassilikos river catchment has a surface area of 150.67 km^2. The site has a total area of about 80,000 m^2 on a raised marine terrace of average ground elevation of 30 m AMSL. The ground at the site has a gentle inclination to the SE with the higher grounds (nearly 50 m AMSL) to the NW and the lower grounds (nearly 15 m AMSL) to the SE. The marine terrace is terminated abruptly to the SSW by a very steep cliff that dominates over the flat sub recent coastal plain. The cliff represents a Holocene coastal cliff and its development is associated with tectonic movements that elevated the marine terrace to its present level. The western boundary of the site coincides with a small orientated tributary valley of the Vassilikos River. This small valley is currently filled with extensive stockpiles of chalk and marl and some umber piles, which are the raw material for the nearby cement factory. To the west of the site, at a distance of about 500 m there is the water divide marking the boundary of the broader Vassilikos river catchment area.

Geology: Memoir 5 of the Geological Survey Department of Cyprus (GSD) (covering the Pano Lefkara-Larnaca area) shows the site is located in a region where the dominant geological features are a series of 60 to 600 m high hills, primarily derived from rocks of the Upper Cretaceous to Pliocene period, and the more recent coastal plain, which is derived from the littoral belt of the Pleistocene period.

Seismicity: Cyprus is separated in five areas based on the seismic intensities expected in each region. For each area, the limits of calculation for the largest acceleration of ground Amax are given in the following **Table 2** as percentage of acceleration of gravity (g).

Table 2: Largest acceleration of ground per area

Area	Amax (g)
I,II,III	0.075
IV	0.10
V	0.15

The new Fuel Farm is situated in an Area [III] region, and consequently, all construction works have to comply with the relevant provisions of the local legislation.

Soil and Geotechnical: Two separate geotechnical surveys were carried out in the area of interest, the first being in November 2015 and the second one was commissioned in June 2016. Both studies showed that the plots west of Vasilikos River bed do not appear to present important geological problems that prevent the implementation of the project.The whole area shows a low relief on the north half about to be significantly higher than the southern part. The average altitude of the northern part is located at 23 meters from the surface of the sea while the south part at 7 meters. Both parts are separated by a relatively sudden slope altitude of 20 to 10 meters. Likely during the construction phase of the project, it will be necessary for some earthmoving (shallow excavation and earth-moving) to be formed flat surfaces. In this case, most of the excavated material can be used for backfill. This shallow excavation material could be used for possible formation of green areas. In the study area there is also a geological and geotechnical uniformity in the subsoil up to the depth of 11 meters. Undoubtedly, before the final design of the foundation of the tanks should be a thorough investigation of each tank, the extent of which depends on the size and the load which will bring.

Contaminated Site Study: A short site reconnaissance visit was conducted on September 12th, 2016 to source onsite information. Visual observations with regards to soil staining and the presence of nearby potential contaminant sources and underground services were recorded and used to assist in streamlining and focusing the subsurface soil investigation. From the on site investigation, the soil of the two plots where the fuel farm will be erected, do not show historical contamination that prevent the implementation of the project. An intrusive assessment consisted of trial pitting and soil sampling was followed in October 2016. Four trial pits distributed across the site were excavated by the Geology Department, and soil samples taken and submitted to a certified laboratory for analyses. Samples were analysed for nine (9) metals and petroleum hydrocarbons (GRO, DRO). Concentrations of individual metals vary do not vary considerably, up to a factor of 2 between trial pits. This small variability is most likely due to nature of the site, being agricultural land without previous known industrial activities. All metal concentrations in the soil are significantly below the action value, indicating no significant health risk. The metals concentrations provide a baseline against which to compare future values in order to assess the potential impacts of the proposed fuel storage facility on the site. Concentrations of total petroleum hydrocarbons (TPH) in the C6 – C10 range (i.e. the volatile TPH range) were below detection for all trial pits. Concentrations of TPH in the C10 – C40 range were below the laboratory detection limit for the majority of the determinants in the 4 trial pits sampled, and between 1 and 3 mg/kg dm for C16 – C21, 2 and 130 mg/kg dm for C21 – C35 and 1 and 14 mg/kg dm for C21 – C35. The detected concentrations were all below the adopted screening values.

Resilience of facility to flooding, rising sea water: Mean sea level trends reported by NOAA for the Mediterranean indicate a rise of 1.15 millimeters/year with a 95% confidence interval of +/- 0.22 mm/yr based on monthly mean sea level data from 1905 to 2001 which is equivalent to a change of 0.38 feet in 100 years. A prospective study (Marcos et al. “Comparison of results of AOGCMs in the Mediterranean Sea during the 21st century”, Journal of Geophysical Research; 113 (c12): C12028 DOI: 10.1029/2008JC004820(2008) of the Mediterranean Sea level rise based on several scenario models for climate change, indicate that the level of the whole Mediterranean sea can rise by between 3cm and 61cm on average over the 21st century as a result of the effects of warming. The lowest site ground level is approx. 13 m above sea level so no flooding impacts are expected in the event of rising sea water as a result of the effects of global warming. At a distance of approx. 30 m to the West, runs Vasilikos river. The buffer zone between the project west boundary and the river bed of Vassilikos rives, as well as the 3 m high walls of the bund area, are considered sufficient to protect the facility from any flooding event.

5.2 Key Socio-economic Baseline Aspects

Administrative Structure: The study area falls under the framework of the Policy Declaration, which is applicable to all rural areas in Cyprus. The Policy Declaration provides for an integrated development framework of the rural areas (which are not covered by the General Development Plans), aiming at the optimum utilization of the development potential of each region. The location of the KODAP fuel farm is within the boundaries of B2 industrial zone.

Population Size and Growth: There are two small communities (villages) in the vicinity of the proposed installation, with a total population of 747 inhabitants. Of these, the Mari village (with a population of 158) is situated approximately 2 km to the north west of the boundary of the proposed installation and Zygi, approximately 2.5 km to the east, with a population of 589 residents, according to the inventory of population 2011. Zygi village is located just to the east of the Study Area and is mainly used for tourism and fishing activities

Vassilikos area developments: Vasilikos area is designated as heavy duty industrial area. It used to be one of the main Hellenic Mining Company mineral processing complexes for copper and iron ore. Since the early seventies, industries such as Vasilikos Cement Works (VCW), Vasilikos port (currently jointly operated by VCW and Cyprus Port Authority) and Cyprus Chemical Fertilisers Industries (CCFI) were established and operated in that area. Additional industrial units and facilities were commissioned in the area during the 1990’s, Vasilikos power stations by Electricity Authority of Cyprus (EAC) which is the biggest power plant of Cyprus; and other small scale units. Vasilikos is also the designated area for the relocation of petroleum storage facilities currently operating at Larnaca bay. After the decommissioning and dismantling of the CCFI plant, an area of approximately 1,000,000 m^2 is designated for future use as the Vasilikos Energy Centre (VEC), a project initiated by the Department of Energy where a large scale project that will include the strategic fuel stocks for the Republic, a Liquid Natural Gas storage and regasification facility as well as petroleum products storage and truck loading facilities for the local market will be implemented. The Vasilikos industrial area is classified as Heavy Industrial Zone B2. Power plants and industrial complexes are already operating in the area. A number of large scale projects were also announced and/or are currently at the conceptual/ basic design phase. There are currently four marine/naval facilities operating in the area, namely the Vasilikos port, an industrial import/export port, the Archirodon port where barges, floating machinery and fishing boats are stationed, the Zygi fishing shelter where local fishermen boats are berthed, and the 'Evangelos Florakis' base, a military naval installation. Vasilikos area may be considered as the heart of the energy and heavy industry of the island. There are numerous, vital energy and industrial complexes in the area and the area may be described as heavily burdened, in environmental terms. The existing planning zone (B2 – Heavy Industry Zone) justifies the area as the most suitable for this type of development.

Traffic: The proposed facility construction site is situated approximately 4 km from A1 motorway. Access to the site is easy, as it follows the existing route on E107 to Vasilikos Cement Works plant. The exit point at the highway is at relatively short distance to major towns of the island i.e. 25 km to Limassol, 30 km to Larnaca and 40 km to Nicosia. Existing road network currently services heavy truck and vehicles traffic to and from the cement works plant and petroleum storage installations in the area and connects with major towns and product destinations.

6 ENVIRONMETAL STATEMENT STRUCTURE

The present Environmental Statement Structure comprises of the flowing sections:

- Introduction

Provides basic information on the under design fuel farm.

- Project Description

This section describes the specific elements of the tank farm development project, including the design, construction and operation of facilities.

- Environmental and Socio-Economic Baseline

In this chapter the existing natural and socio-economic environment at the vicinity of the plots on which the FF will be constructed is described.

- Impacts and Mitigation Management

This section identifies whereas the construction and operational activities interact with the natural and socio economic environments. In addition it discusses the probability of occurrence and consequence of potential environment and social impacts that may arise during construction and operation. At the end it delineates the measures for control and mitigation of impacts.

- Health & Safety Management
- Environmental Management Plan

7 THE EIA PROCESS

The typical EIA process incorporates a number of key steps, which together constitute a systematic approach to the evaluation of a project in the context of its natural (biological and physical), legal and socio-economic environments. The objectives of the EIA process are to:

- Support the goals of environmental management and sustainable development;
- Integrate environmental management and economic decisions at the earliest stages of planning an undertaking or programme of investment;
- Predict the consequences of a proposed undertaking from the environmental, social, economic and cultural perspectives and to develop plans to mitigate any adverse impacts; and
- Consult with Cypriot authorities (national, regional and local) at an early stage of the EIA process.

The EIA has considered the likely impact of the proposed KODAP tank farm works on the local natural and physical environment, local and regional economy and wider project area. Beneficial and adverse, short term and long term impacts have been considered. Where mitigation measures have been identified to either eliminate or reduce potentially adverse impacts, these have been incorporated into the project design. In the cases where no mitigation measures have been identified, the ES has identified the "residual" impact and its significance.

The significance of impacts has been evaluated with reference to definitive standards, accepted criteria and legislation where available. Where it has not been possible to quantify impacts, qualitative assessments have been carried out, based on professional experience and judgement. Residual impacts have been classified according to their severity and probability of occurrence. Where possible, impacts have also been assigned a geographic scale and duration (e.g. temporary, short-term, long-term, regional, transboundary).

8 ENVIRONMENTAL IMPACTS

The significance of impacts which are associated with the construction and operation of the tank farm depends on the size and location of the project and the severity and probability of occurrence of the impact.

Impacts on Soil

The proposed construction and operation will not have impacts on soils and the changes in the geology and the topography of the area are negligible. The impacts on soils during the construction process are restricted to that from the generation of non-hazardous wastes (construction waste, litter from packaging of equipment), and in a lower degree from hazardous solid waste (chemist containers storage, lubricant, fuels etc), liquid chemical wastes and accidental fuel leakages from the operation and the maintenance of vehicles and equipment used during the construction process.

Operational impacts on soil are likely to be restricted to risks of spills of stored materials leading to contamination of site soils and potentially perched groundwater. This risk will be minimised through the use of protection measures such as lined bunds and coalescence separator, as well as the implementation of formal spill response planning. Given the implementation of such systems overall impacts are expected to be of only minor adverse significance.

Impacts on air quality

During the construction phase, the fuel farm has the potential to generate adverse, but temporary, impacts on local air quality as a result of construction traffic exhaust emissions, and also nuisance dust from construction activities.

Emission of combustion products will occur due to fuel combustion associated with construction machinery and equipment and vehicle use.

During the construction period dust emissions are expected to occur. Specifically, main sources of dust will include:

- Excavations;
- Transport and provisional deposition of materials.

The areas which will be affected by the construction and operation of the tank farm are industrial areas. However, the impacts by creation dusts will be negligible by virtue of volume of earthworks.

The overall assessment conclusion is that, with the application of best practicable means, during construction phase, adverse impacts due to construction dust or nuisance effects are unlikely to occur.

During the operation phase, the fuel farm has the potential to affect both local and regional pollution as a result of emissions to air from a variety of stationary and mobile sources including tank losses, and diesel engines. The potential contribution of the fuel farm to pollutant emissions has been assessed quantitatively, and their impact on local air quality has been assessed using computerised modelling.

A quantitative assessment of the impacts of VOC emissions from the storage and loading operations at the fuel farm has been undertaken. The assessment has considered the magnitude of potential losses from storage tanks through breathing losses, working losses and fittings losses, and also the losses expected from the transfer of products to mobile containers.

The assessment, based on conservative estimates of the impact of emissions from the site, has concluded that, as a worst case, the impact of the fuel farm on air quality is likely to be of minor significance.

Impacts on surface and ground water

During the construction phase, the primary potential source of contamination that could pollute surface water drainage is spills of oils, fuels and / or other hazardous chemicals. Such spills, if not properly contained and cleaned-up may also impact groundwater resources. During the construction programme, KODAP will implement an Erosion and Sediment Control Plan that will reduce the potential for adverse impacts to water quality associated with mobilised sediments and wind blown dust.

Once operational, the fuel farm will be equipped with a storm water system that will collect surface water run-off. Surface water runoff and stormwater will be subject to a high level of treatment (oil interceptors and retention pond) before being discharged to the Vasilikos River and furthermore to the sea. Discharges from the fuel farm and from the car park will be regularly sampled and analysed for particulates, metals, hydrocarbons and potentially, salts and nutrients.

It is not anticipated that the site will generate any continuous process wastewater. Principal wastewater discharges will be from drainage and surface water runoff. To reduce the possibility of contamination of surface waters and consequences, mitigation measures will be required (use of oil interceptors, impermeable bunds at fuel tanks area).

Overall, construction and operation of the project will need to be subject to standard management practices to avoid and reduce any impacts of construction on the receiving environment.

Impacts on terrestrial ecology

Given the low ecological sensitivity of the neighbouring site and the industrial character of the project area, the overall ecological impacts on habitats, flora and fauna are considered to be of only low or negligible significance.

Noise emissions

Construction activity inevitably leads to temporary noise generation at locations in close proximity to the construction activities. However, due to the characteristics of the wide area (industrial zone), the typical distances between the proposed site and the nearest receptors, and significant acoustic screening in all directions, the impact of construction activity on sensitive receptors will be minimal.

During the construction works noise pollution in project area is expected to grow substantially while in nearby areas the levels of noise pollution will increase. The area which is near the roads will be used more by heavy vehicles.

Some construction activities can be a source of ground-borne vibration, which can be a cause for concern at the nearest receptors. Typical activities that would lead to vibration effects include compaction, breaking and piling. During piling activities, the maximum level of vibration expected at a distance of perhaps around 100 m from a drop hammer piling rig could be in the range of 2-3 m.

The impact at the nearest properties from any vibration activities is a function of the vibration source and the propagation path to the receptor; larger distances reduce the impact. Due to the large distances involved, construction vibration will not be discernible at the receptor locations. The impact of construction vibration will therefore be negligible.

During the operation of the tank farm noise disturbance will be caused mainly due to the operation of hydraulic devices (various types of fuel pumps). During the operation phase the noise impact is expected to be negligible.

Sources of vibration on site are minimal. Vibration may be transmitted to the floor from balanced rotating equipment such as pumps; however, the level of induced vibration will not be sufficient to propagate to the nearest sensitive receptors over the distances involved. Hence the impact of operational vibration will not be of significance.

The noise and vibration impacts during operation are predicted using a computer noise model, using typical values for the proposed tank farm, and considering directional and screening effects.

Impacts on land use

KODAP tank farm will be installed in an industrial zone (Vasilikos industrial zone) so no impacts on land uses are expected during the construction and operation of the project.

Impacts on inhabitants of the area

No negative impacts on the local inhabitants are expected.

Impacts on traffic

The construction programme will generate short-term increases in all types of vehicle movement along the local and national road networks in the vicinity of the site due to the movement of construction material and personnel. For this reason, a

Construction Traffic Management Plan should be developed and implemented by the construction contractor.

The construction activities tank farm will have a significant effect upon traffic in the local Vasilikos area resulting in a significant increase in traffic through Zygi village and along the old B1 Limassol to Nicosia Road. The effects of this increased traffic, however, will have a low impact once the trucks reach the A1 Limassol to Nicosia Highway, given the capacity of this road.

During the operation of the tank farm no impacts on traffic are anticipated.

Impacts on public health and safety of the area

The new KODAP Fuel Farm (FF) will have a number of health and safety hazards associated with its construction and operation phases. In **Chapter 6,** an evaluation has been made of the potential key occupational health and safety hazards and proposed risk mitigation measures related to dangerous substances and other agents at the site, during the construction and operation phases of the FF.

The owner of the project will have to contact the Department of Labour Inspection in order to confirm whether health and safety plans and management systems for the construction phase will be required as per EU Directive 89/391.

Risk mitigation measures for dangerous substances have to be adopted at the Fuel Farm. These measures will be associated with the good engineering design of the facility, with design criteria meeting international standards and codes. Good design, together with cognisance to the findings of the quantitative risk assessment, should insure that exposure to large quantities of dangerous substances are avoided.

For inadvertent exposures to dangerous substances, appropriate exposure control measures should be adopted using the hierarchy of controls, namely, elimination, substitution, engineering controls, administrative controls, and, in the last resort, personal protective equipment. Appropriate risk assessments should be conducted, procedures adopted and personnel training carried out, to ensure that all exposures to dangerous substances are minimised.

In addition to the hazards of dangerous substances at the FF site, hazards to the occupational health and safety of site workers from other agents should also be considered. Such agents, which may be present during the construction and/or operational phases include dust, noise, vibration, electrical, ionising & non-ionising radiation, thermal stress, lifting equipment, pressurised equipment, slips, trips & falls, as well as general workplace conditions.

Impacts on aesthetic value

During the construction phase solid waste will be generated. If such waste is not managed, aesthetic pollution around the area will be impacted. The aesthetic pollution is considered a short-term impact.

The providences that are taking into account, the characteristics of the wide area (industrial zone) with regard to the architectural planning lead to the conclusion that the aesthetic pollution that potentially results from the construction of the KODAP tank farm will be negligible.

Note that the cumulative effects on landscape and visual have been assessed in conjunction with other projects in the area, such as the Vasilikos Cement Works facilities.

Cumulative impacts

The additional of the oil and fuel storage and distribution facility along with existing and possible future activities within the Vasilikos area, are unlikely to have significant cumulative impacts that warrant additional mitigation measures.

9 RECOMMENDATIONS

The implementation of the mitigation measures detailed in **Chapter 7** of the EIA study and listed in the Environmental Management Programme (EMPr) of the EIA study, including monitoring, will provide a basis for ensuring that the potential positive and negative impacts associated with the establishment of the development are enhanced and mitigated to a level which is deemed adequate for the development to proceed.

In summary, based on the findings of this assessment, AEOLIKI finds no reason why the facility proposed for the site should not be authorised, contingent on the mitigations and monitoring for potential environmental and socio- economic impacts as outlined in the AEOLIKI and EMPr being implemented.

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Chapter 1

Introduction

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1 INTRODUCTION

1.1 Name of the project

KODAP is the Cyprus Organisation for Storage and Management of Oil Stocks and is a public body establish by law. As per European Union Directives, KODAP has to maintain and administrate minimum strategic fuel reserves equal to at least 90 days consumption and under the EU accession agreement Cyprus has committed to maintain 60 days fuel reserves up to the end of 2007 and 90 days reserves thereafter.

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1.2 Objectives

The main objective of the Environmental Impact Assessment is to evaluate the environmental impact of the construction and operation of the new KODAP Tank Farm in the area of Vasilikos and addresses the following aspects:

- public health;
- amenities of inhabitants and users of the affected area;
- the degree of influence;
- suggestions for avoidance;
- minimization;
- reclamation or replenishment of the negative impacts;
- the impacts which are not confronted and their degree of minimization.

1.3 Fuel Farm basic data

The construction of a new complex of fuel storage tanks (Fuel Farm) is currently under development. The new Fuel Farm will be situated on the north/east of the Vasilikos Cement Company, and it will consist of the following:

- 10 oil storage tanks (50m in diameter, 22m in height);
- 1 water tank for firefighting purposes;
- 1 product pumping station;
- 1 fire-fighting pumping station;
- 1 administration building;
- 1 intake pipeline from the sea/ port (some 1.5km long) complete with its own pumping station by the sea/ port;
- A set of [3] product lines (about 1km long) which will connect the terminal with the import lines from Vasilikos Port and the storage terminals of other oil companies in the area

1.4 Environmental Statement Structure

The present Environmental Statement Structure comprises of the flowing sections:

- Introduction

Provides basic information on the under design fuel farm.

- Project Description

This section describes the specific elements of the tank farm development project, including the design, construction and operation of facilities.

- Environmental and Socio-Economic Baseline

In this chapter the existing natural and socio-economic environment at the vicinity of the plots on which the FF will be constructed is described.

- Impacts and Mitigation Management

This section identifies whereas the construction and operational activities interact with the natural and socio economic environments. In addition it discusses the probability of occurrence and consequence of potential environment and social impacts that may arise during construction and operation. At the end it delineates the measures for control and mitigation of impacts.

- Health & Safety Management
- Environmental Management Plan

1.5 The EIA Process

The typical EIA process incorporates a number of key steps, which together constitute a systematic approach to the evaluation of a project in the context of its natural (biological and physical), legal and socio-economic environments. The objectives of the EIA process are to:

- Support the goals of environmental management and sustainable development;
- Integrate environmental management and economic decisions at the earliest stages of planning an undertaking or programme of investment;
- Predict the consequences of a proposed undertaking from the environmental, social, economic and cultural perspectives and to develop plans to mitigate any adverse impacts; and
- Consult with Cypriot authorities (national, regional and local) at an early stage of the EIA process.

The EIA has considered the likely impact of the proposed KODAP tank farm works on the local natural and physical environment, local and regional economy and wider project area. Beneficial and adverse, short term and long term impacts have been considered. Where mitigation measures have been identified to either eliminate or reduce potentially adverse impacts, these have been incorporated into the project design. In the cases where no mitigation measures have been identified, the ES has identified the “residual” impact and its significance.

The significance of impacts has been evaluated with reference to definitive standards, accepted criteria and legislation where available. Where it has not been possible to quantify impacts, qualitative assessments have been carried out, based on professional experience and judgement. Residual impacts have been classified according to their severity and probability of occurrence. Where possible, impacts have also been assigned a geographic scale and duration (e.g. temporary, short-term, long-term, regional, transboundary).

1.6 Environmental Impacts

The significance of impacts which are associated with the construction and operation of the tank farm depends on the size and location of the project and the severity and probability of occurrence of the impact.

1.6.1. Impacts on Soil

The proposed construction and operation will not have impacts on soils and the changes in the geology and the topography of the area are negligible. The impacts on soils during the construction process are restricted to that from the generation of non-hazardous wastes (construction waste, litter from packaging of equipment), and in a lower degree from hazardous solid waste (chemist containers storage, lubricant, fuels etc), liquid chemical wastes and accidental fuel leakages from the operation and the maintenance of vehicles and equipment used during the construction process.

Operational impacts on soil are likely to be restricted to risks of spills of stored materials leading to contamination of site soils and potentially perched groundwater. This risk will be minimised through the use of protection measures such as lined bunds and coalescence separator, as well as the implementation of formal spill response planning. Given the implementation of such systems overall impacts are expected to be of only minor adverse significance.

1.Soils: The proposed tank farm will cause:	**Yes**	**Maybe**	**No**
a) Changes of soil formation and geological arrangement	....	....	X
b) Cleavage, movement, compression or coverage soil	X	....	....
c) Changes in topography or in specific surface soil characteristics	X	....	....
d) Destruction, overlap, change geological or natural characteristics	......	....	X
e) Erosion in soil by wind or water, in place or place in distance	....	X	....
f) Changes in disposal or erosion	......	X	....
g) Danger of human exposure and characteristics in geological disasters	....	....	X

1.6.2. Impacts on air quality

During the construction phase, the fuel farm has the potential to generate adverse, but temporary, impacts on local air quality as a result of construction traffic exhaust emissions, and also nuisance dust from construction activities.

Combustion emissions

Emission of combustion products will occur due to fuel combustion associated with construction machinery and equipment and vehicle use.

Dust emissions

During the construction period dust emissions are expected to occur. Specifically, main sources of dust will include:

- Excavations;
- Transport and provisional deposition of materials.

The areas which will be affected by the construction and operation of the tank farm are industrial areas. However, the impacts by creation dusts will be negligible by virtue of volume of earthworks.

The overall assessment conclusion is that, with the application of best practicable means, during construction phase, adverse impacts due to construction dust or nuisance effects are unlikely to occur.

During the operation phase, the fuel farm has the potential to affect both local and regional pollution as a result of emissions to air from a variety of stationary and mobile sources including tank losses, and diesel engines. The potential contribution of the fuel farm to pollutant emissions has been assessed quantitatively, and their impact on local air quality has been assessed using computerised modelling.

A quantitative assessment of the impacts of VOC emissions from the storage and loading operations at the fuel farm has been undertaken. The assessment has considered the magnitude of potential losses from storage tanks through breathing losses, working losses and fittings losses, and also the losses expected from the transfer of products to mobile containers.

The assessment, based on conservative estimates of the impact of emissions from the site, has concluded that, as a worst case, the impact of the fuel farm on air quality is likely to be of minor significance.

2. Air: The proposed tank farm will cause:	**Yes**	**Maybe**	**No**
a) Emissions in atmosphere or deterioration of air quality	....	....	X
b) Odours	X	....	....
c) Change in the circulation of the wind, humidity or the temperature or any change in the climate, locally or on a more extended basis	....	....	X

1.6.3. Impacts on surface and ground water

During the construction phase, the primary potential source of contamination that could pollute surface water drainage is spills of oils, fuels and / or other hazardous chemicals. Such spills, if not properly contained and cleaned-up may also impact groundwater resources. During the construction programme, KODAP will implement an Erosion and Sediment Control Plan that will reduce the potential for adverse impacts to water quality associated with mobilised sediments and wind blown dust.

Once operational, the fuel farm will be equipped with a storm water system that will collect surface water run-off. Surface water runoff and stormwater will be subject to a high level of treatment (oil interceptors and retention pond) before being discharged to the Vasilikos River and furthermore to the sea. Discharges from the fuel farm and from the car park will be regularly sampled and analysed for particulates, metals, hydrocarbons and potentially, salts and nutrients.

It is not anticipated that the site will generate any continuous process wastewater. Principal wastewater discharges will be from drainage and surface water runoff. To reduce the possibility of contamination of surface waters and consequences, mitigation measures will be required (use of oil interceptors, impermeable bunds at fuel tanks area).

Overall, construction and operation of the project will need to be subject to standard management practices to avoid and reduce any impacts of construction on the receiving environment.

3. Water: The proposed tank farm will cause:	**Yes**	**Maybe**	**No**
a) Change in flows and direction of surface water	…….	…….	X
b) Change in absorption, drainage or flush of the soil	…….	…….	X
c) Change of water flow in the case of flooding	…….	…….	X
d) Change of the quality of surface water of aquatic ecosystems	…….	…….	X
e) Wastewater disposal in surface or ground water bodies and water quality changes	…….	…….	X
f) Change of groundwater flow	…….	…….	X
g) Change of the groundwater quality	…….	…….	X
h) Minimization of water quantity supplied to users	…….	…….	X
i) Human health and/or private properties which are in danger from natural disasters (e.g. floods).	…….	…….	X

1.6.4. Impacts on flora

Given the low ecological sensitivity of the neighbouring site and the industrial character of the project area, the overall ecological impacts on habitats, flora and fauna are considered to be of only low or negligible significance.

4. Flora: The proposed tank farm will cause:	Yes	Maybe	No
a) Change on the biodiversity	…….	…….	X
b) Decrease the numbers of rare and endangered flora species	…….	…….	X
c) Induction of new intrusive species in the area or blockage of renewal of existing local species	…….	…….	X
d) Decrease the amplitude of agricultural area	…….	…….	X

1.6.5. Impacts on fauna

Given the low ecological sensitivity of the neighbouring site and the industrial character of the project area, the overall ecological impacts on habitats, flora and fauna are considered to be of only low or negligible significance.

5. Fauna: The proposed tank farm will cause:	Yes	Maybe	No
a) Changes on biodiversity	…….	…….	X
b) Decrease the numbers of unique, rare and endangered species	…….	…….	X
c) Induction of new intrusive species in the area or blockage of emigration and movement of animals	…….	…….	X
d) Worsening of the local natural environment of wild animals	…….	…….	X

1.6.6. Noise emissions

Construction activity inevitably leads to temporary noise generation at locations in close proximity to the construction activities. However, due to the characteristics of the wide area (industrial zone), the typical distances between the proposed site and the nearest receptors, and significant acoustic screening in all directions, the impact of construction activity on sensitive receptors will be minimal.

During the construction works noise pollution in project area is expected to grow substantially while in nearby areas the levels of noise pollution will increase. The area which is near the roads will be used more by heavy vehicles.

Some construction activities can be a source of ground-borne vibration, which can be a cause for concern at the nearest receptors. Typical activities that would lead to vibration effects include compaction, breaking and piling. During piling activities, the maximum level of vibration expected at a distance of perhaps around 100 m from a drop hammer piling rig could be in the range of 2-3 m.

The impact at the nearest properties from any vibration activities is a function of the vibration source and the propagation path to the receptor; larger distances reduce the impact. Due to the large distances involved, construction vibration will not be discernible at the receptor locations. The impact of construction vibration will therefore be negligible.

During the operation of the tank farm noise disturbance will be caused mainly due to the operation of hydraulic devices (various types of fuel pumps). During the operation phase the noise impact is expected to be negligible.

Sources of vibration on site are minimal. Vibration may be transmitted to the floor from balanced rotating equipment such as pumps; however, the level of induced vibration will not be sufficient to propagate to the nearest sensitive receptors over the distances involved. Hence the impact of operational vibration will not be of significance.

The noise and vibration impacts during operation are predicted using a computer noise model, using typical values for the proposed tank farm, and considering directional and screening effects.

6. Noise: The proposed tank farm will cause:	**Yes**	**Maybe**	**No**
a) Increase local noise pollution	X	....	....
b) Human exposure to high noise pollution	....	X	....

1.6.7. Impacts on land use

KODAP tank farm will be installed in an industrial zone (Vasilikos industrial zone) so no impacts on land uses are expected during the construction and operation of the project.

7. Land uses: the proposed tank farm will cause:	**Yes**	**Maybe**	**No**
Changes in the prospective land use	....	....	X

1.6.8. Impacts on inhabitants of the area

No negative impacts on the local inhabitants are expected.

8. Population: the proposed tank farm will cause:	Yes	Maybe	No
Change on the installation, dispersal, density or increased rate of population in the area	…….	…….	X

1.6.9. Impacts on traffic

The construction programme will generate short-term increases in all types of vehicle movement along the local and national road networks in the vicinity of the site due to the movement of construction material and personnel. For this reason, a Construction Traffic Management Plan should be developed and implemented by the construction contractor.

The construction activities tank farm will have a significant effect upon traffic in the local Vasilikos area resulting in a significant increase in traffic through Zygi village and along the old B1 Limassol to Nicosia Road. The effects of this increased traffic, however, will have a low impact once the trucks reach the A1 Limassol to Nicosia Highway, given the capacity of this road.

During the operation of the tank farm no impacts on traffic are anticipated.

9. Transport/ traffic: the proposed tank farm will cause:	Yes	Maybe	No
a) Further traffic	…	X	…….
b) Impacts in parking or needs for new parking	…	…….	X
c) Important influence in road network	…	…….	X
d) Changes in traffic humans/goods movement	…	…….	X
e) Changes in marine, air, railway traffic	…	…….	X
f) Increase traffic danger	…	…….	X

1.6.10. Impacts on public health and safety of the area

The new KODAP Fuel Farm (FF) will have a number of health and safety hazards associated with its construction and operation phases. In **Chapter 6,** an evaluation has been made of the potential key occupational health and safety hazards and proposed risk mitigation measures related to dangerous substances and other agents at the site, during the construction and operation phases of the FF.

The owner of the project will have to contact the Department of Labour Inspection in order to confirm whether health and safety plans and management systems for the construction phase will be required as per EU Directive 89/391.

Risk mitigation measures for dangerous substances have to be adopted at the Fuel Farm. These measures will be associated with the good engineering design of the facility, with design criteria meeting international standards and codes. Good design, together with cognisance to the findings of the quantitative risk assessment, should insure that exposure to large quantities of dangerous substances are avoided.

For inadvertent exposures to dangerous substances, appropriate exposure control measures should be adopted using the hierarchy of controls, namely, elimination, substitution, engineering controls, administrative controls, and, in the last resort, personal protective equipment. Appropriate risk assessments should be conducted, procedures adopted and personnel training carried out, to ensure that all exposures to dangerous substances are minimised.

In addition to the hazards of dangerous substances at the FF site, hazards to the occupational health and safety of site workers from other agents should also be considered. Such agents, which may be present during the construction and/or operational phases include dust, noise, vibration, electrical, ionising & non-ionising radiation, thermal stress, lifting equipment, pressurised equipment, slips, trips & falls, as well as general workplace conditions.

11. Public health: the proposed tank farm line will cause:	**Yes**	**Maybe**	**No**
a) Danger of the public health	…….	…….	X
b) Human exposure, possible danger on public health	…….	…….	X

1.6.11. Impacts on aesthetic value

During the construction phase solid waste will be generated. If such waste is not managed, aesthetic pollution around the area will be impacted. The aesthetic pollution is considered a short-term impact.

The providences that are taking into account, the characteristics of the wide area (industrial zone) with regard to the architectural planning lead to the conclusion that the aesthetic pollution that potentially results from the construction of the KODAP tank farm will be negligible.

Note that the cumulative effects on landscape and visual have been assessed in conjunction with other projects in the area, such as the Vasilikos Cement Works facilities.

12. Aesthetic value: the proposed tank farm will cause:	**Yes**	**Maybe**	**No**
Blockage of the view and creation of un-acceptable landscape	…….	…….	X

1.6.12. Cumulative impacts

The additional of the oil and fuel storage and distribution facility along with existing and possible future activities within the Vasilikos area, are unlikely to have significant cumulative impacts that warrant additional mitigation measures.

1.7 Conclusion

The evaluation of the major environmental impacts refers to the proposed KODAP tank farm construction and operation.

Overall, the proposed fuel farm development is not considered to constitute a significant risk to either environmental or social and community receptors.

13. Conclusion	**Yes**	**Maybe**	**No**
Will the proposed plan affect the environment in a unfavorable way?	……	……	X

Chapter 2

The EIA Team - Review Data

Contents

2. The EIA Team – Data Collection

2.1 The EIA Team

The Environmental Assessment Team is provided by the leading environmental consultancy firm Aeoliki Ltd. and is consisted of the following experts:

- Dr. Ioannis P. Glekas, Mechanical and Environmental Engineer, Team leader;
- Dr. Dimitris Glekas, Electrical Engineer;
- Mr. Nikolaos Chourdakis, Chemical Engineer, MSc;
- Mr. George Kakouris, Environmental Scientist;

2.2 Review data – Collection information

The following data have been collected during the composition of this EIA:

- Topographical charts (scale 1:5000);
- Land maps (scale 1:5000);
- Meteorological data (temperature, humidity, evaporation, rainfall etc.);
- Satellite photographs (http://earth.google.com);
- Preliminary drawings from the civil engineer / project designer

For the collection of socio-economic data of the affected area the following sources have been used:

- Ministry of Finance, Department of Statistics;
- Ministry of Tourism;
- Central Intelligence Agency, Publications;
- Nation Master – World Statistical Database;
- The Hellenic Research Institute;
- The United Nations Economic Commission for Europe ;
- Encyclopedia Britannica

Internet:

- www.mof.gov.cy/mof/cystat/statistics.nsf,
- www.visitcyprus.org.cy,
- www.moa.gov.cy/moa/dfmr
- www.cia.gov/cia/publications/factbook,
- www.nationmaster.com/encyclopedia/Demographics-of-Cyprus,
- www.hri.org/news/cyprus/cna/2003/03-06-24.cna.html,
- www.unece.org/stats/trend/cyp.pdf,
- www.britannica.com/eb/article-9109746?query=cyprus&ct=,

The following studies and technical reports have been also reviewed:

- Progress report - Dion. Toumazis & Associates – May 2016;
- KODAP Oil Strategic Reserves Depot at Vasilikos Conceptual Design Report, EAC, July 2014;
- KODAP – Preliminary Geological / Geotechnical Survey, GEOINVEST, November 2015;
- KODAP - Preliminary Geological / Geotechnical Survey, Department of Geological Survey, July 2016;
- Design, construction, and operation of petroleum products storage terminal at Vasilikos Area, VTT Vasiliko Ltd, Prepared by Qualitylink
- Land Reclamation, Construction and operation of VTTV Phase III Terminal at Lower Vasilikos Area, VTT Vasiliko Ltd, Prepared by Qualitylink
- Census 2011 - General Demographic Characteristics - Volume I, Cyprus Statistical Service.

It must be noted that the most significant pieces of information concluded by the visits that took place during the preparation of the study by all the members of the team.

Chapter 3

Project Description

Contents

List of Figures

3. PROJECT DESCRIPTION

3.1 Introduction

This Chapter provides a technical description of the proposed facility and also provides an overview of the planned Project activities and location.

The main scope of this comprehend description is the identification and evaluation of the potential sources of environmental impacts that may emerge due to the construction and operation of the new oil strategic reserves depot (OSRD).

3.2 Site Overview

The OSRD is a complex fuels reception and storage installation that will allow KODAP to maintain and administrate minimum strategic fuel reserves equal to at least 90 days consumption.

A dedicated pipeline system has to be constructed from the neighbouring fuel storage facilities (ie. VTTV and Petrolina fuel farms and unloading facilities).

The erection of the tanks is anticipated to be carried out in phases according to the storage requirements of KODAP.

Four (4) tanks of CLASS A (Mogas) products, and seven (7) tanks of CLASS B (Jet fuel, and Diesel) products will be erected, of total storage capacity of approximately 430,000 m^3. The tank sizes are identical and are of 45m in diameter and 22m height. During this phase an Administration Building, filling pipelines, a Fire pump house and Fire Fighting Storage Tank and all other infrastructure will be constructed.

Table 3.1 below indicates the tanks sizes and volumes.

Table 3.1: Tankages and fuel quantities

TANKS	DIA. (m)	HEIGHT (m)	TANK VOL. (m^3)	ROOF	FUEL	Total Vol. (m^3)
Tk1-Tk4	45	22	43,000	Internal Float. Roof	CLASS A	172,000
Tk5-Tk11	45	22	43,000	Fixed Roof	CLASS B	258,000
					TOTAL	**430,000**

The main components of the OSRD are the following:

- 11 (above ground) tanks;
- product pumping and filtering station with manifolds;
- fire water tank (4,000 m^3),
- set of 3 product lines (about 1 km long) connecting the terminal with the import lines from Vasilikos Port and the storage terminals of other oil companies in the area
- transfer-pipeline receiving station;
- intake pipeline from the sea/ port (some 1.5km long) complete with its own pumping station by the sea/ port;
- mobile truck loading system;
- office block;
- guard house;
- fire / foam pumping station;
- technical building including power transforming station;
- high security fence complete with truck entrance / exit gates and emergency exits;
- road network and walkways;
- parking lots;
- associated lighting and closed circuit television (CCTV)

Figure 3.1 shows the preferred layout of the OSRD.

Solar panels with power packs will be installed on the lighting fixtures the power for the lights. Solar panels will also be installed on the office building roofs for power output. Rainwater will be collected in water tanks for the flush toilets to be installed.

3.3 Location

The proposed plot of land to be developed is located on the north-west side of Vasilikos Cement Factory in the south coast of Cyprus approximately 25 km to the east of Limassol and 30 km to the South-west of Larnaka (**Figure 3.2**).

The boundaries of this area run along Vasilopotamos river to the West and follow the existing road towards the North. Its west boundary runs parallel the existing Vasilikos road. To the South there is a common boundary with Vasilikos Cement Works plant and a small agricultural property.

At short distance there are a number of fuel tanks owned by VTTV and Petrolina companies to the south-west. The nearest residential development is Mari Village 1.7 km northwest of the site.

The site's borderline is described by the following coordinates (UTM):

Table 3.2: Site border coordinates

	North	East
Northwest corner	528777	3843268
Northeast corner	528966	3843336
Southwest corner	529010	3842857
Southeast corner	529139	3842816

The specific position was selected after an extensive optimization study that was based on the following parameters:

The area was selected due to easy access to road accessibility and the subsoil composition, satisfactory space availability, easy access to electricity supply, site proximity to water bodies for the fire fighting water supply.

3.4 Product Storage

3.4.1 Oil Products Storage

The volume of storage to be provided will be sufficient to meet the strategic reserve requirements of 90 days average consumption, as well as the operational reserves, typically running at around 10 days of peak consumption. The number of tanks required at the facility has been determined by the number of types of products required to be held. The dimension, and number required is described below in **Table 3.3** for each product handled at the facility.

Table 3.3: Tank Size and Number by Product

PRODUCT	DIMENSIONS		No. REQUIRED	
	Diameter (m)	Height (m)	Phase I	Phase II
MOGAS	45	22	2	4
Jet Fuel (JET A1)	45	22	3	4
DIESEL	45	33	1	3

The most appropriate type of tank required to store the material varies from product to product as a result of the physical properties of the material to be stored. The type of tank and relevant design code is listed below in **Table 3.4**. This table lists the products from the most volatile MOGAS decreasing through to the least volatile DIESEL. The table shows the different storage tank technology with is proposed for each of the specific products and the details of each of these technological options are discussed further below.

All storage tanks will be designed and built to meet the API 650 Welded Steel Tanks of Oil Storage standard in order to cater for seismicity.

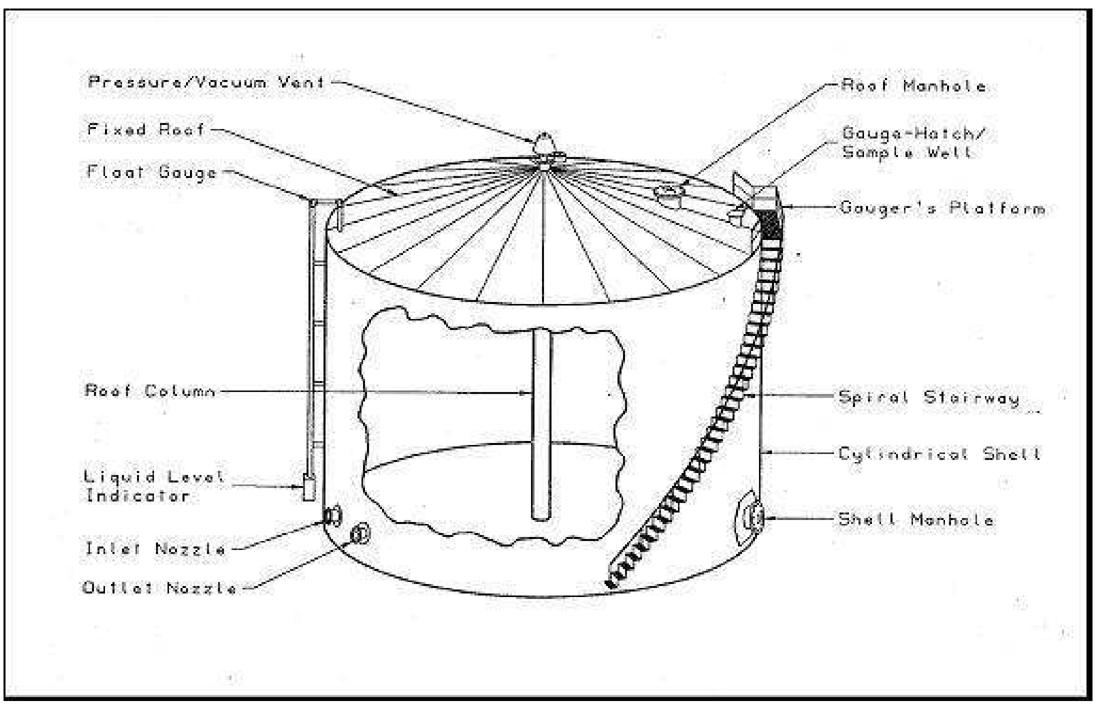
Table 3.4: Tank Dimensions

Product Category	Tank Type		Design Code
	Roof	Bottom	
MOGAS	Internal Floating Roof	Cone 1:30	API 650
Jet Fuel	Fixed, Cone	Cone 1:30	API 650
Diesels	Fixed, Cone	Cone 1:60	API 650

3.4.1.1 Fixed Roof Tanks

Fixed roof tanks are the most common type of tank used for the storage of bulk liquid products across industry and will be used for the Jet Fuel (JET A1) and the DIESEL fuel. A drawing of a typical vertical fixed roof tank is shown below.

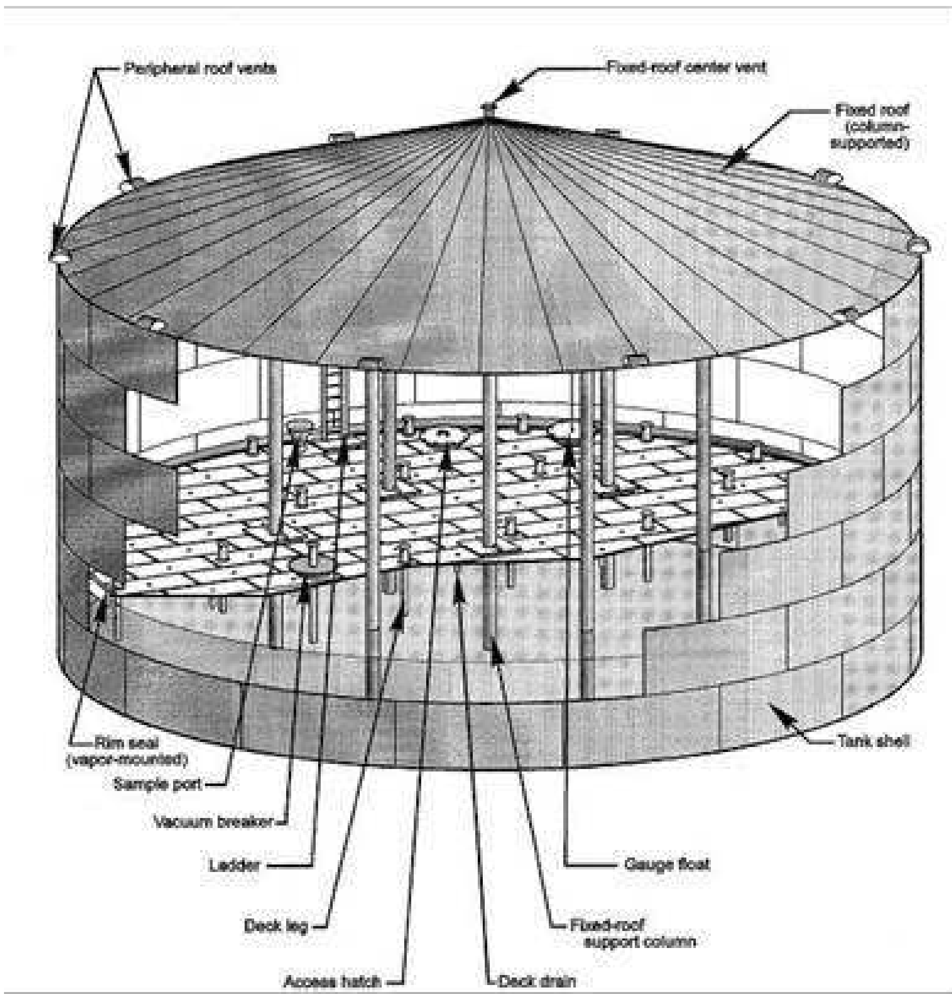
The tank consists of a cylindrical welded steel shell with a coned roof and coned bottom, with a slope, which is proportionate to the viscosity of the liquid intended to be stored in the tank. The cone bottom will drain to a sump designed to minimise the head of material which is left in the tank, however under normal operating conditions liquid will not be drawn from the sump but from a separate discharge line slightly above the bottom of the tank in order to avoid drawing off settled solids which may accumulate within the tank.



The fixed roof tanks will be equipped with an over pressure and vacuum relief valve or vent which will allow the tanks to operate at a slight internal pressure or vacuum to prevent the release of vapours during very small changes in temperature, pressure, or liquid level. As such it can be seen that fixed roof tanks will emit vapours when filled (known as working losses) and when the daily changes in temperature between night and day cause the liquid within the tanks to expand and contract (a process known as diurnal breathing).

3.4.1.2 Internal Floating Roof Tanks

Internal floating roof tank (IFRT) are commonly used across industry for the storage of volatile products and will be used for the storage of MOGAS fuel. A drawing of a typical internal floating roof tank is shown below.



The tank consists of a cylindrical welded steel shell with a coned roof and a floating roof inside as well as a coned bottom, sump and separate drainpipe and operational discharge line. Depending upon the size of the tank the fixed roof will either be supported by vertical columns within the tank or provided with a self-supporting fixed roof and no internal support columns. In any event, this does not change the operation of the tank. Within each tank an internal floating roof will be installed which is designed to rise and fall with the liquid level. This floating roof either floats directly on the liquid surface in a system known as a contact deck, or more commonly rests on pontoons several centimetres above the liquid surface in a system (known as a non-contact deck).

The floating decks will be equipped with rim seals, which are attached to the deck circumference sealing the annulus between the edge of the deck and the tanks vertical wall. The seal slides up and down against the tank wall as the roof is raised and lowered by liquid being pumped into and out of the tank respectively and as such the rim seal system minimizes evaporative loss from the liquid.

Emissions from the tank occur due to emissions through gaps in the rim seal, and leaks from any potential gaps in the floating deck. These vapours leak into the vapour space between the tank's floating deck and the fixed roof and these emissions are known as standing losses. In addition to standing losses, additional vapour emissions into the tank's vapour space will occur when product is discharged from the tank, leaving a smear of product on the wall of the tank as the rims seals will never be 100% efficient. These vapours which escape into the space between the floating deck and the fixed roof can then be emitted to the environment by either diurnal breathing or working loss mechanisms described above. Internal floating roof tanks are estimated to reduce emissions of vapours by up to 97% when compared with external floating roof tanks and are a key feature of the facility's design to minimise emissions of vapours.

3.4.2 Tank feed

Three new above ground pipelines is expected to feed the product storage tanks from Vasilikos Port and the storage terminals of other oil companies in the area. The pipelines will run aboveground alongside the service road network and enter the OSRD terminal past the nearby FFS facility, terminating at the OSRD import fuel manifold. At this stage for the proposed new section of pipeline it is assumed a metering skid will be required but no pigging station will be needed.

The pipeline will transfer jet fuel, diesel and Mogas to the terminal and is expected to perform transfers not more than once per year for Mogas, Diesel and Heating Diesel, and twice a year for jet fuel. The layouts of the two additional piping options are shown in (**Figure 3.3**). The pipelines will be inspected regularly.

3.4.3 Tank allocation / bund storage

The storage tanks will be founded on a raft type foundation reinforced by concrete piles. This will be required due to the poor ground conditions as the area is on reclaimed ground, where uncontrolled dumping has taken place (rubble, RC slab, tyres, rubbish etc). The tank allocation is shown in **Table 3.1** above.

The proposed facility will have a total nominal tank capacity of approximately 430,000m^3.

All liquid hydrocarbon products stored at the facility will be stored in a bunded area that will be leak proofed as follows:

- The bund walls and the bund floor will be constructed of a material that is impervious to the material stored within the bund.

The layout of the bunds is set out so that no more then 4 tanks is located in one bund and each bund will be sized at 110% of the capacity of the largest tank within the bund. To achieve this bund walls are required to be 3.0m high for the bunds A and C, and 2.7 m high for bund B.

A common system will be used to drain storm water, product spills and firewater runoff within oil storage bunds. This system comprises of:

- Each low level bunded area will drain to a corner sump;
- Each corner sump will be emptied by a drainpipe controlled by sluice gate;
- The outlet pipe from each low level bunded corner sump will be connected by buried pipe draining to the communal sump in the corner of the main bunded area;
- The communal sump will be connected by buried pipe through the bund wall to a valve pit outside the bunded area;
- The valve pit (valve normally closed) will drain the communal sump and thereby any low level bunded area as required; and
- The valve pit will be opened as required to discharge into a single pipe header connecting all the bunded areas.

3.4.4 Tank gauging

An automated tank gauging system will be installed to cover each product tank, and the fire water tank. The gauging system will consist of tank instrumentation, a communications interface unit and a link into the site digital control system (DCS) operator computer interface.

Each tank will have a tank gauge and temperature element installed. Information on the tank product level and temperature readings will be transmitted to a tank side indicator and the communications interface unit located within the office building. The type and manufacturer of tank gauge technology to be used will be determined at a later stage once the required accuracy and availability of technical support in the area has been established.

The communications interface unit takes the communications link from the tank gauges and transmits this to the DCS which then displays information on the computer interface.

The site DCS computer interface will provide tank level and temperature information in the control room and will be configured to provide a range of 'soft' alarms for each tank on the interface itself.

3.4.5 Tank overfill protection

The overfill prevention philosophy for each product storage tank consists of alarms generated from the tank gauging system with alarms and a trip function generated from the independent tank overfill prevention system. The independent tank overfill prevention system for each tank is composed of a High high level switch, logic, fail close remotely operated shutoff valves (ROSOVs) located tank side on the tank inlet and outlet lines and terminal alarms.

In order to prevent possible damage to the pipework or pumps in operation as a result of increased pressures within the system due to product surging in the pipework, the closing speed of all ROSOVs will be limited.

3.5 Fuels Properties

3.5.1 Jet A-1

3.5.1.1 Main Data

Jet A-1 is a specialized type of petroleum-based fuel used to power aviation turbine engines and is a preparation manufactured from kerosenes derived from crude petroleum. It is a complex mixture of hydrocarbons consisting of paraffins, cycloparaffins, aromatic and olefinic hydrocarbons with carbon numbers predominantly in the C9 to C16 range. Total aromatic hydrocarbons present are typically in the range of 10-20% v/v. May also contain several additives at <0.1% v/v each. Indicative Jet A-1 additives are the followings:

- Antioxidants to prevent gumming;
- Antistatic agents, to dissipate static electricity and prevent sparking;
- Corrosion inhibitors;
- Fuel System Icing Inhibitor (FSII) agents

Jet A-1 is stored under ambient temperatures and pressures. The materials recommended for storage and transfer equipment are mild steel, stainless steel or aluminium. In contrary, plastics and fiberglass must not be used.

3.5.1.2 Physical and Chemical Properties

The physical and chemical properties of the fuel are listed in the following table.

Table 3.5: Jet A-1 physical and chemical properties

Colour	Pale straw
Physical State	Liquid
Odour	Characteristic
Vapour Pressure	<0.1 kPa at 20°C.
Initial Boiling Point	circa 150°C.
Final Boiling Point	circa 300°C.
Solubility in Water	Negligible
Density	775 to 840 kg/m^3 at 15˚C.
Flash Point	38°C minimum
Flammable Limits - Upper	6%(V/V) maximum.
Flammable Limits - Lower	1%(V/V) minimum.
Auto-Ignition Temperature	>220°C.
Vapour Density (Air=1)	Greater than 5

3.5.1.3 Hazards Identification

Jet A-1 is a hazardous substance and is enlisted as a dangerous product. It is harmful to human, may cause lung damage if swallowed. It is irritating to skin and aspiration into the lungs may cause chemical pneumonitis which can be fatal.

It is flammable and its liquid phase evaporates quickly and can ignite leading to a flash fire, or an explosion in a confined space. May ignite on surfaces at temperatures above auto-ignition temperature. Vapour in the headspace of tanks and containers may ignite and explode at temperatures exceeding auto-ignition temperature, where vapour concentrations are within the flammability range.

3.5.1.4 Fire Fighting Measures

Combustion is likely to give rise to a complex mixture of airborne solid and liquid particulates (smoke), and gases, including carbon monoxide, oxides of sulphur, and unidentified organic and inorganic compounds. The vapour is heavier than air, spreads along the ground and distant ignition is possible. Will float and may be reignited on surface water. Flammable vapours may be present even at temperatures below the flash point.

The extinguishing media that are proposed are:

- Foam;
- Fine water spray;
- Dry chemical powder

Carbon dioxide, sand or earth may be used for small fires only and it is recommended not to use water in a jet.

3.5.1.5 Ecological Information

Jet A-1 floats on water and partly evaporates from water or soil surfaces, but a significant proportion will remain after one day. If it enters soil, it will adsorb to soil particles and will not be mobile. Large volumes may penetrate soil and could contaminate groundwater. It oxidises rapidly by photochemical reactions in air. Major components are inherently biodegradable. The volatile components oxidise rapidly by photochemical reactions in air. Contains components with the potential to bioaccumulate. May cause tainting of fish and shellfish. Jet A-1 forms poorly soluble mixtures and classified as toxic to aquatic organisms. Films formed on water may affect oxygen transfer and damage organisms.

3.5.2 Diesel

3.5.2.1 Main Data

Diesel is a specialized type of petroleum-based fuel used to power internal combustion engines. It is a complex mixture of hydrocarbons consisting of paraffins, cycloparaffins, aromatic and olefinic hydrocarbons with carbon numbers predominantly in the C9 to C25 range. May contain catalytically cracked oils in which polycyclic aromatic compounds, mainly 3-ring but some 4- to 6-ring species, are present. May also contain several additives at <0.1% v/v each. Dyes and markers can be used to indicate tax status and prevent fraud. May contain cetane improver (Ethyl Hexyl Nitrate) at <0.2% v/v.

Diesel is stored under ambient temperatures and pressures. The materials recommended for storage and transfer equipment are mild steel, stainless steel. Aluminium may also be used for applications where it does not present an unnecessary fire hazard. Examples of suitable materials are: high density polyethylene (HDPE), polypropylene (PP), and Viton (FKM), which have been specifically tested for compatibility with this product. In contrary, plastics and fiberglass must not be used.

3.5.2.2 Physical and Chemical Properties

The physical and chemical properties of the fuel are listed in the following table.

Table 3.6: Diesel physical and chemical properties

Colour	Colourless/pale straw/yellow
Physical State	Liquid
Odour	Characteristic
Vapour Pressure	<0.1 kPa at 20ºC.
Initial Boiling Point	circa 170ºC.
Final Boiling Point	circa 390ºC.
Solubility in Water	Negligible
Density	815 to 870 kg/m^3 at 15°C.
Flash Point	>50ºC
Flammable Limits - Upper	6%(V/V) maximum.
Flammable Limits - Lower	1%(V/V) minimum.
Auto-Ignition Temperature	>220ºC.
Vapour Density (Air=1)	Greater than 5

3.5.2.3 Hazards Identification

Diesel is enlisted as a dangerous product. Harmful, may cause lung damage if swallowed. Limited evidence of a carcinogenic effect. Aspiration into the lungs may cause chemical pneumonitis which can be fatal.

It is not classified as flammable, but will burn. May ignite on surfaces at temperatures above auto-ignition temperature. Vapour in the headspace of tanks and containers may ignite and explode at temperatures exceeding auto-ignition temperature, where vapour concentrations are within the flammability range.

3.5.2.4 Fire Fighting Measures

Combustion is likely to give rise to a complex mixture of airborne solid and liquid particulates (smoke),and gases, including carbon monoxide, oxides of sulphur, and unidentified organic and inorganic compounds. Flammable vapours may be present even at temperatures below the flash point. The extinguishing media that are proposed are:

- Foam;
- Fine water spray;
- Dry chemical powder

Carbon dioxide, sand or earth may be used for small fires only and it is recommended not to use water in a jet.

3.5.2.5 Ecological Information

Diesel floats on water. Contains volatile components. Partly evaporates from water or soil surfaces, but a significant proportion will remain after one day. If it enters soil, it will adsorb to soil particles and will not be mobile. Large volumes may penetrate soil and could contaminate groundwater. The volatile components oxidise rapidly by photochemical reactions in air. Contains components with the potential to bioaccumulate. It is classified as toxic to aquatic organisms and films formed on water may affect oxygen transfer and damage organisms.

3.5.3 Mogas (gasoline)

3.5.3.1 Main Data

Automotive gasoline (Mogas) is a very sophisticated fuel and is often a blend of separately distilled petroleum products. Gasoline is very volatile and produces large amounts of vapor at ordinary temperatures. Gasoline contains hydrocarbon compounds in the C4-C10 range. The major component (60-80%) of gasoline consists of the alkanes, which are stable and burn cleanly. Aromatic compounds comprise about 20-40% of gasoline formulations; however, these compounds are gradually being replaced with other, less polluting, octane boosters such as MTBE and ethanol.

There are several toxic compounds in gasoline, the most notable of which are lead and benzene. Benzene is a confirmed carcinogen. Other suspected carcinogens in gasoline include other aromatics, ethylene dibromide, and oxygenating additives. The major toxic risks from gasoline come from breathing tailpipe, evaporative, and refueling emissions.

Mogas is typically stored at installations in underground/above ground tanks located near motor fleet operations or vehicle maintenance areas.

3.5.3.2 Physical and Chemical Properties

The physical and chemical properties of the fuel are listed in the following table.

Table 3.7: Mogas physical and chemical properties

Colour	Yellow. Clear, bright
Physical State	Liquid
Odour	Hydrocarbon
Vapour Pressure	570 hPa at 37.8ºC
Initial Boiling Point	25 ºC - 220ºC
Solubility in Water	Negligible
Density	710 to 770 kg/m^3 at 15°C.
Flash Point	<-35°C
Flammable Limits - Upper	7.6%(V/V) maximum.
Flammable Limits - Lower	1.4%(V/V) minimum.
Auto-Ignition Temperature	>250ºC

3.5.3.3 Hazards Identification

Mogas is enlisted as a dangerous product. Slightly irritating to respiratory system. This product contains benzene which may cause leukaemia (AML - acute myelogenous leukaemia). May cause MDS (Myelodysplastic Syndrome).

Liquid evaporates quickly and can ignite leading to a flash fire, or an explosion in a confined space. This material is a static accumulator. Even with proper grounding and bonding, this material can still accumulate an electrostatic charge. If sufficient charge is allowed to accumulate, electrostatic discharge and ignition of flammable air-vapour mixtures can occur.

3.5.3.4 Fire Fighting Measures

Hazardous combustion products may include: A complex mixture of airborne solid and liquid particulates and gases (smoke). Carbon monoxide may be evolved if incomplete combustion occurs. Unidentified organic and inorganic compounds. The vapour is heavier than air, spreads along the ground and distant ignition is possible. Will float and can be reignited on surface water. The extinguishing media that are proposed are:

- Foam;
- Fine water spray or fog;
- Dry chemical powder

Carbon dioxide, sand or earth may be used for small fires only and it is recommended not to use water in a jet.

3.5.3.5 Ecological Information

Evaporates within a day from water or soil surfaces. Large volumes may penetrate soil and could contaminate groundwater. Toxic to aquatic organisms; may cause long-term adverse effects in the aquatic environment. Ether oxygenates are significantly more water soluble and less biodegradable than benzene, toluene, ethyl benzene and xylenes (BTEX). Consequently ether oxygenates have the potential to migrate relatively longer distances than BTEX in groundwater. Contains volatile components. Floats on water. Methyl tertiary butyl ether degradation may result in the formation of tert-butyl alcohol (TBA).

Major constituents are expected to be inherently biodegradable, but the product contains components that may persist in the environment. The volatile constituents will oxidize rapidly by photochemical reactions in air. While biodegradation of Methyl tertiary butyl ether has been documented, it is generally less biodegradable than many petroleum hydrocarbons and has a potential to migrate relatively longer distances in groundwater.

3.6 Fire protection

3.6.1 Fire protection arrangement

The Fire Fighting System consists of a critical component of the OSRD since the volumes and flammability of the stored fuels may lead to extended damages in case of a fire explosion incident.

The two means that will be used is water (water sprinkling) and fire retardant foam (foam jets)[1].

Water will be stored in a water tank (**item F** on **Figure 3.1**), with a capacity 20,000m^3. Water will be distributed to the following component of the OSRD:

- Pump station;
- Fuel tanks 1 to 11;
- Office buildings (under design speculation)

This water flow stream serves as cooling agent of the components in case of a fire explosion incident and will be distributed through a water manifold and numerous sprinklers. A parallel water hydrant system will be also constructed that will be equipped with standpost hydrants and monitors.

Foam will be stored in foam tanks and will be distributed to the following components of the FF :

- Fuel tanks 1 to 11;
- Tank basin area;

Usually two alternative types of foam are used in similar OSRD, ie. FP (fluroprotein) and AFFF (aqueous film forming foam). The final selection will be implemented with the support of Fire Service. Foam will be distributed through a foam manifold, pouring nozzles, injection pipes and foam monitors.

For the fire fighting system, sea water will be supplied to the depot from the sea with a pipeline some 1.5 km long. A pumping station will be constructed by the sea to feed

[1] Fire Retardant Foam, or fire suppression foam, is foam used for fire suppression. Its role is to cool the fire and to coat the fuel, preventing its contact with oxygen, resulting in suppression of the combustion. The surfactants used produce foam in concentration of 3%. Other components of fire retardant foams are organic solvents (eg. trimethyltrimethylene glycol and hexylene glycol. Foam stabilizers are also used, for example lauryl alcohol. Other chemicals are used as well, such as corrosion inhibitors.

in the 4,000 m^3 fire fighting storage tank. Approximately 1,500m^3 will be required to fire fight the worst case scenario fire for one hour.

The sea water fire fighting system will have the following features:

- Sea water pumping station;
- Sea water pipeline (1.5 km long);
- Fire Fighting Storage Tank (4,000 m^3);
- Fire Pump Station;
- Fire Water Distribution;
- Tank Foam Facilities;
- Tank Cooling;
- Bund Foam; and
- Bunds

Fire Pump Station

- Two or three fire water pumps (duty pumps and one standby);
- Two foam pumps: one duty pump and one standby pump;
- Foam stocks stored on site;

Fire Water Distribution

A fire water ring main around all three portions of the site has been catered which will be used for the portable fire fighting equipment if necessary.

Tank Foam Facilities

- All tanks will be fitted with foam top pouring systems;
- Manifolds will be located at a safe distance away from the tanks and these valves will be manually operated; and
- Testing facilities will be incorporated into the system.

Tank Cooling

- All tanks will be fitted with tank cooling rings with one mini ring on the roof of the tank and one main ring running around the perimeter of the tank;
- Manifolds will be located at a safe distance away from the tanks and these valves will be manually operated; and
- The valves for the tank cooling will be automated valves that can be controlled from the control room.

Pump Manifold

- The pump manifold will be protected against fire by fire detection and monitoring.

Bund Foam

- All bunds will be fitted with fixed bund foam pourers;
- Manifolds will be located at a safe distance away from the tanks and these valves will be manually operated; and
- The valves for bund foam pourers will be automated valves that can be controlled from the control room.

Bunds

- Bund walls will be constructed with a bund capacity of 110 percent of the tank;
- All bund floors will be sealed with concrete;
- Bunds will drains which are controlled via pipes and valves;
- Tanks have been sub-divided into intermediate bund areas; and
- Underflow/ overflow weirs are installed to control flow from one sub- division to the next.
- Additionally, the road loading gantry area will have an automated overflow system.

3.6.2 Fire alarm system

A zoned fire alarm system will be installed will consist of the following:

- Break glass units situated throughout the terminal;

- Break glass units and smoke alarms within the office building;
- Fire alarm panel located in the control room;
- An early detection smoke alarm system in the switch room and MCC; and
- Fire alarm sirens within the office building and site areas.

The break glass units will be separated into several detection zones, located at least in the following areas:

- Site entrance and exit;
- Pump skid;
- Bund entrance / exits;
- Office building;
- Workshop;
- MCC / switch room.

In addition to the above early smoke detection systems installed, the MCC/switchroom will be linked into the fire alarm system and will have its own zone. The fire alarm sirens will be located on the office building roof, and tank farm area to inform personnel when a site evacuation is required. The activation of the office building fire alarm zone will also interlock to the air conditioning. Activation of the fire alarm system will create a site emergency shutdown.

3.6.3 Power Supply

The Fire Fighting System will be supplied by an emergency diesel generator.

3.7 Drainage systems

3.7.1 Drainage

Three pipeline grids will be constructed under the ground of the OSRD site that will collect and transfer the water streams that will be formed due to the rainwater flow and the aqueous mixtures that will emerge in cases of fluid substances spills.

The drainage pipeline grid will be installed along the internal road paths and it will lead the water quantities to an oil separator (and only during a major spill incident it will be forwarded to a retention tank for further processing) that will be constructed in the OSRD site or the First Flush Basin.

The sewage pipeline network ends up to a pipe through which the sewage will be forwarded to the sewage tank where all the sewage sources will be collected for further processing.

3.7.2 Drainage streams

From a drainage perspective the site has been separated into three portions:

- Land Portion 1 includes the offices (area D), fire pump room and water reservoir (area E) (see **Figure 3.1**);
- Land Portion 2 includes the bulk storage tanks, import manifold, export manifold, export pumps with associated spill slabs, bundwalls and bund floor sealing (areas A – B – C) (see **Figure 3.1**); and
- Land Portion 3 which includes the parking areas (area D) (see **Figure 3.1**)

Drainage streams have been segregated as follows.

Oily water (OW)

This would be drainage from the 'dirty' areas where accidental spillages could occur. Such areas include the pump bay. The drainage from these areas will be collected via a separate drainage system and discharged to the oily water separator. The separator outlet will be valved and will discharge into the treated oil water tank. Oil build up in the separator will be pumped into an Ultra-spin unit (see **Figure 3.9**), which will separate the oil from the water and collect the oil recovered in a tank for later disposal. Clean water from the Ultra-spin unit will be discharged into the treated oil water tank. Any substantial hydrocarbon product spill collected inside the primary chamber of the separator will be pumped out by an approved hydrocarbon removal contractor as required, and will then be discharged off site. Treated water complying with the specifications of the national legislation will be discharged to the sea.

Occasionally Oil Contaminated (OCC)

Water falling on the concrete hard standing area within the fenced area, will be deemed 'clean', except for possible minor contamination (such as oil leaks from vehicles). These areas will be graded towards central to low areas and all storm water will be piped to the First Flush Basin (FFB), which will be designed to retain a volume equal to [the area of the 'hardstanding' area] x [4mm]. The remainder of the runoff will be directed straight to the stormwater system. After a storm event, the water in the FFB will be pumped to the site separator.

Clean Stormwater (SW)

Storm water runoff from the undeveloped areas ie gravel surface areas, car park area and roof drainage will be designed for a 1:10 year storm event. This storm water will be discharged off the site to the closest natural clean storm water system.

All sewer water will be collected by licensed contractors for further cleaning process.

Each Land Portion has been analysed in the context of the above drainage streams, as described below.

Land Portion 1

Land Portion 1 will contain oily water, occasionally oil contaminated and clean storm water drainage streams.

- Oily Water (OW): the drainage will be drained into the OW drainage stream.
- Occasionally Oil Contaminated (OCC): the water falling on the concrete hard standing area within the fenced area, will be deemed 'clean', except for possible minor contamination such as oil leaks from vehicles. This stream will be drained into the OCC drainage system.
- Clean Stormwater (SW): runoff from undeveloped areas such as the gravel surface areas, car park and roof drainage will be designed for a 1:10 year storm event and will be discharged of site to the nearest natural clean water system.

Land Portion 2

Land Portion 2 will contain oily water, occasionally oil contaminated and clean storm water drainage streams.

- Oily Water (OW): the drainage from the spill slab will be drained into the OW drainage stream.
- Occasionally Oil Contaminated (OCC): drainage from the bunded areas, import manifold, export manifold and pump slabs will be drained into the OCC drainage stream.

- Clean Stormwater (SW): runoff from the undeveloped areas such as the gravel surface areas will be designed for a 1:10 year storm event. This water will be discharged off site to the closest natural clean water system.

Land Portion 3

- Land Portion C will contain occasionally oil contaminated and clean storm water drainage systems.
- Occasionally Oil Contaminated (OOC): this will be drained from the truck parking area into the OOC drainage system.
- Clean Stormwater (SW): the storm water runoff from the undeveloped areas such as the gravel surface will be designed for a 1:10 year storm event. This water will discharge off site to the closets natural clean water system.

3.7.3 Oil-water separator

It is proposed that one oily water separator will be installed at the depot.

The separator would be installed to treat contaminated surface runoff and unintentionally contaminated water from the fuel storage terminal more specifically the bund area. This is to ensure to that contaminant concentrations are within the limits for disposal to the sewer. It is anticipated that the throughput capacity of the separator would be no more than 15,000m^3 per annum and approximately 9m^3 per day per separator.

The separator is designed as a one in ten year intensity rainfall separator with three chambers. The oily water separators will have the following capacities: two meters wide by one and a half meters in depth. The primary chamber will be three meters in length, the secondary chamber two meters in length and the tertiary chamber one meter in length. If any severe fuel spill occurs within the bunded area, the spill will be pumped out by an appropriate hydrocarbon removal contractor. Additionally, the separator will be constructed in reinforced concrete and will be designed according to SANS 10089.

Figure 3.8 below illustrates the process that occurs in an oily water separator. The oily water separator to be installed on site would be used to treat contaminated water. The Ultraspin Technology to be used, is able to remove <10mg/l of oil and grease, without the use of chemicals.

3.7.4 Ultraspin Oil-water Separator

The Ultraspin separator produces a separation force of more than 1000 times of the force of gravity, thereby separating smaller oil droplets to 15-microns in size from oily water.

The oily water is pumped into the large diameter end. This initiates a spinning vortex. This spinning vortex is accelerated as it moves down the tapered separation tube flinging the heavier water to the outside walls while the lighter oil moves to the centre. The separated oil is removed and the treated water is discharged out the other end of the tube.

Additionally, all water released from the separator will be tested before discharge. The figure below shows a diagram of the process of oil water separation within the Ultraspin Separator as shown in **Figure 3.9**.

3.7.5 First flash basin (FFB)

The purpose of the FFB is to collect the first 4mm of runoff from the OOC areas, excluding the bunded areas. Once the FFB has reached full capacity (such as after a storm event), the excess runoff will bypass the FFB and drain into the nearest natural clean water system. A pump will be installed next to the FFB in order to pump the 'dirty' water if required to the first chamber of the oily water separator.

3.8 Buildings

The buildings that will be constructed are the complex building that will host the administration-control services that will operate the OSRD installations (**item1 in Figure 3.1**), the technical building (**item 2**), fire fighting building (**item 3**) and guard house.

3.8.1 Office Building

The office building will be used by the personnel that will operate the OSRD.

This will be a one storey building (ground no basement) and the following uses will be hosted in its compartments:

- Control room;
- Server & PLC room;
- Offices;
- Secretary-Reception office;

- Meeting and conference room;
- Storage room;
- Kitchen & recreation room;
- Changing room, Lockers, Showers and toilets;
- Toilets;
- Archive, file room;
- Police – security room

The expected number of personnel working in this building is 16, including management staff, while the expected number of employees that will be present in the same time is 8 (in morning shift).

3.8.2 Technical Building

Several auxiliary systems will be installed in this building such as:

- Emergency power generator;
- Storage room of fire fighting equipment;
- Control cabinets;
- Pump cabinets;
- Power supply panels;
- Electric transformers

3.8.3 Fire fighting Building

Several auxiliary systems will be installed in this building such as:

- Storage room of fire fighting equipment;
- Control cabinets;
- Pump cabinets;
- Power supply panels

3.9 Terminal Automation

A distributed control system (DCS) will be installed. This will include the main server rack located in the office building equipment room, remote inputs outputs (I/O) located in the switchroom and office building equipment room, site entrance / exit card readers and a series of operator interface computers.

The main server rack will hold the servers operating the DCS software and include for redundant servers and backup facilities. The rack will also hold the communications interfaces that will allow the system to talk to the remote I/O, the card readers, the tank gauging system and the road and rail load controllers. The servers will be connected to the internet to allow communication with a host / ERP system and for remote system support.

The remote I/O allows hard wired signals from the pump control, remotely operated shutoff valve (ROSOV) status and tank High high switch level status to be connected to the DCS with the required logic programmed within.

Card readers located at all site and office entrance and exits will log the card holder's information on the system before providing a signal to open the appropriate entrance.

Operator interfaces will allow the DCS interface to be viewed and controlled. The DCS interface will provide control, status feedback and control alarms on the following site systems:

- Road loading including the road tanker overfill system;
- Pump control;
- Tank gauging;
- Tank High high switch level status; and
- ROSOV status.

In addition to the DCS, site business process software will be installed. Server racks for the business process software will also be located within the office building equipment room that will communicate with the DCS. The business process system will perform all business and stocks facilities operations. The servers will be connected to the internet to allow communication with a host / ERP system.

3.10 Site alarms

All non-critical control alarms are to be handled by the DCS interface. All site alarms deemed as critical or not control based will alarm on the site annunciator panel. This will be located within the control room and provide a visual and audible alarm through a 'lamp box' type interface. While the alarms will be able to be silenced, the reset of an alarm can only be achieved once the alarm input has been removed. This system will include a data logger which will provide a time and date stamp log of all alarms and resets.

3.11 Operational Control System

OSRD will be fully automated by means of a central redundant control PLC (programmable logic controller) and SCADA (Supervisory, Control and Data Acquisition) System. The automation system will control all fuel related operations, fire fighting, electrical systems, etc. The connection between the field equipment will be provided by cables and fiber optics.

3.11.1 Emergency Control Systems

An emergency shutdown (ESD) system will be installed that will be activated from either the fire alarm system or any ESD push button that are located in the following areas:

- Site entrance and exit;
- Pump skid area;
- Bund entrance / exits;
- Control room;
- MCC / switchroom; and

The ESD panel will be located within the switchroom and consist of relay logic, local lamps for system status and reset functionality. The ESD system will have one level of activation with the following functionality:

- Stopping of all site pumps by tripping the main distribution board ESD circuit breaker feeding the MCC and all non - maintained supplies;
- Closing of the site separator outlet automated valve; and
- Alarm activation on the site annunciator panel in the control room.

3.12 OSRD Power Supply

The electric power necessary for the operation of the OSRD will be supplied from the national power network. Although it has not been decided yet the connection point, very close to the OSRD is located the Mari EAC Substation. So it is anticipated that the OSRD will be connected to this substation.

At this stage of the study, it has not been calculated the power consumption required for the OSRD operation. However from similar facilities the maximum power consumption is not expected to exceed 1 MW. The calculations were based on the worse operational scenario which consists of the simultaneous operation of all the following installations/devices and the corresponding efficiency/concurrency factors:

Tank pumps	Buildings
MOVs[2]	Lighting
Sump pump	Cathodic protection

[2] Mechanically operated valve

Hydrant pump	
Transfer pump	
Service pumps	

The capacity of the selected electric transformer that will serve the OSRD power grid is 800 kV.

The main distribution board will be split into two halves and contain a maintained and non maintained side. An air circuit breaker tripped from activation of the site emergency shutdown (ESD) system will feed the non maintained side and enable all power to the non maintained feeds to be removed. This non maintained side of the distribution board will feed all the pumps via the site motor control centre (MCC).

A single diesel emergency standby generator will be provided to supply power to safety critical and other essential loads in case of a power failure and be capable of sustaining this supply for at least 24 hours. Loss of power should initiate automatic starting of the emergency generator and the transfer of all safety critical and other essential loads onto this supply system.

Equipment items that are connected to the emergency generator are as follows:

- Potable Water Pumps;
- One Instrument Air Compressor;
- All emergency systems, including Emergency Shutdown (ESD), Fire Detection and Public Address / General Alarm Systems.

An uninterrupted power supply (UPS) system will be installed to feed all components that have been identified as requiring power in an emergency situation or sensitive to fluctuations in the supply voltage including a selection of local area lighting. The UPS autonomy time will be established during the detailed design stage. The UPS design will take the time period to safely shutdown the site systems and evacuate the site into consideration. The UPS will include a bypass switch to allow for maintenance of equipment and in case of failure and the UPS DB will have surge protection included for when it is supplied in this nature.

3.13 Lighting

Perimeter and general area lighting at the site will be provided by lighting towers, each consisting of adequate LED spot lights. These lighting towers will be fed in such a way that a loss of one circuit will not turn off all the stop lights on each tower. The control of the lighting towers will be from a timer and light detection sensor enabling the lighting to automatically turn on at a given light level between a given time period. This control circuit will form part of the lighting distribution board and an override switch will be provided.

The local area lighting will be covered by LED fittings. The hazardous area rated fittings will cover the following areas:

- Tank side valves;
- Tank instruments;
- Oily Water Separator;
- Pump platform; and

The non-hazardous area twin LED fittings will cover the following areas:

- Firefighting equipment; and
- Fire water tank

A feed from the UPS will be installed into the lighting control panel. This will allow a selection of the local area lighting to continue to be lit following a loss of power.

3.14 ORSD Water Supply

The water quantities that will be necessary for the operation of the OSRD will be supplied from the water supply pipe grid of Moni. The overview of the corresponding pipeline is presented in **Figure 4.27 (Chapter 4 – Environemnt)**.

Taking into account that approx. 10 people will work at the OSRD installations during its operation and that the necessary water quantity per person in such installations is 100 lt/day it can be estimated that the total daily consumption will be around 1,000 lt.

The necessary water quantities used by the fire fighting system are mentioned in the corresponding paragraph.

3.15 Cathodic Protection

The majority of the components that will be installed at the OSRD will be made of steel and so it is necessary that all this items to be protected from corrosion and erosion. One deep well anode will be placed to protect the entire system and this can be placed within the boundaries of the OSRD.

In order to allow the proper testing of the system, cathodic measuring points will be included in the construction.

3.16 ORSD Internal Road Network/Road Traffic

3.16.1 ORSD Internal Road Network

An internal road network will be constructed in order to serve the vehicle movements that will take place during the operation of the OSRD. These roads are presented at the general layout of the OSRD (**Figure 3.1**) and will be covered with asphalt.

3.16.2 Road Traffic

The routes that will be ran by the operational and auxiliary vehicles are presented in **Figure 3.1**.

3.17 Soil Protection

Apart from the passive (structure) and active (mechanical systems) counter leakage systems the soil above OSRD installations will be counter-leakage protected through the construction of relevant types of ground sheathings. Liquid tight concrete and HDPE membrane covered by round gravel 8/3 are used at areas of the OSRD where there will be a higher frequency of accidental fuel/oil spills of larger possibility of massive leakages (e.g. tank basin and refuelling pits).

3.18 Lightning Protection

The lightning protection system that will be constructed/installed in order to protect the installations against lightning strikes and the consequent possibility of explosion emergence is still under design. Further detail will be submitted by the designer during a following design stage.

3.19 OSRD Site Security Measures

The substantially sensitive character of the under construction installations imposes the need of extended security measures implementation.

3.19.1 Fence

The most important component of the security system will be the special fence that will be constructed around the OSRD site in order to suspend any non authorized entrances. An indicative layout of that fence is presented in **Figure 3.12**. It will be a chain link fence with barbed wire on top (height: 2.9 m.) and its frame will be constructed through the assembly/welding of metal beams.

3.19.2 Gate Check Points

At the site's gateway a guard house will be constructed. It will be equipped search/screening equipment.

3.19.3 CCTV

All OSRD area will be surveyed by a CCTV (closed circuit television) system.

CCTV (closed circuit television) will be installed at the site to cover the site perimeter, site entrance and exit, and internal road network. All CCTV will be recorded and viewing and control of all cameras will be possible both in the control room and security hut. All Phases cameras will have telemetry allowing movement and zooming from both the control stations. Each control station will consist of one large overview screen showing a small image from all cameras and one small spot screen that can be used to view individual camera images one at a time.

3.19.4 ACS

In every point that there is access to secure parts of the installations, an Access Control System (ACS) will be installed.

3.20 Maintenance Procedures

Briefly, the maintenance works that will take place during the operation of the OSRD are the following (frequency):

- Fuel Tests;
- Filter Changes;
- Fire Fighting Tests

3.21 OSRD Personnel

Approximately 10 people will work at the site specialized in OSRD Management and Fuel Delivery.

3.22 Project Phases and Activities

3.22.1 Construction

The OSRD facilities construction will involve the following main activities:

- Site preparation activities, involving further cut and fill works, construction of an access road infrastructure and installation of security fencing and lighting.

- Construction of temporary facilities, drinking water stations, water supply and pipeline and filtration systems, guardhouses and security office.
- General services, to include generators to provide power for temporary site construction facilities, septic tank facilities for sewage system for site staff to use, during site preparations these will be temporary structures only.
- Construction of the principal elements of the OSRD including but not limited to storage tanks, pipe infrastructure, office buildings and road/ground cover works.
- Development of ancillary facilities including the development of supplementary tanks and safety & security systems.

3.22.1.1 Schedule

The construction activities are expected to last for 12 months. Detailed project scheduling is ongoing.

3.22.1.2 Site Preparation Activities

3.22.1.2.1 Cut and fill of the existing site

There is no need of significant site preparation activities since the elevation slope of the site is gentle. At this stage it is not considered that significant quantities of fill material will be required from any sources external to the site due to the gentle elevation slope of the site.

3.22.1.2.2 Installation of security fencing and lighting

A temporary perimeter fence will be installed during the initial site activities to provide a secure and safe operating zone for construction works. This fencing will eventually be replaced as part of the operational phase of the asset.

3.22.1.3 Construction of site buildings

A small number of buildings will be constructed on site, including owner and contractor offices, guardhouses, security office. These facilities will be of a temporary nature and water supply will be sourced from a daily tanker delivery and will provide for the requirements of onsite personal and equipment, and onsite dust suppression operations. Power supply will be from temporary generator supply.

3.22.1.4 Road Access

The vehicles that will be commissioned for the site preparation and construction works may access the site through the designated site entrance This is from the road leading to the worksite entrance that is near the OSRD site (**Figure 3.10**).

3.22.1.5 Construction of Facilities

The general facilities provision for the onsite activities are to include generators, water and sewerage services for site staff to use whilst the main facilities are being constructed. The sewerage system will be a basic septic tank arrangement, which will be pumped on an as required basis. Waste will be transported to the local treatment plant.

The construction of the OSRD will include the following principal tasks:

- Site clearing, leveling and setting out;
- Civil construction to include all bases and piling;
- Mechanical erection of steelwork;
- Tanks construction;
- Building construction;
- Pipe racking construction and piping installation;
- Mechanical equipment installation;
- Electrical and instrumentation installation;
- Mechanical completion;
- Commissioning

3.22.1.6 Construction Staff

During the construction works aprrox. 150 workers specialized in all building trades will be engaged.

3.22.1.7 Construction Equipment

The pieces of construction equipment (types and power level) and the estimated operational time that will be used during the OSRD construction are listed in **Table 3.10**.

3.22.1.8 Water Supply

The estimation of the allocated water quantities needed during the construction works is presented in the following table, taking into account the following assumptions:

- Mean number of construction workers in the worksite during the entire construction period: 75;
- Construction duration: 12 months;
- Pieces of equipment used: as listed in the previous Table

Table 3.8: Water consumption during construction activities

Activities	Consumption (m^3)
Workers personal needs	525
Vehicle washing	70
Wheel washing	60
Dust production mitigation process	700
Various	300
Total	**1,655**

3.22.1.9 Energy Consumption

The estimation of fuel consumption (diesel) during the construction works was based on the construction equipment assumptions, as it was presented in the following Table, taking also into account the assumption according to which the Construction works mean duration will be 10 hours per day.

Table 3.9: Fuel consumption (diesel) during construction activities (main equipment)

Pieces of equipment	Operational duration (hrs)	Specific consumption (lt/hr)	Total consumption (lt)
Loader	600	25	15,000
Hydraulic excavator	640	30	19,200
Motor grader	360	40	14,400
Dump truck	2,840	20	56,800
Road roller	80	40	3,200
Truck	1,800	20	36,000
Crane	1,200	30	36,000
HI-AB	1,840	20	36,800
Self-moving crane	800	30	24,000
Cement transit mixer	200	30	6,000
Cement pump	200	20	4,000
		Total	**251,400**

3.22.1.10 Construction Materials

It is necessary to refer to the provision of the constructor to use types of materials for the construction of the project that comply with the relevant specifications in order to avoid any impacts to the environment and the health and safety of the workers.

3.22.2 Operation

Once the site is complete and operational it is expected that the facility will have a lifespan of approximately 40 years or more. The operation of the facility will create employment opportunities for 10 staff members in total. Waste resulting from the operation of the facility will include oily water and general office waste.

3.22.3 Decommissioning

Once the facility reaches the end of its lifespan, the facility will be decommissioned. After this time, the site will be rehabilitated in accordance with best practice at the time of decommissioning.

3.23 Consideration of alternatives

3.23.1 Site location alternatives

Three areas have been proposed by KODAP to study regarding the erection of the OSRD. All the proposed areas are near the Vasilikos Cement Company and the new tank farms developed by VTTV and Petrolina companies. The three parcels of land available for development of tank farms have been designated as Areas 1, 2 and 3 on **Figure 3.11**.

a. Area 1

This area is bound towards the East and towards the North by areas restricted for development. Towards the west it is bound by a future road proposed under the Vasilikos Area Master Plan and to the south it abuts to an area currently considered as agricultural. It has a total area of 40,000 m^2.

The area currently holds extensive stockpiles of materials from varied sources with general grade levels ranging from 25m to 45m above mean sea level. Evidently the current general grade has been the results of extensive filling operations that in areas may have a depth of fill as much as 30 metres. A geotechnical investigation would need to be conducted to establish the actual extent of the backfill operations. Given the nature of these operations and the varied sources of these materials with possible contaminants, any tank development on this parcel of land would need to be done on reinforced concrete piles of depth exceeding 35m. Alternatively extensive soil improvement techniques maybe used should the Geotechnical Investigation indicate that these would be appropriate. Additionally it needs to be noted that the general landscape of the area indicates that the underlying original ground profile would be sloping steeply and therefore extensive differential settlements would be expected unless piling operations are undertaken. In either case the cost of tank foundations would be prohibitive. Furthermore the general grade of the tank farm would be an elevation that would necessitate intermediate pumping facilities during tanker unloading or an agreement with VTTV or Petrolina to use their pumping station.

b. Area 2

An existing road which runs between Area 2 and Area 3 along the east boundary of Area 2, is planned to be upgraded. North and West of Area 2 is bound by land restricted for development and to the South by general agricultural land. It has a total area of 34,097 m^2.

The area is generally flat at approximately +17m above mean sea level.

Other than the stored materials noted below the area does not appear to have undergone extensive fill operations. Along its western boundary however it appears that it may be affected by over spilling fill that appears to have been placed there over the years. This will most likely require measures to protect against erosion and mud transport during heavy rains,

The advantage of this area is that its general grade is between +15m to +17m above mean sea level. This has the significant benefit that no additional pumping station is required and a tanker with at least 8 bar discharge pressure can discharge oil products directly into the tanks.

The area is used for storage of materials like glass which will be recycled and shredded car tyres that will be used as “fuel”. Therefore the area must be cleaned before future development.

c. Area 3

The boundaries of this area run along Vasilopotamos river to the East and follow the restricted area for development towards the North. Its west boundary runs along the road mentioned above. To the South Area 3 has a common boundary with EAC’s New Mari substation and a small agricultural property.

It has a total area of 40,026 m^2.

Area 3 is generally of an even grade sloping between +15m and +10m above mean sea level. It is currently used as agricultural land, with part of it being a reclaimed river valley. To establish the actual underlying soil conditions a Geotechnical Investigation will need to be carried out. Nevertheless it can be anticipated that soil improvement down to a few metres will most likely be required. The cost of such soil improvement is within reason.

Just as Area 2, Area 3 has the added advantage that the general elevation of the tank farm is anticipated to be at around +15m. In this way it has the significant benefit that no additional pumping station is required and a tanker with at least of 10 bar discharge pressure can discharge oil products directly into the tanks.

There are two transmission lines crossing this area, but according to EAC's Transmission Department there is a plan for upgrading and rerouting these lines. The upgrading is due in 2016. The planned overhead lines however still cross this land. A proposal to relocate the terminal tower and use underground cables running along the road is feasible and will be considered in case KODAP will proceed with this project.

Based on the above Area 3 and then Area 2 are the most advantageous areas to be developed and therefore the aforementioned areas have been selected for further study.

d. Area 4

Further study of Area 3 revealed, after consultation with Water Development Department, that the available area for the development of the OSRD is not enough as a result of the existing protection zone of the Vasilopotamos river which passes through the plot.

As an alternative Area 4 (to the west of Area 3) was studied and proved to be the best alternative option for the development of the OSRD (**Figure 3.11**).

It has a total area of 82,400 m^2 and can accommodate 10 vertical tanks of 50 m diameter 50m (**Figure 3.12**). The plot has the potential for an expansion to the east allowing the construction of 4 more tanks.

Area 4 is of a gentle sloping towards the north/sea of 1% and 1.5% towards the east /river, with general grade levels ranging from 14m to 26m above mean sea level. It is currently used as agricultural land. To establish the actual underlying soil conditions a preliminary Geotechnical Investigation was carried out which showed that the plot does not appear to present important geological problems that prevent the implementation of the project.

3.23.2 Technological alternatives

No alternative technologies have been considered. Fuel storage tanks can be stored either aboveground or underground and underground storage tanks are not a feasible option given the proposed location and the volumes anticipated for the Project.

3.23.3 NO-GO alternative

The no-go alternative is the option of not implementing the activity or executing the proposed development. As per European Union Directives, KODAP has to maintain and administrate minimum strategic fuel reserves equal to at least 90 days consumption and under the EU accession agreement Cyprus has committed to maintain 60 days fuel reserves up to the end of 2007 and 90 days reserves thereafter.

KODAP in order to meet its obligation of minimum oil stocks has:

- Limited own stocks in Cyprus;
- Its own stocks stored in Greece (renting of tanks);
- An agreement with Electricity Authority of Cyprus (EAC) (min storage for electricity generation);
- Stockholding tickets with commercial operators in other Member States; and
- Operational stocks of oil companies operating in Cyprus.

With the decision of the Government of Cyprus to move all the fuel storage facilities from Larnaca area, assuming that the storage facility will not be developed at the proposed site, KODAP will not have own fuel stock facilities in Cyprus and the provisions of the EU directives 98/93/EC and 68/414/EEC would not be met. The site is currently unoccupied, and the economic stimulus the proposed development has the potential to create would not occur. There would also be no potential negative environmental and risk impacts which may be associated with the proposal.

3.24 Environmental Aspects

The way by which the environment inside and around the OSRD construction site will be affected by the construction and operation of the OSRD will be expressed through specific types of environmental disturbances that may emerge. These types are the following:

- Production of Liquid Wastes;
- Production of Air Emissions;
- Production of Solid Wastes;
- Noise

3.24.1 Liquid Wastes

3.24.1.1 Construction phase

During the construction of the project the liquid wastes that will be produced are the following:

- <u>Leakage of fuels and lubricants during the maintenance of the construction vehicles</u>

It is assumed that the quantities that may be spilled on the site's ground will be minimal since the main part of the maintenance activities will take place at the maintenance workshops of the contractors. The quantities of lubricants that will be removed from the construction vehicles during the maintenance procedure and the corresponding data are presented in the following table.

Table 3.10: Lubricant waste generation during construction activities (main equipment)

Pieces of equipment	Operational duration (hrs)	Lubricant volume per service (lt)	Service frequency (hr)	Produced lubricant quantities (lt)
Loader	600	25	200	75
Hydraulic excavator	640	22	200	70.4
Motor grader	360	40	200	72
Dump truck	2,840	20	200	284
Road roller	80	40	200	16
Truck	1,800	20	200	180
Crane	1,200	50	200	300
HI-AB	1,840	20	200	184
Self-moving crane	800	30	200	120
Cement transit mixer	200	35	200	35
Cement pump	200	45	200	45
			Total	**1381.4**

- Sanitary wastes

The flow of the liquid wastes produced by the construction staff will be totally controlled under the management scheme that is already under elaboration in the main worksite and hence these quantities will be treated immediately and efficiently. Taking into account the worst case, that refers to the contemporary presence of approx. 150 workers at the site it is estimated that the flow the quantities of sanitary wastes will be 3 m^3/day. Sufficient number of chemical toilets will be provided at the constructions site. The sanitary effluent will be removed by licensed contractors.

- Waste water from the tanks hydrotest

Industry standards and government regulations require that new tanks undergo a hydrostatic test before being placed into service to ensure the integrity of the tank, floating roof, foundation, and appurtenances.

Domestic raw water (free of chlorine, etc.) is the preferred test medium although other sources may be used (i.e. lake water, river water, well water, recycled water, etc.). Alkaline water is not used as a test medium. Laboratory tests of the water are performed prior to use with the results found to be satisfactory to the Department of the Environment. Additives shall not be used unless approved by the Department of the Environment. If additives are approved for use a list of the additives used and the reasons for using them shall be included in the testing documentation. The volume of water required for the test is substantial; a suitable source for the water and a disposal site must be identified early on in the test planning to avoid delays.

During the planning phase of the test, KODAP should consider utilizing, where possible, alternatives to natural bodies of water as a source of hydrostatic test water such as municipal water supplies or industrial water supplies at plants or refineries. Tertiary treated water from the nearby Limassol – Amathus Sewerage Board treatment plant can be the preferred test medium for the OSRD.

Dewatering of the tanks after the hydrotest should be in such a manner that prevents soil erosion and damage to the beds and banks of the nearby water body (Vasilikos river). This requires using low velocities, dissipating water energy and utilizing protective riprap, sheeting, tarpaulins or equivalent to prevent washouts, flooding or erosion. Undertaking representative sampling and obtaining a laboratory analysis of discharge test water and obtaining soil chemistry analysis, is required, prior to discharging on land.

However if recycled water is to be used for the hydrotest, discharging the water after the hydrotest to the nearby Vasilikos river is not allowed. In that case all quantities of the test water can be transferred to the nearby Vasilikos Cement Plant to be used in the production lines.

- Other liquid wastes

Waste type	Source	Management
Uncontaminated waters	Various activities	Discharged in the direction of the sea but also allowed to permeate into the ground to soak away
Detergents	Various activities	Managed as 'Uncontaminated waters' above
Storm and surface water runoff	Vehicle and plant wash down area, and road and stockpile dempening	Managed as 'Uncontaminated waters' above

Since very little information is available of the OSRD design details, there is no firm basis for the estimation of the waste generated during the construction phase.

Based on the experience from similar facilities, the estimated expected generated waste quantities are included in **Table 3.11.**

Table 3.11: Liquid Waste streams – Construction phase

Waste stream	Type	Unit	Estimated Quantity				
			<10	<100	<1000	<10000	>10000
Sanitary effluent	Non hazardous	m^3				X	
Detergents	Non hazardous	lt			X		
Effluent water (Hydrostatic Tests)	Non hazardous	m^3					X
Effluent grey water (maintenance repair works)	Non hazardous	kg				X	
Metal (ferrous and non ferrous)	Non hazardous	kg				X	
Spent chemicals	Hazardous	m^3		X			
Lubricants, grease, hydraulic fluids	Hazardous	lt				X	
Adhesives, dyes	Hazardous	lt		X			
Oil contaminated water / effluent	Hazardous	lt			X		
NDT waste (spent radiographic isotopes, containments of radiography development chemicals, liquid waste from radiography development, developed films, contaminated containments)	Hazardous	lt		X			

3.24.1.2 Operation phase

During the normal operation of the OSRD the liquid waste streams that will be produced are the following:

Waste type	Source	Management
Uncontaminated storm water	Rain events	Discharged to sea through the site setting basin
Potentially contaminated storm water	Rain events	Discharged to sea through the site setting basin and oil interceptors
Sewage	Administration office	Stored on site in septic tanks and transported off site by a local waste removal; contractor for proper treatment ad disposal off-site
Oil sludge	Sludge from oil / water separators from the site oil water interceptors	Stored on site in a bunded waste storage area in drums or a steel tank and transported off site by a local waste removal contractor for proper treatment and disposal off-site for recycling

Since very little information is available of the OSRD design details, there is no firm basis for the estimation of the waste generated during the construction phase.

Based on the experience from similar facilities, the estimated expected generated waste quantities are included in **Table 3.12.**

Table 3.12: Liquid Waste streams – Construction phase

Waste stream	Type	Unit	Estimated Quantity				
			<10	<100	<1000	<10000	>10000
Sanitary effluent	Non hazardous	m^3				X	
Detergents	Non hazardous	lt		X			
Storm water - uncontaminated rain water	Non hazardous	m^3					X
Spent fire water (sea water used in fire fighting exercises - and fire fighting system inspection and testing provided that contains no foam)	Non hazardous	m^3		X			
Spent chemicals	Hazardous	m^3	X				
Lubricants, grease, hydraulic fluids	Hazardous	lt		X			
Adhesives, dyes	Hazardous	lt		X			
Oil contaminated water / effluent	Hazardous	m^3		X			
Hydrocarbons (tank cleaning, drainage)	Hazardous	m^3		X			
Foam, water containing foam	Hazardous	m^3		X			
Laboratory waste	Hazardous	lt		X			

3.24.1.3 Non-normal operations

The terrestrial activities associated with the OSRD facility have associated risks of accidents that can lead to spillages of oil, chemicals or other materials. The different phases of the project (e.g. construction, operations) and activities (e.g. vessel movements, site levelling) have different risk profiles and have to be managed.

Whilst spill risks at the site are discussed in **Chapter 8** it is relevant to note that the clean up of chemicals and hydrocarbons after a spill can create large amounts of contaminated waste in the terms of materials used and oily sludge. The handling and disposal of this waste will need to be carefully considered. Depending on the volume of the waste, disposal via incineration may be the most appropriate option.

3.24.1.4 De-commissioning

It is anticipated that the majority of the project components will be in place for 25 years or more and as such decommissioning will broadly comprise the following activities:

- Operating processes will systematically be shut down in a safe manner;
- Liquid and solid contents/wastes will be removed for treatment and disposal. For pipelines and tanks, this will entail flushing and cleaning to remove oils and gases; and
- The fate of the emptied and cleaned structures and equipment will then be decided by a feasibility study to determine the best environmental and economic solution consistent with international oil and gas industry practice.

It is anticipated, that all activities are manageable according to best practice at the time of decommissioning and as such, impacts are anticipated to be low.

3.24.2 Air Emissions

3.24.2.1 Construction phase

Air emissions sources during the construction phase involves those activities which are likely to result in generation of:

- fuel combustion emissions from construction vehicles and equipment; and
- dust emissions

Fuel combustion emissions during construction will result from:

- Exhaust from the off-road construction equipments, including diesel construction equipment used for site grading, excavation, and construction of on-site structures, and water/polymeric sealant trucks used to control construction dust emissions; and,
- Exhaust from on-road vehicles, including worker vehicles, busses, pickup trucks and diesel trucks used to transport workers and materials around the construction site, and from diesel trucks used to deliver concrete, equipment, and construction supplies to the construction site. Emissions from both on-site and off-site portions of trips made by these vehicles were estimated;

Vehicle and construction equipment exhaust emissions (**Table 3.15**) were estimated using equipment lists and construction scheduling information as in **Table 3.13** and vehicle / equipment emission factors as in **Table 3.14.**

Exhaust emission estimations are based on previous experience from similar projects. Once the final design of the project is finalised, these estimations (and the associated impacts on air quality) must be updated with the accurate figures.

Table 3.13: Construction equipment usage schedule

Construction equipment	hours/day	% on onsite sealed roads	% on onsite unpaved roads	% on onsite paved roads	Max daily offsite trip distance	Load Factor	Months after construction commence												
							HP	1	2	3	4	5	6	7	8	9	10	11	12
Off-road equipment																			
Air compressor (825hr)	6					0.48	50	1	1	3	3	2	2	1					
Asphalt paver (95hr)	7					0.62	120								1	1			
Backhoe (1,600hr)	7					0.55	120	2	5	3	3	2	2	2					
Compactor (850hr)	7					0.55	120	1	2	2	2	2	1						
Crane (Large) (1,325hr)	5					0.43	175	1	2	3	4	4	2	2	2	2	2	2	2
Crane (Small) (650hr)	7					0.43	500			3	3			2	2	2	2	2	2
Dozer (550hr)	8					0.64	250	1	1	1		1	1						
Generator (1,550hr)	8					0.74	50	1	1	2	2	2	2	2					
Grader (650hr)	7					0.61	175	1	2	2		1	1						
Light Tower (950hr)	9					0.78	50		1	1	1	1	1	1					
Loader (750hr)	7					0.55	250	1	1	2	2	2	1						
Trencher (2,400hr)	9					0.75	50	1	2	2	3	3	3	2					
Bobcat (700hr)	7					0.55	50	1	1	2	2	2							
Welding machine (300hr)	5					0.45	50				3	3	3	3	3	3	3	3	3
Aerial lift (1,000hr)	6					0.46	120	1	2	2	2	2	1	1	1	1	1	1	1
Fork lift (500hr)	4					0.30	50	1	2	3	3	2	2	1	1	1	1	1	1
Vehicles with on-road engines for emissions estimates		**% on onsite sealed roads**	**% on onsite unpaved roads**	**% on onsite paved roads**	**max daily offsite trip distance (km)**	**On site distance per day traveled by vehicle (km) - Load factor**													
Worker passenger cars	12	100	-	-	40	1	175	10	20	20	20	20	20	10	10	10	10	10	10
Concrete pump (1,750hr)	12	10	10	80	40	10 - 0.55	250	2	5	5	5	5	5						
Dump truck (2,200hr)	12	-	50	50	0	12 - 0.55	250	2	4	5		2	2						
Flatbed truck (6,300hr)	12	100	-	-	0	50 - 0.55	250	3	5	5	5	5	3	3	3	3	3	3	3
Pickup truck (12,300hr)	12	95	5	-	0	20 - 0.78	187	6	6	6	6	6	6	6	6	6	6	6	
Water bowser (3,000hr)	12	25	75	-	0	20 - 0.46	175	2	5	3	3	2	2	2	2	1	1	1	1
General materials delivery trucks	12	-	-	100	70	10	250	3	3	3	3	3	3	3	3	3	3	3	3
Metal plates delivery trucks	12	55	-	45	70	10	250			2	2	2	2	2	2	2	2		
Pumps delivery trucks	12	-	-	100	70	10	250			2	2	2	2	2	2	2	2	2	2
Pipes delivery trucks	12	-	-	100	70	10	250			2	2	2	2	2	2	2	2	2	
Mechanical equipment delivery trucks	12	-	-	100	70	10	250			2	2	2	2	2	2	2	2	2	
Electrical and control system	12	-	-	100	70	10	250					2	2	2	2	2	2		
Building material delivery trucks	12	-	-	100	70	10	250	2	2	2	2	2				2	2	2	2
TOTAL								**43**	**73**	**88**	**85**	**83**	**73**	**51**	**44**	**45**	**45**	**40**	**30**

Table 3.14: Construction equipment emission factors (gr/hr)

Equipment	Hours/ year	Emission factor (gr/hr) PM_{10}	$PM_{2.5}$	CO	VOC	NO_x	SO_2	CO_2	CH_4	N_20	$CO2_{eq}$
Off-road equipment											
Air compressor (825hr)	825	12.15	11.25	127.35	54	108	0	10012.95	4.95	0	10115.1
Asphalt paver (95hr)	95	31.05	28.8	185.85	60.75	358.2	0.45	24502.5	5.4	0	24617.7
Backhoe (1,600hr)	1600	24.75	22.95	164.7	44.55	272.7	0.45	23256.9	4.05	0	23341.05
Compactor (850hr)	850	30.15	27.9	189.9	57.6	349.65	0.45	26521.2	5.4	0	26630.1
Crane (small) (1,325hr)	1,325	25.2	23.4	220.5	57.15	442.8	0.45	36122.4	4.95	0	36231.3
Crane (Large) (650hr)	650	32.85	30.15	322.2	85.95	844.2	0.9	80973	7.65	0	81135.9
Dozer (550hr)	550	37.35	34.2	271.8	96.75	922.5	0.9	74691.9	8.55	0	74875.5
Generator (1,550hr)	1,550	13.05	12.15	132.3	52.2	139.5	0	13767.75	4.5	0	13866.75
Grader (650hr)	650	36.9	34.2	334.8	82.8	646.65	0.45	55714.5	7.65	0	55871.55
Light Tower (950hr)	950	12.6	11.7	136.35	50.85	127.35	0	12583.8	4.5	0	12680.55
Loader (750hr)	750	27	24.75	199.35	71.1	733.95	0.9	66979.35	6.3	0	67113.9
Trencher (2,400hr)	2,400	18.9	17.55	200.7	86.85	164.7	0	14799.6	7.65	0	14963.85
Bobcat (700hr)	700	10.8	9.9	117.45	40.05	112.5	0	11473.2	3.6	0	11549.25
Welding machine (300hr)	300	13.05	12.15	137.25	57.15	123.75	0	11670.75	4.95	0	11778.75
Aerial lift (1,000hr)	1,000	1.35	1.35	634.5	2.7	99.9	0	14055.75	21.6	0	14507.55
Fork lift (500hr)	550	0.9	0.9	132.3	1.35	61.65	0	8232.75	12.15	0	8486.55
Vehicles with on-road engines for emissions estimates											
Worker passenger cars		0	0	0.45	0	0	0	21.15	0	0	21.6
Concrete pump (1,750hr)	1,750	0.9	0.9	6.3	2.7	13.5	0	1568.7	0	0	1575
Dump truck (2,200hr)	2,200	0.9	0.9	7.2	3.15	15.75	0	1830.15	0	0	1840.05
Flatbed truck (6,300hr)	6,300	0	0	2.7	0	0	0	444.6	0	0	471.6
Pickup truck (12,300hr)	12,300	0	0	10.35	0.9	0.9	0	849.6	0	0	868.95
Water bowser (3,000hr)	3,000	1.8	1.35	12.15	5.85	27.45	0	3137.4	0	0	3154.05
General materials delivery trucks		0.45	0.45	3.15	1.35	6.75	0	784.35	0	0	788.4
Suncatcher pedestals delivery trucks		0.9	0.9	6.75	3.15	14.85	0	1699.65	0	0	1708.65
Stirling Engines		0.45	0.45	3.15	1.35	6.75	0	784.35	0	0	788.4
Suncatcher Metal Supports		0.45	0.45	3.15	1.35	6.75	0	784.35	0	0	788.4
Suncatcher Mirrors		0.45	0.45	3.15	1.35	6.75	0	784.35	0	0	788.4
Electrical and control system		0.45	0.45	3.15	1.35	6.75	0	784.35	0	0	788.4
Azimuth and elevation drive		0.45	0.45	3.15	1.35	6.75	0	784.35	0	0	788.4

Different areas within the project site and the construction laydown areas would be disturbed at different times over the period.

Table 3.15: Greenhouse emissions estimated for the entire-12 month construction period (tons/year)

	PM_{10}	$PM_{2.5}$	CO	VOC	NOx
Onsite construction emissions					
Onsite combustion emissions – equipment	0.19	0.18	2.23	0.48	3.26
Onsite combustion emissions - vehicle	0.01	0.01	0.22	0.05	0.18
Subtotal of Onsite Emissions					
Offsite construction emissions					
Offsite combustion emissions	0.00	0.00	0.01	0.01	0.03
Subtotal of Offsite Emissions					
Total Maximum Annual Emissions	0.20	0.19	2.46	0.54	4.47

	SO_2	CO_2	CH_4	N_20	$CO_{2\ eq}$
Onsite construction emissions					
Onsite combustion emissions - equipment	0.00	292.68	0.07	0.00	294.18
Onsite combustion emissions - vehicle	0.00	32.52	0.00	0.00	33.02
Subtotal of Onsite Emissions					
Offsite construction emissions					
Offsite combustion emissions	0.00	3.00	0.00	0.00	3.02
Subtotal of Offsite Emissions					
Total Maximum Annual Emissions	0.00	328.20	0.07	0.00	330.22

Fugitive dust emissions during construction will result from:

- site grading/excavation activities;
- construction of roads, main service complex and substation;
- installation of Tanks, equipment, pipes, etc;
- on-site travel paved roads, roads sealed with polymeric sealant, and the minimized but unavoidable travel on unpaved surfaces,
- off-site travel of worker vehicles and delivery trucks on paved roads.

Fugitive dust emissions during the construction phase are estimated using empirical relations for:

- Earthworks including excavation, handling on site and deposition :

$$e_1 = 1.2\ ton / dec / month$$ [3]

- Handling and storage of materials (including loading and unloading):

$$e_2 = 1.9 \frac{s}{1.5} * \frac{365-P}{235} * \frac{f}{15}\ kg / ημέρα / εκτάριο$$ [2]

Where s: silt (20%)

P: number of days with rainfall > 0.25 mm

f: percentage of time (%) with wind speed >5.4 m/sec at mean height of the pile

- Haulage roads and unsealed site surfaces (including vehicles travelling along them)

$$e_3 = 1.7 * \left(\frac{s}{12}\right) * \left(\frac{S}{48}\right) * \left(\frac{W}{2.7}\right)^{0.7} * \left(\frac{w}{4}\right)^{0.5} * \left(\frac{365-p}{365}\right)^{K}\ kg / οχημ.χλμ$$

Where: k = dimensionless parameter of the material size

s = silt (20%)

S= average vehicle speed (km/hr)

W= average vehicle weight (ton)

w= number of wheels

p= number of days with rainfall > 0,25 mm.

[3] ***Source*** : *Compilation of air pollutant emission factors, Chapter 13 : Miscellaneous Sources, AP-42, December 2003, U.S. Environmental Protection Agency, U.S.A*

	$PM_{2.5}$	PM_{10}
k	0.15	1.7
κ	1	1

- Paved roads (including vehicles travelling along them)

$$e_4 = [\, k * (sL/2)^{0.65} * (W/3)^{1.5} - C \,]\ (1 - p/4*365)$$

Where: k = dimensionless parameter of the material size

sL = road surface silt loading (1.6 gr/m2)

S= average vehicle speed (km/hr)

W= average vehicle weight (ton)

C= emission factor for exhaust, break wear and tire wear

p= number of days with rainfall > 0,25 mm.

	$PM_{2.5}$	PM_{10}
k	0.0024	0.016
C	0.00036	0.00047

The estimated construction fugitive dust emissions are provided below in **Table 3.16** based on the construction equipment usage schedule in **Table 3.13** and emission factors in **Tables 3.17 and Table 3.18**.

Table 3.16: Total fugitive dust emissions estimated for the entire-12 month construction period (tons/year)

Description	Emission rate $PM_{2.5}$ tn/year	kg/h *	Dust ** ($gr/m^2/day$)
Excavation works	10 tn/year	55 kg/h	0.010
Accumulation and storage materials	15 kg/day	1.5 kg/h	0.03
Vehicles / equipment movements	120 tn/year	325 kg/h	0.055
Description	**Emission rate PM_{10} tn/year**	**kg/h ***	**Dust ** ($gr/m^2/day$)**
Excavation works	110 tn/year	550 kg/h	0.10
Accumulation and storage materials	110 kg/day	10 kg/h	0.25
Vehicle / equipment movements	1,120 tn/year	3,000 kg/h	0.53

* *It refers to the busiest month 3*

** *concentration of fallen dust at monitoring station according to the German standards VDI-RICHTLINIEN VDI 2119 Blatt 2, Measurement of dustfall Bergehoff (standard Method). The air quality limit for fallen dust for residential areas according to the German air quality standards is 350 $gr/m^2/day$. In residential areas in the absence of fugitive dust sources, the dust concentrations in the air quality is ranging between 0 - 0.16 $gr/m^2/day$.*

Table 3.17: **F**ugitive dust emissions estimated for the entire-12 month construction period (tons/year) – Excavation works & accumulated materials

Fugitive dust emissions - Excavation works & accumulated materials	
Description	**Quantities**
Excavation surfaces (m^2)	50,000 m^2
Dust emissions from excavations works	10 ton/month 500 kg/ hour of continuous activity
Surface of accumulated materials (m^2)	10,000 m^2
Dust emissions from accumulation and storage of materials	125 kg/day 16 Kg/ hour of continuous activity

Table 3.18: Fugitive dust emissions estimated

Equipment					Unpaved surfaces			Paved roads				
Off-road equipment	Mean weight (ton)	Number of vehicles	Hours	Max daily distance (km)	% on unpaved roads	Emission factor $PM_{2.5}$	Emission factor PM_{10}	% on paved roads	Emission factor $PM_{2.5}$	Emission factor PM_{10}	$PM_{2.5}$ Ton/year	PM_{10} Ton/year
Asphalt paver	5	3	420	1	100	0.124	1.243	0	0.02205	0.1485	14.749	147.594
Crane (Large)	10	28	2,772	1	100	0.082	0.823	0	0.0054	0.03735	9.779	97.684
Crane (Small)	35	18	3,080	1	100	0.144	1.446	0	0.0369	0.24615	17.153	171.695
Aerial lift	4	16	2,112	1	100	0.054	0.545	0	0.00135	0.00945	6.466	64.713
Fork lift	3	19	1,672	1	100	0.048	0.479	0	0.0009	0.00585	5.664	56.858
Vehicles with on-road engines for emissions estimates												
Worker passenger cars	2	170	44,880	40		0.040	0.399		0.00045	0.00315	2.405	23.860
Concrete pump	12	27	7,128	40	20	0.113	1.124	80	0.01575	0.1062	4.168	36.786
Dump truck	20	15	3,960	10	50	0.113	1.124	50	0.01575	0.1062	7.615	73.049
Flatbed truck	20	44	11,616	40	100	0.082	0.823	0	0.0054	0.03735	9.779	97.684
Pickup truck	4	66	17,424	20	100	0.054	0.545	0	0.00135	0.00945	6.466	64.713
Water bowser	20	25	6,600	20	100	0.113	1.124	0	0.01575	0.1062	13.359	133.487
General materials delivery trucks	20	36	9,504	20	0	0.113	1.124	100	0.01575	0.1062	1.870	12.611
Metal plates delivery trucks	20	16	4,224	30	55	0.113	1.124	45	0.01575	0.1062	8.189	79.093
Pumps delivery trucks	20	20	5,280	30	0	0.113	1.124	100	0.01575	0.1062	1.870	12.611
Pipes delivery trucks	20	18	4,752	30	0	0.113	1.124	100	0.01575	0.1062	1.870	12.611
Mechanical equipment delivery trucks	20	18	4,752	20	0	0.113	1.124	100	0.01575	0.1062	1.870	12.611
Electrical and control system	20	12	3,168	20	0	0.113	1.124	100	0.01575	0.1062	1.870	12.611
Building material delivery trucks	20	18	4,752	20	0	0.113	1.124	100	0.01575	0.1062	1.870	12.611
										TOTAL	**120**	**1120**

3.24.2.2 Operation phase

Emissions Volume Modelling

The site will be used to store Mogas, diesel, and Jet A1 fuel. **Table 3.19** shows the proposed number of storage tanks and fuel throughput per tank.

Table 3.19: Tankages and fuel quantities

Tankages and fuel quantities				
Tank	**Quantity (no)**	**Nominal capacity**	**Product**	**Throughput (m^3/yr)**
TANK 1 – 4 Internal Floating Roof	4	43,000	MOGAS	31,104@ 4 124,416
TANK 5 - 6 Fixed Roof	3	43,000	JET A1	62,208@ 3 186,624
TANK 7 – 11 Fixed Roof	4	43,000	DIESEL	31,104@ 4 124,416

The emission inventory was based on the Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources (AP-42), Section 7.1, Organic Liquid Storage Tanks (US-EPA, 2006 in DDA, 2014) and the US-EPA emissions inventory model TANKS 4.0.9d (US-EPA, 2006) was utilised. Site-specific information regarding fuel quantities, the storage tanks (dimensions, tank type, paint condition, tank fittings, etc.), the fuel contents (chemical components and liquid temperature), and meteorological data (ambient minimum and maximum temperatures, atmospheric pressure, etc.) were utilised as inputs into the model.

Losses from the internal floating roof tanks proposed for the storage of Mogas products were withdrawal losses and standing storage losses. Withdrawal losses occur as the liquid level is lowered and product remaining on the inner tank wall evaporates. Standing losses occur through rim seals and deck fittings. **Table 3.20** shows the emission estimates for the gasoline tanks. The input data used in the estimation of gasoline tank emissions are provided in **Appendix D**.

Losses from the fixed roof tanks proposed for the storage of petroleum products were breathing losses and working losses. Breathing losses occur as a result of the expulsion of vapours due to the expansion and contraction of tank vapours due to diurnal temperature and barometric pressure variations. Working losses occur as a result of the loading and unloading operations changing the tank liquid level. For instance, during loading, as the liquid level rises, the pressure level within the tank increases and exceeds the relief pressure and vapours are expelled. **Table 3.20** shows the emission estimates for fixed roof tanks. The input data used in the estimation of gasoline tank emissions are provided in **Appendix D**.

Fixed roof tanks are proposed for the storage of Diesel, and Jet Fuel. All tank storage is at ambient pressure and unheated.

Table 3.20: Estimated Emissions Summary

Tank	Quantity	Nominal Capacity (m^3)	Throughput	Emissions
				Tankage
			m^3/yr	kg/yr/tank
MOGAS - Internal Floating Roof Tank	4	43,000	124,416	4,766
Diesel – Vertical Fixed Roof Tank	3	43,000	93,312	401
Diesel (Heating) - Vertical Fixed Roof Tank	1	43,000	31,104	401
JET A1- Vertical Fixed Roof tank	3	43,000	186,624	1,635

3.24.3 Solid Waste

3.24.3.1 Construction phase

All wastes generated from the project will be categorised as either non-hazardous or hazardous following an assessment of the hazard potentials of the material in line with national legislative requirements.

The construction of the facility will produce a variety of waste products. The initial solid waste generated on site will be the cleared vegetation (although sparse) and soil overburden from levelling and grading of areas of the site. Some building rubble will be produced throughout the construction phase from activities such as the construction of buildings and concrete pouring. Packaging material will be accumulated from unpacking of facility components.

The main sources of waste will result from the construction and decommissioning activities. These wastes will be produced daily and comprise of the following:

- domestic type waste;
- residual packaging and food wastes;
- metal cans (from food and drinks);

- plastics drinks bottles;
- glass jars and bottles;
- Wooden pallets and cartons;
- Scrap metal;
- Concrete waste;
- Paper and cardboard;
- Grey water - from ablutions; and
- Food wastes

The following hazardous wastes may also be produced from construction activities.

- Batteries (including large lead acid type);
- Medical/clinical wastes;
- Oily rags and absorbents;
- Used oil and oil filters - from generators or vehicle maintenance;
- Contaminated water - slops and oily water from drip trays; and
- Sewage from toilets.

All wastes produced from Project activities on site will be transferred to designated temporary storage areas and where necessary into secure containers. Solid wastes will be segregated to facilitate reuse and recycling of specific materials. All wastes that can be recycled will be collected and taken to an appropriate recycling facility. All wastes that cannot be reused or recycled will be collected by approved waste contractors and transferred to an appropriately licensed waste management facility for treatment and disposal.

Table 3.21: Solid Waste streams – Construction phase

Waste type	Source	Management
Domestic wastes, including office waste and kitchen waste.	Temporary office and support facilities	Stored on site in labelled sealed containers and removed by a local waste removal contractor for proper disposal off site.
Packaging waste, including wood, metal and plastic.	Unpacking of delivered materials	Stored in skips ready for removal off site for recycling. The skip containing plastic will be covered so that material does not blow out of it.
Various hazardous wastes including oils, oil filters, oily rags, expended sand blast and grit, chemical/oil containers, batteries.	Machine maintenance	Oils will be stored in steel tanks located on an impervious base and provided with impermeable bund walls to give a containment capacity of at least 110 per cent of the tanks' volume. The remainder will be stored in labelled sealed containers. These wastes will be collected as required by a local waste removal contractor for proper treatment and disposal off-site at a suitably licensed facility to be identified.
Paint waste and tins/buckets.	Left over from painting activities	Waste paint and paint tins/buckets are likely to be classified as hazardous waste and so will be stored with the hazardous wastes for removal by a licensed local waste removal contractor and disposed of using appropriate disposal methods.
Electrical waste including cables, cable drums (wood), and cable trays (galvanized).	Wiring activities	Scrap metal and wood will be collected and recycled at the local scrap yard.
An as yet unquantified amount of contaminated soils. The final amount will only be determined during excavation itself.	Excavated as a part of the site levelling procedures	It is likely to be classified as a hazardous waste, and so will require disposal at a suitably licensed facility to be identified.
Uncontaminated excavated soils from across the site.	Excavated as a part of the site levelling procedures	Where possible soils will be reused across site. Where this is not possible individuals can retrieve it from a safe allocated point on the site.
Medical waste.	First aid actions on site.	Stored on site in labelled sealed containers and removed by a local waste removal contractor for proper disposal off site.
Other construction materials waste such as steel and pipe off-cuts, used grinding discs, weld electrodes, welding flux, wire off-cuts, used timber, concrete.	Various construction activities	Scrap metal and wood will be collected and recycled at the local scrap yard.

Non-hazardous Waste

Construction waste will most likely consist of:

- Excavated soil:

  Earthworks will be required to make the site sufficiently level for the purposes of the OSRD. The amount of earth material cannot be estimated at this phase of the study, but it is likely to be of the order of 150,000 m^3. Where possible, excess cut material will be used as fill for foundations and road formation.

- Excess excavated material:

  Defined as inert material removed from the ground and sub-surface that will not be reused on site. It is intended as a part of the project design to achieve a neutral cut and fill balance whereby materials cut from one are of the site will be used to fill other areas as such minimising as far as practicable the need to ship excess excavated material off site for disposal.

- General construction waste

  Comprises unwanted materials generated during construction, including rejected structures and materials, materials which have been over ordered or are surplus to requirements, and materials, which have been used and discarded.concrete (from buildings, bunds and foundations) and scrap metal. All concrete mixing will be undertaken on impermeable plastic lining to prevent contamination of the soils and surrounding areas. The management of construction solid waste is detailed in the Environmental Management Programme (EMPr) and will incorporate reduction, recycling and re-use principles. All construction debris will be placed in appropriate on-site skips and periodically disposed of by a licensed waste contractor in accordance with applicable national regulations. The construction contractor will remove refuse collected from the designated waste storage areas at the site at least once a week. All rubble generated during the construction phase will be removed from the site regularly to a licensed landfill site.

These wastes will be generated at all construction sites and will typically comprise wood waste from formwork and false work, material and equipment packaging/wrapping, and surplus or rejected construction material.

Although the expected total volume of waste is quite limited, their storage, handling, transport and disposal has the potential to create visual, water, dust and associated traffic impacts.

During the construction phase, waste materials will be separated at source, where possible, according to its waste classification. Waste management based on the following priority values (the most important being at the top) should be developed for each category of waste:

- Avoidance and minimisation of waste generation by good design;
- Good site management to minimise over-ordering and waste material generation, particularly for bulk materials;
- On-site reuse of materials thereby avoiding unnecessary transport and disposal requirements.
- Off-site recycling. Proper segregation of wastes on site will increase the feasibility of recycling elements of the waste stream by off site Contractors.
- Treatment and disposal, which will need to be undertaken according to relevant regulations, guidelines and good practice.

Hazardous Waste

The construction phase will require the use of hazardous materials such as fuels and greases to fuel equipment and vehicles and maintain equipment. These substances will be stored on-site in temporary aboveground storage tanks. All fuels storage tanks will be locked, and fuels on site in drums will be stored in a locked container within a fenced and secure temporary staging area. Trucks and construction vehicles will be serviced off-site. The use, storage, transport and disposal of hazardous materials used for the Project will be carried out in accordance with all applicable national regulations. Material Safety Data Sheets for all applicable materials present on site will be readily available to on-site personnel. It is proposed that the construction contracting company supply the required temporary ablution facilities and be responsible for the removal and treatment thereof. KODAP will be responsible to ensure that the contracting company is accredited and has the necessary permits to remove the sewage. The sewage will be treated in accordance with the municipal sewage works policies and guidelines. There is potential for waste, effluent and sewerage stored on site to leach into the soil causing harm.

Chemical Waste: Typically generated by the maintenance of equipment, scrap batteries or spent acid/alkali, used engine oils and hydraulic fluids, waste paints, chemical/oil based emulsions, spent mineral oils and cleaning fluids, and spent solvents.

Chemical waste may pose serious environmental, and health and safety hazards if not properly managed. These hazards may include:

- Toxic effects on workers;
- Fire hazards;
- Downstream effects on water quality from spills;
- Downstream effects on sewage treatment plants where disruption is possible if chemical wastes enter the sewerage system in large quantities.

Since very little information is available of the OSRD design details, there is no firm basis for the estimation of the waste generated during the construction phase. However it is expected contractors will typically incorporate waste rates of 0.03 percent to 0.05 percent for major construction items.

Based on the experience from similar facilities, the estimated expected generated waste quantities are included in **Table 3.22.**

Table 3.22: Solid Waste streams – Construction phase

Waste stream	Type	Unit	Estimated Quantity				
			<10	<100	<1000	<10000	>10000
Paper	Non hazardous	kg		X			
Used office supplies	Non hazardous	kg		X			
Packaging material	Non hazardous	kg				X	
Domestic waste (kitchen waste)	Non hazardous	kg			X		
Metal (ferrous and non ferrous)	Non hazardous	kg				X	
Glass	Non hazardous	kg		X			
Plastic	Non hazardous	kg		X			
Spare parts (uncontaminated)	Non hazardous	kg			X		
Steel bands, cladding steels	Non hazardous	kg		X			
Thermal insulation	Non hazardous	kg		X			
Cables, plastic tubes	Non hazardous	kg		X			
Building material	Non hazardous	MT		X			

Excavated material	Non hazardous	MT					X
Tires	Non hazardous	pieces		X			
Printer cartridges, tones, etc.	Hazardous	kg		X			
Packaging material (contaminated)	Hazardous	kg		X			
Oily cloths, rags	Hazardous	kg			X		
Spent light bulbs and fluorescent tubes	Hazardous	kg		X			
Batteries, dry cells	Hazardous	kg		X			
Empty containments (contaminated)	Hazardous	pieces				X	
Spent X Ray films	Hazardous	pieces			X		
Spent auto spare parts	Hazardous	pieces			X		
Contaminated soil	Hazardous	m^3			X		
Gaskets, sealing material	Hazardous	kg		X			
Tools, machinery and electric equipment	Hazardous	pieces		X			
Office equipment	Hazardous	pieces		X			

3.24.3.2 Operation phase

All wastes generated by the operation of the OSRD facility (identified in **Table 3.23**) will be temporarily stored prior to transportation off-site. The temporary waste storage facilities will be located in such a place so as to enable access for waste transportation without impeding operation. All wastes stored on this site will be in clearly identifiable containers. All loading and unloading operations will be conducted in the dedicated area.

Table 3.23: Solid Waste streams – Operation phase

Waste type	Source	Management
Domestic wastes, including office waste and kitchen waste.	Administration office and support facilities	Stored on site in labelled sealed containers and removed by a local waste removal contractor for proper disposal off site.
Packaging waste, including wood, metal, uncontaminated glass and plastic.	Unpacking of delivered materials	Stored in skips ready for removal off site for recycling. The skip containing plastic will be covered so that material does not blow out of it.
Paint waste and tins/buckets.	Left over from painting / maintenance activities	Waste paint and paint tins/buckets are likely to be classified as hazardous waste and so will be stored with the hazardous wastes for removal by a licensed local waste removal contractor and disposed of using appropriate disposal methods.
Various hazardous wastes including oily rags and working clothes, activated carbon, expended sand blast and grit, chemical/oil containers. Spent mercury light bulbs / tubes, batteries.	Maintenance	The remainder will be stored in labelled sealed containers. These wastes will be collected as required by a local waste removal contractor for proper treatment and disposal off-site at a suitably licensed landfill facility to be identified.
Electrical waste including cables, cable drums (wood), and cable trays (galvanized).	Wiring / maintenance activities	Scrap metal and wood will be collected and recycled at the local scrap yard.
Medical waste.	First aid actions on site.	Stored on site in labelled sealed containers and removed by a local waste removal contractor for proper disposal off site.
Waste concrete, cement, broken ceramic scrap metal, Bitumen, tar paper, ruberoids, insulation material.	Left over from access and installations maintenance	Scrap metal and wood will be collected and recycled at the local scrap yard.

Non-Hazardous Waste

As mentioned in the construction waste section above certain guidelines should be followed with respect to non-hazardous wastes. Non-hazardous wastes should be disposed of at the new Limassol waste landfill once operational.

Hazardous Waste

As mentioned in the construction waste section above; construction hazardous wastes for management and disposal guidelines. The operators of the Centre will need to determine which options are most appropriate management practices however it should be expected that much of the hazardous wastes produced at the facility will require transport off the island by a appropriately licensed contractor before ultimate disposal.

Since very little information is available of the OSRD design details, there is no firm basis for the estimation of the waste generated during the operation phase.

Based on the experience from similar facilities, the estimated expected generated waste quantities are included in **Table 3.24.**

Table 3.24: Solid Waste streams – Operation phase

Waste stream	Type	Unit	Estimated Quantity				
			<10	<100	<1000	<10000	>10000
Paper	Non hazardous	kg			X		
Used office supplies	Non hazardous	kg			X		
Packaging material	Non hazardous	kg			X		
Domestic waste (kitchen waste)	Non hazardous	kg			X		
Metal (ferrous and non ferrous)	Non hazardous	kg			X		
Glass	Non hazardous	kg		X			
Plastic	Non hazardous	kg		X			
Spare parts (uncontaminated)	Non hazardous	kg		X			
Printer cartridges, tones, etc.	Hazardous	kg		X			
Packaging material (contaminated)	Hazardous	kg		X			
Oily cloths, rags	Hazardous	kg		X			
Spent light bulbs and fluorescent tubes	Hazardous	kg		X			
Batteries, dry cells	Hazardous	kg	X				
Empty containments (contaminated)	Hazardous	pieces		X			

Gaskets, sealing material	Hazardous	kg		X			
Tools, machinery and electric equipment	Hazardous	pieces		X			
Office equipment	Hazardous	pieces		X			
Paint	Hazardous	lt		X			
Sludge	Hazardous	m^3		X			

3.24.3.3 Non-normal Operations

The terrestrial activities associated with the operation of the OSRD facility have associated risks of accidents that can lead to spillages of oil, chemicals or other materials.

Whilst spill risks at the site are discussed in **Chapter 8** it is relevant to note that the clean up of hydrocarbons after a spill can create large amounts of contaminated waste in the terms of materials used and oily sludge. The handling and disposal of this waste will need to be carefully considered. Depending on the volume of the waste, disposal via incineration may be the most appropriate option.

3.24.3.4 De-commissioning

It is anticipated that the majority of the project components will be in place for 25 years or more and as such decommissioning will broadly comprise the following activities:

- Operating processes will systematically be shut down in a safe manner;
- Liquid and solid contents/wastes will be removed for treatment and disposal. For pipelines and tanks, this will entail flushing and cleaning to remove oils and gases; and
- The fate of the emptied and cleaned structures and equipment will then be decided by a feasibility study to determine the best environmental and economic solution consistent with international oil and gas industry practice.

It is anticipated, that all activities are manageable according to best practice at the time of decommissioning and as such, impacts are anticipated to be low.

3.24.4 Noise

3.24.4.1 Construction phase

NOISE

Construction activity inevitably leads to temporary noise generation at locations in close proximity to the construction activities. However, due to the typical distances between the proposed site and the nearest receptors, and significant acoustic screening in all directions, the impact of construction activity on residents and tourists will be negligible.

In the absence of specific information regarding the proposed construction plant and activities, it is possible to provide information as to the predicted construction noise levels using the methodology set out in BS 5228 in conjunction with general information regarding proposed activities.

Table 3.25 shows the noise levels associated with typical construction activities, and predicts the likely noise contribution from each item at a distance of 200 m. (This is the worst case distance from the boundary of the proposed site to the closest receptor).

The estimated sound pressure levels shown are worst-case estimates based on propagation attenuation only. Due to the screening offered by the topography of the intervening land, these levels would be up to 10 dB lower at the receptor locations.

The levels at 200m shown represent the worst case scenario, when the construction plant will be at its closest to the nearby receptors. For the majority of the construction period, noise levels will be lower due to increased distances between plant and receivers.

Considering the temporary and changing nature of the proposed construction works, and the large distances between the proposed construction activities and NSR locations, construction noise may be audible at times, but the noise level is not predicted to significantly increase pre-existing daytime ambient noise levels. Hence the impact of construction noise is not predicted to be significant.

Table 3.25: Sound Pressure Levels – Construction activities

Construction activity / Vehicle type	Typical A-weighted Sound Pressure Level (L_A) at 10 m db(A)	Estimated Sound Pressure Level (L_A) at 200 m dB(A)
SITE PREPARATION		
Dozer	75	49
Tracked Excavator	78	52
Wheeled Backhoe Loader	68	42
EXCAVATION		
Dozer	81	55
Tracked Excavator	79	53
Loading Lorry	80	54
Articulated Dump Truck	81	55
ROLLING and COMPACTION		
Roller	79	53
Vibratory Plate	80	54
PILING		
Hydraulic Hammer Rig	89	63
Large Rotary Bored Piling Rig	83	57
WELDING / CUTTING STEEL		
Welder (Welding Piles)	73	47
Generator for welder	57	31
Cutter (Cutting Piles)	68	42
OTHER		
Large Lorry Concrete Mixer	77	51
Concrete Pump	67	41
Tower Crane	77	51

The spatial distribution of the produced noise is presented in **Figure 3.14.**

VIBRATION

Some construction activities can be a source of ground-borne vibration, which can be a cause for concern at the nearest receptors. Typical activities that would lead to vibration effects include compaction, breaking and piling.

The impact at the nearest properties from any vibration activities is a function of the vibration source and the propagation path to the receptor; larger distances reduce the impact. Due to the large distances involved, construction vibration will not be discernible at the receptor locations. The impact of construction vibration will therefore be negligible.

3.24.4.2 Operation phase

NOISE

During the operation of the OSRD noise disturbance will be caused mainly due to the operation of hydraulic devices (various types of fuel pumps). The worst case that is taken into account is the contemporary operation of the listed devices during the typical operation of the OSRD installations. The pieces of equipment that were taken into account are the following:

Type of equipment	Number	Sound pressure per unit dB(A)	Sound pressure at 1m dB(A)
Fire fighting pumps	5	110	85
MOGAS pumps (near tanks)	4	100	85
JET A1 pumps (near tanks)	2	100	85
DIESEL pumps (near tanks)	4	100	85
Service pump	1		75
Motor operated valve		2	75

The spatial distribution of the produced noise for day time operation is presented in **Figure 3.15.**

VIBRATION

Sources of vibration on site are minimal. Vibration may be transmitted to the floor from balanced rotating equipment such as pumps; however, the level of induced vibration will not be sufficient to propagate to the nearest sensitive receptors over the distances involved. Hence the impact of operational vibration will not be of significance.

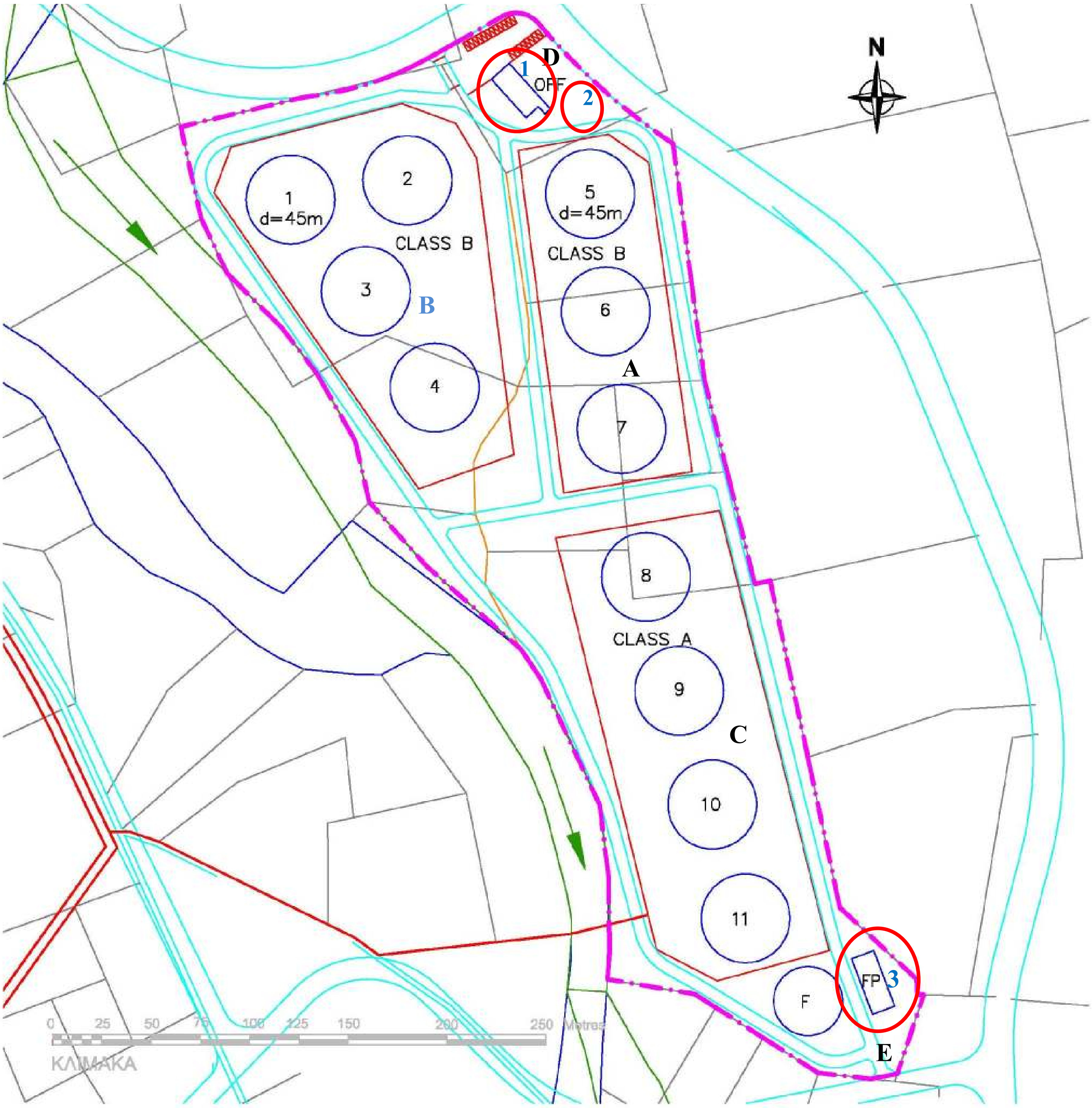


Figure 3.1: OSRD Overview Layout

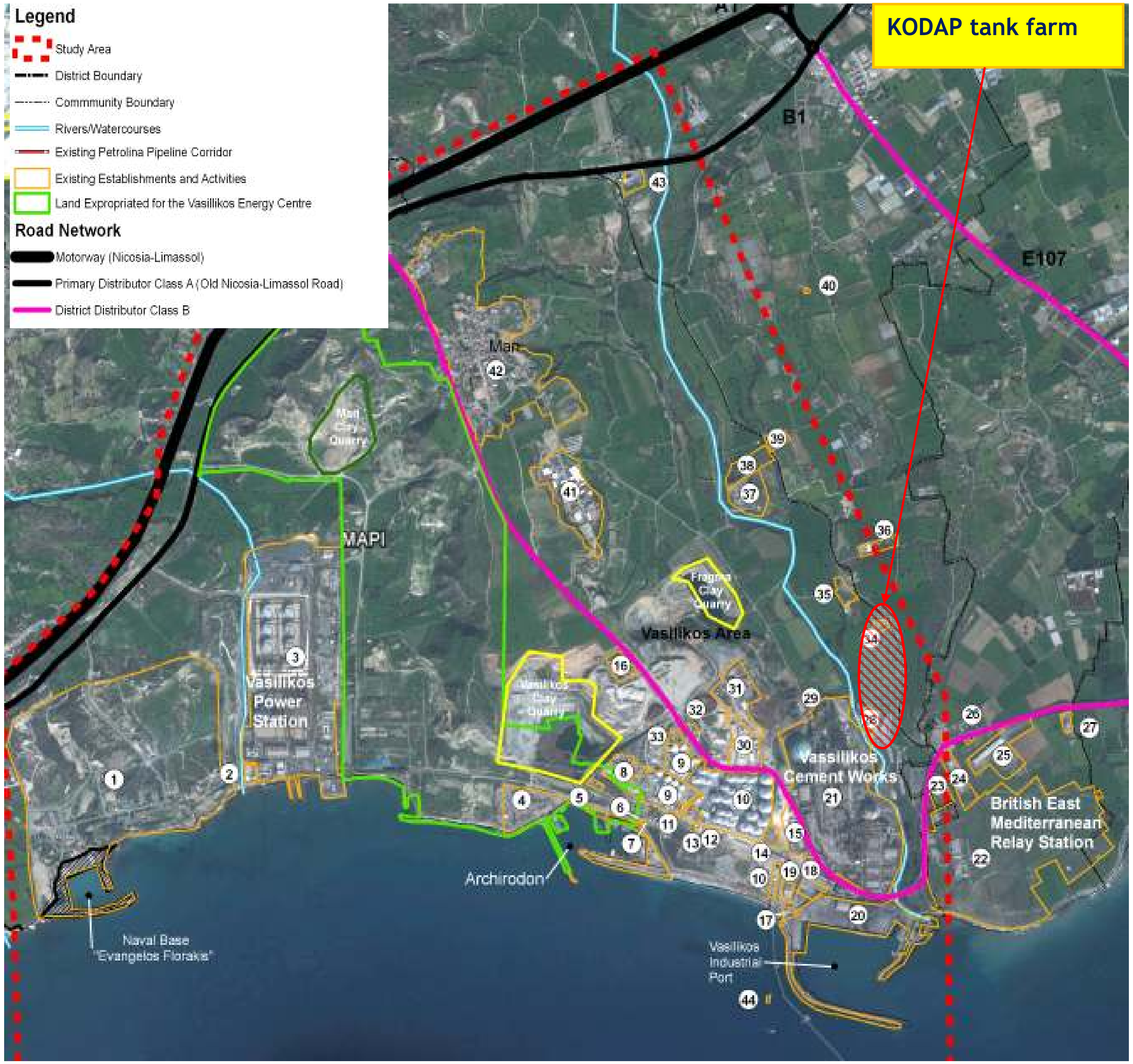


Figure 3.2: Map of OSRD broader area

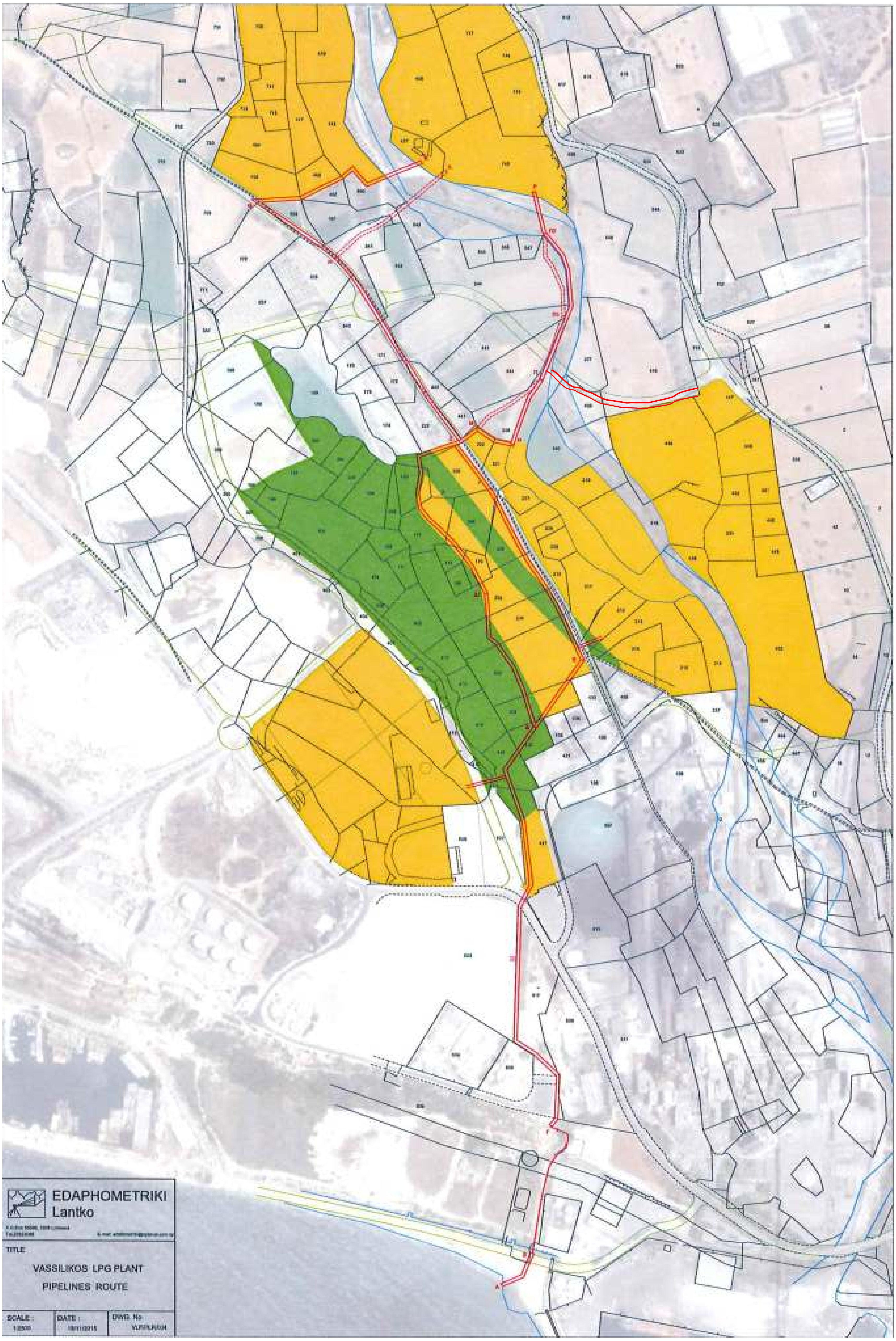


Figure 3.3: Pipe line routes

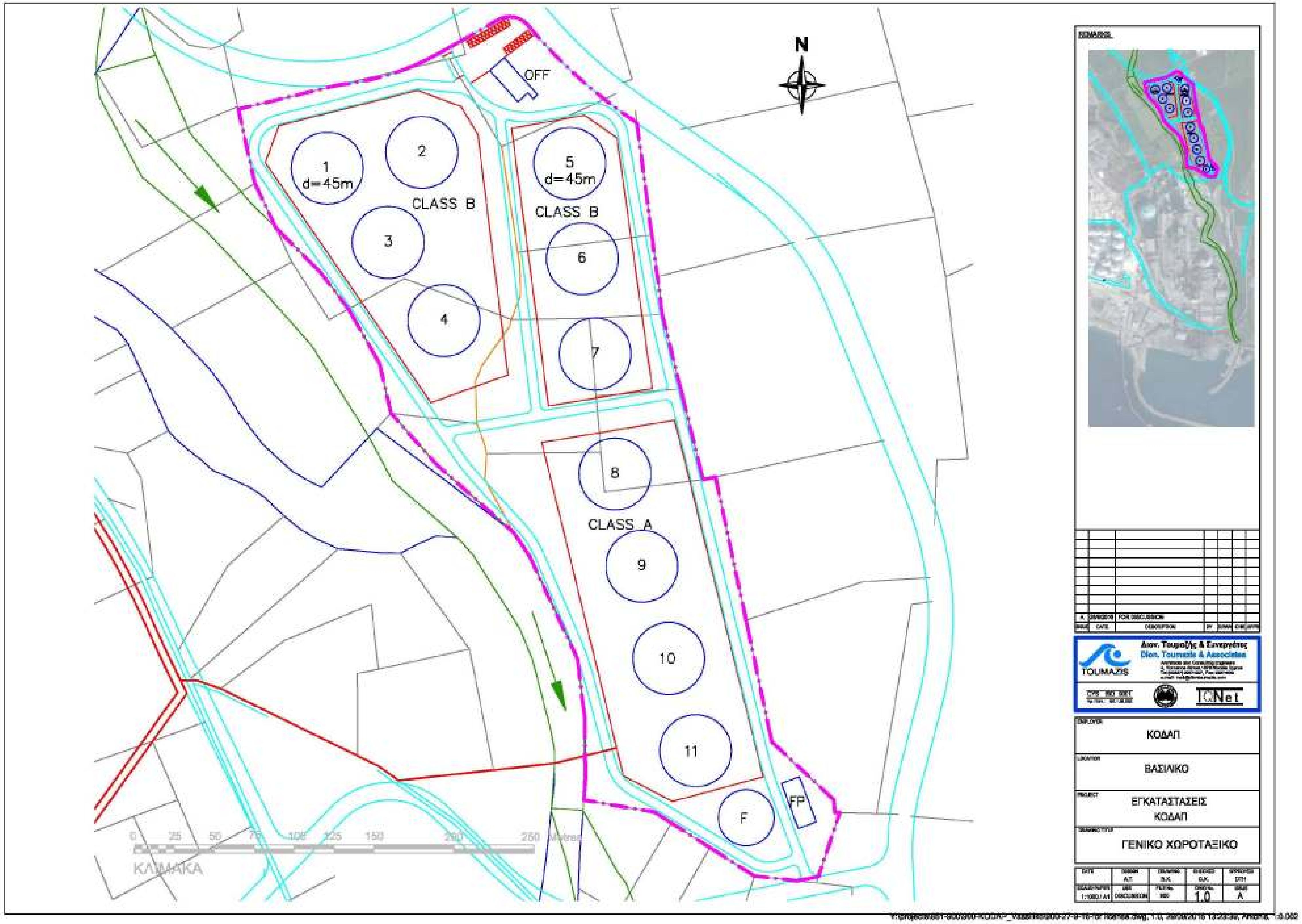


Figure 3.4: Detailed overview and side view of fuel tanks

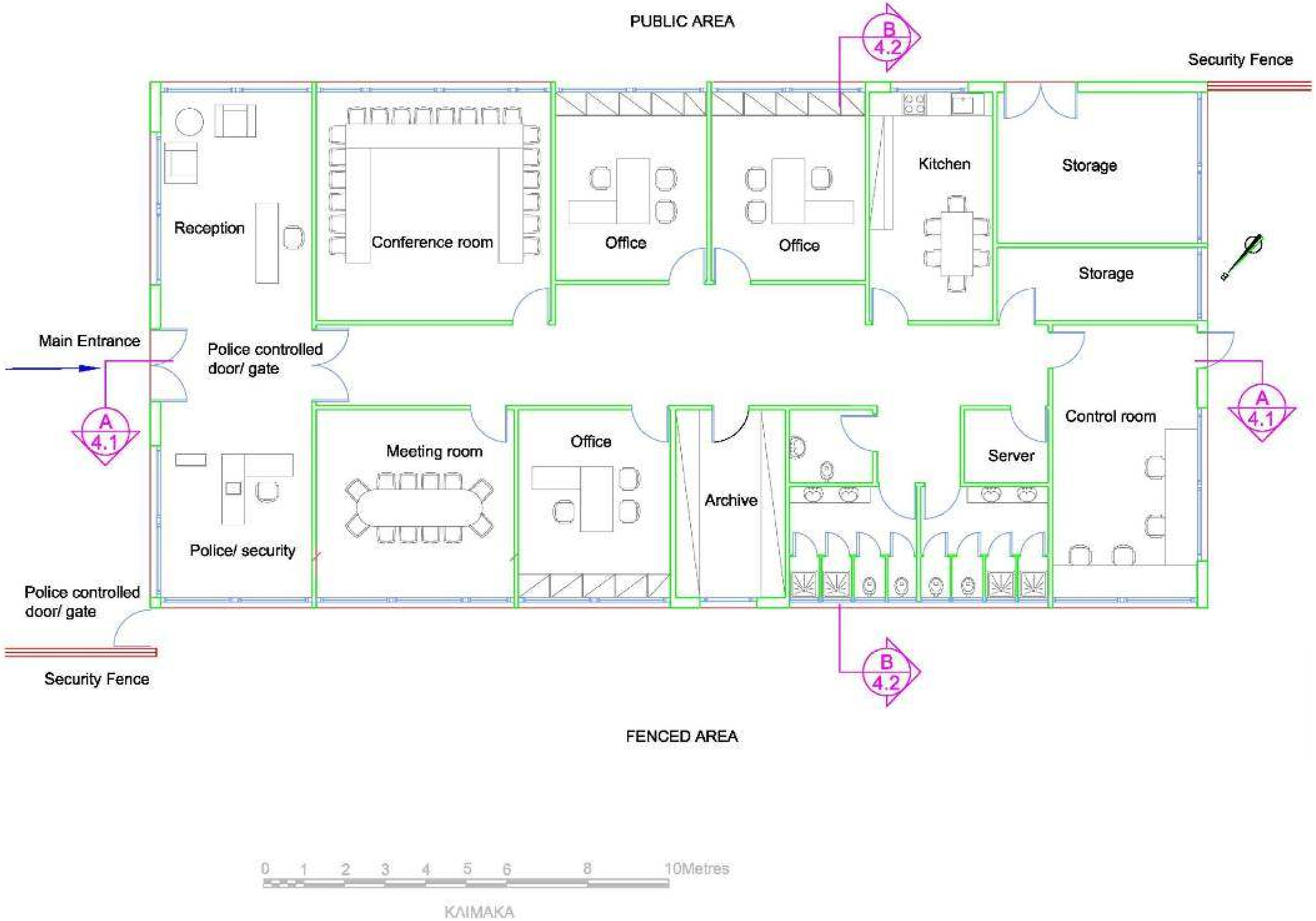
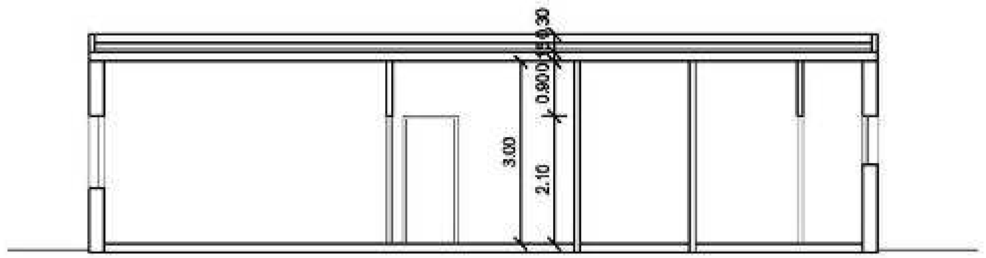
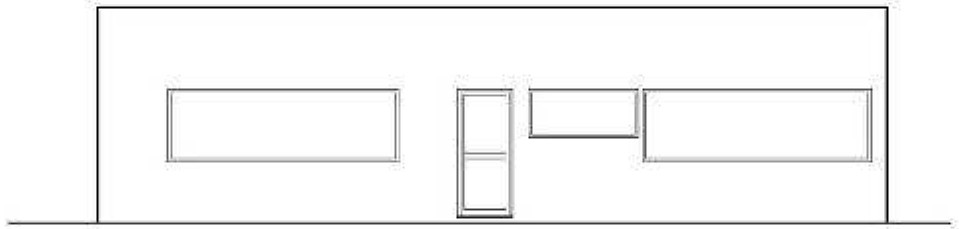


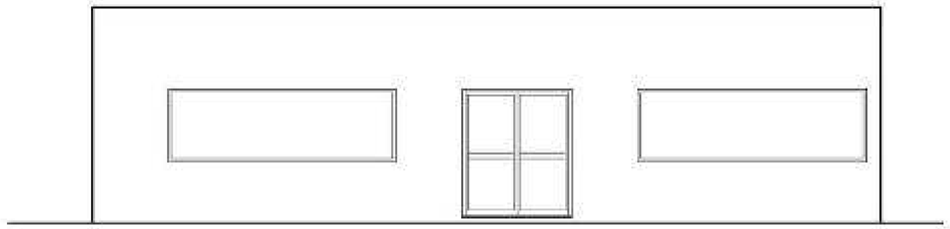
Figure 3.5: Office building



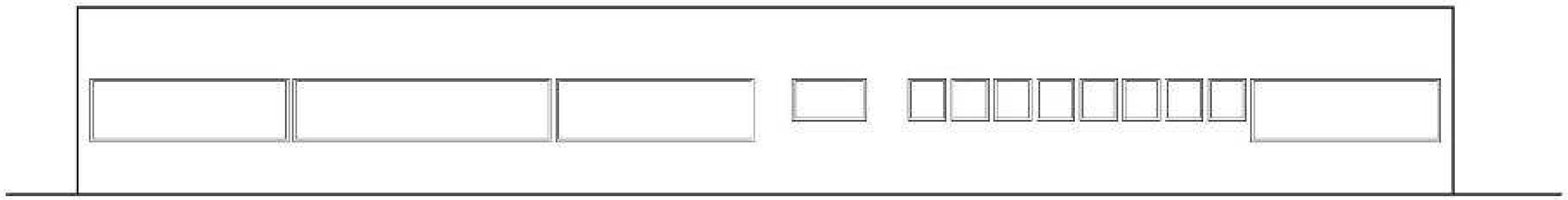
ΤΟΜΗ Β-Β



ΑΝΑΤΟΛΙΚΗ ΟΨΗ



ΔΥΤΙΚΗ ΟΨΗ



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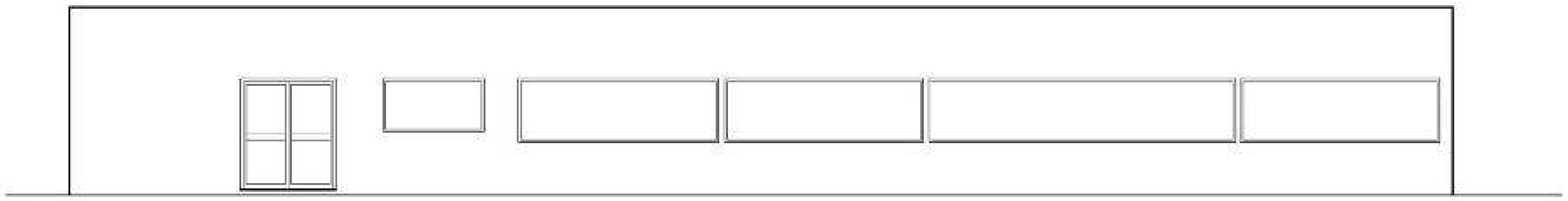


ΝΟΤΙΑ ΟΨΗ

Figure 3.6: Office building elevation layouts

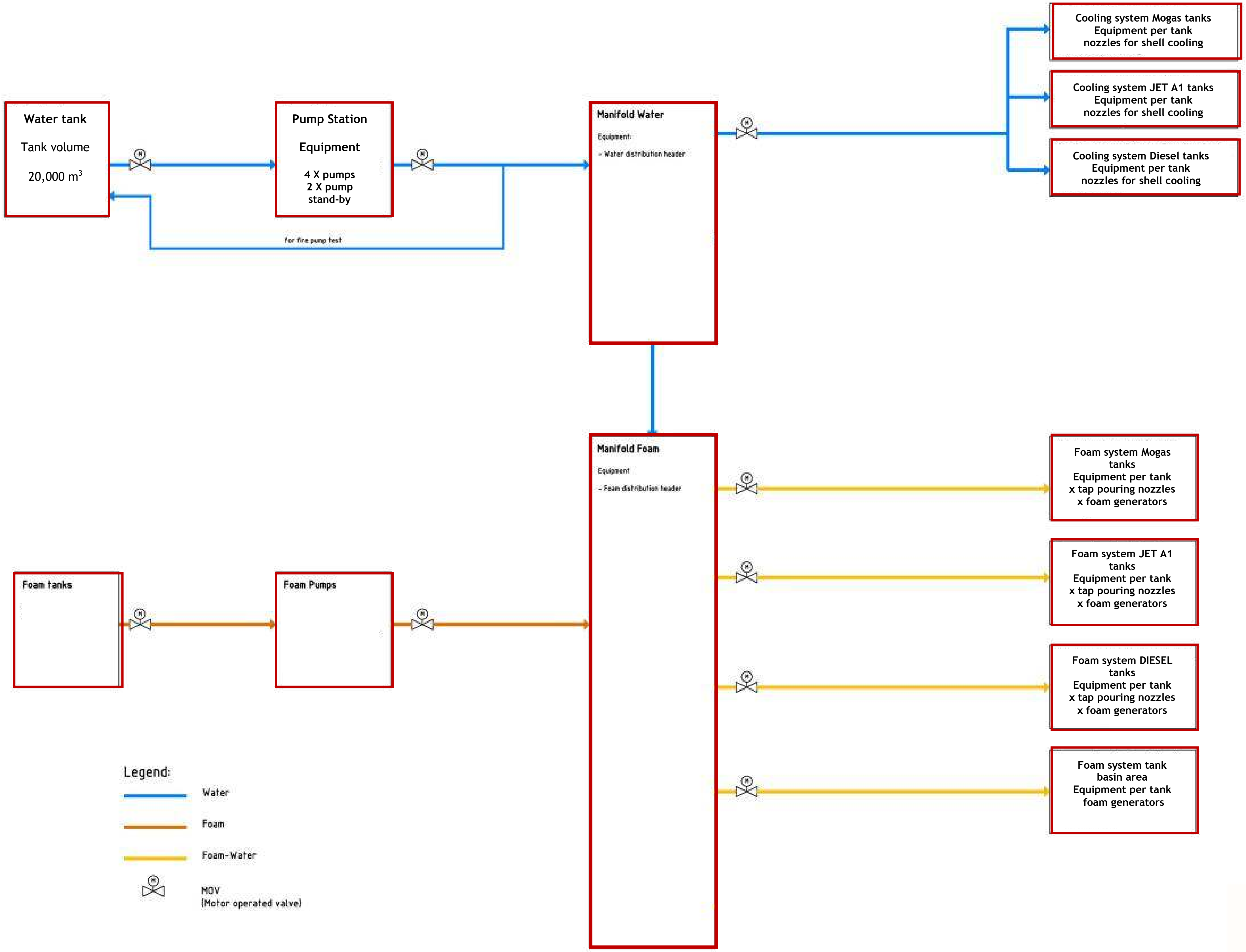


Figure 3.7: Fire fighting system flow diagram

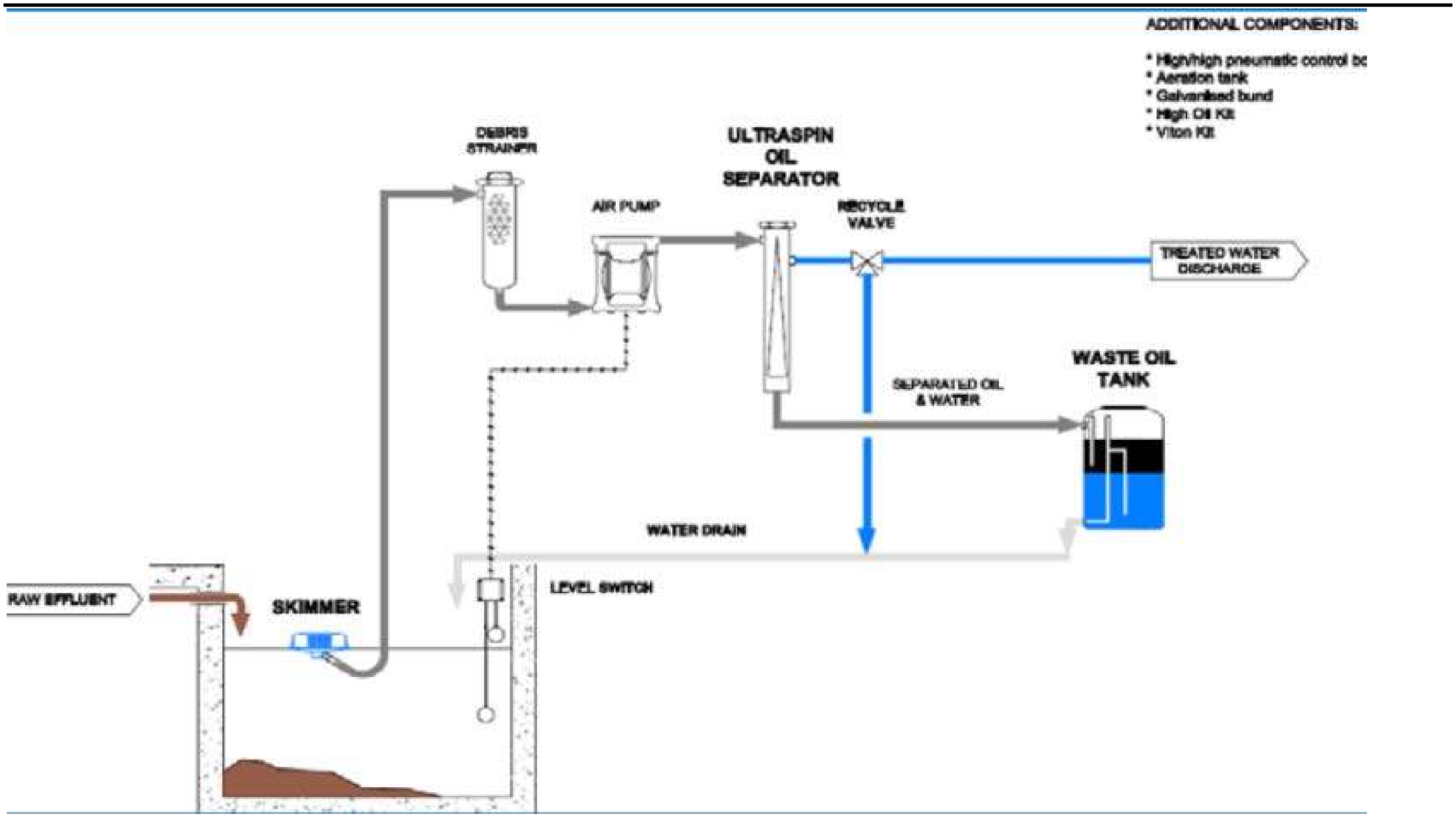


Figure 3.8: Oily water process diagram

Figure 3.9: Oily water process diagram

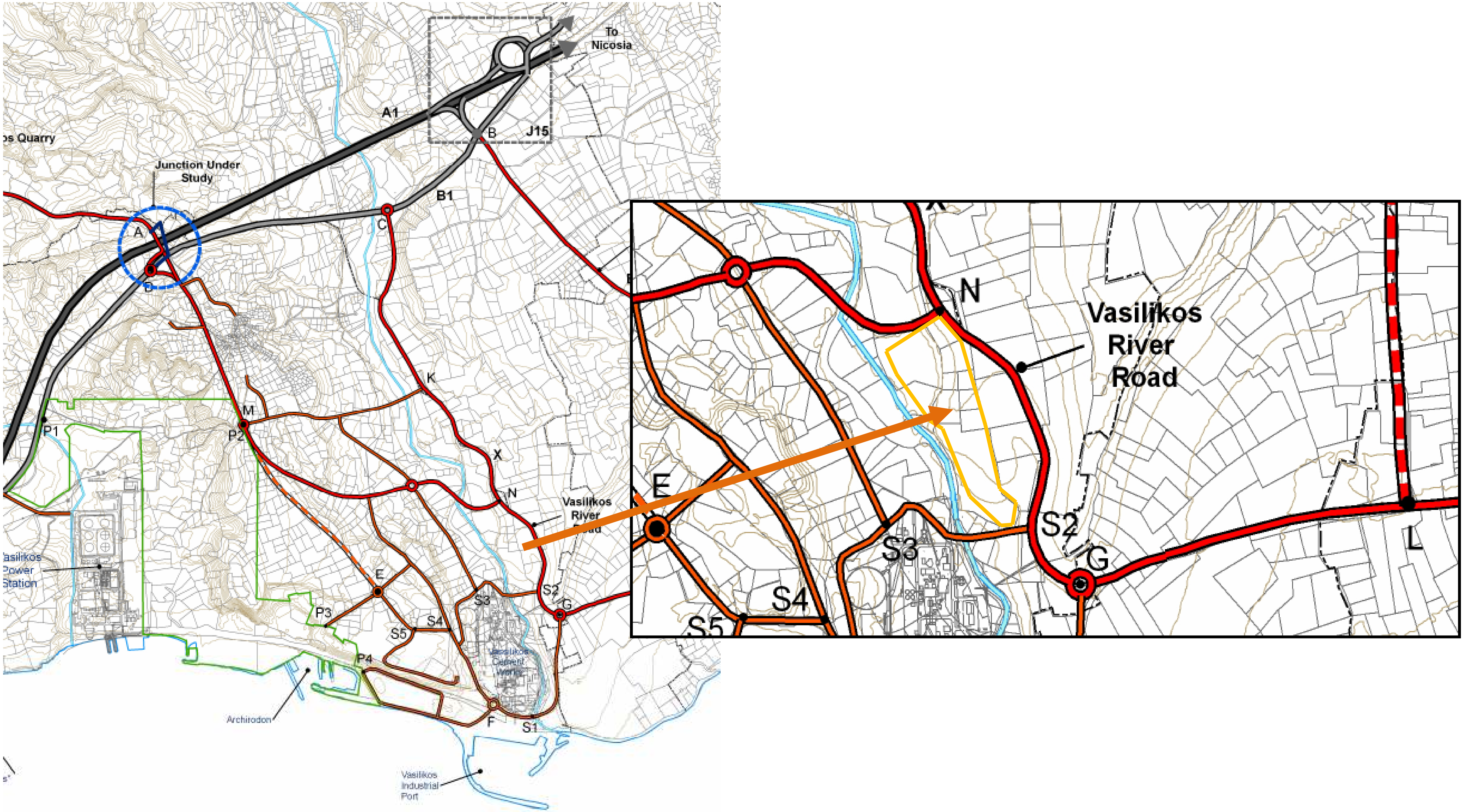


Figure 3.10: Road network

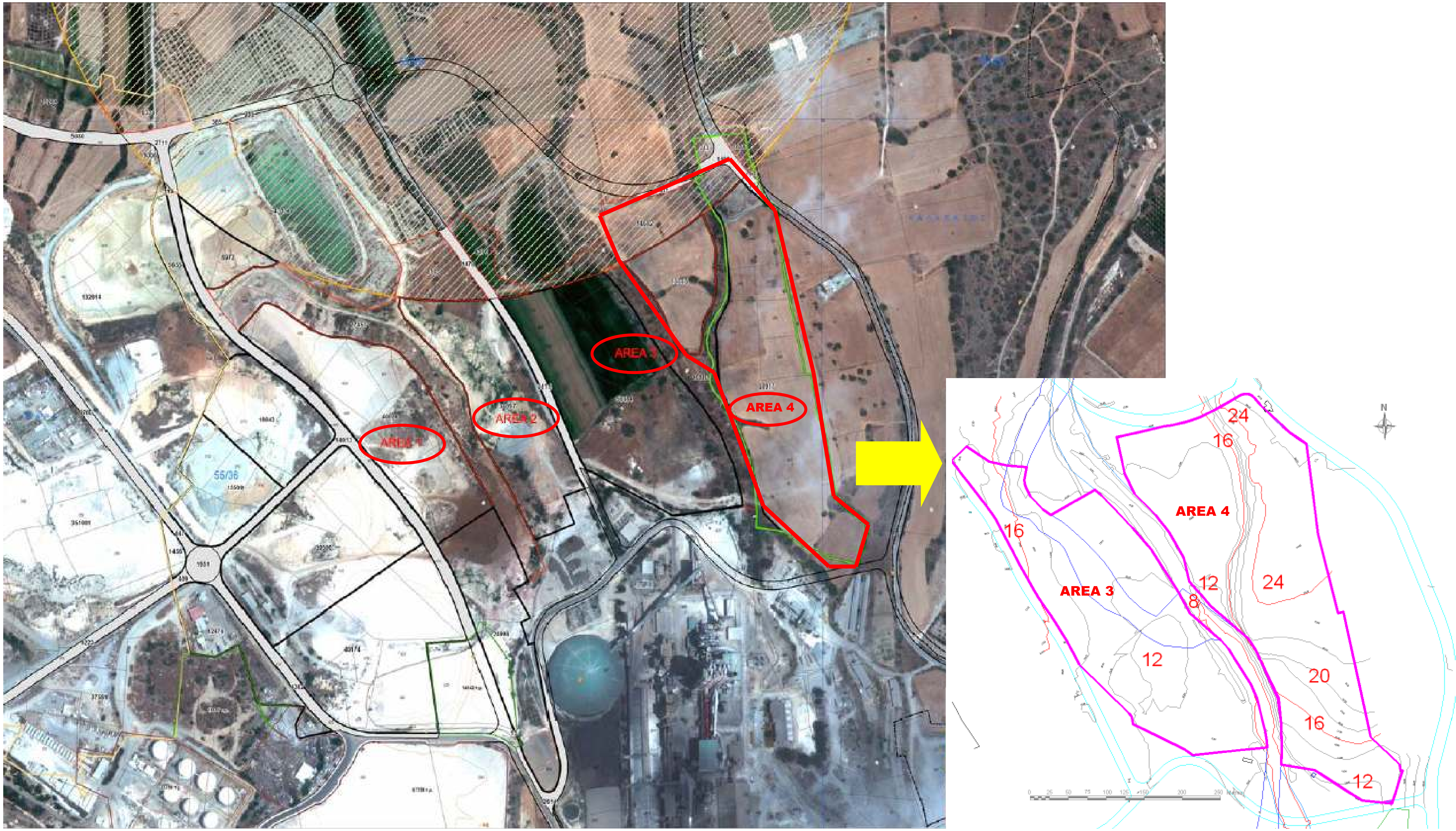


Figure 3.11: OSRD alternative locations - Stage I

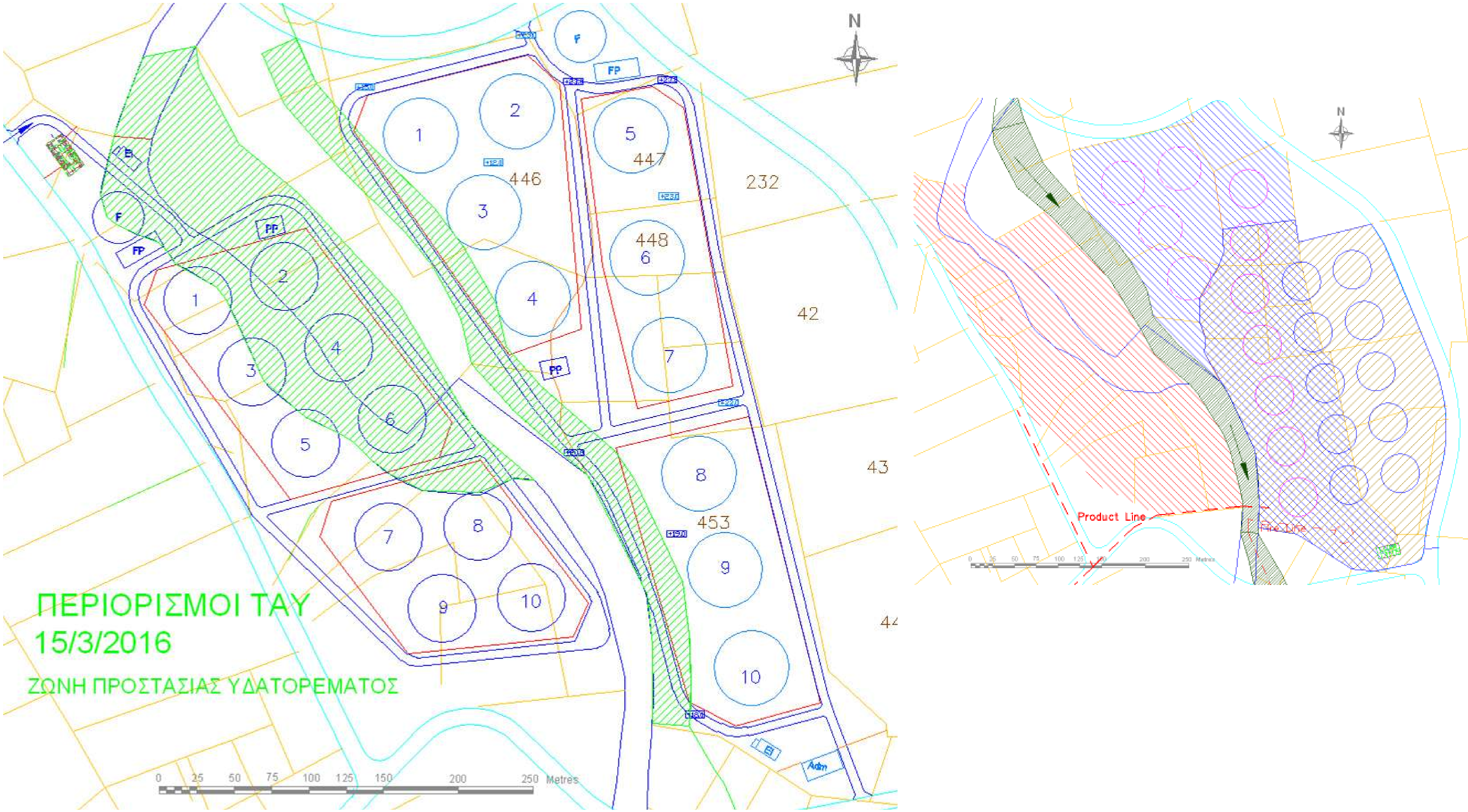


Figure 3.12: OSRD alternative locations - Stage II

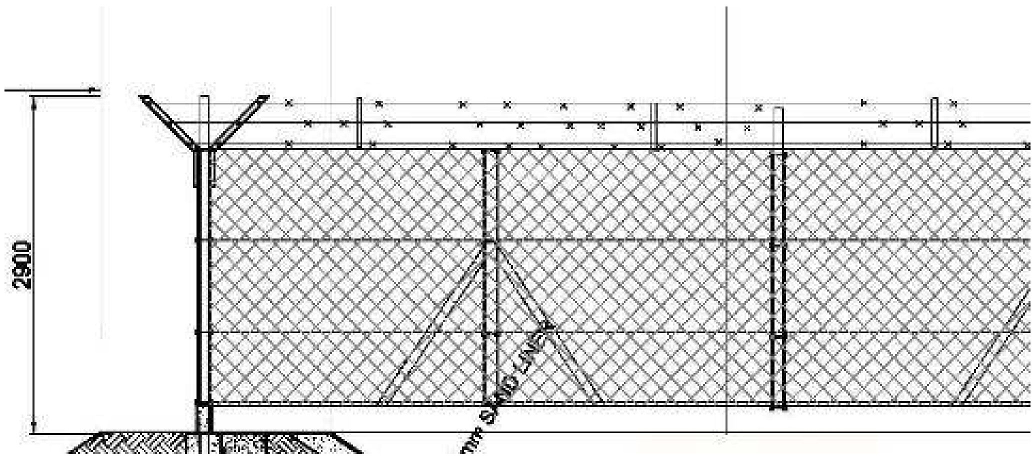


Figure 3.13: Fence

Figure 3.14: Noise levels during OSRD construction works

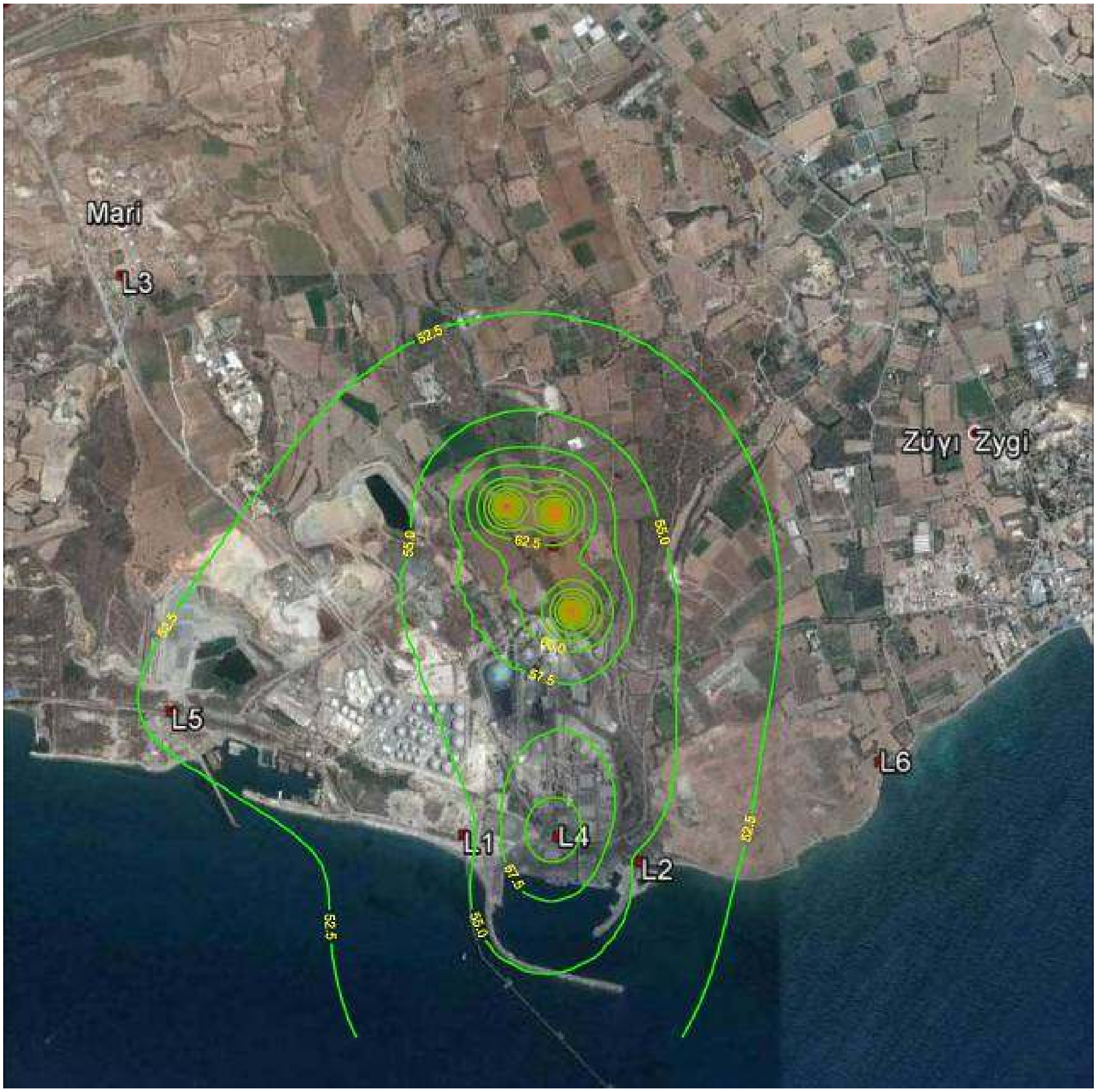


Figure 3.15: Noise levels– Operation phase : product transfer

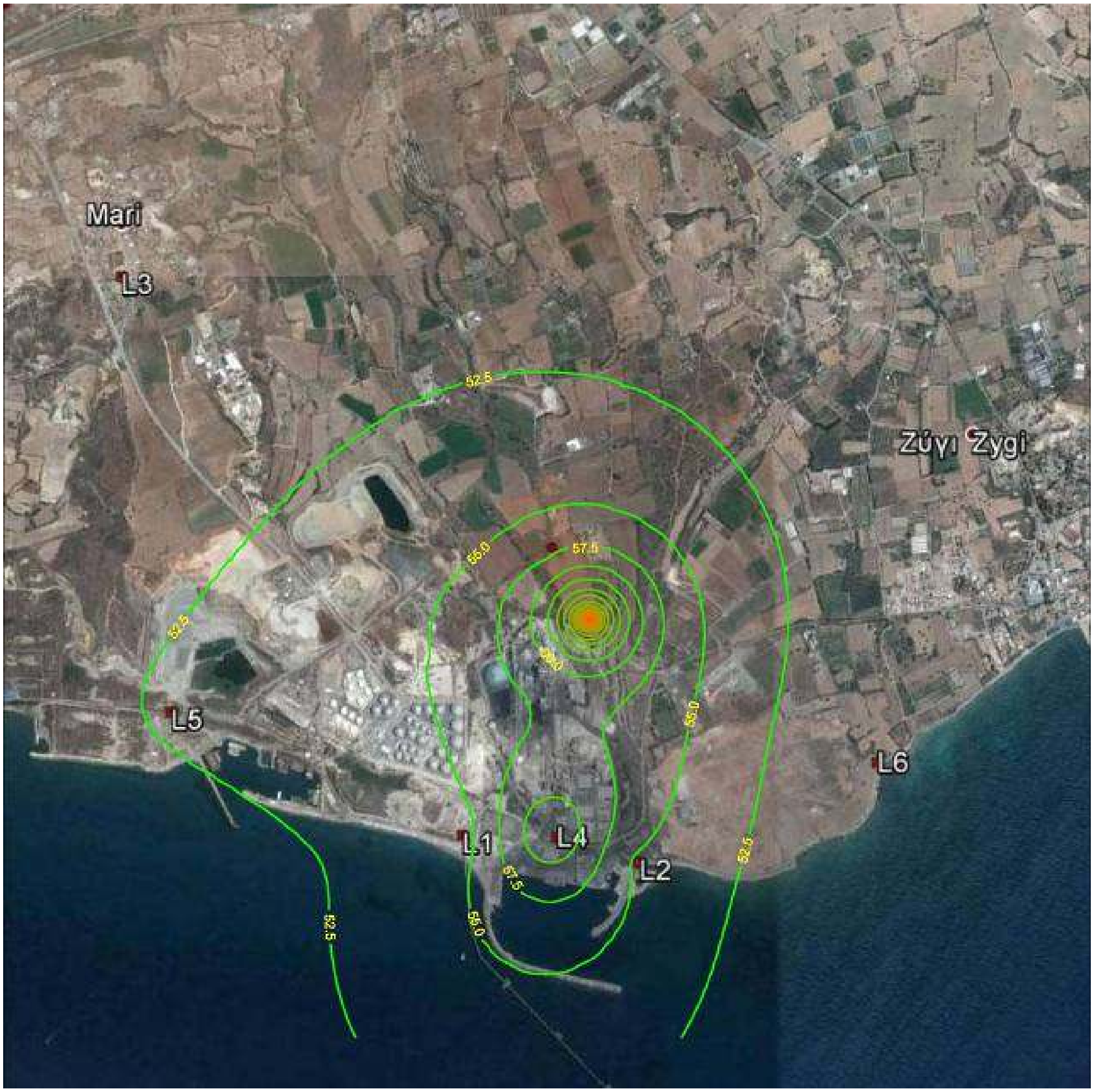


Figure 3.16: Noise levels – Operation phase : fire fighting drills

Chapter 4

Baseline environment description

Contents

4 ENVIRONMENT DESCRIPTION

The environment consists of the entire complexity of interacting geological, biological, social, economic and cultural factors, which influence the lives of individuals and communities. It is thus essential that the effects of any proposed development on all aspects of the environment be assessed before a decision to proceed is taken. The biophysical baseline conditions of the study area for this EIA are described in this section.

Information on the existing environment at Vasilikos area presented in this chapter was obtained using:

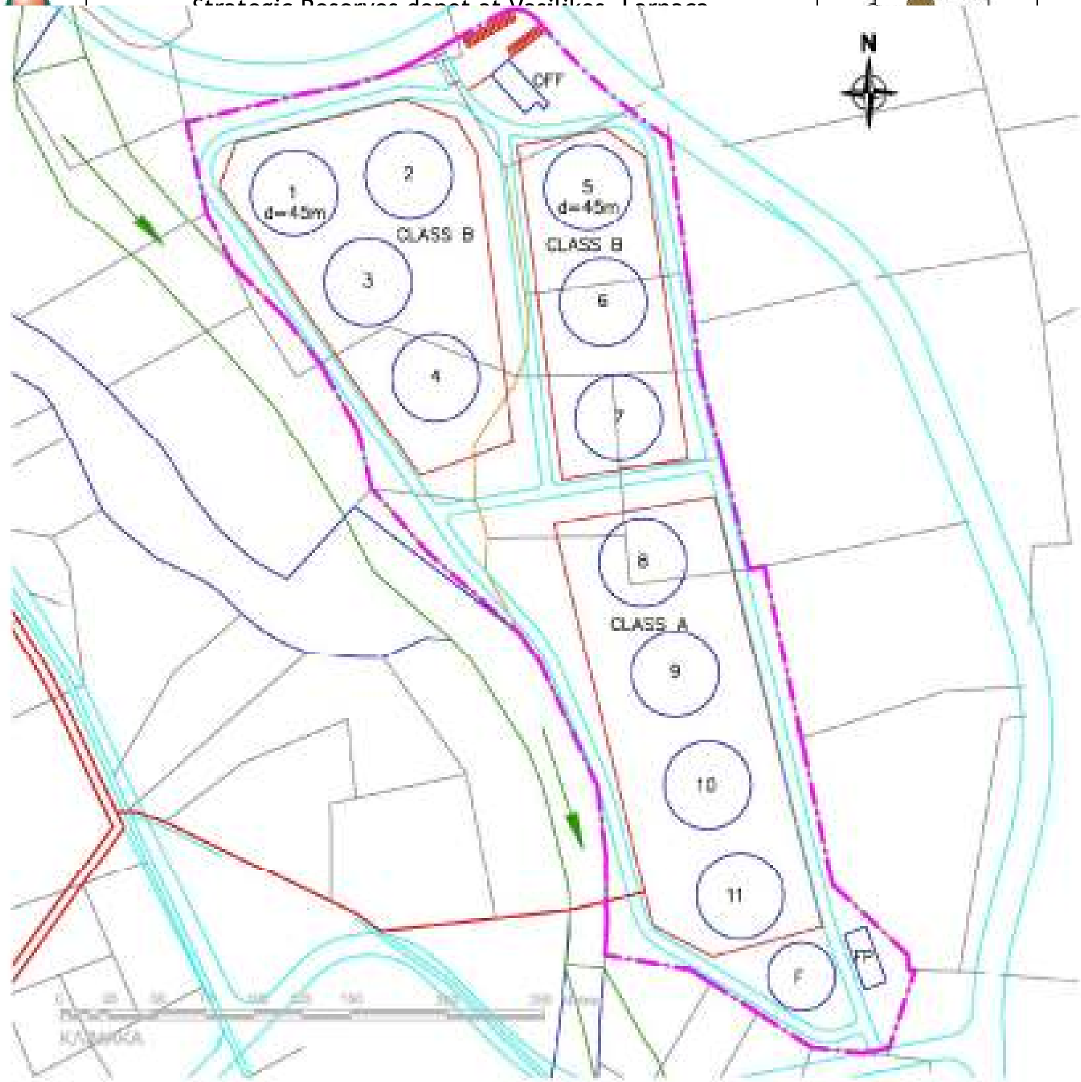
- Information supplied by the sponsors of the project;
- Data from the:
- Vassilikos Cement Works,
- Cyprus Port Authority,
- Meteorological Service,
- Electricity Authority of Cyprus,
- Fisheries Department,
- Department of Town Planning and Housing
- Statistical Service of Cyprus.
- Publicly available published sources;
- Data collected in situ;
- Information provided by other published reports and studies.

4.1 Natural environment -Introduction

The construction of a new complex of fuel storage tanks (Fuel Farm) is currently under design. The new Fuel Farm will be situated on the north/east of the Vasilikos Cement Company, and it will consist of the following:

- 11 oil storage tanks (45m in diameter, 22m in height)
- 1 water tank for firefighting purposes;
- 1 product pumping station;
- 1 fire-fighting pumping station;
- 1 administration building;

- 1 intake pipeline from the sea/ port (some 1.5km long) complete with its own pumping station by the sea/ port;
- A set of [3] product lines (about 1km long) which will connect the terminal with the import lines from Vasilikos Port and the storage terminals of other oil companies in the area;
- 1 mobile truck loading system



one of the main Hellenic Mining Company mineral processing complexes for copper and iron ore. Since the early seventies, industries such as Vasilikos Cement Works (VCW), Vasilikos port (currently jointly operated by VCW and Cyprus Port Authority) and Cyprus Chemical Fertilisers Industries (CCFI) were established and operated in that area. Additional industrial units and facilities were commissioned in the area during the 1990's, Vasilikos power stations by Electricity Authority of Cyprus (EAC) which is the biggest power plant of Cyprus; and other small scale units. Vasilikos is also the designated area for the relocation of petroleum storage facilities currently operating at Larnaca bay.

After the decommissioning and dismantling of the CCFI plant, an area of approximately 1,000,000 m^2 is designated for future use as the Vasilikos Energy Centre (VEC), a project initiated by the Department of Energy where a large scale project that will include the strategic fuel stocks for the Republic, a Liquid Natural

Gas storage and regasification facility as well as petroleum products storage and truck loading facilities for the local market will be implemented.

The Vasilikos industrial area is classified as Heavy Industrial Zone B2. Power plants and industrial complexes are already operating in the area. A number of large scale projects were also announced and/or are currently at the conceptual/ basic design phase. There are currently four marine/naval facilities operating in the area, namely the Vasilikos port, an industrial import/export port, the Archirodon port where barges, floating machinery and fishing boats are stationed, the Zygi fishing shelter where local fishermen boats are berthed, and the 'Evangelos Florakis' base, a military naval installation.

Vasilikos area may be considered as the heart of the energy and heavy industry of the island. There are numerous, vital energy and industrial complexes in the area and the area may be described as heavily burdened, in environmental terms. The existing planning zone (B2 – Heavy Industry Zone) justifies the area as the most suitable for this type of development.

Facilities and installations currently operating in the wider Vasilikos area are listed in **Table 4.1** and their location can be seen on **Figure 4.2**.

Table 4. 1: Installations in the wider Vasilikos area

1. Naval Base "Evangelos Florakis"
2. Desalination Plant
3. Vasilikos Power Station
4. Archirodon Port
5. Archirodon Offices
6. Telia Vasilikos Fish Storage
7. Petrolina Booster Pump
8. Archirodon Storage Facilities
9. Petrolina Tank Farm
10. VTTV Tank Farm and Support Facilities
11. Old Vasilikos Custom Offices
12. New Vasilikos Custom Offices
13. Church
14. Vouros Group-Handling Medicinal Waste
15. Vasilikos Cement Works Crusher
16. Construction Storage
17. Sulphuric Acid Storage
18. Animal Foods
19. Ecofuel Processing Unit
20. Vasilikos Port
21. Cement Factory
22. British East Mediterranean Relay Station
23. Football Field and Park
24. Blue Island Fish Industry
25. Metal Storage and Retail
26. VCW Medical Offices
27. Seawave Fish Indusrty
28. Simona Construction
29. Mari Substation
30. J&P Construction Camp
31. Economides Metal Recycling
32. Trucks Weighing Station
33. Air Pumps Machinery
34. Cement Storage Silo
35. General Storage Yard
36. Scrap Storage Facilities
37. Concrete Batching Plant
38. Bottle Recycling
39. Scrap Metal Storage
40. Church
41. Animal Husbandry Area
42. Mari Development Zones
43. Lorry Maintenance Facilities
44. Old Loading Pylon

KODAP tank farm

Figure 4.2: Facilities and installations in the proposed development area (Source: Vasilikos MasterPlan, 2015)

The wider area of Vassilikos hosts the following installations (in brief):

EAC's Vassilikos Power Station

This Power Station is situated around 25 km east of Limassol on the southern coast of Cyprus. The first phase of the Station was commissioned in 2000 and consists of 2 x 130 MW heavy fuel oil/steam units and 1 x 38 MW diesel oil fired gas turbine which was commissioned back in 1999 and mainly serves as a black start unit. The second phase consists of 1 X 130 MW heavy fuel oil steam unit. This unit is also equipped with a Flue Gas Desulphurization Unit (FGD) for reducing the dioxide emissions below the limits set by the European Large Combustion Plants Directive.

Vasilikos Power Station generated in 2006, 2.293.410 MWh, which corresponds to 49,66% of the total electricity generated from the Authority's Power Stations. During the same period the Station exported, 2.160.237 MWh, which corresponds to 49,52% of the total electricity exported from the Authority's Power Stations.

The thermal coefficient of efficiency of the Steam Units for units generated reached 39,22% whereas the corresponding thermal coefficient of efficiency for the Gas Turbines reached 23,45%.

Moreover, the thermal coefficient of efficiency of the Steam Units, for units exported, reached 36,95% whereas the corresponding thermal coefficient of efficiency for the Gas Turbine reached 20,49%.

On July 11th 2011, due to an explosion at the adjacent Mari Naval Military Base, Vasilikos Power Station suffered extensive damage which has caused the complete interruption of its operation.

Immediately after the incident a series of decisions and actions were taken to install and operate temporary generating units. The installation and operation of existing standby generators was mandated by the Energy Regulator. To that extend the Electricity Authority of Cyprus has collaborated closely with the generator owners, offering technical support and planning.

The Israel Government offered standby generators, totaling 15MW, which were installed on the distribution networks within the 2nd week after the incident.

An agreement was reached for the supply of up to 120 MW from a Power Company operating in the Turkish Occupied Areas. This supply was made possible under the green line trade collaboration between the two communities. Initial connection took place on the 16th July 2011 and the current agreement expires on the 29th February 2012.

The Greek Government, through the Public Power Company (PPC), has mobilized 71,6 MW of temporary generating units. These units were installed in the Vasilikos Power Station Area, and have been operating since 14th August. The lease contract has since been extended by EAC for an additional 6 month period.

The Vasilikos Power Station Black Start Gas Turbine (38 MW) was restored and put in operation by August 17th.

The Electricity Authority of Cyprus has contracted, in accordance with the Cyprus Energy Regulating Authority Decision, temporary generating units with a total capacity of 95 MW, for a six month period. The initial request for proposal was issued on July 13th and contract award was on July 30th. These generators have been in operation in Dhekelia and Moni Power Stations since late August.

The combination of the above measures has ensured that the electricity system has enough, albeit marginal, capacity to meet the electricity demand, and the rotating power cuts have effectively stopped since mid August.

The Electricity Authority of Cyprus is proceeding with the restoration of the Vasilikos Power Station, and to that effect a large Restoration Project Team has been established. The mission of the Project Team is the speedy, safe and cost effective return of the station to full operation.

Though the final restoration schedule is still being developed, as the detailed damage assessment is still ongoing, the targets of the restoration are set with an aim to reduce the economic effects, mainly by reducing the electricity cost to its prior level, the soonest possible.

Picture 4. 1: EAC Vasilikos Power Station

<u>PPT Aviation Services Ltd and Petrolina Holdings PLC, Vasilikos terminal</u>

Integrated storage facility comprises of 8 tanks, approximately 5000 m^3 capacity each. It is situated approximately 1 km west of the proposed power plant. The Petrolina Holdings terminal comprises of 4 tanks predominantly for heavy fuel oil storage and there are plans for the import and storage of bitumen at a later stage. PPT Aviation Services Ltd manages three storage tanks in JET A1 service. Remaining tank is in heavy fuel oil service and is managed by Vasiliko Cement Works. Petroleum derivatives unloading is taking place at Vasilikos port and product is transferred to storage facilities via pipelines, running at a relative distance from the shoreline. Product transfer is assisted by a booster pump station. Supporting facilities such as heating package, fire water mains and waste water treatment are available for this terminal.[1]

Scrap Metals Storage Yard

A scrap metals storage yard is situated adjacent to Petrolina Holdings storage terminal at approximately 1,000 m distance from the proposed construction site.

Picture 4. 2: Petrolina Holdings storage terminal and Scrap metals storage yard

Navy Base "Evagelos Floraki"

[1] *EIA Study of Design, Construction, commissioning and operation of marine jetty at Vassilikos Area – VTTV, Prepared by Quality Link, Jan.2011*

A naval base of the Republic of Cyprus Navy (named Evagelos Florakis) is located to the southwest of the under examine area. A relatively small port was constructed in order to meet the needs of the base's operation. There are also two exercise areas located to the east of the Marine Base.

Vassilikos Cement Works

The cement works is one of two Cypriot cement kilns, the other being the Moni Cement Industry facility located roughly 13 km to the west of the Vassilikos site. Vassilikos Cement Works Ltd was established in 1963, as a Public Company, on the initiative of Hellenic Mining Company. Vassiliko was chosen as the best possible location for the erection of the plant in view of the abundance of raw materials of excellent quality and the proximity to the sea.

Picture 4. 3: View of Vasilikos Cement Works

Vouros Healthcare Clinical Waste Processing Unit

Vouros Healthcare Clinical Waste Processing Unit is located at approximately 1.200 m distance from the proposed facility implementation site. Hazardous medical wastes are collected in the unit and sterilised before are being sent to the landfill.

Picture 4. 4: Vouros Healthcare Clinical Waste Processing Unit installation

Vassilikos harbour

Vasilikos Port (34°43'N, 33°19'E) is a small industrial port situated near the entrance point of Vasilikos Bay, 25 km north east of Limassol city. The principal function of the port is to service the cement plant close that stands north of the port. It has facilities for handling bulk and liquid chemical products, together with a Ro-Ro facility.

Picture 4. 5: View of Vasilikos harbour

Slop oil and Oily water processing unit (now abandoned)

A facility for the processing of slop oil is situated adjacent to Vouros Clinical Waste Processing unit. The facility is now non operational and it is abandoned.

Picture 4. 6: Slop oil and Oily water processing unit (now abandoned)

Customs House

Vasilikos port Customs House is situated adjacent to Petrolina Holdings storage terminal, at approximately 0.5 km distance from the proposed construction site.

Picture 4. 7: Vasilikos port Customs House

Vasilikos Quarry

Vasilikos Quarry is situated approximately 1.4 km in an area west of the proposed construction site. The basic raw material for the making of cement is produced in the Limestone Quarry of the Vasilikos Cement Industries. The Limestone Quarry operates since the very first years of the Cement Industry's establishment.

Archirodon Port

The Archirodon port is a small industrial port/ shelter which is situated approximately 500 metres west of Vasilikos industrial port and approximately 1.2 km south - west of the proposed construction area. It is mainly used for the repair and maintenance of Archirodon's vessels and other floating media. The port has a permit, to operate in the area by the Cyprus Ports Authority.

Picture 4. 8: View of Archirodon port

VTT Vasilikos Plant

Vitol Tank Terminals International (VTTI) proposes to develop a marine jetty facility at Vasilikos bay, Cyprus to enable safe berthing of oil tankers' to facilitate hydrocarbon loading, unloading and ship to ship operations. Proposed facility construction is expected to commence at the same time as Vitol Tank Terminals Vasilikos, in the same area.

Ecofuel installations, used oil processing facilities

Ecofuel's facility is a slop oil/ oily water reception, processing, separation and treatment facility, situated adjacent to Vasilikos port.

Picture 4. 9: Ecofuel installations, used oil processing facilities

Zygi Fishing Shelter

The new Zygi fishing shelter is located approximately 2 km east of the proposed construction site. It has a capacity of approximately 200 boats.

Picture 4. 10: Zygi Fishing Shelter

EAC's Single Point Mooring

EAC’s Single Point Mooring (SPM) is primarily used for Heavy Fuel Oil and Gasoil imports for the adjacent power plants. It is located at a distance of approximately 1 km from the shore and at approximately 3.5 km distance south west of the project implementation site. Vessels up to 80,000 DWT can safely berth at the SPM and its occupancy is approximately 3-4 days every month.

Picture 4. 11: EAC’s Single Point Mooring, Vasilikos bay

Aquaculture Installations

There are six licensed aquaculture facilities operating in the greater Vasilikos bay area (area between Vasilikos port and Cape Dolos). At the moment, four facilities are operational whereas the remaining two are dormant. The closest fish farm facility, Telia Aqua Marine Public Ltd is situated at approximately 2 km distance from the proposed facility construction site.

Picture 4.12: Blue Island aquaculture installation, Vasilikos bay[2]

4.1.2. Potential Future Developments

According to Vasilikos Master Plan (2015) there are plans for several other facilities within the general area such as a HVDC converter station for an electrical submarine cable (the EurAsia Interconnector), a wind farm, warehouses, fish food manufacturing plants, power stations etc.

In addition, VTTV Ltd is operating an oil storage depot in the area, and is also planning the expansion of this depot on reclaimed land near the Vasilikos Industrial Port. Another major development is the current expansion of the existing oil storage depot owned and operated by Petrolina (Holdings) Public Ltd.

Very close to the plot where the OSRD will be erected a number of petroleum facilities will be developed in the very near future.

These include (**Figure 4.13**):

[2] EIA Study for the expansion of Blue Island PLC aquaculture installation, Vasilikos Bay, AP Marine Environmental Consultancy Ltd, Feb 2012.

1. Hellenic Petroleum Cyprus /Intergaz / Petrolina / SYNERGAZ LPG storage facility (plot 2);
2. Blue Circle Engineering LPG storage facility (plot 1a);
3. Petrolina storage facilities (plot 4)– existing;
4. KODAP (plots 8 and 9);
5. Exxon Mobil (plot 10);
6. BP Eastern Mediterranean (plot 11a);
7. Petrolina (Holdings Ltd.) (plot 14)
8. Hellenic Petroleum Cyprus (plot 15)

2

1a

8

9

10

11b 4

11a

14 15

Picture 4.13: Future Fuel storage developments

4.1.3. Authorities at the Vassilikos Bay Area

- Ministry of Defence (National Guard). Military reserved zones in the area are "Evangelos Florakis" naval base and Zygi antiaircraft training grounds.
- Ministry of Communications and Works
  - Department of Merchant Shipping (DMS). The Department of Merchant Shipping (DMS) is responsible for all aspects related to vessels and tanker safety, commercial shipping legislation as well as international treaties and conventions singed by the Republic. Furthermore, DMS is responsible for tier II and III emergencies handling and marine incidents/ accidents in national territories and marine security aspects.
  - Public Works Department (PWD). Responsible for public roads and infrastructure development
  - Department of Electromechanical Services (EMS). Responsible for Electrical/Mechanical installations and equipment.
  - Department of Antiquities.
- Ministry of Justice and public order (Police, Fire Brigade, EMAK)
- Ministry of Health (Larnaca Hospital)
- Ministry of Labour and social insurance
  - Department of Labour Inspection (DLI)
- Ministry of Agriculture, Natural Resources and the Environment
  - Department of Environment
  - Department of Fisheries and Marine Resources (DFMR)
  - Department of Forests. Natura 2000 areas (Vassilikos river basin)
  - Water Development Department
- Ministry of Commerce, Industry and Tourism
  - Department of energy (Responsible for industrial development and energy issues, including energy conservation, new and renewable source and grant support for the installation of WasteWater treatment and air pollution control systems).
- Ministry of Interior
  - Civil Defense
  - Department of Town Planning and Housing (DTPH)

– Ministry of interior (permitting authority for non hazardous waste management facilities/ services)

- Other Government Agencies
  – Cyprus Tourism Organization (CTO). Promotes agrotourism and is the coordinator of the 'blue flag' scheme for Cyprus.
  – Cyprus Game Fund (CGF)
  – Cyprus Ports Authority (CPA). The activities of the Authority are two-fold. According to the legal framework governing it, it operates as the administrative organization of Cypriot ports, which on the one hand has a public role incorporating administration, construction and management of port infrastructure and on the other engages in activities of commercial value relating to the coordination and control of port services offered.
  – Electricity authority of Cyprus (EAC). Power generation and distribution as well as responsible for CO_2 reduction targets (for own power generation units only).

4.1.4. General description of the wider Fuel Farm area

The plot of land to be developed is located on the north-west side of Vasilikos Cement Factory in the south coast of Cyprus, 1 km of Vassilikos harbour, approximately 25 km to the east of Limassol (the most important commercial port of Cyprus), 30 km to the South-west of Larnaka (hosts the major Cyprus international airport and a secondary commercial port) and 40 km south of the island's capital city, Nicosia. (**Figure 4.3**)

At short distance there are a number of fuel tanks owned by VTTV and Petrolina companies to the south-west. The nearest residential development is Mari Village 1.7 km northwest of the site. The nearest coastal population centre is Zygi village, which is located just to the east of the Study Area and is mainly used for tourism and fishing activities.

The proposed location of the new Fuel Farm is depicted in **Figure 4.4**.

The general overview of the fuel farm area is presented in **Pictures 4.14-4.21**. The area surrounding the proposed location for the construction of the fuel farm is characterised by industrial development (see **Picture 4.17**) along its east, west and south boundary. Finally, a pumping station of South Stream is located to the south of the study area (**Picture 4.20)**

Figure 4.3: Location of Vasilikos Area

Figure 4.4: Satellite picture of the wider study area

Picture 4. 14,4. 15: The north-west part of the area in which the fuel farm will be constructed

Picture 4. 16 : The south border of the fuel farm

Picture 4. 17 : The south west border of the fuel farm (Vassilikos Cement Works Facilities and VTTV tank farm)

Picture 4.18: North boundary of the fuel farm area

Picture 4.19: Road network near KODAP tank farm

Picture 4.20: Pumping station of South Stream south of the proposed tank farm

Picture 4.21: Vasilikos river bed

4.1.5. General Topography – Morphology

The site is situated at the southwestern edge of the Vassilikos river catchment area, approximately 400 m east of the river estuary. The Vassilikos river catchment has a surface area of 150.67 km^2. It has a NW – SE general trend and its general topographic characteristics are depicted in **Figure 4.5** while its hydrographic network is shown in **Figure 4.14**. The Vassilikos river transgresses a number of geological formations starting at its upper reaches from the Diabase and Lava Formations of the Troodos ophiolite complex, transgressing (in places the Gabbros and Plagiogranites as well part of the mantle sequence (serpantinites and Pyroxenites of the Akapnou Forest) and extends over the overlying, more recent sediments represented by the Lefkara and Pakhna Formations and the Plio – Pleistocene and Holocene deposits of the topographically lower grounds.

The site under study has a total area of about 80,000 m^2 on a raised marine terrace of average ground elevation of 30 m AMSL. The ground at the site has a gentle inclination to the SE with the higher grounds (nearly 50 m AMSL) to the NW and the lower grounds (nearly 15 m AMSL) to the SE. The marine terrace is terminated abruptly to the SSW by a very steep cliff that dominates over the flat sub recent coastal plain. The cliff represents a Holocene coastal cliff and its development is associated with tectonic movements that elevated the marine terrace to its present level. The western boundary of the site coincides with a small orientated tributary valley of the Vassilikos River. This small valley is currently filled with extensive stockpiles of chalk and marl and some umber piles, which are the raw material for the nearby cement factory. To the west of the site, at a distance of about 500 m there is the water divide marking the boundary of the broader Vassilikos river catchment area.

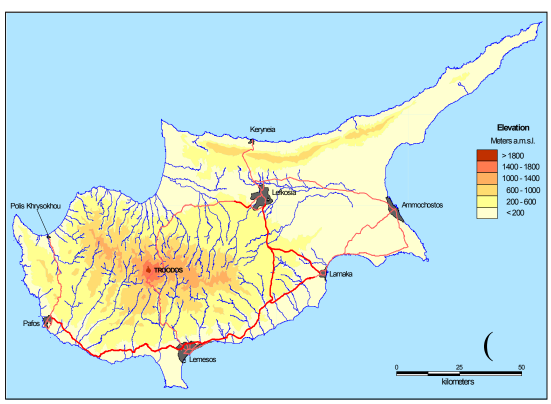
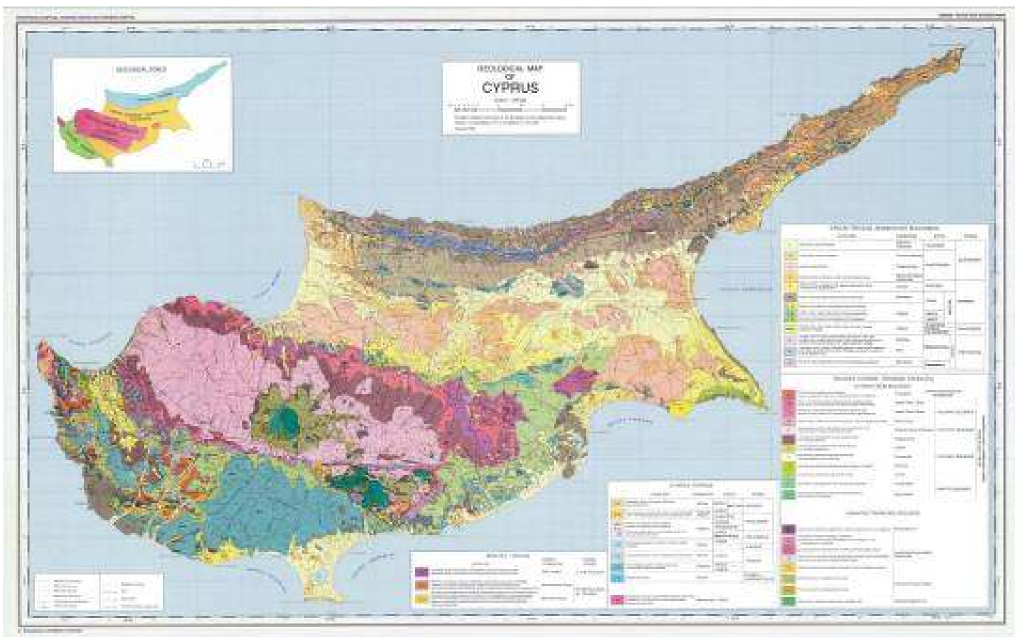


Figure 4.5: Topographic Map of Cyprus

4.1.6. General Geological

The geomorphology of Cyprus (**Figure 4.6**) is dominated by two mountain massifs: the Troodos range in the central, southern and western parts of the island, and the Pentadaktylos range which runs parallel with the northern coastline. Situated between the two mountain ranges is the Mesaoria Plain. The coastline is comprised of a mixture of low hills, rocky areas, cliffs and narrow plains. Wider plains exist around river estuaries.



Source : Geological Department Cyprus

Figure 4.6: Geological map of Cyprus

The central part of the Troodos Massif consists of igneous rocks (Troodos Ophiolite Complex), whiles the southern and southwestern fringes, and is composed of autochthonous sedimentary rocks. The central and highest part of the ophiolite complex consists of ultramafic rocks (harzburgites, serpentinites) and plutonic rocks (dunites, wehrlites, pyroxenites, gabbros and plagiogranites). Bordering this is the Sheeted Dyke Complex and, lower down, the volcanic rocks (pillow lavas). Autochthonous sedimentary rocks dominate the southern and southwestern periphery with alternating layers of chalks and marls (Lefkara, Pachna and Kalavassos Formations).

The Pentadaktylos Mountain Range has retained its limestone covering over the ages. The two mountain ranges were originally separated by a shallow sea, the bed of which is now the Messaoria (or middle)plain - a fertile agricultural region with the capital city of Nicosia situated at its centre. The highest peak within the Pentadaktylos Mountain Range is Kyparissovouno (1024 metres (m)), followed by Boufavento (955m) and Gialas (935m). These mountains consist mostly of allochthonous recrystallized limestones, dolomites and marble.

The Mesaoria Plain sits between the two mountain ranges and extends from Morfou Bay to Ammochostos Bay. The topography is dominated by flat or softly undulating areas and scattered, characteristically flat-topped or conical-shaped hills. The altitude reaches up to 300m. The plain consists mainly of marls, calcarenites, sands and gravels (Lefkosia, Athalassa, Kakkaristra and Apalos Formations) as well as alluvial deposits.

Local Features

The general geological setting in the broader area, north of the site, is shown in **Figure 4.7**. In the higher grounds, north of Kalavassos Village, there are extensive outcrops of chalk, marl and chert belonging to the upper Cretaceous to lower Miocene sediments referred to as Lefkara Formation. They have a SSE gentle dip and they provide the source of calcareous sediments for the cement factory in the area. Overlying the chalks – marls of the Lefkara Formation is the sedimentary sequence of the Middle Miocene period known as Pakhna Formation. Outcrops of this Formation are encountered south of Kalavassos – Tokhni Villages and are characterized by a sequence starting at the lower parts with conglomerates followed by calcarenites, calcarenitic marls, limestones, paper shales and at the upper parts by gypsiferous marls, gypsum and limestone. The occurrence of gypsum in the area is of significance in that it represents a good aquifer though of somewhat poor water quality. However, the overall hydrogeological regime of the area will be discussed below under separate paragraph. The regional dip of the Pakhna Formation is to the SSE, similar to the underlying sediments.

Overlying, unconformably the Pakhna Formation are the sediments of the Pliocene, which are represented by over 100m thick alternating sequence of marl, sandy marl, calcarenites and marly calcarenites. These sediments extend as far as the coastline and outcrops of them are well exhibited along the coastal cliff bordering the site to the south. The significance of these sediments is two fold. On the one hand they provide excellent argillaceous sediments needed for the cement industry and on the other hand they constitute a cap-rock over the underlying gypsum horizon (mentioned above as belonging to the Pakhna Formation) providing a protecting layer to the gypsum aquifer preventing sea water from polluting the gypsum aquifer which in a confined format extends to the coast and beyond, below the sea bottom. Holocene deposits in the form of marine deposits, alluvium and colluviums cover parts of the area forming in places extensive outcrops along the valley floor and the relatively flat terrace levels.

The tectonic picture prevailing in the broader area is rather poorly exhibited in the more recent sedimentary rocks and the published geological maps show major faults affecting the Pliocene Pleistocene and Holocene sediments, further north. Faulting is reported in the Pakhna – Lefkara sediments and the recorded faults indicate a general N-S, NE – SW trends although E-W NW-SE trends are also noted.

Solid Geology

Memoir 5 of the Geological Survey Department of Cyprus (GSD)3 (covering the Pano Lefkara-Larnaca area) shows the site is located in a region where the dominant geological features are a series of 60 to 600 m high hills, primarily derived from rocks of the Upper Cretaceous to Pliocene period, and the more recent coastal plain, which is derived from the littoral belt of the Pleistocene period. Within the region, a number of major geological groups are present including the following:

Lapithos Group

The sedimentary rocks of the Lapithos group lie about 4.1 km to the north of the site consist of a group of chalks, cherts and siltstones divided into lower chert bearing and upper chert free chalks. The rocks dip at between 10º to 20º to the south and south-east with evidence of faulting with a maximum thickness of around 500 m with vertical thrust faults in the area to the west of Tokhni.

The Pakhna Group

The Pakhna Group, lies about 3 km north of the site with a thickness of around 200 m at maximum formation, with shales, marls and limestones containing sandy siltstone layers, gypsum veins as well as limonitic gypsum nodules. The upper beds are composed of light white fissile calcareous paper shales, yellowish gypsiferous shales and/or siliceous or marly limestones. The rocks here dip southwards at an angle of about 8° to 12° with little if any faulting.

Koronia Limestone

A very small outcrop of the reef limestone facies found approximately 4.6 km north-north-east of the site. The Koronia Limestone is of middle Miocene age, overlying the Pakhna Formation to the north, and in turn probably underlying the Athalassa Formation beneath the site. The reef limestone facies is represented by hard grey shelly limestones with grain sizes ranging from clay-sized to conglomeratic.

The locations of these different formations are shown in **Figure 4.7**. The main sedimentary rock of the site itself is the Koronia Limestone, which is primarily made up of a combination of sandy red-brown marls and associated limestone nodules. Estuarine deposits of bedded ferruginous sandstones with thin bands of calcareous sandstone and siltstone are also present, as well as beach deposits of sandstones, siltstones and gravels. The thickness of these deposits is unknown and there is no recorded faulting within the site. A nearby quarry mining this formation shows iron-staining near the top. Whilst no specific information is available at the present time regarding the geological make-up of the sea-bed (that will form the foundation for the proposed jetty structure) reports, including Royal Haskoning 2006 assume that the terrestrial solid geology extends into the marine environment.

Kalavasos Formation

The “Kalavasos Formation” is proposed to include the deposits of gypsum which occur at the top of the Pakhna formation peripheral to the Troodos massif. The gypsum is widespread throughout the island and forms deposits which have been included in the Pakhna formation. Later, detailed mapping in various parts of the island showed that the gypsum deposits occur at the top of the Pakhna succession forming a mappable lithological unit. Investigations in the Pharmakas-Kalavasos area showed that the gypsum deposits form a mappable litho-stratigraphic unit at the top of the Chalk-Marl member of the Pakhna Formation. As the gypsum has also a considerable geographical extent, it is regarded as a separate formation.

The Kalavasos formation is confined to the southeastern portion of the Pharmakas-Kalavasos area. In the former it forms isolated groups at the top of the Pakhna formation, in the area between Kalavasos and Cape Dolos and particularly north of the Limassol road, varying in thickness from about 4 to 30 feet. The main variety of gypsum in this region is selenite.

Athalassa Formation

The Athalassa Formation of the southeastern part of the surveyed area is composed of current-bedded, cream to light brown, loosely cemented, sandy marls, fossiliferous sands, conglomerates and pebble beds. The pebble beds and the conglomerates form bands in the upper part of the succession which are usually interfingering. The pebbles are mostly igneous, derived from the Troodos Igneous Massif, they are well rounded, greenish-grey to dark grey in colour and are up to one foot in diameter. The sands and the fossiliferous sands are, in places, unconsolidated but well-bedded and intercalated with sandy marls particularly in the middle and upper part of the succession. The basal beds are well-bedded, they dip generally gently to the south and show progressive discordance.

Sediments of the Athalassa formation are reported from a rectangular area, defined by the villages of Kalavasos, Maroni, Zygi and Mari but in this region they exceed 100 feet in thickness and overlie the Pakhna formation.

In the Pharmakas-Kalavasos area the Athalassa formation forms two restricted outcrops; one at the southeastern and another at the southwestern portion of this area. In both regions the Athalassa deposits overlie unconformably by Pleistocene and recent conglomerates and sands. The thickness of the Athalassa formation is variable; it is about 20 to 25 feet at the southwest and about 70 feet at the southeast of the area.

Drift Geology

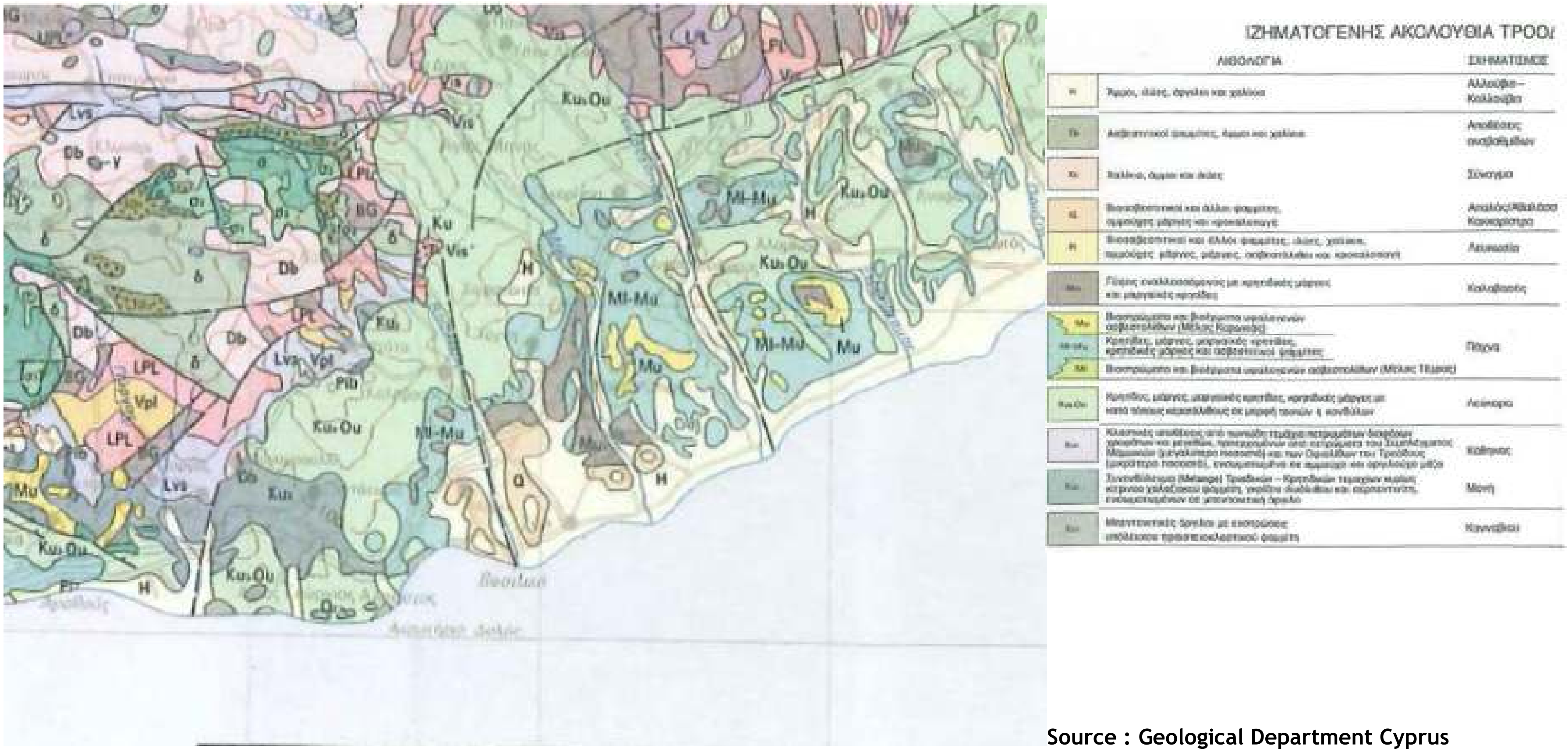
The solid geology of the site is incompletely overlain by drift deposits of Pleistocene to recent age, including terrace and flood plain alluvium and two raised beach deposits. Site-specific data collected prior to construction of the fertiliser complex1 indicates these deposits to be dominated by light brown highly plastic clay, changing to grey and dark grey with depth. A further site investigation undertaken by the GSD in 2003 also found sandy clays and sands and gravels of an alluvial nature, overlying a grey clay confining layer stratum which extended to a gypsum aquifer at 125-150 m below ground level (b.g.l.), and even extended to some 250 m depth b.g.l in places. Trial pitting carried out by the GSD in 2003 also encountered deposits of silts and sands with frequent gravel and high loam content. It should be noted that comparison with the 1977 laboratory results indicates that the “silts” may actually have been clays as the identification was determined from visual observation only and photographs of the trial pits show the sides of the pits as being stable with some side smears from the action of the excavator bucket, as expected of a clay material.

4.1.7. Hydrogeology

The more argillaceous members of the geological formations described above can be considered as aquiclude by the very nature and consistency of the lithologies involved. Naturally at a later stage of the investigation details from existing hydro geological boreholes drilled by government departments and the private sector should be further evaluated so this assumption is quantified. However the records so far evaluated and experience strongly suggest that the marly members of the Lefkara Formation as well as the Nicosia marls and Calcarenitic marls of the Pliocene era can be considered s aquiclude and offer no groundwater potential.

In the broader area of the site under consideration the aquifers, of variable significance, that can be considered are:

- The alluvium in the Vassilikos valley.
- The alluvium / colluvium and terrace deposits of the coastal area.
- The calcarenite member of the Pakhna Formation, which mainly occur in the Khirokitia – Tokhni areas and the massive chalk member of the Lefkara Formation occurring close to Kalavassos village and extending NE – SW.
- The Gypsum of the upper Pakhna Formation – which represent the most significant aquifer in the area.



Source : Geological Department Cyprus

Figure 4.7. Geological map of Cyprus – Area of interest

4.1.8. Seismicity

The seismic behavior of Cyprus is directly related to the plate tectonic movements in the region. The Cyprus tectonic trough some 60 km south of Cyprus marks, the collision line between the African shield to the south with the Eurasian shield to north and is a continuous source of earthquake activity. Epicenters (see **Figure 4.9**) have been recorded over the whole island and current studies at the Cyprus Geological Survey aim to determine the neotectonic behavior of the island and the determination of faults that could be considered as active.

Cyprus is separated in five areas (**Figure 4.8**) based on the seismic intensities expected in each region. For each area, the limits of calculation for the largest acceleration of ground Amax are given in the following **Table 4.2** as percentage of acceleration of gravity (g).

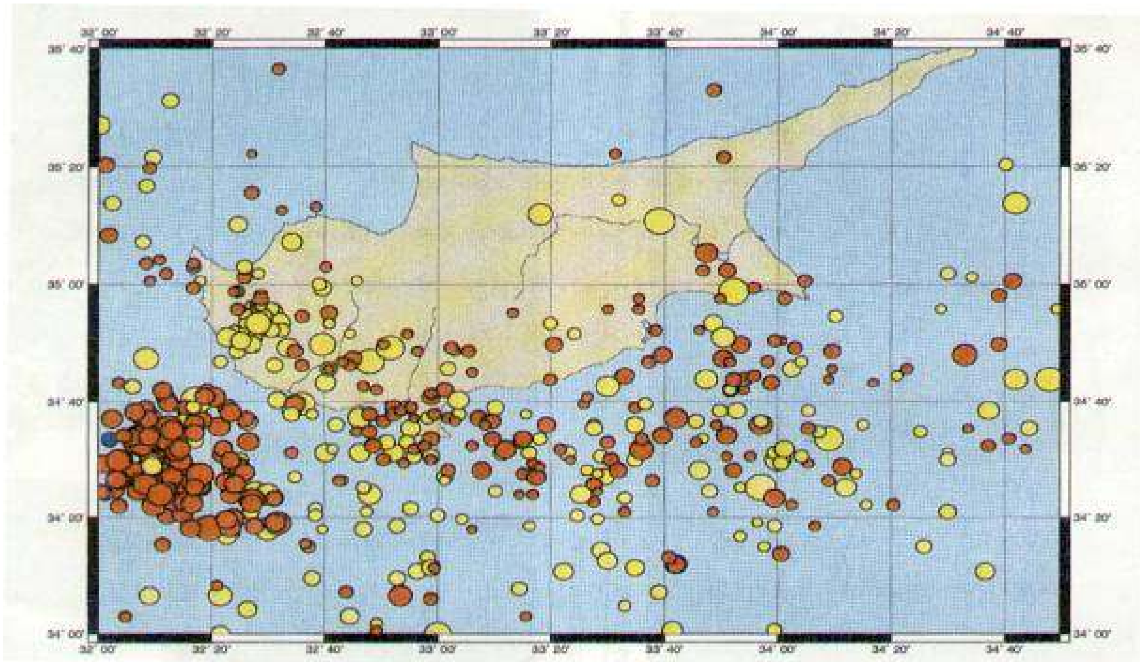
Table 4. 2: Largest acceleration of ground per area

Area	Amax (g)
I,II,III	0.075
IV	0.10
V	0.15

Source: Department of Geology

Figure 4.8. Seismic Zoning map of Cyprus

The new Fuel Farm is situated in an Area [III] region, and consequently, all construction works have to comply with the relevant provisions of the local legislation.



Source:Department of Geology

Figure 4.9: Earthquakes in Cyprus (1904-1995)

4.1.9. Climate and meteorology

Regional characteristics

Cyprus has a typical Mediterranean climate with hot dry summers and mild wet winters with rainfall occurring mainly between November and March while altitude tends to govern internal temperature and rainfall variations. The average annual precipitation for the island as a whole is 500 mm with an average of 300 to 400 mm in the central plain to nearly 1,200 mm at the highest point of the Troodos Massif. Average temperature ranges in Nicosia are from 5 to 15 degrees Celsius in January to 21 to 37 degrees Celsius (^oC) in July.

Snow is rare on the Mesaoria Plains and on the Pentadaktylos Mountain Range. In areas of the Troodos massif with an altitude greater than 1000m, it snows periodically from December to the middle of April. At altitudes lower than 1700m snow rarely persists for more than one or two days; only on the higher peaks is there snow-cover for a longer period of time.

Local characteristics

The following data is provided from Zygi meteorological station. Station latitude and longitude are 34° 45' E and 33°20' N respectively and its elevation is 40 m. It is the closest station to the area of interest (approximately 3 km distance).

Data is provided for the following parameters:

- Air Temperature;
- Precipitation and Evaporation;
- Air Humidity and
- Wind
- Seawater temperature

Temperature

Listed data contains seasonal averages, high and low temperature readings from year 2000 to 2009. Additionally, data from the summary of the annual report from Meteorological Service states that the average temperature showed a 2°C increase for 2009. The highest recorded temperature since the beginning of the last century was measured on August 1st 2010 at Athalassa station and was 45.6 °C (8.4 °C higher than normal) and the lowest temperature recorded for the same day was 29 °C (7 °C higher than normal).

Table 4.3 details the mean daily and mean monthly air temperature at Zygi. In addition, the extreme temperature minimums and maximums are detailed. Data is recorded from 2000 to 2009.

Table 4. 3: Meteorological data – Zygi station for the period year 2000-2009

Description	Arithmetic Value	Remarks
Daily mean maximum Temperature	33 °C	July and August period
Daily mean lower Temperature	6.8 °C	January and February period
Mean monthly maximum Temperature	37 °C	July
Mean monthly lower Temperature	1 °C	February
Highest Temperature recorded	40 °C	June

Lowest Temperature recorded	-2.5 °C	December
Annual mean daily Temperature	19.3 °C	January 11.3oC August 26.9oC

Precipitation/Evaporation

Precipitation is almost negligible but still, isolated thunderstorms may take place which give precipitation amounting to less than 5% of the total in the average year. In winter, Cyprus is near the track of fairly small depressions that cross the Mediterranean Sea from west to east between the continental anticyclone of Eurasia and the generally low-pressure belt of North Africa. These depressions give periods of disturbed weather usually lasting from one to three days and produce most of the annual precipitation. The average precipitation from December to February is 60% of the annual total amount of precipitation during the year (Pashiardis2).

The average annual total precipitation increases up the south-western windward slopes from 450 millimeters to nearly 1,100 millimeters at the top of the central massif. On the leeward slopes amounts decrease steadily northwards and eastwards to between 300 and 350 millimeters in the central plain and the flat south-eastern parts of the island.

Rainfall in the warmer months contributes little or nothing to water resources and agriculture. The small amounts which fall are rapidly absorbed by the very dry soil and are soon evaporated at high temperature and low humidity.

Autumn and winter rainfall, on which agriculture and water supply generally depend, is somewhat variable. The average rainfall for the year as a whole is about 480 millimeters but it was as low as 182 millimeters in 1972/73 and as high as 759 millimeters in 1968/69. Statistical analysis of rainfall in Cyprus reveals a decreasing trend of rainfall amounts in the last 30 years. The average precipitation for the year as a whole is about 500 mm but it was as low as 182 mm in 1972/73 and as high as 759 mm in 1968/69. The average precipitation refers to the island as a whole and covers the period 1961-1990 which is used as baseline.

Precipitation Data for Zygi station and for all over Cyprus are shown in the table below (Normal Precipitation 1961 – 2009). Precipitation data listed below indicates a steady decline during the past 30 years when compared with data provided for the whole island.

Table 4. 4: Monthly average precipitation for the period 1961- 1990 (in mm)

Month	Precipitation -	Precipitation -	Month	Precipitation -	Precipitation -

	Zygi (mm)	Cyprus (mm)		Zygi (mm)	Cyprus (mm)
Jan	84.0	102.4	Jul	0.0	2.6
Feb	67.0	81.6	Aug	0.4	2.9
Mar	43.0	61.9	Sept	1.0	4.5
Apr	19.0	29.9	Oct	22.0	32.7
May	6.6	19.6	Noe	38.0	53.3
Jun	1.0	6.0	Dec	92.0	105.6

According to data which were obtained from the Meteorological Service for the period 2000-2009 for Zygi station, January and December are the months with the highest levels of mean monthly precipitation, 86,1 mm and 108,1 respectively while for the months June, July and August was noticed null amount (0.0 mm) of precipitation.

Monthly precipitation (mm) for the period 2000-2009 for Zygi station is shown in the table below (**Table 4.5**).

The total precipitation for 2010 (Jan-Dec) was 428,7 mm which corresponds to 85% of the expected annual precipitation (comparing to data gathered for the period 1961- 1990).

Table 4. 5: Monthly average precipitation for the period 1961- 1990 (in mm)

Month	Precipitation - (mm)	Month	Precipitation - Zygi (mm)
Jan	86.1	Jul	0.0
Feb	64.6	Aug	0.0
Mar	27.1	Sept	6.2
Apr	16.0	Oct	25.9
May	7.1	Noe	41.8
Jun	0.0	Dec	108.1

Table 4.6 presents monthly and annual precipitation (mm) at Limassol station.

Table 4. 6: Precipitation and number of rainy days (mm) (1961 - 1990) – Limassol station

Station Number and Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Limassol	96	76	49	23	7	3	3	1	1	26	48	102	435

Number of rainy days													
>= 0,2 mm	13	11.2	8.7	5.2	2.3	0.4	0.1	0.1	0.5	3.9	5.9	12	63.3
>= 1 mm	10.1	8.9	6.6	3.6	1.6	0.2	0.0	0.1	0.2	2.9	4.7	10.1	49
>= 5 mm	5.4	5	2.9	1.5	0.4	0.1	0.0	0.1	0.1	1.4	2.6	5.8	25.3
>= 10 mm	3.1	2.5	1.6	0.7	0.2	0.1	0.0	0.0	0.0	0.8	1.7	3.8	14.5

Relative humidity

Elevation above mean sea level and distance from the coast also has considerable effects on the relative humidity which to a large extent are a reflection of temperature differences. Humidity may be described as average or slightly low at 65 to 95% during winter days and night throughout the year. Near midday in summer it is very low with values on the central plain usually a little over 30% and occasionally as low as 15%.

Fog is infrequent and usually confined to the early mornings but there are longer periods on the mountains in winter when clouds often envelop the highest peaks. Visibility is generally very good or excellent but on a few days each spring the atmosphere is very hazy with dust brought from the Arabian and African Deserts.

The annual mean Relative humidity (RH) for Zygi station at 8:00 hrs LST which was recorded at the period 2000-2009 was 66%. The maximum RH was noticed on month February (78%) and the minimum RH was noticed on month June (58%).

Table 4. 7: Relative Humidity, Zygi station for the period 2000 - 2009

Description	Arithmetic Value	Remarks
Annual mean Relative humidity value	66%	08:00 hrs LST
Maximum Relative humidity value	78%	February
Minimum Relative humidity value	58%	June

Wind

The dominant wind direction is from the southwest-to-northwest sector due to the general circulation and local thermal circulations. In general, during winter the prevailing surface winds are easterly to westerly gradient winds. With very light gradient winds, the northerly land breezes at night become predominant feature. With moderate to strong gradient winds, the land breezes are suppressed.

During summer the south-westerly gradient winds, enhanced by the southerly sea-breezes during the day, are the predominant feature.

During spring, the easterly to westerly gradient winds and in autumn the south-westerly to westerly gradient winds suppress the weak land-breezes during the night and enhance the weak sea-breezes during the day.

In general, all coastal areas of Cyprus are windy, due either to exposure in the synoptic or local forcing. For the southern coastal areas, during the cold period of the year, the prevailing winds are from the west-to-southwest and sometimes appear from the east.

Over the eastern Mediterranean generally surface winds are mostly westerly or southwesterly in winter and northwesterly or northerly in summer, usually of light or moderate strength, they rarely reach gale force.

Over the island of Cyprus however winds are quite variable in direction with orography and local heating effects playing a large part in determination of local wind direction and strength. Considerable land and/or sea direction breezes are build up on a daily basis as a result of the temperature difference between sea and land. Whilst these are most marked near the coasts they regularly penetrate far inland in summer reaching the capital, Nicosia, and often bringing a welcome reduction of temperature and also an increase in humidity.

The meteorological and wind related data from Zygi and Larnaca airport stations are shown in **Appendix A** (Meteorological Data)

Wind speeds in the area exhibits seasonal variability. The strongest mean daily wind speeds at Zygi station are experienced during the period from December to June ranging from 2,6 m/s to 3,4 m/s (at 7 m agl). Lighter winds occur from July to November when wind speeds range from 1,6 m/s to 2,3 m/s (at 7 m agl).

The average monthly wind speed variation is presented in **Figure 4.10.**

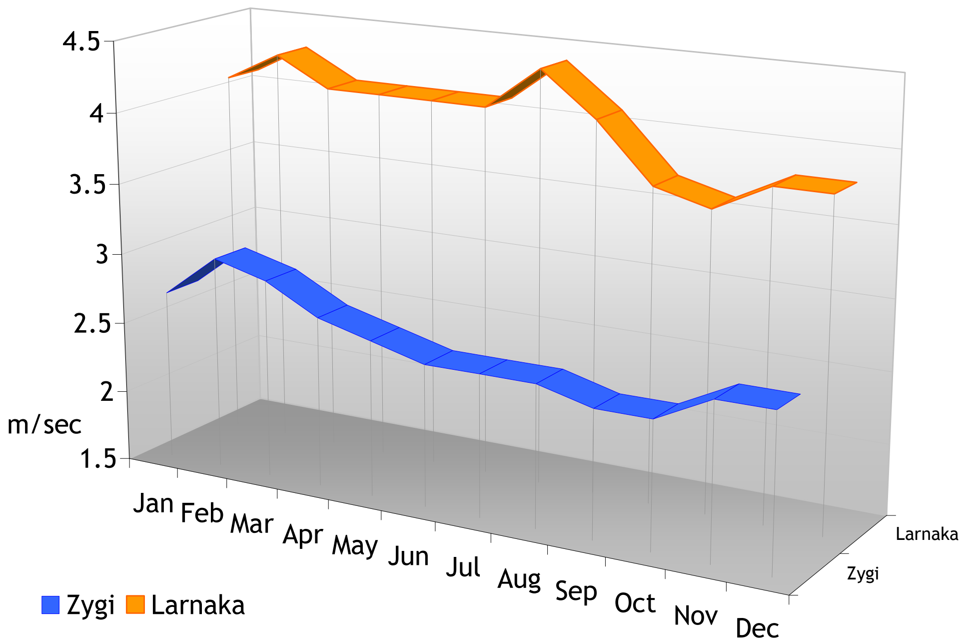


Figure 4.10. Average monthly wind speed variation

The maximum mean monthly wind speed recorded was 11,8 m/sec at Zygi station and 22,7 m/sec at Larnaca airport (in February).

Table 4.8 presents recorded mean hourly wind speeds and directions at the three meteorological stations.

Table 4. 8: Average Monthly Wind Direction and Speed at Zygi station

STATION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Mean Daily Wind (Direction in Tens of Degrees, Speed in knots[3])											
Larnaca air.	32/9	32/9	32/8	18/9	18/9	18/9	18/10	18/9	32/8	32/7	32/8	32/9
Limassol Port	36/7	27/7	27/7	27/7	27/7	27/7	27/7	27/7	27/6	36/5	36/5	36/5
Zygi	32/2.8	36/3.7	32/3.2	32/3.1	23/2.9	23/3.1	23/3.1	23/3	32/2.8	32/2.8	36/2.8	36/3.1
	Highest Mean Hourly Wind (Direction in Tens of Degrees, Speed in knots)											

[3] 1 kt = 1,152 miles/h = 1,853 km/h = 0,515 m/sec

Larnaca air.	24/38	20/44	22/32	22/36	22/33	21/38	20/38	20/34	21/38	21/36	19/32	21/38
Limassol Port	21/30	25/28	06/34	06/30	25/26	24/24	22/24	25/23	19/24	28/26	27/30	25/28
Zygi	20/8.5	28/11.8	4/10.8	24/9.0	24/8.2	3/9.6	24/9.6	23/9.2	24/9.2	25/9.6	27/9.6	36/11.8
	Highest Gust (Direction in Tens of Degrees, Speed in knots)											
Larnaca air.	25/68	25/58	21/47	26/57	35/47	21/49	20/49	20/46	22/49	23/47	24/63	24/71
Limassol Port	21/56	25/58	22/51	01/51	31/43	24/36	24/35	25/41	15/37	30/36	27/52	21/57

The predominant wind directions throughout the year are NW-W (29%),SW-W (16,4%), N (13,9%), W(7,1%) and S-SW (6,4%). For more details see **Appendix A.**

The extreme wind speeds for each directional sector in the open sea predicted from ship observations (in m/s) is given in **Table 4.9**.

Table 4. 9: Extreme wind speeds in the open sea (m/sec)

Direction (°N)		Return period (years)				
		1	5	10	15	20
-15	15	13.8	17.8	19.5	21.7	23.4
15	45	14.7	18.2	19.6	21.5	22.9
45	75	14.4	17.7	19.1	20.8	22.2
75	105	14.5	17.9	19.3	21.1	22.4
105	135	13.3	17.5	19.3	21.7	23.5
135	165	12.7	16.4	18.0	20.1	21.6
165	195	13.9	18.2	20.0	22.3	24.0
195	225	16.5	20.6	22.3	24.4	26.0
225	255	19.6	24.1	26.0	28.4	30.3
255	285	19.0	22.9	24.1	26.9	28.7
285	315	16.8	20.1	21.4	23.2	24.5
315	345	16.7	20.4	22.0	24.0	25.6

Surface winds are prevailing gradient winds modified by local land and sea breeze effects that extend 15 – 30km depending on their strength.

Winds are mainly light to moderate. The maximum sea breeze during the day is Force 4 (5.5– 7.9 m/s). The maximum land breeze during the night is Force 2-3 (1.6 – 5.4 m/s). Strong winds and gales are of short duration.

<u>Offshore Winds</u>

In winter, the prevailing winds are easterly to westerly gradient winds. In summer, the westerly to southwesterly gradient winds predominate.

Inshore Winds

In winter, when gradient winds are very light, the northerly land breeze at night becomes the dominant feature.
In summer, the westerly to southwesterly gradient winds enhanced by the southerly sea breeze during the day are the predominant features.

4.1.10. Oceanography

Bathymetry and Topography

The seabed topography of the area is relatively uniform with smooth gradients and no significant irregularities or obstructions. (**Figure 4.11**)

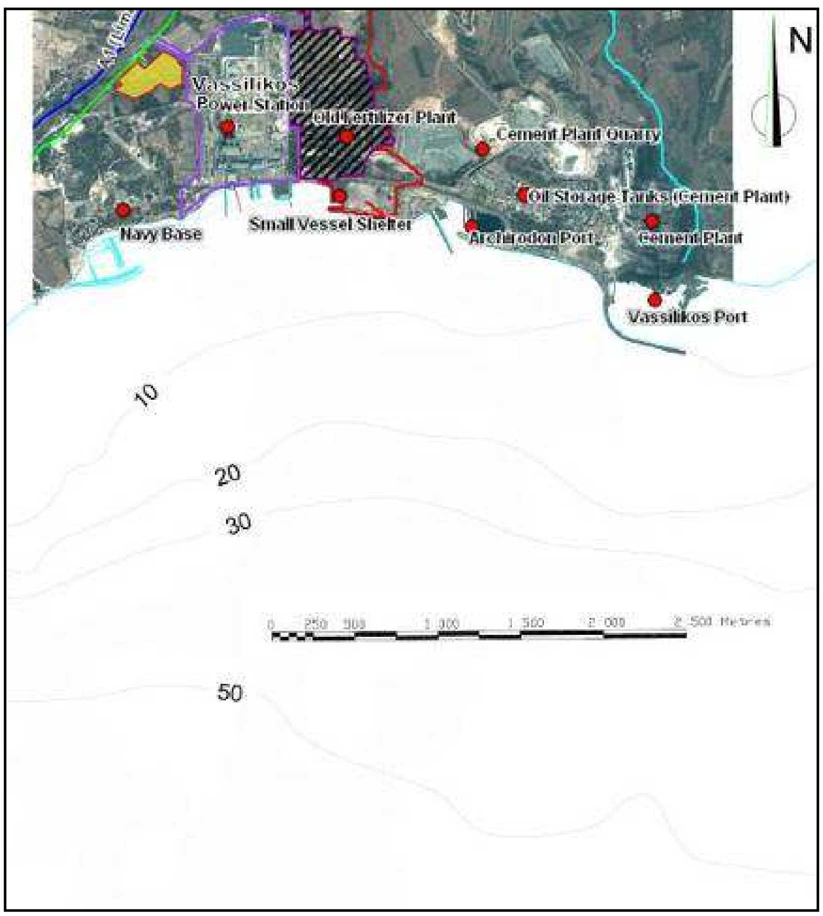


Figure 4.11: Vassilikos gulf bythometry

Seawater temperature

The water column from surface to the seabed indicates homogeneity. Thermocline is observed only during summertime between 15 – 18 meters. Measurements from mid 90's showed that the sea water temperature varies throughout the year between 15°C in February to 25°C in September. The mean seawater temperature seasonal variation is given in **Table 4.10**, based on data from the Fisheries Department.

Table 4. 10: Average sea water temperature

Mean sea water temperature (°C)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
16.0	15.6	15.9	17.3	19.1	21.8	23.7	24.6	25.5	23.5	20.8	18.1

The temperature drop with the depth is of the order of - 0,065°C/m, from data obtained for the first 50 m.

A oceanographic study led by the University of Cyprus during the summer of 2004, showed that:

- From sea surface down to 100 meters the vertical temperature distribution off shore shows a variation between 16,5°C – 27°C;
- The temperature increases by 1-2°C at the upper surface layer 0-15 m towards off-shore, and
- Below the thermocline 25 m, the horizontal temperature differences at the depths of 50-60 m are 0.2 – 0.4°C.

Waves

Wave data of the study area is available from the study "Coastal zone management in Cyprus – Near-shore wave climate analysis", X. Loizidou, Public Works Department (1994), The 50 year deep water significant wave height is 5.2 m with a predominant wave incident direction from W-SW. The frequency of occurrence from other directions is much less, with a wave height of 5.2 m too. The 25 year deep water significant wave height is 4.8 m, respectively.

The extreme wave heights near Zygi for each directional sector, predicted from ship observations (in m) are given in **Table 4.11**.

Table 4. 11: Extreme wave heights in the open sea (m)

	Return period (years)				
Direction (°N)	1	5	10	15	20
75 105	2.1	2.6	2.8	3.1	3.3

105	135	2.0	2.6	2.8	3.1	3.3
135	165	1.9	2.5	2.7	3.0	3.3
165	195	2.2	3.1	3.4	3.9	4.2
195	225	3.0	3.9	4.3	4.8	5.2
225	255	2.3	2.9	3.1	3.4	3.6
Total sector		**3.2**	**4.0**	**4.3**	**4.8**	**5.2**

Table 4. 12: Wave heights and direction class in the deep water near Zygi (whole year)

	Wave direction (deg. N)												
Observed wave height	**-15-15**	**15-45**	**45-75**	**75-105**	**105-135**	**135-165**	**165-195**	**195-225**	**225-255**	**255-285**	**285-315**	**315-345**	**Total**
< 0.25	3.19	2.30	2.97	2.78	0.88	0.60	1.11	2.09	9.65	8.30	6.78	5.99	46.65
0.25-0.75	0.29	0.51	2.25	3.75	1.08	1.05	1.00	3.49	15.03	5.97	2.32	0.58	37.32
0.75-1.25	-	-	0.18	1.86	0.61	0.69	0.76	1.95	5.15	0.28	0.06	-	11.54
1.25-1.75	-	-	0.02	0.48	0.27	0.21	0.12	0.80	1.13	-	-	-	3.03
1.75-2.25	-	-	-	0.17	0.10	0.03	0.11	0.31	0.27	-	-	-	0.99
2.25-3.25	-	-	-	0.04	0.03	0.04	0.03	0.15	0.06	-	-	-	0.36
3.25-3.75	-	-	-	0.01	-	-	0.01	0.04	0.01	-	-	-	0.08
3.75-4.25	-	-	-	-	-	-	0.01	-	-	-	-	-	0.02
4.25-4.75	-	-	-	-	-	-	-	0.01	-	-	-	-	0.01
4.75-5.75	-	-	-	-	-	-	-	0.01					0.01
5.75-6.75								0.01					0.01
Total	**3.48**	**2.81**	**5.41**	**9.09**	**2.96**	**2.62**	**3.16**	**8.87**	**31.32**	**14.56**	**9.16**	**6.58**	**100.00**

Table 4. 13: Wave heights and direction class in the deep water near Zygi (winter)

	Wave direction (deg. N)												
Observed wave height	**-15-15**	**15-45**	**45-75**	**75-105**	**105-135**	**135-165**	**165-195**	**195-225**	**225-255**	**255-285**	**285-315**	**315-345**	**Total**
< 0.25	4.37	3.23	4.25	4.22	1.15	0.73	1.17	1.56	5.90	5.45	5.62	5.99	43.65

0.25-0.75	0.45	0.78	3.40	5.56	1.59	1.39	1.23	2.93	9.66	4.70	2.14	0.74	34.56
0.75-1.25	-	-	0.29	2.91	1.01	0.13	1.16	2.20	5.32	0.35	0.09	-	14.46
1.25-1.75	-	-	0.04	0.85	0.45	0.35	0.20	1.20	1.64	0.01	-	-	4.74
1.75-2.25	-	-	-	0.31	0.17	0.06	0.22	0.54	0.41	-	-	-	1.70
2.25-3.25	-	-	-	0.08	0.05	0.08	0.07	0.29	0.11	-	-	-	0.68
3.25-3.75	-	-	-	0.02	-	-	0.02	0.08	0.03	-	-	-	0.15
3.75-4.25	-	-	-	-	-	-	0.02	0.01	0.01	-	-	-	0.03
4.25-4.75	-	-	-	-	-	-	-	0.01	-	-	-	-	0.01
4.75-5.75	-	-	-	-	-	-	-	0.01					0.01
5.75-6.75								0.01					0.01
Total	**4.82**	**4.01**	**7.98**	**13.93**	**4.41**	**3.72**	**4.10**	**8.85**	**23.07**	**10.51**	**7.85**	**6.73**	**100.00**

Table 4. 14: Wave heights and direction class in the deep water near Zygi (summer)

	Wave direction (deg. N)												
Observed wave height	**-15-15**	**15-45**	**45-75**	**75-105**	**105-135**	**135-165**	**165-195**	**195-225**	**225-255**	**255-285**	**285-315**	**315-345**	**Total**
< 0.25	2.05	1.42	1.75	1.46	0.63	0.50	1.06	2.59	13.23	11.06	7.92	6.00	49.67
0.25–0.75	0.13	0.23	1.09	1.96	0.58	0.71	0.77	4.05	20.40	7.25	2.51	0.43	40.12
0.75–1.25	-	-	0.07	0.81	0.21	0.24	0.36	1.71	4.97	0.21	0.02	0.01	8.59
1.25–1.75	-	-	-	0.11	0.09	0.07	0.03	0.40	0.61	-	-	-	1.30
1.75–2.25	-	-	-	0.03	0.02	-	-	0.08	0.13	-	-	-	0.27
2.25–3.25	-	-	-	0.01	0.02	-	-	0.01	0.01	-	-	-	0.04
3.25–3.75	-	-	-	-	-	-	-	-	-	-	-	-	-
3.75–4.25	-	-	-	-	-	-	-	-	-	-	-	-	-
4.25–4.75	-	-	-	-	-	-	-	-	-	-	-	-	-
4.75–5.75	-	-	-	-	-	-	-	-	-	-	-	-	-
5.75–6.75	-	-	--	-	-	-	-	-		-	-	-	-
Total	2.18	1.65	2.91	4.37	1.54	1.52	2.22	8.84	39.36	18.52	10.44	6.44	100.00

Currents and Tides

Current data exist from a series of current measurements which were made in the area of the no longer existing Lapertas Fish Farm (34o42'3.49'' – 33o17'55.38'', CM point – **Figure 4.12**) during the period 26/11/93 – 25/10/94. The depth of the water at the mooring position was approximately 24 m and the depth of the instrument was 7 m below the surface.

Figure 4.12: Location of the Current measurement station (CM point - former Lapertas Fish Farm)

Table 4.15 shows the frequency of current velocity and current direction in terms of the number of observations during the recording time.

Table 4. 15: Frequency Table of current velocity – current direction[4] (%)

Current direction (deg)	Current velocity (cm/sec)								
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	Total
0-30	2.47	0.85	0.09	0.00	0.00	0.00	0.00	0.00	3.41
30-60	4.15	3.00	0.93	0.26	0.02	0.01	0.01	0.00	8.38
60-90	4.28	8.41	5.86	3.30	1.01	0.25	0.04	0.1	23.17
90-120	2.99	4.31	1.34	0.31	0.07	0.00	0.00	0.00	9.03
120-150	1.39	1.75	0.34	0.05	0.00	0.00	0.00	0.00	3.53

[4] current direction is in the direction towards which the current flows, measured in degrees from magnetic north

150-180	1.06	0.98	0.04	0.00	0.00	0.00	0.00	0.00	2.08
180-210	1.11	0.69	0.02	0.00	0.00	0.00	0.00	0.00	1.82
210-240	1.56	1.32	0.14	0.03	0.00	0.00	0.00	0.00	3.06
240-270	3.44	4.51	1.94	0.84	0.36	0.01	0.05	0.02	11.17
270-300	5.58	9.32	4.98	1.77	0.90	0.32	0.11	0.01	23.00
300-330	4.43	2.98	0.46	0.02	0.01	0.00	0.00	0.00	7.89
330-360	2.56	0.86	0.03	0.00	0.00	0.00	0.00	0.00	3.45
Total	35.03	38.99	16.17	6.59	2.38	0.60	0.20	0.04	100.00

The results are typical of the situation where the tidal range is small and the inshore tidal stream can be modified by the effect of the wind. 16% of the observations exceeded 10 cm/sec, 10% of the observations exceeded 15 cm/sec.

A thermocline is present during summer between 15 and 25 meters. The dynamic activity of currents contributes to the high oxygen of the water in all columns.

Salinity

Sea water salinity in the area is approx. 39 ‰ (parts per thousand), based on information provided by the Department of Fisheries and marine Research (DFMR). Salinity is relatively steady with values fluctuating about 0.5 ‰. An oceanographic study led by the University of Cyprus in 2004, showed that the salinity varies by about 0.2 ‰ in depths of 3 - 5 - 10 and 15 meters.

4.1.11. Soil data of the area

Two separate geotechnical surveys were carried out in the area of interest, the first being in November 2015 and the second one was commissioned in June 2016. The 2015 study was conducted by Geoinvest on behalf of KODAP in order to investigate and record the area geology for the development of the tank farm in within the boundaries of plots west or east of Vasilikos river bed (**Figure 4.13**). The second study, performed approximately in 6 months interval, was conducted by Geological Survey Department. The studies also contained laboratory testing of samples obtained (**Figure 4.14**).

Both studies showed that the plots west of Vasilikos River bed do not appear to present important geological problems that prevent the implementation of the project.

The whole area shows a low relief on the north half about to be significantly higher than the southern part. The average altitude of the northern part is located at 23 meters from the surface of the sea while the south part at 7 meters. Both parts are separated by a relatively sudden slope altitude of 20 to 10 meters. Likely during the construction phase of the project, it will be necessary for some earthmoving (shallow excavation and earth-moving) to be formed flat surfaces. In this case, most of the excavated material can be used for backfill. This shallow excavation material could be used for possible formation of green areas.

Also, in the study area there is also a geological and geotechnical uniformity in the subsoil up to the depth of 11 meters. Undoubtedly, before the final design of the foundation of the tanks should be a thorough investigation of each tank, the extent of which depends on the size and the load which will bring.

Figure 4.13: Examined plots west and east of Vasilikos river bed

Figure 4.14: Location of drillings and wells in both suggested sites (west and east of Vasilikos river bed)

4.1.12. Water Resources

Introduction - General Hydrology of the Island

Cyprus is a semiarid country and water scarcity is one of its major problems. The average yearly precipitation over the part of Cyprus under Government control, for the period 1916 to 2000 is 515 mm. The average yearly rainfall for period 1971 –2000 is 460 mm and 435 mm for the last decade i.e.1991 – 2000.

Water demand in the Island has always been much higher than the available water resources. Great effort was invested in the struggle for water development in the country. This was manifested mainly by the construction of over 100 dams on almost all rivers of the country. During the last ten to fifteen years and after the completion of the major Cyprus Water Projects repeated droughts have dramatically reduced the water crop of the country and consequently increased water shortages. Ever increasing water deficits, in conjunction with the deterioration of groundwater quality forced the government to opt for desalination to supplement domestic water supply.

The last island-wide groundwater study was carried out some thirty years ago. Studies of individual aquifers carried out within the framework of the major water development projects were completed twenty years ago. The general hydrometeorological, hydrological and hydrogeological conditions have changed dramatically since then. Frequent and long lasting droughts during the last decades have considerably reduced recharge to the aquifers. The problem of reduced recharge to the aquifers was exacerbated by the construction of a great number of dams on the major rivers of the country.

Table 4. 16: Annual Groundwater Balance of all Cyprus Aquifers (averaged over period 1991-2000)

Replenishment of the aquifers (*10^6 m^3)	
Natural Recharge from:	
Rainfalls	205.1
River flows	44.8
Return from irrigation/domestic	22.1
Groundwater inflow	8.8
Dam losses	1.7
Natural Recharge	282.5

Artificial Recharge	9.8
Sea intrusion	12.8
Replenishment (total recharge)	305.14 mcm
Outflow from the aquifers (*10^6 m^3):	
Extraction	129.1
Groundwater outflow	166.7
Sea outflow	24.6
Total outflow	320.4 mcm
Total water balance= Replenishment- Outflow	-15.3 mcm

The existing monitoring system of the aquifers in most cases is insufficient and inadequate and it only covers the main aquifers. A great number of smaller aquifers of local importance are not monitored at all. The networks and the surveys for quality control of the aquifers have been neglected for many years. Monitoring which is so crucial to qualitative water management has been almost completely abandoned in the last five years because of serious stall shortage in the chemical laboratories of WDD.

Water level and quality observation networks cover only the main and most productive aquifers of the country. About 1100 boreholes in these aquifers are monitored, some of them for several decades. Groundwater for the greatest part of the Island is erratically monitored if at all and many of the existing networks have not been revised for many years. Most of the data collection and processing programs have been partly or, worse, completely abandoned because of chronic and serious personnel shortages in the Water Development Department.

Surface water, rivers and lakes

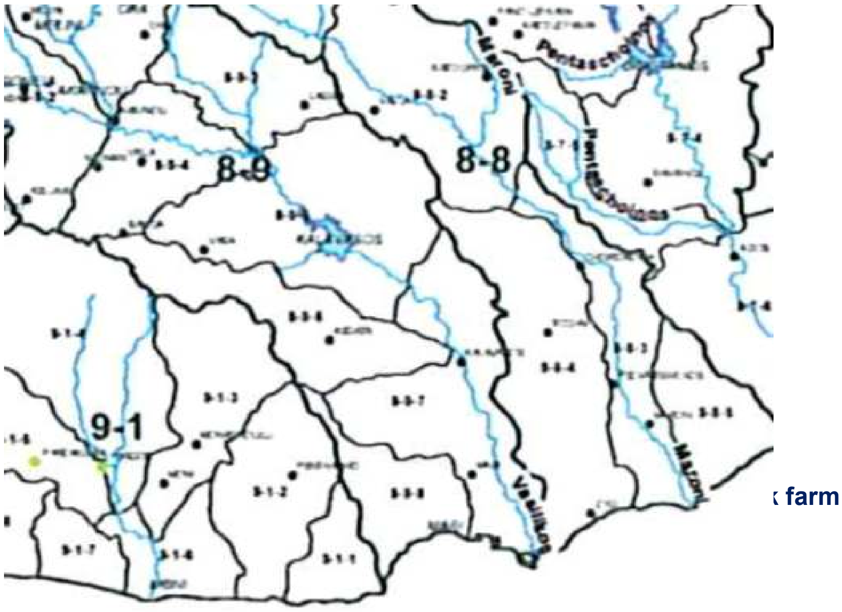


Figure 4.15: Surface water reserves in the area

Under the scope of Directive 2000/60/EC of 2000 aiming at compiling a framework for Community action in the field of water policy, a surface water monitoring program was established in Cyprus. Extracts specific to the area of Vasiliko, from a report issued in 2009 by the Department of Water works to assess the results of the monitoring program, are mentioned hereafter.

The report recognizes two river water bodies within the area of Vasilikos:

– Vasilikos

The river estuary to the sea is located directly adjacent to the Vasilikos port east boundary. The river has dried out, mostly because of the Kalavasos damp construction in 1985.

– Pentasxoinos

The current condition of those bodies as well as the reasons that lead to their current condition is presented in the following table:

Table 4. 17: Conclusions per control section of surveyed area (department of water works – March 2011)

River Water Body	Code	Condition	Reason that lead to

			the current position
Vasilikos	CY_8-9-1_R3-HM	Medium	Agricultural activities
	CY_8-9-5_R3	Medium	N/A
	CY_8-9-5_R3-HM	Medium	Agricultural, metallurgic and industrial activities.
Pentasxoinos	CY_8-7-5_R3	Medium	Agricultural activities

Groundwater reservoir

Most of the island aquifers are phreatic, developed in river or coastal alluvial deposits. These are the biggest and the most dynamic aquifers, replenished mainly by river flows and rainfall. There are three large coastal aquifers that include all the perpendicular riverbeds. The coastal parts of these aquifers are composed by sands, silts, limestones, conglomerates and clays. Riverbeds consist of alluvial deposits, gravels, sands and silts. These aquifers are phreatic and are around 30 m deep. Apart from the large but not so productive aquifer of the Troodos igneous rocks, other aquifers exist in gypsum, sandstones, limestones and chalks. These aquifers are mainly phreatic with some parts being semi-confined to confined. These parts are covered by silty-clayey layers or marls, sandy marls. It is noted that the aquifer of Troodos Mountain has been developed generally in low permeability ophiolites and locally in medium permeability fractured zones of igneous rocks and it is therefore confined in places.

The aquifers of Cyprus have been grouped into 20 groundwater bodies, mainly based on lithology, the hydraulic characteristics, the pressures and the importance of each aquifer. The groundwater bodies can be seen on **Figure 4.16** below.

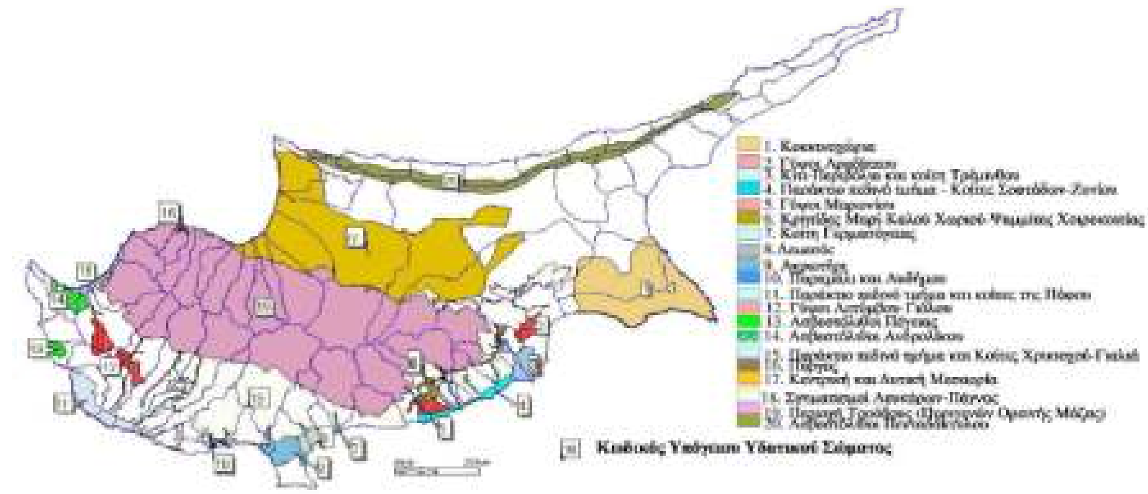


Figure 4.16: Groundwater bodies of Cyprus

Ten of these groundwater bodies have a connection with the sea. The Lemesos groundwater body has outflow to the sea have a discharge up to 350 m^3/h, while the others have discharge recharge below 150 m^3/h. Most groundwater bodies are phreatic with parts that semi-confined or confined. Only the Maroni gypsum aquifer is completely confined. Two of them, Maroni and Mari/ Kalo Chorio are in the vicinity of the project development.

<u>Maroni groundwater body</u>

Although the aquifer is heavily exploited it is currently in "good" condition in terms of quantity due to its ability, as a result of its geology, to recover easily following rainfall. In periods of drought the groundwater level drops dramatically. The soil it consists of absorbs water at increased rate and causes it to move downwards. Because the water cannot find its way into the sea, it is trapped and stored in rocks more than 40 meters in thickness, giving a dynamic character to the aquifer.

From a chemical point of view the aquifer is qualitatively 'good' although exceedances have been observed in some pesticides during some periods. The values of sulfates and electrical conductivity are much higher than other aquifers because of the chemistry of the soil (gypsum $CaSO_4$) which defines the natural quality of water.

Qualitative monitoring of the Maroni aquifer the years 2008-2009 is listed in **table 4.18** below.

Table 4. 18: Qualitative condition of Maroni aquifer for the period 2008-2009

Chemical Characteristics	Qualitative limit	Average value	Exceedances recorded during this period		
			Max value	Suspected cause	Location of measurement
Nitrates (NO_3-N)	11.29 ppm	3.84	9.96	Fertilizers	Psematismenos
Sulfates $(SO_4)_2$-	3000 ppm	1523.37	1798.72	Soil chemical composition	Zygi
Chlorides (Cl-)	400 ppm	254	368.21		Zygi
Electrical conductivity	5000 μS/cm	3478	4070		Kalavasos
Ammonia (NH_3-N)	0.39 ppm	0.01	0.06	Livestock	-
Pesticides	0.5 μg/l	0.116	0.697	Agriculture	Psematismenos

Mari/ Kalo Chorio groundwater body

The aquifer is currently relatively small in size and volume, but in the past it had a significant hydrological importance for the water supply of several areas of Larnaca. It is a narrow zone of southwest-northeast direction and extends from the village of Mari up to Kalo Chorio Larnaca. Today its quantitative condition is 'bad'. This is due to heavy exploitation the past few decades where its stocks were almost exhausted. Even today, the aquifer is utilised extensively enough leaving it no opportunity to recover. Qualitatively it is characterized to be in "good" condition, though local exceedances have occurred in some substances (ammonium and arsenic), which are since more closely monitored.

Qualitative monitoring of Mari/Kalo Chorio aquifer the years 2008-2009 is listed in **table 4.19** below.

Table 4. 19: Qualitative condition of Mari/Kalo Chorio aquifer (period 2008-2009)

Chemical	Qualitative	Average	Exceedances recorded during this

Characteristics	limit	value	period		
			Max value	Suspected cause	Location of measurement
Nitrates (NO_3-N)	11.29 ppm	0.49	1.05	Fertilizers	Kalo Chorio
Sulfates $(SO_4)_2$-	250 ppm	111.29	190.4	Soil chemical composition	Choirokoitia
Chlorides (Cl-)	250 ppm	140	249.5		Kalo Chorio
Electrical conductivity	2500 μS/cm	1120	1565		Kalo Chorio
Ammonia (NH_3-N)	0.39 ppm	0.13	0.7	Livestock	Choirokoitia
Pesticides	0.5 μg/l	0.023	0.18	Agriculture	Kalo Chorio

4.1.13. Soil Quality and Contaminated Land

A short site reconnaissance visit was conducted on September 12th, 2016 to source onsite information. Visual observations with regards to soil staining and the presence of nearby potential contaminant sources and underground services were recorded and used to assist in streamlining and focusing the subsurface soil investigation. From the on site investigation, the soil of the two plots where the fuel farm will be erected, do not show historical contamination that prevent the implementation of the project.

An intrusive assessment consisted of trial pitting and soil sampling was followed in October 2016. Four trial pits distributed across the site (**Figure 4.17**) were excavated by the Geology Department, and soil samples taken and submitted to a certified laboratory for analyses. Samples were analysed for nine (9) metals and petroleum hydrocarbons (GRO, DRO) as detailed in the following.

	Metals	Petroleum Hydrocarbons
Analyses package	Cr, Ni, Fe, Cu, Zn, Mn,	GRO : gasoline range organics (C_6 – C_9)

content	Pb, Hg, As	DRO ; diesel range organics (C_{10} - C_{36})

Complete laboratory results are provided in **Table 4.20** with comparison to the adopted screening criteria.

KODAP tank farm

Figure 4.17: Soil sampling points within the fuel farm area

No specific legislation exists in Cyprus regarding soil and groundwater contamination and criteria for remediation. There is only an existing law N.189(I)/2007 concerning the environmental liability and the prevention and the remediation of the environmental damage.

Furthermore, in the frame of the project National inventory of potential sources of soil contamination in Cyprus, Risk Based Soil Guideline values for Cyprus have been calculated.

Due to absence of soil and groundwater contamination limits in Cyprus, the comparison of the analyses results was made with general accepted international and European standards.

A variety of provincial regulations exist within the European Union, setting limits for contaminants in soil and groundwater. In Germany, for example, each province has its own list for the tolerable concentration of various contaminants.

According to the New Dutch List, the regulatory list, which is valid in many European countries, two different values are given for the concentration of each pollutant:

- <u>Optimum value</u>: determines the average concentration in the soil;

- Action value: determines the concentration above which the application of decontamination measures is compulsory

All chemical analyses results are presented in **Table 4.20**.

Table 4.20: Soil samples analysis

Determinant	Unit	Method	TP 018	TP 016	TP 017	TP 013
pH	-	CS01	7,71	7,83	7,52	7,74
Electrical conductivity	mS/cm	CS02	0,525	1,06	2,46	2,09
Cr	mg/Kg dry basis	CS53* ICP OES	144	146	114	114
Ni	mg/Kg dry basis		102	122	77	65
Fe	% dry basis		4,01	2,86	3,40	2,65
Cu	mg/Kg dry basis		68	48	55	53
Zn	mg/Kg dry basis		75	57	75	60
Mn	mg/Kg dry basis		936	757	830	663
Pb	mg/Kg dry basis		6,93	7,05	8,89	6,43
Hg	mg/Kg dry basis		0,96	1,97	3,13	2,48
As	mg/Kg dry basis		2,93	2,74	6,27	5,18
TOC	% w/w dry basis	CS23*	1,39	1,42	0,97	1,44
TPH (C5-C6 aliphatic)	mg/Kg as received	CS61*	<0,01	<0,01	<0,01	<0,01
TPH (C6-C8 aliphatic)	mg/Kg as received		<0,01	<0,01	<0,01	<0,01
TPH (C8-C10 aliphatic)	mg/Kg as received		<0,01	<0,01	<0,01	<0,01
TPH (C10-C12 aliphatic)	mg/Kg as received		<1	<1	<1	<1
TPH (C12-C16 aliphatic)	mg/Kg as received		<1	<1	<1	<1
TPH (C16-C21 aliphatic)	mg/Kg as received		1	1	<1	3
TPH (C21-C35 aliphatic)	mg/Kg as received		<2	4	<2	130
TPH (C6-C7 aromatic)	mg/Kg as received		<0,01	<0,01	<0,01	<0,01
TPH (C7-C8 aromatic)	mg/Kg as received		<0,01	<0,01	<0,01	<0,01
TPH (C8-C10 aromatic)	mg/Kg as received		<0,01	<0,01	<0,01	<0,01
TPH (C10-C12 aromatic)	mg/Kg as received		<2	<2	<2	2
TPH (C12-C16 aromatic)	mg/Kg as received		<1	<1	<1	3
TPH (C16-C21 aromatic)	mg/Kg as received		<1	1	<1	3
TPH (C21-C35 aromatic)	mg/Kg as received		<1	14	8	<1

According to the New Dutch List, the limit values of metal contaminants in the soil are given in the following Table.

Limit Values (New Dutch List) for metal contaminants in the soil

Determinant	Optimum value mg/Kg dry basis	Action value mg/Kg dry basis
Cr	100	380
Ni	35	210
Fe	-	-
Cd	0.8	12
Cu	36	190
Zn	140	720
Mn		
Pb	85	530
Hg	0.3	10

As	29	55
Barium	200	625
Molybdenum	10	200
V	42	250
TPH Limit value according to European Community decision 2003/33 : 500 mg/kg dm	50	5000

In the frame of the project National inventory of potential sources of soil contamination in Cyprus prepared for Geological Survey Department of Cyprus (Nov 2006), Risk Based Soil Guideline values for Cyprus have been calculated.

Risk Based Soil Guideline Values for Cyprus (RBSGVs)

Chemical	Industrial	Residential	Recreational
Arsenic	1,80	0,39	11
Barium	120.,000	11.000	330.000
Cadmium	900	70	2.100
Chromium III	280.000	37.000	1.100.000
Chromium VI	530	110	3.200
Copper	43.000	3.000	89.000
Iron	320.000	23.000	670.000
Mercury (elemental)	14	1.90	57
Mercury (mercuric chloride)	180	17	490
Molybdenum	5.300	380	11.000
Nickel	8.600	920	27.000
Zinc	320.000	23.000	670.000

<u>Metals</u>

Concentrations of individual metals vary do not vary considerably, up to a factor of 2 between trial pits. For example concentrations of As range from 2.74 mg/kg dm in TP 016 and 6.27 in TP 017 (**Table 4.20**). This small variability is most likely due to nature of the site, being agricultural land without previous known industrial activities.

All metal concentrations in the soil are significantly below the action value, indicating no significant health risk. The metals concentrations provide a baseline against which to compare future values in order to assess the potential impacts of the proposed fuel storage facility on the site.

<u>Total Petroleum Hydrocarbons (TPH)</u>

Concentrations of total petroleum hydrocarbons (TPH) in the C6 – C10 range (i.e. the volatile TPH range) were below detection for all trial pits (**Table 4.20**). Concentrations of TPH in the C10 – C40 range were below the laboratory detection limit for the majority of the determinants in the 4 trial pits sampled, and between 1 and 3 mg/kg dm for C16 – C21, 2 and 130 mg/kg dm for C21 – C35 and 1 and 14 mg/kg dm for C21 – C35 (**Table 4.20**). The detected concentrations were all below the adopted screening values

4.1.14. Marine water quality

Data have been taken from the Environmental Impact Assessment Study for Design, Construction, Commissioning and Operation of Marine Jetty at Vassilikos Area, carried out in January 2011 and from the survey of the Fisheries Department carried out in 1992 in the Vassilikos Bay.

Oxygen Concentrations and Distribution

Dissolved Oxygen is influenced by wave action and turbulence. In case of presence of organic matter, dissolved oxygen might be reduced especially near the seabed, where at initial stage there is microbial aerobic action (decomposition process of organic matter).

The values of dissolved oxygen obtained by a number of studies in the vicinity of the proposed project showed a fully oxygenated water column (values between 7.0 and 8.6 mg/l) with relatively homogenous oxygen levels from surface to the seabed. In depths shallower than 45 meters water is well oxygenated in all column, partly due to the photosynthetic activity of seagrasses and to the high activity of currents.

Up to the depth of 80 m the oxygen concentration increases with depth, but beyond that depth there is an abrupt reduction. The oxygen concentration is relative high, typical for the waters of the Eastern Mediterranean Sea.

pH levels

In the Vassilikos Bay pH is relatively constant ranging approx. from 8,33 – 8,37 from the surface to a depth of 50m.

Nutrient Concentrations

Excessive use of fertiliser has resulted in high nitrate levels in the aquifer and other areas as well. The heavy utilization of underground water for agricultural purposes has resulted in the overexploitation of this water a drastic reduction of the level of the aquifer and in sea water intrusion in some coastal areas (Demetropoulos, 2002). The main source of nutrients in seawater originates from marine aquaculture activities and agriculture (discharges from river basins).
Nutrient concentrations recorded in the study area, are presented in **Table 4.21**.

Table 4. 21: Nutrient Levels in Vassilikos area (2010)

S/N	PO_4^{3-}	NO_2^-	NO_3^-	NH_3
1	12.0	4.3	9.7	6.2
2	17.6	4.9	8.9	<1
3	19.5	4.4	11.2	<1
4	11.4	4.6	10.9	<1
5	35.6	6.3	8.6	<1
Unit	μg/l	μg/l	μg/l	μg/l
Method	In house CW82	In house CW81	In house CW80	In house CW83

The waters of the eastern Mediterranean Sea naturally are highly oligotrophic, with phosphorous being the limiting factor and have therefore low concentrations of algae.

Turbidity

The Secchi Disc measurement of water turbidity gives an approximate evaluation of the transparency of the water and therefore an estimate of the amount of algae, in the water, as algal particles affect the penetration of light. This method is a subjective one, as it is influenced by factors such light intensity and sky conditions and wave action. The comparative analysis of results obtained by a high number of samplings showed a homogenous condition of turbidity throughout all sampled stations in the vicinity of the examined CCPP location.

Chlorophyll

Recent studies of the author at the vicinity of the Vassilikos Bay area proposed area have shown that the levels of chlorophyll range between 0.13 and > 0.1 μg/l. Normal levels of chlorophyll for Eastern Mediterranean are between 0.1and 0.1 μg/l (Bianchi et al 1996). It is worth mentioning that the concentrations of chlorophyll in the area, are remarkably lower than the range of concentrations observed in deep oligotrophic waters of the Eastern Mediterranean (Krom, T.S. et al. 1991).

Granulometric analysis

Granulometric sampling was carried out on a transect line between 5 and 50 meters in front of the proposed CCPP location. The finess of the sediment increases from shallower to deeper water. From 30-50 meters there is a sharp drop of finess. Between 2-50m depth sediment contains between 30-50% fines (< 63mm) whereas at depths exceeding 50m the quantity of fines is >50%.

Organic matter analysis

Accumulation of excess organic matter via sedimentation may have an important impact on the composition of benthic communities (flora and fauna). The sedimentation rate depends on the anthropogenic practices and the oceanographic variables, especially depth, currents and wave action.

Indicative concentrations of organic matter in stations within the Vassilikos Bay show slightly higher values below fishfarms than at other stations. However, these levels decreased in proportion to the increased distance from the epicenter of the fishfarming activity and were in any case far below any critical level for the marine environment.

Microbial Pollution

The quality of coastal waters at all monitoring stations conforms to the WHO/UNEP standards. Microbial analysis of seawater samples obtained from the area of interest is listed in **Table 4.22** below.

Table 4. 22: Microbial Pollution – Laboratory analysis

Determinant	Unit	Method	1	2	3	4	5
TVC @ 37°C	cfu/ml	MW01	2	6	ND[5]	8	6
Feacal	cfu/100 ml	MW03	-	16	-	5	-

[5] *ND: not Detected*

Levels of feacal coliforms and intestinal Enterococci are higher than anticipated, most likely attributed to an unauthorised discharge from a vessel in the area.

Coliforms							
Intestinal Enterococci	cfu/100 ml	MW04	-	1	-	ND	-
TOC	mg/l		1.32	1.14	-	0.95	1.02

Effluent discharge

Studies, in order to determine the impact of pollution to marine ecology are carried out on a continuous basis. A number of studies, such as 'ecological effects of pollution from the wine factories in Limassol' and 'ecological effects from the operation of the CCFI plant at Vasilikos' were developed, executed and completed by DFMR.

Vasilikos power station's cooling water discharges is the main effluent source in the area. **Table 4.23** below shows effluent water monitoring results for Vasilikos power station (time period that samples were taken were not available).

Table 4. 23: Vasilikos power station effluent water monitoring results

Total Phosphorus	Ammoniacial Nitrogen	Iron	Copper	Zinc	Cadmium	pH
0.085 – 4.92	0.01-3.7	0.1 – 0.445	0.01 – 0.71	0.00 – 0.32	0.002 – 0.1	4.1 – 8.0

4.1.15. Water Quality

Given the current lack of any national standards for water quality, impacts have been assessed against a generic series of standards developed within the UK12 to meet the requirements of the relevant European legislation. These include both Environmental Quality Objectives (EQOs), which set out key objectives for local coastal waters according to their proposed use (e.g. bathing, fisheries), and Environmental Quality Standards (EQS), which set limit levels for key water (or sediment) parameters as appropriate to that use. The EQOs set out criteria for required aesthetic, biological, bacteriological and chemical conditions use a scale of A-D as shown in **Table 4.24** below in which A is excellent quality, B is good, C is unsatisfactory and D is seriously polluted.

Table 4. 24: Indicative Coastal Water Classification Scheme

Class	Description	Aesthetic Condition Biological	Condition	Bacteriological

A Excellent	Near Pristine	Flora and fauna Normal	Likely to meet quality standards no less stringent than the guideline standards for EC Designated Bathing Waters	
B Good	Unpolluted, but may show traces of contamination	Flora and fauna Normal	Likely to meet quality standards no less stringent than the mandatory standards for EC Designated bathing waters.	
C Unsatisfactory	Occasional observations or Substantiated complaints of sewage solids smell nuisance or oil	Flora and/or fauna modified by effluent discharges	Likely to occasionally fail to meet quality standards no less stringent than the mandatory standards for EC Designated bathing waters	Likely to meet all quality standards applied as a consequence of the EC Dangerous Substances Directive
D Seriously Polluted	Frequent observations or substantiated complaints of sewage solids, smell nuisance or oil	Flora and/or fauna impoverished or absent	Likely to frequently fail or to meet quality standards no less stringent than the mandatory standards for EC Designated bathing waters.	Likely to fail any one or more of quality standards applied as a consequence of the EC Dangerous Substances Directive

The effects of the proposed development have been assessed in relation to the potential for changes in the water quality classification affecting areas of greater than 1 ha. If an area of coast greater than 1 ha in area improves or degrades in classification then it will be regarded as a positive or negative impact respectively.

EQS levels relating to the EC Dangerous Substances Directive are provided below in **Table 4.25**. If levels of a substance is likely to exceed the relevant EQS then the classification would be determined as D, seriously polluted.

Table 4. 25: Environmental Quality Objectives for Water Quality

Parameter	Value
Colouration	No change
Dissolved Oxygen	80-120 %
Transparency	>2 m
Mineral oils	<0.3 mg/l
Mercury	0.3 μg/l
Cadmiu	2.5 μg/
Chromium	15 μg/l
Inorganic lead	25 μg/l
Zinc	40 μg/l
Copper	5 μg/l
Nickel	30 μg/l
Arsenic	25 μg/l
Boron	7,000 μg/l
Vanadium	100 μg/l

Inorganic tin	10 μg/l
Iron	10 μg/l
Pentachlorophenol	2 μg/l
Chloroform	12 μg/l
Total drins	0.03 μg/l
1,2-dichloroethane	10 μg/l
Perchloroethylene	10 μg/l
Trichlorobenzene	0.4 μg/l
Trichloroethylene	10 μg/l

4.1.16. Sediment Quality

Sediment quality, in terms of heavy metal and trace organic contamination, has been assessed by comparing levels in the sediment with EQS levels (as defined above and within the UK-based Interim Marine Sediment Quality Guidelines14 -ISQGs - , Probable Effect Levels 2 - PEL, and national Action Levels. These EQS values (listed in **Table 4.26**) can be used to determine the suitability of dredged material for disposal at sea, and have been adopted here to provide a benchmark for comparison with field data with regard to the significance of contamination levels in the intertidal sediments.

Table 4. 26: Sediment Quality Objectives

	Determinant	ISQG	PEL	DEFRA in house Action Level 1	DEFRA in-house Action Level 2
Metals and metalloids (mg/kg)	As	7.24	41.6	20	100
	Cd	0.7	4.2	0.4	5
	Cr	52.3	160	40	400
	Cu	18.7	108	40	400
	Pb			50	500
	Hg	0.13	0.70	0.3	3
	Ni	30.2	112	20	200
	Zn	124	271	130	800
Organic ($\mu g kg^{-1}$)	Acenaphthene	6.71	88.9	100	-
	Acenaphthylene	5.87	128	100	-
	Anthracene	46.9	245	100	-
	Aroclor 1254	63.3	709		-
	Benz(a)anthracene	74.8	693	100	-
	Benzo(a)pyrene	88.8	763	100	-

	Chlordane	2.26	4.79		-
	Chrysene	108	846	100	-
	DDD2	1.22	7.81	-	-
	DDE2	2.07	374	-	-
	DDT2	1.19	4.77	-	-
	Dibenz(a,h)anthracene	6.22 135	135	10	100
	Dieldrin	0.71	4.30	-	-
	Endrin	2.673	- 62.44	-	-
	Fluoranthene	113 1	494	100	-
	Fluorene	21.2	144	100	-
	Heptachlor epoxide	0.603	2.744	-	-
	Lindane	0.32	0.99	-	-
	2-Methylnaphthalene	20.2	201	-	-
	Naphthalene	34.6	391	- 100	-
	PCBs ,Total	21.5	189	-	-
	Phenanthrene	86.7	544	100	-
	Pyrene	153	1398	100	-
	Toxaphene	1.53	C5	-	-
	PCBs ICES 7	-	-	100	-
	TBT6			0.2	-

4.1.17. Air Quality

The direct Study area currently includes privately owned tank farms by Petrolina and VTTV, both of which are looking to expand further. VTTV is currently constructing a Jetty for marine offloading. The implication of such marine off loading facilities is that there will be an increase in the level of shipping in the area (for both petroleum products and LPG). The increase in exhaust emissions from these ships may potentially have an impact on air quality as shipping can be a significant source of pollutants such as sulphur dioxide (SO_2).

Also, at a distance of about 2.5 km to the west, there is Vasilikos Power Station. The three steam units (Units 1, 2 and 3) of 130 MW each, fuelled by heavy fuel oil, are back in operation and can now also run on natural gas. The pollutants released into the atmosphere by burning of HFO are mainly SO_2, NOx and CO (carbon monoxide). There are also two combined cycle units in operation (Units 4 and 5), which now run on low sulphur distillate fuel oil but will eventually run on natural gas.

Once gas is available distillate fuel oil will only be used as the emergency fuel. The switch from fuel oil to gas will have a positive effect on air quality in the region as gas is a relatively clean fuel. There should be a substantial reduction in SO_2, NOx and particulate emissions from switching to natural gas.

The ministry responsible for the application and enforcement of the laws and regulations is the Ministry of Labour and Social Insurance via the Department of Labour Inspection (DLI). The DLI is responsible for the enforcement and implementation of the European Legislation regarding Ambient Air Quality. The Framework Directive 2008/50/EC, along with the Daughter Directive 2004/107/EC, place a structure on how should the Member States of the European Union, including Cyprus, should handle the matters of Ambient Air Quality, and how the limit values for the concentrations of various pollutants in the atmosphere are determined.

DLI's Air Quality Sector has developed and implemented necessary infrastructure, processes and equipment. The department has established a network of nine advanced monitoring stations. Measurements are taken and recorded on an hourly basis and are then presented on a dedicated website (www.airquality.dli.mlsi.gov.cy) and on public indoor/ outdoor panels. DLI is responsible for the networks operation as well as for the implementation of abatement measures in order to reduce environmental pressures and improve air quality.

The industrial air quality monitoring station, located at Zygi village, Larnaca, records pollutant levels as a result of the industrial activity in the greater Vasilikos area (EAC power stations, VCW plant etc). The station has been placed downwind of these sources in the nearest residential area. Background atmospheric pollution levels in the Vassilikos Bay area record short term peak pollution levels caused from the nearby industrial activities (Vassilikos Power Station, Vassilikos Cement Works).

Zygi Industrial Station Details

Operational Status	Since 1991
Station address	Zygi, larnaca
Station coordinates	34 43' 46'' N, 33 20' 15'' E
Station type	Industrial Station
Pollutants measured	CO, NO, NO_2, NOx,O_3, SO_2, PM_{10}, $PM_{2.5}$, Pb, C_6H_6
Meteorological parameters measured	W/S, W/D, T, R/H, P, S/R

In any case, data on ambient air quality from the Department of Environment and the DLI show no significant issues for the last 6 months, as follows. The below graphs show the hourly average concentrations of the pollutants, monitored at Zygi industrial station for the last one, three and six months alternatively. (**Figures 4.18 - 4.19 - 4.20**)

Table 4. 27: Air quality classification range (colour system)

Pollutant	Low	Moderate	High	Very High
SO_2	0-150	150-250	250-350	>350
PM_{10}	0-50	50-100	100-200	>200
$PM_{2.5}$	0-25	25-50	50-100	>100
NO_2	0-100	100-150	150-200	>200
O_3	0-100	100-130	130-160	>160
CO	0-7000	7000-15000	15000-20000	>20000
C_6H_6	0-5	5-10	10-15	>15

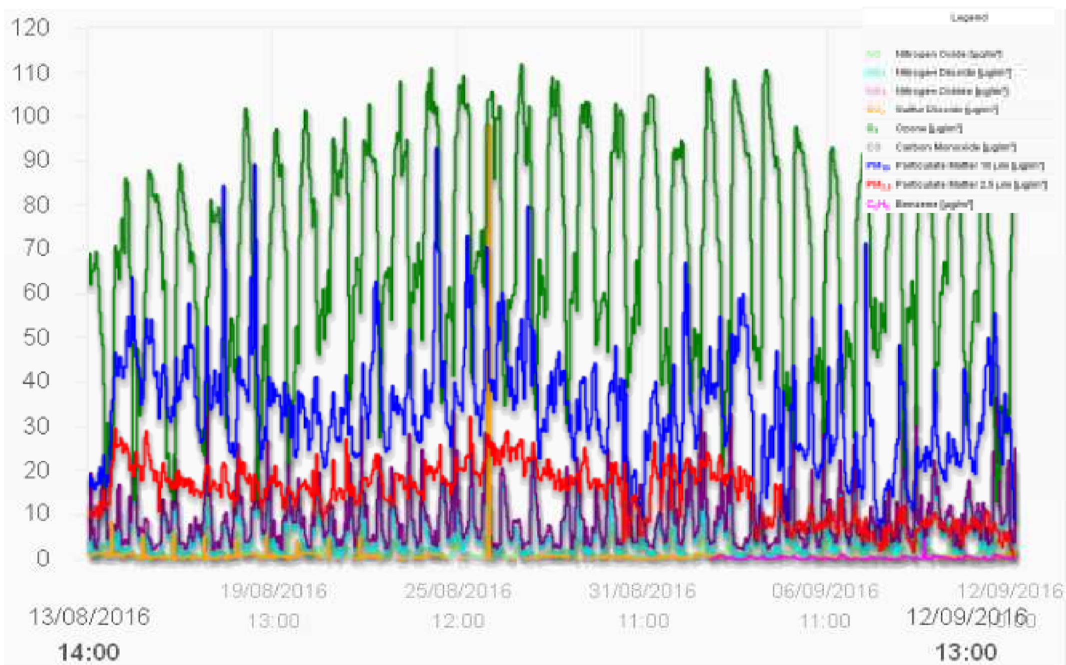


Figure 4.18: Hourly average pollutants concentrations for the last one month (12/08-12/09/2016) at Zygi industrial station

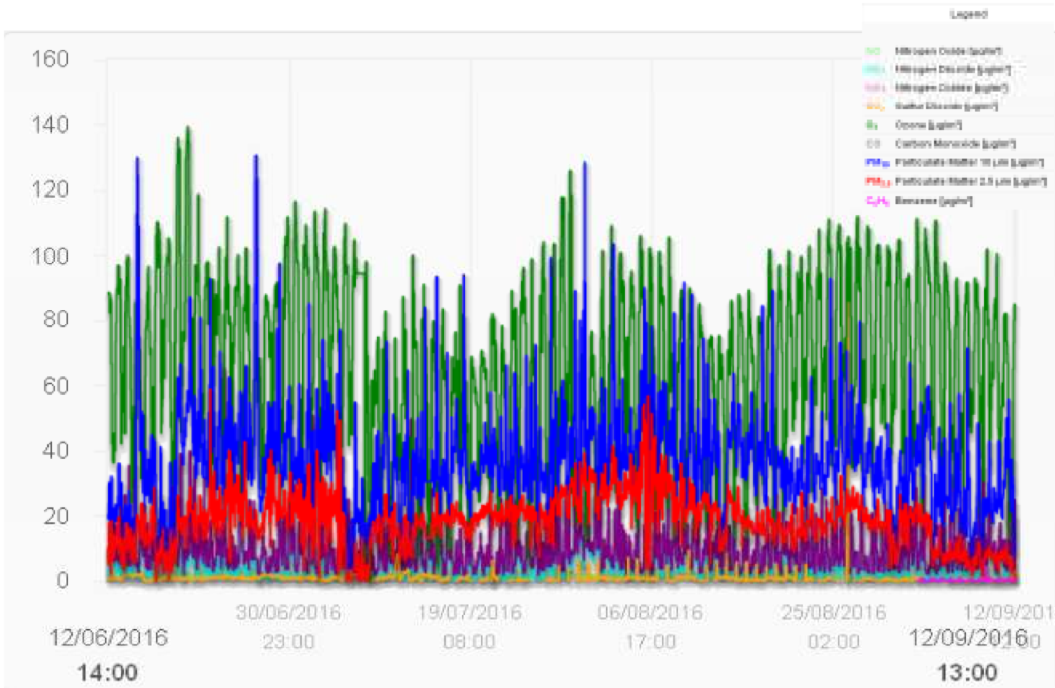


Figure 4.19: Hourly average pollutants concentrations for the last three months (12/06-12/09/2016) at Zygi industrial station

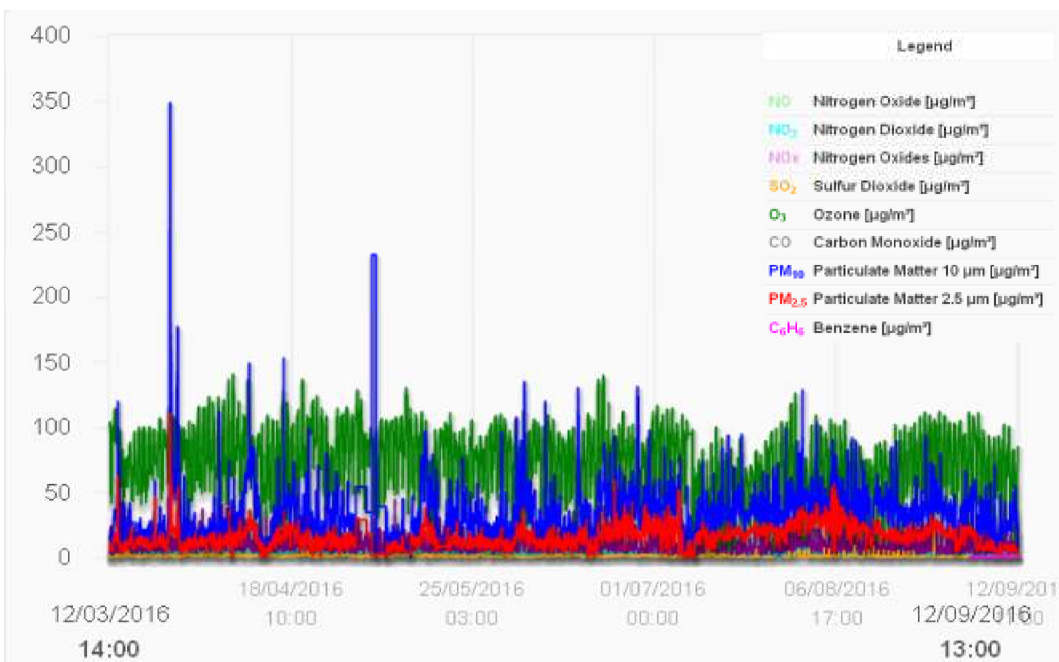


Figure 4.20: Hourly average pollutants concentrations for the last six months (12/03-12/09/2016) at Zygi industrial station

4.1.18. Noise pollution

Vasilikos area is characterized mostly as an industrial area with many heavy industries localized in. Noise emission sources will include the operation of heavy industries (Vasilikos Cement Works, Vasilikos Power Plant) vessels and the increased road traffic in the area for industrial use.

The competent authority responsible for monitoring Noise Pollution is the Department of Environment.

4.1.19. Vibration

There is no existing data/ information with regard to vibrations and negative effects to the facilities and installations in the area. Heavy truck movements and the operation of the hydraulic presses at Economides scrap metal yard are the most important sources of vibrations in the area but there are no records of damage to infrastructure and/or buildings in the area attributed to these activities/ operations.

4.1.20. Ecology and Nature Conservation

This section describes the terrestrial ecology present on the site and in the surrounding area.

As the general area is heavily industrialised, and much of the site itself is a brownfield redevelopment, the potential for endangered or protected habitats is generally considered low.

Given the desk study done for the area, concerning its terrestrial ecology, it was obvious firstly from a site visit and secondly from other available reports-studies that the area is relatively poor area of no ecological interest. The site supports a fairly homogenous species composition and abundance. However the vegetation is very common thought Cyprus and there are no priority species, protected areas or priority habitats or species found in the vicinity of the site.

The main EU policies with respect to ecology and nature conservation enacted within Cyprus are the Habitats Directive (92/43/EEC amended 97/62/EC) and the Wild Birds Directives (79/409/EEC, as amended 94/24/EC and 97/49/EC).

Under these Directives the country is required to compile a national list of important habitats and species and designate sites for protection as either Special Areas of Conservation (SACs) or Special Protection Areas (SPAs) respectively. All designated sites (SAC and SPA) across Europe will form an ecological network of protected areas, labelled Natura 2000.

Management plans should be designed for the conservation of these identified habitats and species, and whilst the Directives do not call for the exclusion of all human activities within Natura 2000 sites, human activity must not undermine the conservation objectives of the protected areas.

As required, Cyprus has compiled national lists of important habitats and species, with key designated habitats including certain areas of the Troodos mountain range and the Larnaca Salt Lakes. There are not any designated habitats in vicinity of the tank farm site.

4.1.21. Habitats and Flora

The proposed area for the tank farm has been significantly altered by anthropogenic impacts, including the construction and operation of the EAC Power Station, the Vasilikos Cement Works, and the British Sovereign Base, amongst others.

No protected areas or priority biodiversity habitats or plant species are known to be present in the vicinity of the site, and, despite the presence of a number of endemic species (see below) these are all common throughout Cyprus and the area is therefore generally considered to be of only limited ecological value. The site supports a fairly homogenous species composition typical to Cyprus. The density and abundance of species is low, which has been attributed to the downgrading of the habitat over the years due to the mostly industrial use of the site.

The different environments mentioned above create a diverse habitat for many different plant species. The agricultural fields host many species of herbs and grasses. Shrubs and phryganas blended with trees compose a different plant community.

The flora identified in the area may only represent a portion of the diverse flora that habits the area. However, the flora identified is most certainly the dominant and prevailing flora species of the region. Fifty three (53) species belonging thirty six (28) different families were detected in this study, while 7 more species were detected but their identification has not been possible. Approximately seven (7) tree species and numerous shrubs, sub-shrubs, herbs and grasses were recorded. **Table 4.28** reports the species detected and their family names.

The International Union for Conservation of Nature (IUCN) Red List of Threatened Species provides taxonomic, conservation status and distribution information on taxa that have been globally evaluated using the IUCN Red List Categories and Criteria. The main purpose of the IUCN Red List is to catalogue and highlight those taxa that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered, Endangered and Vulnerable). **Table 4.28** lists the threatened species of the flora of Cyprus that may subsist in this area. These species have not been observed by the researchers in the area. The Red Data Book of the Flora of Cyprus was used to detect the flora that exists in a similar ecotype to the one studied. The listed species fitted the criteria if their habitat was reported to be calcareous soils, phryganas or agricultural areas at low elevations. Twenty nine (29) species are reported on **Table 4.28**, fifteen (15) of which are vulnerable, four (4) are critically endangered, seven (7) are endangered and four (4) are data deficient.

Table 4. 28: Flora in the surrounding area

Name of Species	Name of family
Juniperus phoenicea	*Cupressaceae*
Cypressus sempervirens	*Cupressaceae.*
Ceratonia siliqua	*Leguminosae*
Acacia saligna	*Mimosaceae*
Ficus carica	*Moraceae*
Olea europaea	*Oleaceae*
Pinus brutia	*Pinaceae*
Pistacia terebinthus	*Anacardiaceae*
Pistacia lentiscus	*Anacardiaceae*
Asparagus acutifolius	*Asparagaceae*
Lithodora hispidula	*Boraginaceae*
Heliotropium hirsutissimum	*Boraginaceae*
Anchusa aegyptiaca	*Boraginaceae*
Capparis spinosa	*Capparaceae*
Chenopodium opulifolium	*Chenopodiacea*
Noaea mucromata	*Chenopodiacea*
Cistus creticus	*Cistaceae*
Phagnalon rupestre	*Compositae*
Phangalon rupestre	*Compositae*
Inula viscosa	*Compositae*
Conyza bonariensis	*Compositae*
Hedypnois rhagadioloides	*Compositae*
Senecio vulgaris	*Compositae*
Carlina involucrata	*Compositae*
Onopordum cyprium	*Compositae*

Carthamus lanatus	*Compositae*
Echinops spinosissiums	*Compositae*
Enarthrocarpus arcuatus	*Cruciferae*
Sinapis alba	*Cruciferae*
Didesmous aegyptius	*Cruciferae*
Matthiola tricuspidata	*Cruciferae*
Ephedra fragilis	*Ephedraceae*
Mercurialis annua	*Euphorbiaceae*
Trifolium species	*Fabaceae*
Hyparrhemia hirta	*Gramineae*
Oryzopsis miliacea	*Gramineae*
Arundo donax	*Gramineae*
Grasses	*Gramineae*
Phalaris minor	*Gramineae*
Phalaris paradoxa	*Gramineae*
Calycotome villosa	*Leguminosae*
Allium ampeloprasum	*Liliaceae*
Asparagus stipularis	*Liliaceae*
Urginea Maritima	*Liliaceae*
Asphodelus aestivus	*Liliaceae*
Malva parviflora	*Malvaceae*
Oxalis pes-caprae	*Oxalidaceae*
Polygonum equisetiforme	*Polygonaceae*
Ziziphus lotus	*Rhamnaceae*
Sarcopoterium spinosum	*Rosacea*
Solanum nigrum	*Solanaceae*
Ferula communis	*Umbelliferae*
Eryngium creticum	*Umbelliferae*
Lantana camara	*Verbenaceae*

Table 4. 29: Threatened flora of Cyprus listed on International Union for Conservation of Nature (IUCN) Red List that may occur in this area. They have not been detected in the area of study, but the habitat in the area fits their ecological environment

Name of species	Family of species	Elevation	Agricultural Areas	Phryganas	Other habitats	Threat categories	Chorology
Bupleurum nodiflorum	Apiaceae	0-300m	Y			EN	C
Cachrys scabra	Apiaceae	0-70m			Coastal areas	EN	C
Daucus guttatus	Apiaceae	0-100m	Y	Y		VU	D
Eryngium campestre	Apiaceae	0-100m	Y			VU	E
Asphodelus tenuifolius	Asphodelaceae	0-350m			Limestone rocks	VU	E
Achille cretica l.	Asteraceae	0-120m		Y		VU	E
Achillea santolinoides	Asteraceae	40m	Y			CR	E
Gundelia tournefortii	Asteraceae	0-500m	Y	Y		EN	E
Crambe hispanica	Brassicaceae	30-50m			Coastal shrubs	EN	D
Sisymbrium olyceratium	Brassicaceae	0-1100m	Y			EN	D
Herniaria hemistemon	Caryophyllaceae	30-370m			Scattered phrygana	VU	D
Silene fuscata	Caryophyllaceae	0-700m	Y			CR	D
Convolvulus lineatus	Convolvulaceae	0-50m			Side of roads	VU	E
Euphorbia hierosolymitana	Euphorbiaceae	0-750m		Y		VU	C
Argyrolobium uniflorum	Fabaceae	30m		Y		CR	D
Astragalus suberosus	Fabaceae	0-200m	Y			EN	A&C
Trifolium globosum	Fabaceae	0-750m		Y		VU	C
Trigonella spinosa	Fabaceae	0-700m	Y			DD	C
Ranunculus	Isthmicus	0-250m			Rocky substrate	VU	D
Salvia pinnatta	Lamiaceae	0-450m			Sub-shrub	DD	B
Malvella sherardiana	Malvaceae	0-150m			Agricultural areas	EN	E
Ophrys kotschyi	Orchidaceae	0-900m		Y		VU	A
Orchis tridentata	Orchidaceae	0-500m		Y	Limestone areas	DD	E

Aegilopsn bicornis	Poaceae	30m			1 km from the beach	VU	E
Alopcurus urticulatus	Poaceae	30-120m			Limestones	VU	E
Crithopsis delileana	Poaceae	0-300m			Scattered phrygana	VU	E
Nigella ciliaris	Ranunculaceae	0-150m	Y			DD	B
Galium divaricatum	Rubiaceae	0-300m	Y			VU	D
Haplophyllum buxbaumii	Rutaceae	0-50m	Y			CR	D

VU=Vulnerable, CR=Critically Endangered, EN=Endangered, DD=Data deficient, A=Cyprian endemic, B=Near endemic,
C=East-mediterranean, D=mediterranean,
E=Wider distribution

4.1.22. Fauna

No protected animal species have been recorded in the vicinity of the site, and faunal species that have been identified are restricted to common lizards, weasels and mice, as well as common invertebrates. The area is generally considered to be of low ecological value.

Arthropods

The varied habitat types make home to distinct groups of invertebrates and vertebrates. The agricultural fields with the numerous herbs produce considerable amounts of nectar. These places are insect havens and countless invertebrates time their life cycles with the blooming period. Many nectar feeders such as butterflies (superfamily Papilionoidea) (**Picture 4.21**), and bees (superfamily Apoidea) (**Picture 4.22**) play an important ecological role as pollinators. These insects are preyed by other carnivorous invertebrates such as ants (family Formicidae) (**Picture 4.23**) and wasps (family Vespidae) up the next trophic level. Wasps such as the large European hornets (Vespa spp) may attack both single foraging bees in the field or an entire colony. Ants play an enormous role in terrestrial ecosystems. They are considered to be the “leading invertebrate predators”. Among other things they are known to prey on butterfly caterpillars. There are also other predator insects, beetles (**Picture 4.24**) such as Coccinellidae species have a broad ecological range, living almost anywhere where there are aphids for it to eat. Both the adults and the larvae are voracious predators of aphids. Herbivorous invertebrates such as grasshoppers (suborder Caelifera) are the primary consumers of other food chains where birds are usually the secondary consumers. A substantial diverse community of invertebrates was observed by the researchers in the area due to the frequent watering that results from the farming activities. Insect studies, however, are time and money consuming. The researchers didn’t explore the insect fauna of the area as that will only lead to erroneous results since the insects are so diverse and abundant. The insect-fauna could not be evaluated by three days of field work.

	
Picture 4. 22: *Papilio machaon*	**Picture 4. 23:** *Apis spp* of the family *Apoidea*
	
Picture 4. 24: Black ants *Lasius niger* of the family *Formicidae*	**Picture 4. 25:** *Coccinellidae species*

Reptiles

Table 4. 30 lists the reptile species of the order Squamata (lizards and snakes) that possibly habit the area under study. Not all reptile species have been detected by the researchers but since the area studied is their natural habitat and it is possible that they occur here, they are listed on the Table. **Table 4.30** includes thirteen (13) species and subspecies. There are six (6) endemic species listed. Most of these reptiles are listed in the Bern Convention on the Conservation of European Wildlife and Natural Habitats of which primary purposes are to conserve wild flora and fauna and their natural habitats and to monitor and control endangered and vulnerable species. The convention has lead to the creation of Areas of Special Conservation Interest which operates alongside the European Union's Natura 2000 programme. The

reptiles are also listed in appendices of the Council Directive 92/43/EEC which sets out to conserve natural habitats and wild fauna and flora.

Table 4. 30: Reptiles that possibly habit the area studied. Whether they are endemic to the island is demonstrated

Name of species	Endemic	Bern Convention	92/43/EEC
Ablepharus kitaibelii		II	IV
Acanthodactylus schreiberi schreiberi	Y	II	IV
Agama stelio cyprianus	Y	II	IV
Chalcides ocellatus ocellatus		II	IV
Coluber jugularis		II	IV
Cyrtodactylus kotschyi fitzingeri	Y	II	IV
Eumeces schneiderii schneiderii	Y	III	
Hemidactylus turcicus		III	
Mabuya vittata		III	
Macrovipera lebetina		II	II/IV
Ophisops elegans schlueteri	Y	II	IV
Telescopus fallax cyprinus	Y	II	IV
Typhlops vermicularis		III	

Birds

The numerous plant flowers that survive in the cultivated fields provide essential food source to many insects and pollinators (1st consumers). Other insects or lizards will feed on these herbivorous bugs (2nd consumers). 1st and 2nd consumers will be preyed by various bird species. Great abundance of many bird species either insect or seed feeders (feed directly from the fields) were present in the areas. High concentrations of several bird species were identified in the south sections of the area with more pronounced abundance in the dense patch of vegetation of the southwest section. It is believed that the water source from the cultivated fields is an attractant to both insects and birds. It is also believed that many birds are using the southwest section to spend the night; however that section may remain unharmed since it is located just outside the limits of the area studied.

Overall twenty nine (29) species of birds belonging to twelve (12) different families were observed in the area. Birds observed by the researchers in the area studied are presented on **Table 4.31**. The migratory status, whether they are endemic and the appendices of the Bern Convention or the Council Directive 79/409/EEC in which the species is listed are also shown on the table. The European community adopted Council Directive 79/409/EEC on the conservation of wild birds.

Mammals

The researchers didn't observe any mammals in the area. However faeces of the herbivore Lepus europaeus cyprius were found which confirms the existence of this fury animal in the area. Other signs such as underground holes (dens) are evidence that other mammals may habit and feed in the area.

Table 4. 31: Birds observed by the researchers in the area studied. The migratory status (permanent resident or migratory) and whether they are endemic to the island is demonstrated. The appendix of the Bern Convention or the Council Directive 79/409/EEC in which the species is listed is also shown.

Name of Species	Family of species	Endemic	Migratory	Bern Convention	79/409/EEC
Acrocephalus scirpaceus	*Sylviidae*		m	II	
Anthus species	*Motacillidae*		m	II	
Carduelis cannabina	*Fringillidae*		pr,m	II	
Carduelis carduelis	*Fringillidae*		pr,m	II	
Carduelis chloris	*Fringillidae*		pr,m	II	
Corvus corone	*Corvidae*		pr		II2
Coturnix coturnix	*Phasianidae*		pr,m	III	II2
Erithacus rubecula	*Turdidae*		m	II	
Falco tinnunculus	*Falconidae*		pr,m	II	
Fringilla coelebs	*Fringillidae*		pr,m	III	
Galerida cristata	*Alaudidae*		pr,m	III	
Lullula arborea	*Alaudidae*		pr,m	III	
Melanocorypha calandra	*Alaudidae*		m	II	
Miliaria calandra	*Emberizidae*		pr,m	II	
Motacilla alba	*Motacillidae*		m	II	
Oenanthe cyrpiaca	*Turdidae*	Y	m	II	
Parus major	*Paridae*		pr	II	
Passer domesticus	*Passeridae*		pr,m		
Phylloscopus collybita	*Sylviidae*		m	II	
Pica pica	*Corvidae*		pr		

Saxicola torquata	*Turdidae*		m	II	
Streptopelia decaocto	*Columbidae*		pr		
Sylvia atricapilla	*Sylviidae*		m	II	
Sylvia communis	*Sylviidae*		m	II	
Sylvia conspicillata	*Sylviidae*		pr	II	
Sylvia melanocephala	*Sylviidae*		m	II	
Sylvia melanothorax	*Sylviidae*	Y	pr	II	
Turdus merula	*Turdidae*		m	III	II2
Turdus philomelos	*Turdidae*		m	III	II2

Also, the direst study area is near of a bird migratory path (Vasilikos River), as it shown on **Figure 4.21**. But the low height of the installations and the character of the wider area (heavy industrial zone) ensure that the proposed tank farm will not have any affect on the bird migratory path.

Figure 4.21: Bird migratory paths in the wider study area

Coastal Habitats

The narrow stretches with gravel and the steep cliffs are very poor in marine life. No marine plants are observed on the East side of Vassilikos Bay. The only marine plants observed at the central part of Vassilikos Bay on the shore were *Ulva lactuca* and dead pieces of *Cystoseira sp*. Both species were identified at the opening of a breakwater located in front of the Vassilikos Power Station of the Electricity Authority of Cyprus.

4.1.23. Marine Ecology

The infauna of the sedimentary habitats is dominated in terms of abundance and diversity by bivalve molluscs, gastropods and polychaetes (bristle worms). During a survey for the Vassilikos Power Station EIA, 485 individuals were recovered from 199 species (ERM, 1998). Review of data taken from three sites (Governors Beach, Vassilikos and Zygi) and five depths (5 m, 10 m, 20 m, 30 m and 50 m) indicates that there is a trend of increasing diversity and abundance with depth, with the greatest percentage of infauna recorded located within a depth range of 20 to 40 m.

Recorded macrofauna was particularly poor in shallow water at Vassilikos which may be due to contamination, although this was also observed at sampling stations both within zones found closed to intensive fish farming, and stations located more than 2 km away, following the direction of the prevailing currents. Indeed, surveys carried out around the fish farms indicate a sudden change of species composition and abundance under the cages within 50 metres from the cages. Lamellibranches, such as Corbula gibba, dominated at 50 metres depth, whereas polychaetes dominate in depths from 5 to 50 metres.

Results of various studies (ERM, 1998 and HR Wallingford, 2006a) indicate there is an area of seagrass Posidonia sp in around 10 m within the bay. This seagrass is a priority habitat under the EU Habitats Directive and is likely to be associated with more diverse benthic and epifaunal communities as well as contributing to functionality of the ecosystem in the area. It is understood that there is no background information relating to the importance of the seagrass beds in the Cypriot coast at this stage.

The only marine plants observed at the central part of Vassilikos Bay onshore were Ulva lactuca and dead parts of Cystoseira sp. Both species were identified at the opening of a breakwater located in front of the Vassilikos Power Station of the Electricity Authority of Cyprus (EAC).

There are no data available on the potential importance of the area as a fish nursery or breeding ground, although areas of seagrass are likely to be important nursery areas.

There are no data available on the potential importance of the area for marine reptiles.

Although there is no official documentation of marine mammals presence in Vassilikos Bay, divers and fishermen have reported seeing monk seals (Monachus monachus - included in Annex I of the Habitats Directive), and bottle-nose dolphins (Tursiops truncatus - included in Annex II of the Habitats Directive) in the area.

Marine Environment

Table 4. 32: A list of macrobenthic composition of fauna

Crustaceans	1m	5m	10m	20m	25m	30m	50m	100m
Callianassa tyrrhena						x	x	
Ethusa mascarone						x	x	x
Eypogarus sp.				x				
Galathea squamifera				x			x	
Galathea intermedia							x	x
Paguristes oculatus							x	
Paguristes eremita							x	
Pagurus anachoretus						x		
Pagurus cuanensis							x	x
Inachus dorsettensis							x	x
Anapagurus picorniger				x			x	
Pisa armata								
	1m	5m	10m	20m	25m	30m	50m	100m
Parthenope massena							x	
Liocardius depurator							x	x
Liocardius marculatus							x	x
Liocarcinus corrugatus							x	
Liocarcinus archuatus							x	
Anchialina agilis							x	
Apseudes latreillei							x	
Spaeroma serratum								x
Cirolana borealis							x	x
Lophogaster typicus							x	
Portunus arcuatus				x				
Upogebia pusilla						x		
Alpheus glaber							x	x
Eurynome aspera							x	x
Processa canaliculata								x
Processa edulis							x	x
Pontocaris cantaphracta							x	
Upogebia pusilla							x	
Diogenis pugilator							x	
Leucothoe spinacarpa							x	x
Gammaridae sp.							x	x
Echinodermata								
Acrocnida branchiata						x	x	
Amphiura chianjei						x	x	x
Ophiura alpida				x		x	x	
Ophiura lacertosa							x	
Psammechinus microtuberculatus							x	
Schisaster canaliferus								x
Brissopsis lyrifera							x	x
	1m	5m	10m	20m	25m	30m	50m	100m
Astropecten bispinonsus							x	
Astropecten irregularis							x	x
Astropecten platyacanthus							x	

Astropecten spinulonsus							x	x
Gasteropoda								
Bittium reticulatum				x				
Turritela turbona								x
Bolinus brandaris								x
Philine aperta								x
Cerithium vulgatum				x				
Scaphopoda								
Dentalium dentalis								x
Cerithium vulgatum				x				
Haminea hydatis						x		x
Homalopoma sp							x	
Jujubinus exasperatus				x				
Philine quatripartita						x		
Smaragdia viridis				x		x		
Lamellibranchiata								
Gorbula gibba						x	x	x
Glycymeris pilosa						x		
Guldia minina						x		
Nucula sulctuta							x	
Azorinus chamansolen								x
Phaxas adriaticus								x
Nucula sulcata								x
Arca noae								
Modilula phaseolina								x
Lissopecten hyalinus								x
Thyasira flexuosa								x
Acanthocadtia echinata								x
Parvicardium exiguum								x
Plagiocardium papilosum								x
Polychaeta								
Amphictene auricoma						x		
Capitellidae							x	
Cirratullidae						x		
Exogone gemmifera				x				
Glycera convulata							x	x
Glicera roinereuxii							x	
	1m	**5m**	**10m**	**20m**	**25m**	**30m**	**50m**	**100m**
Hesione patherina								
Jasmineira elegans							x	
Lubrinereis coccinea						x		
Lubrinereis funchalensis						x		
Lubrinereis impatiens						x		x
Nainereis laevigata				x				

Ophelia bicornis			x					
Sthenelais boa		x		x				
Dentalium rubescens			x	x		x	x	
Nemertina sp						x		
Hermonia hystrix								x
Eunice pennata								x
Hyalinoicea tubicola								x
Onuphis eremite								x
Nephtys hombergii								x
Neanthes pelagica								x
Capitella capitata								x
Notomastus sp.								x
Sternaspis scutata								x

Table 4. 33: A list of fish species observed throughout the sampled area

Apogonidae	*Apogon imperbis*		***Sparidae***	*Pagellus acarne*
Balistidae	*Balistis carolinensis*			*Pagrus pagrus*
Belonidae	*Belone belone*			*Pagellus erythrinus*
Carangidae	*Trachurus trachurus*			*Diplodus sargus*
	Seriola dumerilii			*Diplodus annularis*
Centracanthidae	*Spicara maena*			*Diplodus vulgaris*
	Spicara smaris			*Boops boops*
Coryphaenidae	*Coryphaena hippurus*			*Boops salpa*
Clupeidae	*Sardina pilcartus*			*Oblada melanura*
Congidae	*Conger conger*			*Dentex dentex*
Dactylopteridae	*Dactylopterus volitans*			*Sparus aurata*
Holocentridae	*Sargocentron rubrum*			*Spondyliosoma cantharus*
Labridae	*Coris julis*		***Sphyraenidae***	*Sphyarena sphyraena*
	Thalassoma pavo		***Synodontidae***	*Synodus saurus*
	Symphodus tinca		***Torpedinidae***	*Torpedo marmorata*
	Symphodus mediterraneus		***Trachinidae***	*Trachinus draco*
	Xyricthys novacula			*Trachinus radiatus*
Merlucciidae	*Merluccius merluccius*		***Uranoscopidae***	*Uranoscopus scaber*
Mugilidae	*Mugil cephalus*		***Xiphiidae***	*Xiphias gladius*
Mullidae	*Mullus surmulletus*		***Zeidae***	*Zeus faber*
	Mullus barbatus			
Muraenidae	*Muraena helena*			
Pomacentridae	*Chromis chromis*			
Scaridae	*Sparisoma cretense*			
Scombridae	*Thunnus thynnus*			

Scorpaenidae	*Scorpaena scrofa*			
	Scorpaena porcus			
Serranidae	*Anthias anthias*			
	Epinephelus marginatus			
	Epinephelus alexandrinus			
	Epinephelus aeneus			
	Mycteroperca rubra			
	Polyprion americanus			
	Serranus cabrilla			
	Serranus scriba			
Siganidae	*Siganus luridus*			
	Siganus rivulatus			

<u>Marine mammals</u>

Dolphins and rarely monk seals have been observed in the Vassilikos Bay especially in the vicinity of the fish farms.

The highly endangered (Annex I of the Habitats Directive, 92/43 of the European Union) monk seal (Monachus monachus), was observed by divers, swimming around the fishfarms of the Bay.

Despite the fact that there are numerous observations of dolphins by fishermen, divers and the staff of the fish farms in the Vassilikos area, there is not any official documentation of the species presented. However the descriptions pinpoint the bottle-nose dolphin (Tursiops trunchatus), an endangered species under Annex II of the Habitats Directive 92/43 of the European Union.

4.1.24. Protected Areas

<u>Territorial Conservation Areas</u>

Natura 2000 is an ecological network of protected areas, set up to ensure the survival of Europe's most valuable species and habitats. Natura 2000 is based on the 1979 Birds Directive and the 1992 Habitats Directive. The green infrastructure it provides safeguards numerous ecosystem services and ensures that Europe's natural system remains healthy and resilient.

The two Natura 2000 designated locations, adjacent to the greater Vasilikos area as shown on **Figure 4.22**, are:

– The Pentakomo/ Asgata location, at a distance of approximately 5.5 km to the west and;

– The Pentaschoinos river, at a distance of 11 km east of the proposed project development site.

The area's natura 2000 sites are 10,700 m^2 and 405,800 m^2 respectively and they are designated as protected zones under the scope of European directives 79/409/EEC and 92/43/EEC Annex II.

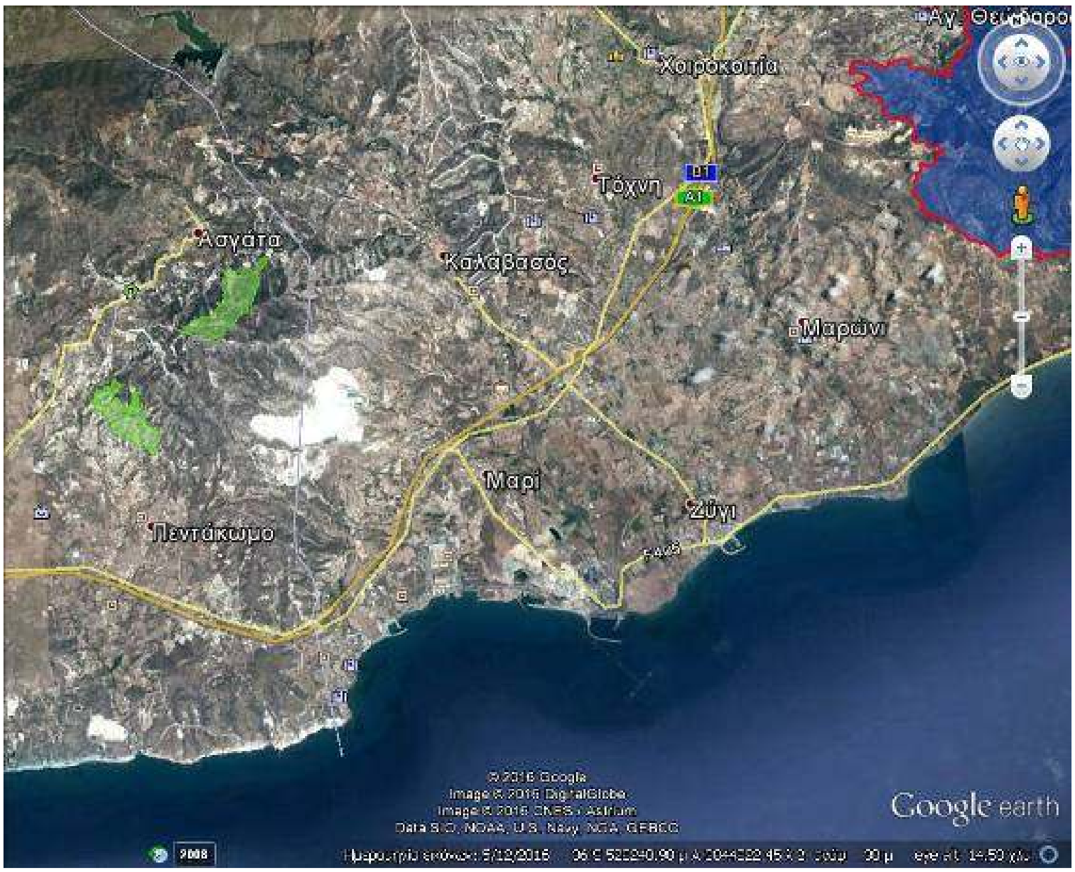


Figure 4.22: Natura/ protected zones in the area

<u>Coastal and Marine Conservation Areas</u>

Due to its site charactieristics which is mostly industrial and as a result of the current agricultural practices associated with the adjacent chemical feltilizer plant and several disposals of different materials, the ecological status of the area is rather poor. However a survey of the Agricultural Research center 1992 record one species as rare in the Flora of Cyprus. The plant is Erodium crossifolium. It was sited in the Hillside of the Vassilikos site.

The field study has generated evidence to suggest the presence of the sea grass, Posidonia oceanica, in Vasilikos Bay. It should be noted that Posidonia beds are cited in the EU Habitats Directive (92/43/EEC) as a priority habitat type of community interest whose conservation requires the designation of Special Areas of Conservation. For Special Areas of Conservation an EU member state must establish the necessary conservation measures and take appropriate steps to avoid the deterioration of these natural habitats. Cyprus is an EU Member State, so it is worthwhile to take into account the special status of Posidonia beds within Europe.

4.1.25. Resilience of facility to flooding, rising sea water

Mean sea level trends reported by NOAA for the Mediterranean indicate a rise of 1.15 millimeters/year with a 95% confidence interval of +/- 0.22 mm/yr based on monthly mean sea level data from 1905 to 2001 which is equivalent to a change of 0.38 feet in 100 years. A prospective study (Marcos et al. “Comparison of results of AOGCMs in the Mediterranean Sea during the 21st century”, Journal of Geophysical Research; 113 (c12): C12028 DOI: 10.1029/2008JC004820(2008) of the Mediterranean Sea level rise based on several scenario models for climate change, indicate that the level of the whole Mediterranean sea can rise by between 3cm and 61cm on average over the 21st century as a result of the effects of warming.

The lowest site ground level is approx. 13 m above sea level so no flooding impacts are expected in the event of rising sea water as a result of the effects of global warming.

At a distance of approx. 30 m to the West, runs Vasilikos river. The buffer zone between the project west boundary and the river bed of Vassilikos rives, as well as the 3 m high walls of the bund area, are considered sufficient to protect the facility from any flooding event.

4.2 Human Environment

The proposed construction site stands in the Larnaka administration district and it is just adjacent to the Larnaka – Limassol administrative borders.In the wider area of the study, three small communities of Mari (2.5 km), Zygi (2 km) [Larnaka district] and Pentakomo (6.5 km) [Limassol District] are located, as depicted in **Figure 4.23**.

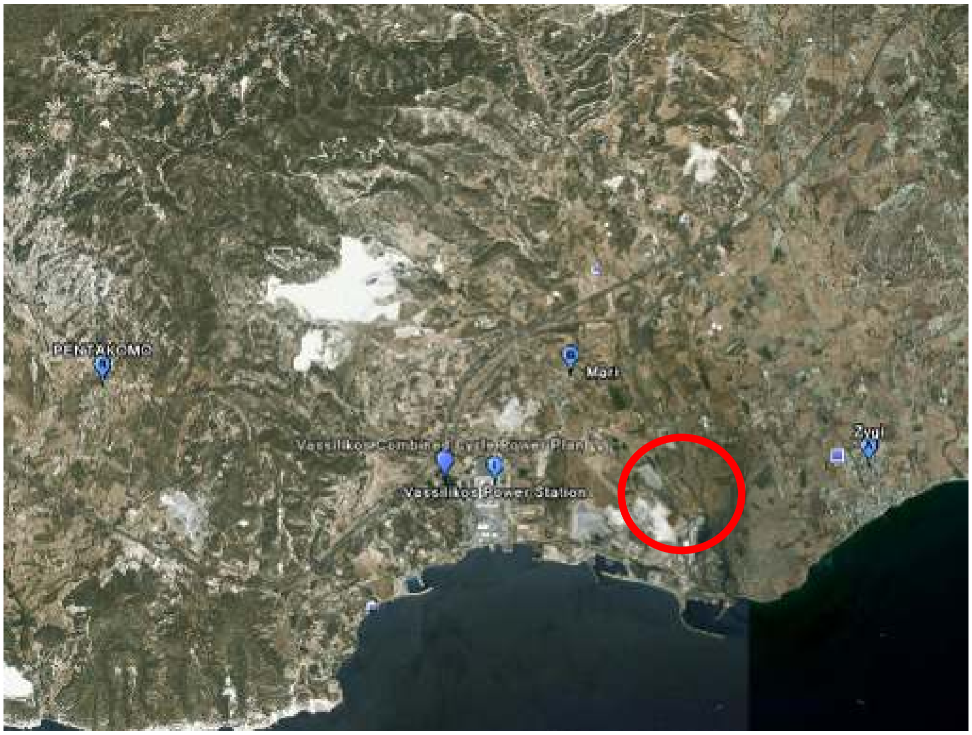


Figure 4.23: Villages near study area

4.2.1 Urban planning

The study area falls under the framework of the Policy Declaration, which is applicable to all rural areas in Cyprus.

The Policy Declaration provides for an integrated development framework of the rural areas (which are not covered by the General Development Plans), aiming at the optimum utilization of the development potential of each region.

The location of the KODAP fuel farm is within the boundaries of B2 industrial zone (**Figure 4.24**).

The Planning zones in the under study area as indicated in below figure are the following:

– B2 Heavy Industry Zone. (Industry Zone Category A).

A special part of Zone B2 at the north-western part of the zone adjacent to the old Nicosia-Limassol road has been allocated for uses such as offices or similar uses associated with the operation of the Vasilikos Energy Centre as it was proposed in 2009.

– Z1, Z2 and Z3 are protection zones with varying plot ratios1 according to the degree of protection of each zone. Z3 (plot ratio 0.01:1), is the strictest protection zone and it protects the banks of the Vasilikos River. Z2 is a less strict protection zone but with a quite high degree of protection (plot ratio 0.03:1). This zone covers a wider "buffer" zone on each side of the Vasilikos River and also a smaller area to the east of the Mari animal husbandry zone. Zone Z1 has the least degree of protection with a plot ratio of 0.06:1. It forms a buffer zone east of the Heavy Industry Zone and around the A1 Nicosia-Limassol highway.

– Γ3 is a general agricultural zone with a plot ratio of 0.10:1. This zone also covers most of the rural areas of Cyprus which lie outside development boundaries.

– Δ1 is the Animal Husbandry Zone of the village of Mari.

– H1 and H2 are the residential zones of Mari village which are developed around the village core of the community in the eastern part of the study area.

The maximum plot ratios, plot coverage percentages, numbers of floors and heights allowed in each planning zone of the study area are given in **Table 4.34**, below.

Table 4. 34: Planning zones parameters

Zone	Maximum Plot Ratio	Maximum number of floors	Maximum height (meters)	Maximum plot coverage
H1	1,20:1	2/3	8.30/11.40	0.70:1
H2	0,90:1	2	8.30	0.50:1
B2	0,90:1	2	-	0.50:1
Δ1	As given in the Policy Statement for the Countryside (PCS)			
Γ3	0.10:1	2	8.30	0.10:1
Z1	0,06:1	2	8.30	0.06:1
Z2	0,03:1	1	5.00	0.03:1
Z3	0,01:1	1	5.00	0.01:1

The Tourism Development Plan for Cyprus shows the entire coastline stretching from the Akrotiri Sovereign base west of Limassol to the Dhekelia Sovereign base east of Larnaca as a "Cyprus Tourism Organization (CTO) Controlled Zone". The designated of a CTO controlled zone presumably does not preclude heavy industrial development within appropriate selected areas of the zone as the country's two cement works and two of the countries largest oil-fired power stations all fall within this zone. The CTO has been granted a permit for the development of a camping site and other tourist installations (restaurants, showers, toilets and shops) in the area around Governors Beach and Zygi. Some development has now taken place in these areas. The Governors Beach (currently used for recreation and being developed as a camping resort) is situated approximately 5 km to the west.

A large proportion of the region around the site is used for agriculture. Generally the Vassilikos region proves very suitable for agriculture due to the relative early growing season and its vicinity to the three major urban areas (Nicosia, Larnaca and Limassol). Similarly, the Vassilikos – Pendaskinos irrigation Scheme has led to a large increase in agriculture, particularly in vegetable growing. The land surrounding Vassilikos area is not used extensively for animal husbandry.

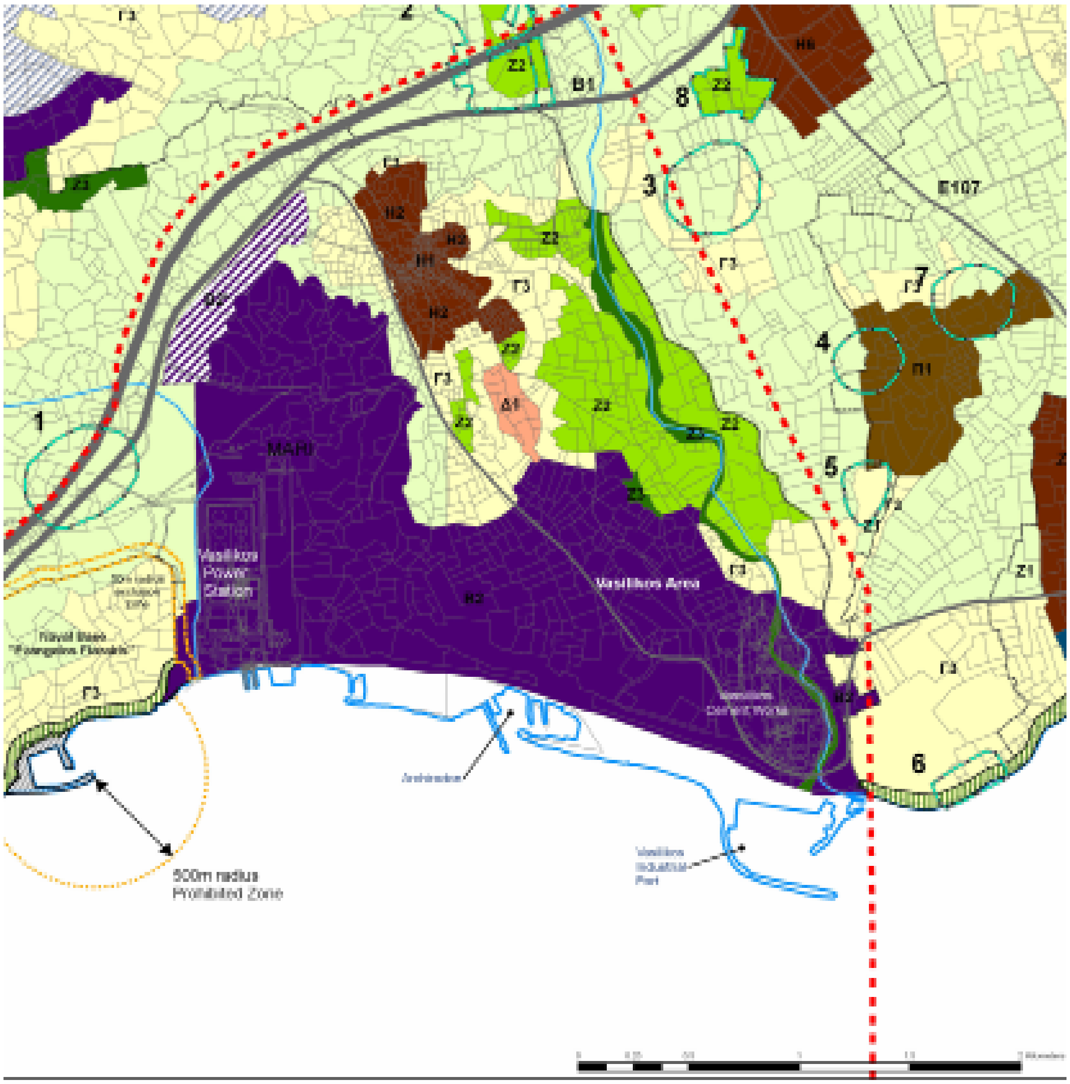


Figure 4.24: Vasilikos Planning zones. (The Vasilikos Master plan 2015)

4.2.2 Land Use

The current land uses within the boundaries of the Heavy Industry Zone are the Vasilikos Power Station to the west, the Vassiliko Cement Works to the east, the Vasilikos Port used for the import and export of raw materials and cement, fuel tanks at the eastern coastal part of the area and the Archirodon port which is currently used for ship repairs. There is also a derelict quarry at the northern part of the study area, and two quarries that are active and used by the Vassiliko Cement Works. One of these quarries is at the eastern border of the Heavy Industry Zone and a large part of it is located in the protection zone Z2 which lies at the east of the Heavy Industry Zone.

The village of Mari, with around 180 inhabitants, is located at the east side of the main road which connects the B1 Nicosia-Limassol Road with the Vasilikos port. The village is a Turkish Cypriot Village and the inhabitants are mainly refugees. Development around the old village core which mainly consists of old houses is very limited because most of the land belongs to Turkish Cypriots. South of the inhabited area of Mari there is an animal husbandry zone with goats and sheep.

The Cyprus Government has proposed the relocation of the existing inhabitants of Mari to a coastal area in Zygi. The Government has already allocated land for this residential development within the Zygi tourist zone T2α. The plot ratio allocated for this development is 0.60:1. The Mari inhabitants consider that the financial incentives given to them for relocation are not attractive and they are reluctant to relocate.

Note that the majority of the land within the wider study area is classed as Private Land. (**Figure 4.25**)

To the west of the study area is the 'Evangelos Florakis' Naval Base. Directly to the east of the study area and located in the community of Tochni is the British East Mediterranean Relay Station (BEMRS).

Two fish packaging and processing centres have been constructed along the Vasilikos-Zygi coastal road by the companies Blue Island Holdings Ltd and Seawave Ltd. Similar fish farming companies are renting coastal land from the Cyprus Ports Authority within the Archirodon and Vasilikos Port areas for the construction of small warehouses for fish packaging.

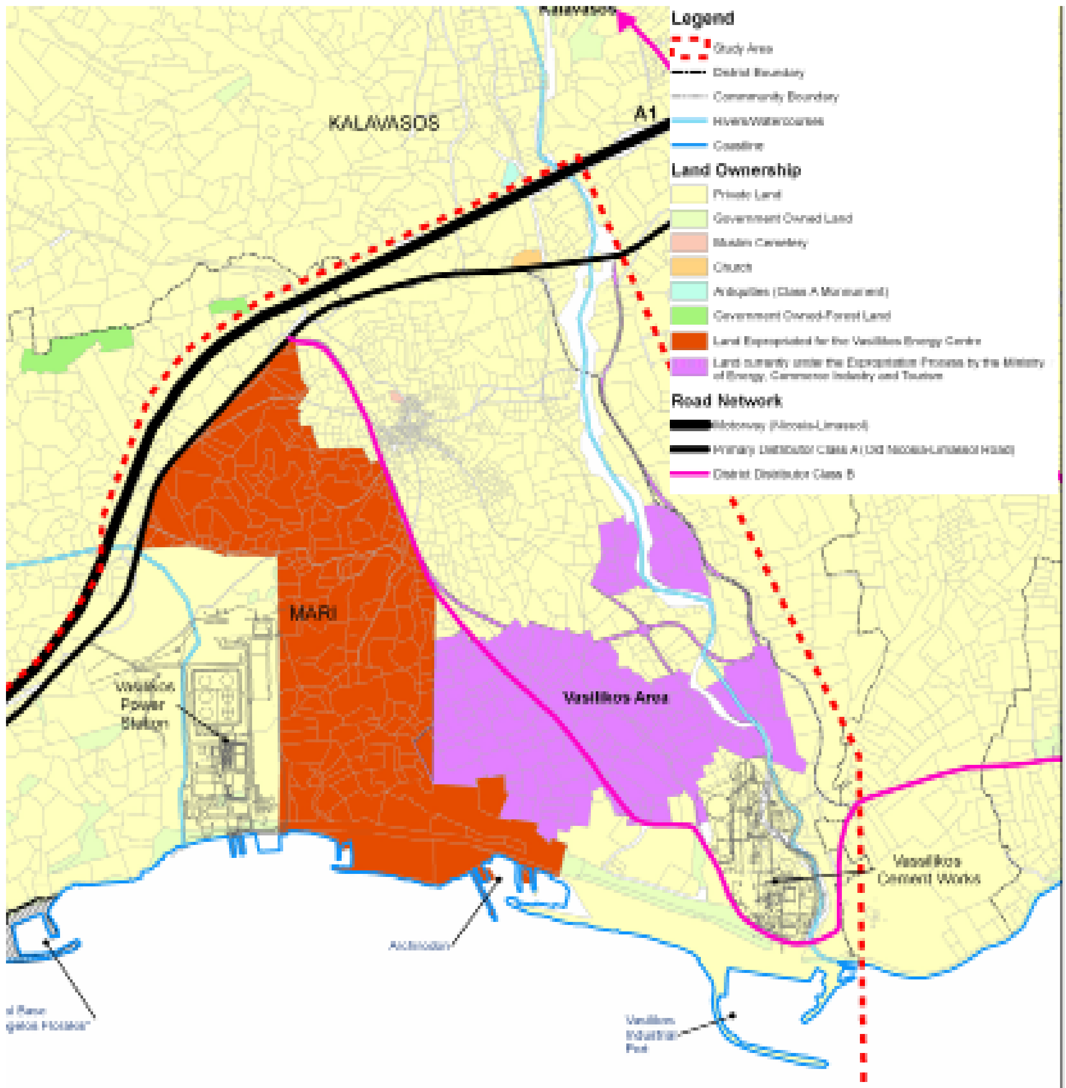


Figure 4.25: Land Ownership Plan (Source: Vasilikos MasterPlan, 2015)

4.2.3 Demographic Data

There are two small communities (villages) in the vicinity of the proposed installation, with a total population of 747 inhabitants. Of these, the Mari village (with a population of 158) is situated approximately 2 km to the north west of the boundary of the proposed installation and Zygi, approximately 2.5 km to the east, with a population of 589 residents, according to the inventory of population 2011. Zygi village is located just to the east of the Study Area and is mainly used for tourism and fishing activities.

According to the 2011 census of population, the population of the area is presented in the **Table 4.35** below.

Table 4. 35: Wider Study Area Population

Location	Households	Population
Zygi	196	589
Mari	59	158
Pentakomo	238	644
Total	**493**	**1.391**

Larnaca District has a population of 143.192 (2011) while 84.591 of them live in urban and 58.601 live in rural areas. **Table 4.36** below gives population figures and percentages by gender and settlement in the villages around the CCPP site for 2011.

Table 4. 36: Neighbor communities Population Figures

Settlement	Male		Female		Total
Zygi	311	52.80	278	47.20	589
Mari (incl. Vasilikos)	83	52.53	75	47.47	158
Pentakomo	318	49.38	326	50.62	644

Source: Census of Population 2011 - General Demographic Characteristics - Volume II

Table 4.37 below shows the age profile in Larnaca District for 2011.

Table 4. 37: Age Profile Larnaca District (2011)

Age	Total	Male	%	Female	%
<4	8.011	4.059	50.67	3.952	49.33
5-9	7.698	3.935	51.12	3.763	48.88
10-14	8.610	4.408	51.20	4.202	48.80
15-19	10.487	5.357	51.08	5.130	48.92
20-24	11.488	5.890	51.27	5.598	48.73
25-29	12.461	6.304	50.59	6.157	49.41
30-34	11.361	5.390	47.44	5.971	52.56
35-39	10.231	4.588	44.84	5.643	55.16
40-44	10.050	4.666	46.43	5.384	53.57

45-49	9.939	4.767	47.96	5.172	52.04
50-54	9.436	4.670	49.49	4.766	50.51
55-59	7.829	3.942	50.35	3.887	49.65
60-64	7.228	3.571	49.41	3.657	50.59
65-69	5.934	2.922	49.24	3.012	50.76
70<	12.384	5.642	45.56	6.742	54.44
Total:	143.147	70.111		73.036	

Source: Census of Population 2011 - General Demographic Characteristics - Volume I

Note that 45 inhabitants are not mentioned during census.

4.2.4 Landscape – Aesthetics

As it can be shown from the **pictures 4.13 – 4.20,** in the wider study area there are no apparent areas that may be considered as aesthetically important. Industrial and commercial exploitation of the landscape is evident.

4.2.5 Infrastructure

Road network

The existing road network of the wider study area includes the official inter-urban and rural road hierarchy and also unofficial and private roads as is typical of many rural areas of Cyprus. The local road network within and around the study area is presented in **Figure 4.25**

The main arteries that service the area comprise of the following roads.

- A1 Motorway (Nicosia –Limassol)
- B1 Motorway (Nicosia – Limassol), junction at Zygi
- Road E107 which connects the Zygi junction to the Vasilikos area and around the old Mari-Vasilikos road (junction at B1).
- Road along the coastline (E321), from Zygi to Vasilikos area

The new Fuel Farm will be accessed from the road connecting the Vasilikos Port with the Vasilikos Cement Company (see **Figure 4.26**).

The condition of the road network of the wider study area can generally be summarized as good. The asphalt on roads tends to be of a good standard with minimal cracking and no significant sections with potholes or rutting, even though the roads serve industrial areas where usage by heavy goods vehicles is high. Since the area in the vicinity of the KODAP Tank Farm is industrial and in some cases agricultural, there are many secondary unpaved roads serving as auxiliary routes within the area under study. The gravel roads are also of a fairly good standard, with generally good level surfaces and few pot-holes. This is probably due to fact that these roads are not used by goods vehicles and only lightly used for local access traffic and farm vehicles.

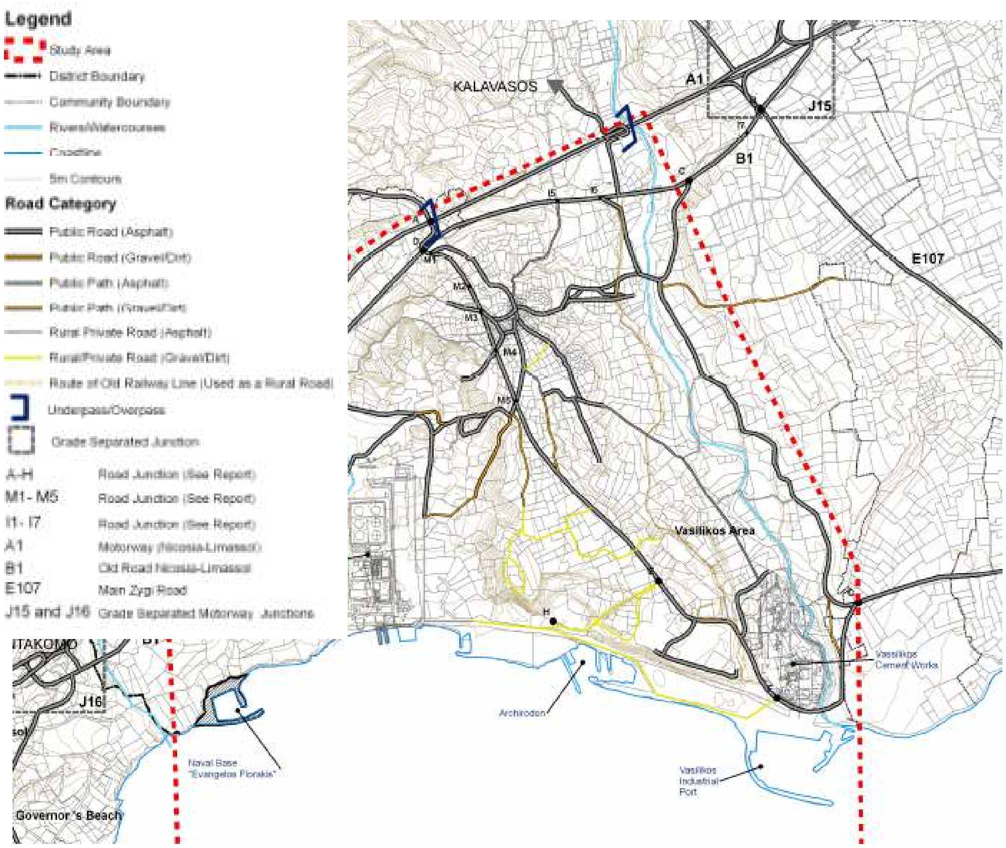


Figure 4.26: Road Network (Source: MasterPlan for the Vasilikos Area, 2015)

Traffic

The proposed facility construction site is situated approximately 4 km from A1 motorway. Access to the site is easy, as it follows the existing route on E107 to Vasilikos Cement Works plant. The exit point at the highway is at relatively short distance to major towns of the island i.e. 25 km to Limassol, 30 km to Larnaca and 40 km to Nicosia. Existing road network currently services heavy truck and vehicles traffic to and from the cement works plant and petroleum storage installations in the area and connects with major towns and product destinations.

The vehicle movements in the Vasilikos area are presented in **Table 4.38**.

Table 4. 38: Traffic load data in the Vasilikos area – Annual daily average for selected road sectors (2009)

Sector	Cars	LGV	MGV	HGV	Buses	Total
Limassol/Nicosia highway (A1) (Kofinou - Parekklisha)	9204	2581	1505	1283	177	14751
Limassol/Nicosia highway (A1) (Parekklisha - Kofinou)	9411	2719	1314	1466	196	15106
Limassol/Nicosia old road (B1) (Zygi - Parekklisha)	1468	918	301	411	67	3165
Zygi - Vasiliko (E0107)	919	201	73	371	34	1598

Source: Public Works Department, Ministry of Communications and Works

The volume of heavy duty (mainly large trucks) vehicle movements on the B1 road can be considered very large (relatively to the road's dimensions and construction quality) and predictable since it serves a constantly evolving wide industrial park.

A more recent (January 2012) traffic count was conducted during the preparation phase of the VTTV EIA study for the part of the E107 (from B1 motorway to Vasilikos) which will serve the OSRD. According to the survey the mean daily traffic accounts for 950 vehicles. Approximately 29.9% of the total vehicles were Heavy trucks, 19.6% smaller trucks and approximately 50.5% were private (saloon) vehicles.

Electricity Transmission

The Electricity Utilities, both Generation and Transmission can be seen in **Figure 4.27**. The main transmission lines from the Vasilikos Power Station consist of three 132 kV overhead lines (OHTL) heading in a north-westerly direction. These then diverge to supply various districts of the island and have no further relevance to the Vasilikos area.

A fourth 132 kV OHTL leaves the power station in an easterly direction and connects to the Mari Substation located at the northern end of the Vassiliko Cement Works.

Here the voltage is stepped down to 11 kV and the power distributed at this voltage to various users in the area, including:

- Vassiliko Cement Works;
- Mari, Zygi and other nearby villages;
- HMC/Petrolina/proposed RJA site;
- British East Mediterranean Relay Station;
- Contractors at Vasilikos Power Station (to be converted to supply the proposed temporary desalination plant on the same site);
- Vasilikos Power Station west gate;
- Governor’s Beach.

Mains power is distributed to consumers by means of pole mounted substations, located at various points along the 11 kV overhead lines, which step the voltage down to domestic mains supply levels.

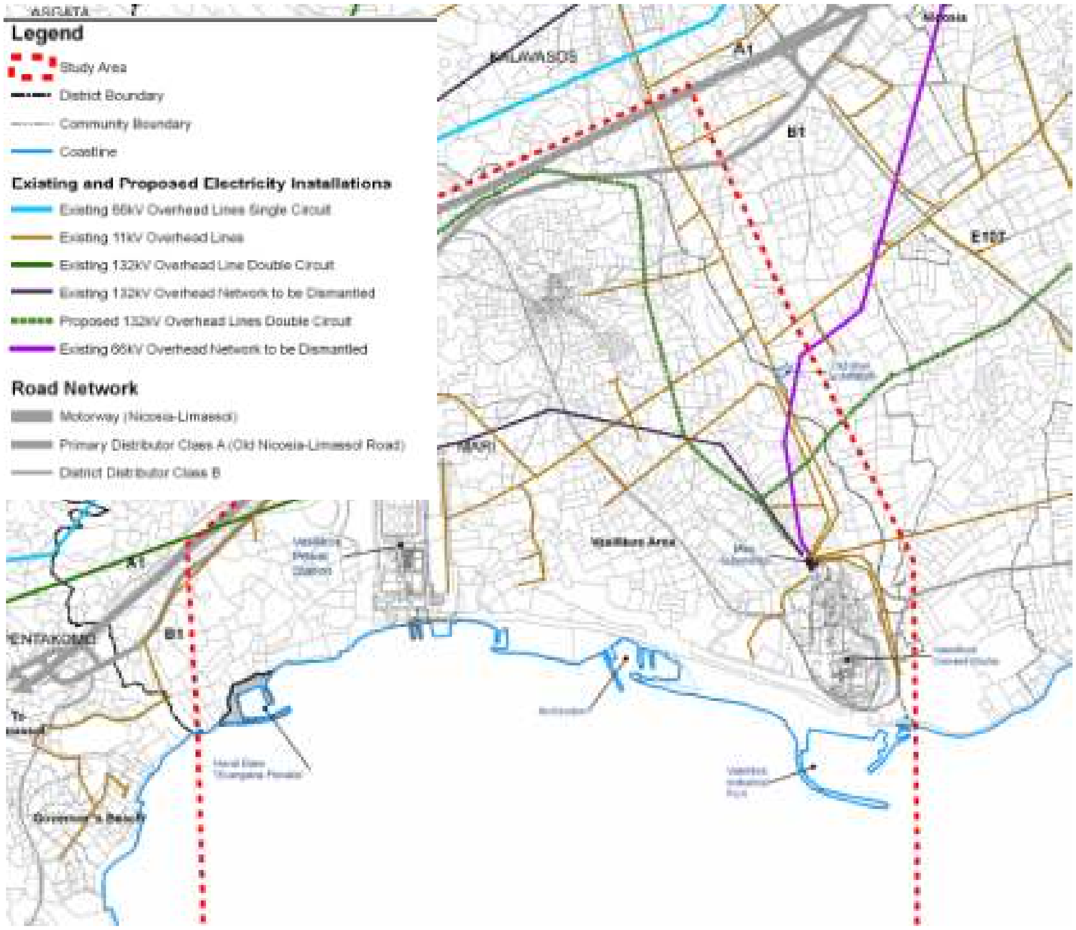


Figure 4.27: Existing electricity transmission, Distribution and Power Generation Utilities (Source: Vasilikos MasterPlan, 2015)

Water Supply Network

The Water Supply Network within the wider Study Area can be seen in **Figure 4.28**.

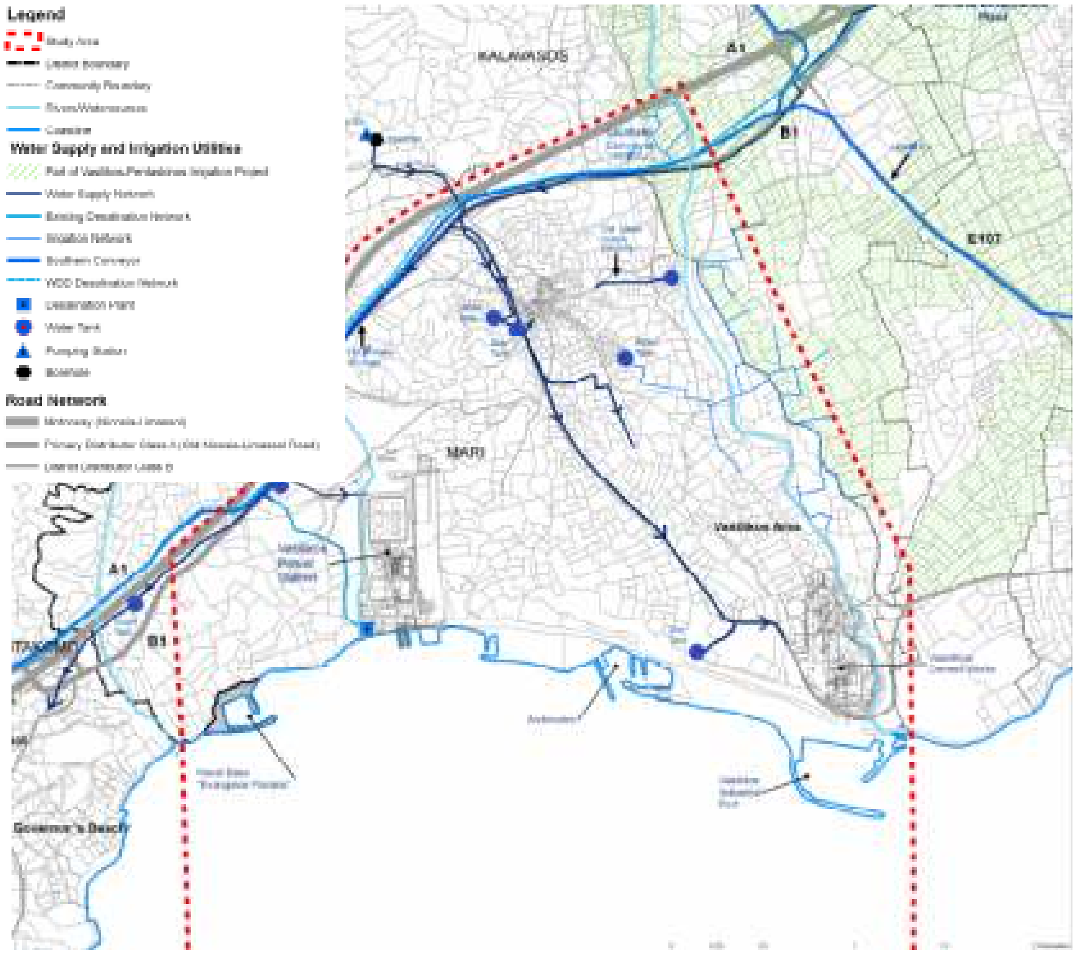


Figure 4.28: Water Supply and irrigation Utilities (Source: Vasilikos MasterPlan, 2015)

Sewage Network

There is currently no sewage network within the study area. The sewage system in Mari Village consists of individual septic tanks and absorption pits. The Water Development Department has stated that no sewage network is being proposed in the area in the near future. We have been informed that the transfer of recycled and treated water and sludge from the Zygi and Tochni Waste Water Treatment Plant originally proposed for irrigation and composting uses has been postponed.

Tourist infrastructure

There is no tourist infrastructure in the area.

4.2.6 Archaeological sites

No historical, archaeological or cultural relics have been uncovered within the boundaries of the proposed project development site according to the Antiquities Department (2016). Survey type investigations and later excavations that took place by the same Department in cooperation with various other archaeologists in the wider area of Vasiliko in the past indicated a number of sites of significant archaeological value. The most important historical sites from **Figure 4.29** (highlighted in **Figure 4.30**) have been summarized below.

In addition there are no data available regarding the marine environment of the surrounding area, although archaeologies of great importance have been found in the coastal region.

<u>Kalavasos – Kokkinoyia early Chalcolithic site</u>

Kokkinoyia is located on agricultural land located about 4 kilometers from the village of Kalavasos. It is the southernmost of a cluster of sites around the intersection of the old road Nicosia – Limassol road leading to the village of Zygi. One of these positions is the Kalavasos – Kokkinoyia belonging to the early Chalcolithic period, as well as the prehistoric Kalavasos-Bamboula site which covers various phases of prehistory. The first phase of excavations at Kalavasos prehistoric project was completed.

<u>Tochni Lakkia Late Bronze Age site</u>

The nearest archaeological site, is situated between Zygi and the British East Mediterranean Relay Station in Tochni – Lakkia close the coast, east of the of Vasilikos River mouth, 1.25 km SW of Zygi. The archaeological site contains some ceramics, chipped stone, and the fragment of a wall bracket aged to the Late Bronze Age (LBA) archaic, classical, Hellenic period. This site is not available to the public.

<u>Zygi – Petrini site</u>

Zygi – Petrini site is located approximately 750 m southwest of Zygi village, in the coastal plain between Zygi and the British East Mediterranean Relay Station, adjacent to a track which leads from the coast to the main road of the area. Several ceramics and small glass vessels have been found, falling in the Later Roman (LR) period (5th – 7th centuries A.D.). This site is not available to the public.

<u>Mari – Asprous Roman Villa</u>

Another rather small archaeological site is found in the Mari – Asprous area and it has been identified as a “roman villa”, ruins of late Roman period. This site is not available to the public.

Kalavasos – Tenta & Chirokitia

The Mari – Kalavasos region, north of the proposed project implementation site, is home to some of the most important prehistoric settlements in Cyprus, the Neolothic settlements of Chirokitia and Tenta.

Approximately 5 km north of the proposed implementation site, the archaeological site Kalavasos – Tenta is situated (**Figure 4.28**). The site of Kalavasos – Tenta was initially excavated in 1947 by P. Dikaios for the Department of Antiquities. Research stopped for many years until 1976 when the Vasilikos Valley Project commenced with the fieldwork of the Vasilikos Valley Project by the American Mission of the University of Brandeis under the direction of Prof. Ian Todd. The aim of the project, which is still in process, is to undertake multidisciplinary studies in the valley as a whole, including the area from the Kalavasos copper mines down to the coast.

Picture 4. 26, 4. 27: Kalavasos – Tenta

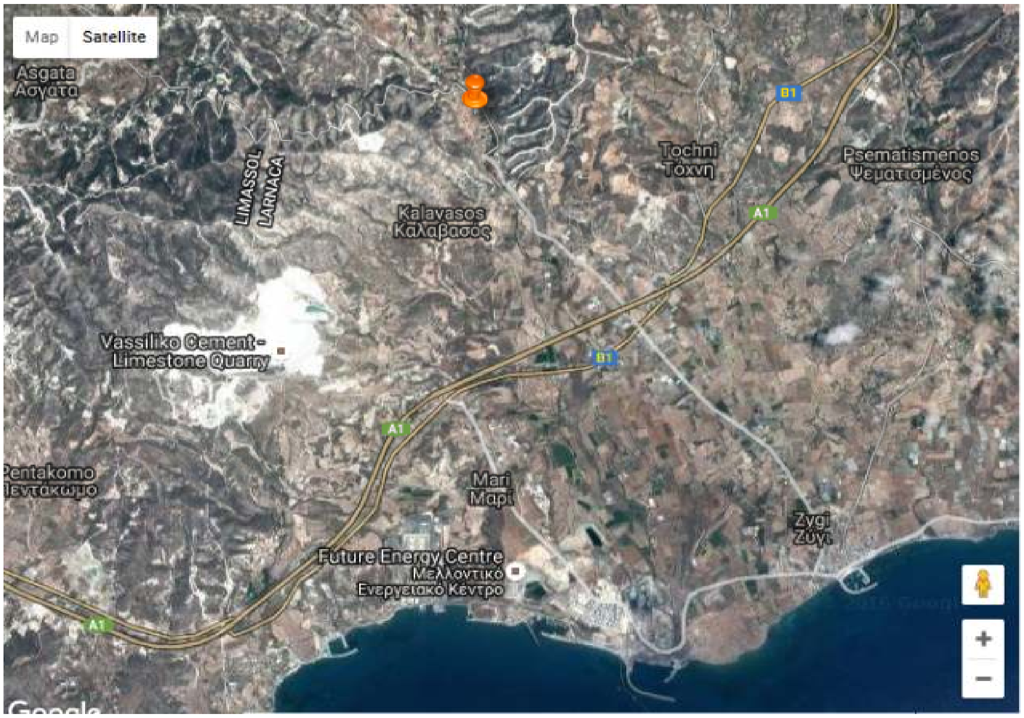


Figure 4.29: Kalavasos – Tenta location

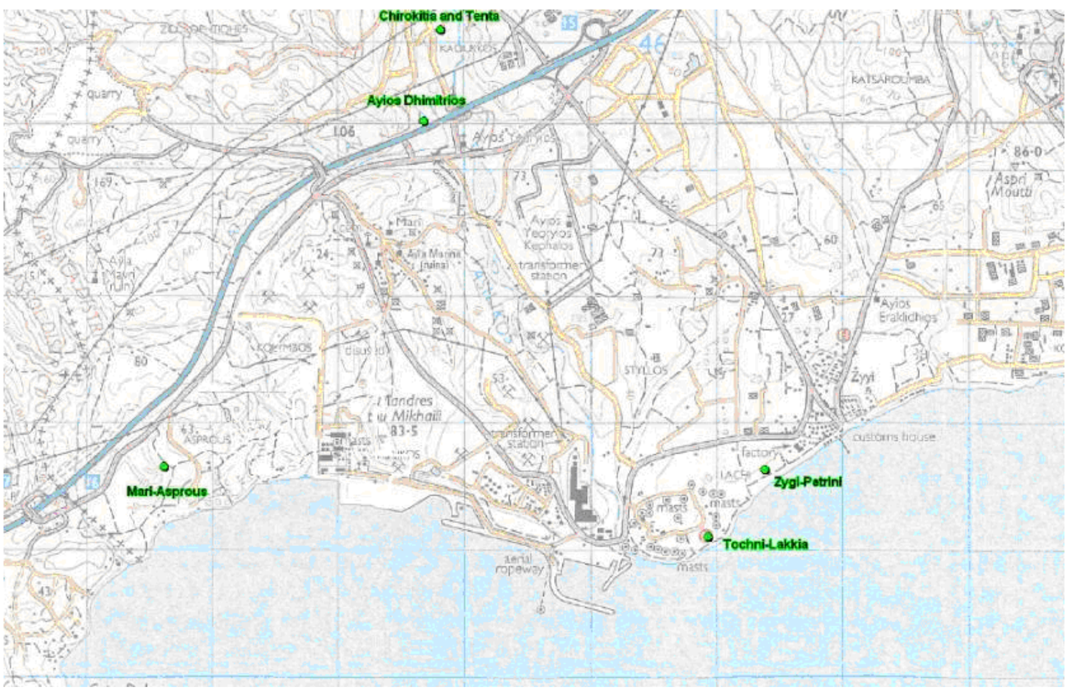


Figure 4.30: Archaelogical sites in the region of Vasilikos

The above mentioned historical sites contain the most important archaeological findings in the area. However, in the surrounding area a great number of archaelogical relics have been found, their details presented in **Table 4.39** where are the named sites and artifacts found in the under examine region.

Table 4. 39: List of Sites in alphabetical order

Site's name	Plot
Asgata - Ayia Marina	1
Asgata - Kambos	110
Asgata - Neron tou Phani	109
Asgata - Locality unknown	2
Kalavasos - Alonia Pano Zyou	3
Kalavasos - Ammos	4
Kalavasos - Andronikidhes	5
Kalavasos - Angastromeni	6
Kalavasos - Argaki	129
Kalavasos - Argaki tou Tahiri	127
Kalavasos - Argaki Yeoryiou	7
Kalavasos - Argaki Yeoryiou	125
Kalavasos - Arkhangelos	8
Kalavasos - Ayiasmata	9
Kalavasos - Ayios Dhimitrios	10
Kalavasos - Ayios Kaloyeros	11
Kalavasos - Ayios Yeoryios	12
Kalavasos - Ayious	13
Kalavasos - Ayious East	14
Kalavasos - Bamboulos	15
Kalavasos - Bamboulos	16
Kalavasos - Draconildaes	7
Kalavasos - Fournia	18
Kalavasos - Gipsari	19
Kalavasos - Gouppos	20
Kalavasos - Ipsopamboulos	21
Kalavasos - Kafkalia I n	22
Kalavasos - Kafkalia IU	23
Kalavasos - Kafkalia IV	24
Kalavasos - Kafkalia V	25
Kalavasos - KafkaliaVI	124
Kalavasos - Kafkalies	26
Kalavasos - Kafkalies	27
Kalavasos - Kafkalies	107
Kalavasos - Kambanaris	28
Kalavasos - Kampos	29
Kalavasos - Kampos	30
Kalavasos - Kampos	31
Kalavasos - Kaparovouno	32
Kalavasos - Kaphkalia A	33
Kalavasos - Kaphkalia B	34
Kalavasos - Kaphkalia C	35
Kalavasos - Kharkokolymbos	36
Kalavasos - Khorapheri West	135
Kalavasos - Khorapheri	37
Tokhni - Petreli North	102
Tokhni - Petreli North	103

Site's name	Plot
Kalavasos - Kokkino Kremmos	38
Kalavasos - Kokkino Kremmos	39
Kalavasos - Kokkino Kremmos	40
Kalavasos - Kopetra	41
Kalavasos - Krommidhia	42
Kalavasos - Laos/Pamboules	43
Kalavasos - Laroumena	44
Kalavasos - Latomari/Argalda	45
Kalavasos - Latomari/Argalda	46
Kalavasos - Lourca	47
Kalavasos - Lourca North	130
Kalavasos - Loures	48
Kalavasos - Malouteri	49
Kalavasos - Mandres tou Sam	50
Kalavasos - Mangia I	51
Kalavasos - Mangia I	52
Kalavasos - Mangia III	53
Kalavasos - Mangia IV	54
Kalavasos - Mangia V	55
Kalavasos - Mangia Tombs 7/8	55
Kalavasos - Markotis	56
Kalavasos - Mazeri	57
Kalavasos - Melisotriba	113
Kalavasos - Melisotriba East	114
Kalavasos - Mersinia	58
Kalavasos - Milsingites	59
Kalavasos - Pamboules	60
Kalavasos - Pamboulos Haji Mih.	142
Kalavasos - Perivolia I	61
Kalavasos - Perivolia I	62
Kalavasos - Pervolia	126
Kalavasos - Peira I	111
Kalavasos - Petra H	112
Kalavasos - Pidieri	134
Kalavasos - Plakes	143
Kalavasos - Plakes	140
Kalavasos - Potima I	63
Kalavasos - Poiima II	64
Kalavasos - Poiima III	65
Kalavasos - Psoumadhes	66
Kalavasos - Sirmaia	67
Kalavasos - Skhisti Petra	68
Kalavasos - Sokopra	69
Kalavasos - Spilios	70
Kalavasos - Tenta	71
Tokhni - Zorpas	104
Vasa - Livadhia	105

Site's name	Plot
Kalavasos - Vasilikos River Bridge	72
Kalavasos - Village Cinema Area	73
Kalavasos - Mosque Mavrovouni Area	74
Kalavasos - Village Pansyia Church	75
Kalavasos - Village Plot 37	76
Kalavasos - Village Other Areas	77
Kalavasos - Yeromano	115
Kalavasos - Yeroskhinia	78
Kalavasos - Yirtomylos	79
Kalavasos - Yinomylos Tomb 1	80
Kalavasos - Zoulofdidhes	128
Kalavasos - Locality Unknown	81
Mari - Alonotopo	82
Mari - Asprous	144
Mari - Kalotsikous	83
Mari - Kopeira	84
Mari - Koupetra Loura Kaphkaloudi	145
Mari - Kremnos tou Sani Livadhia	85
Mari - Mazera	86
Mari - Mesovouni	87
Mari - Moutsounin Mandra Rirou	88
Mari - Paliambela	89
Mari - Skali I	90
Mari - Skali H	91
Man - Village	92
Mari - Locality Unknown	93
Maroni - Limni Yialos	94
Ora - Ammouthia	121
Ora - Aspro Khorapha	118
Ora - Betaleyi	122
Ora - Klitari	117
Ora - Lakxia Constandi	119
Ora - Loures	116
Ora - Mazo Kambos	95
Ora - Mersinia	120
Psematismenos - Petres Kathisi	96
Sanidha - Petres tou Kathisi	123
Tokhni - Kapsala	97
Tokhni - Lakkia	98
Tokhni - Latomaes	99
Tokhni - Mesovouni	133
Tokhni - Mouthkia	100
Tokhni - Orili North	132
Tokhni - Oriri South	131
Tokhm - Petreli	101
Zyyi - Petrini	106

Source : The field Survey of Vasilikos Valley, Volume I (SIMA) by Dr Ian Todd

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Chapter 5

EIA Methodology

Contents

5. EIA SCOPE AND METHODOLOGY

5.1 Introduction

The typical EIA process incorporates a number of key steps as illustrated in **Figure 5-1**. The assessment process constitutes a systematic approach to the evaluation of a proposed project in the context of its natural, regulatory and socio-economic environments.

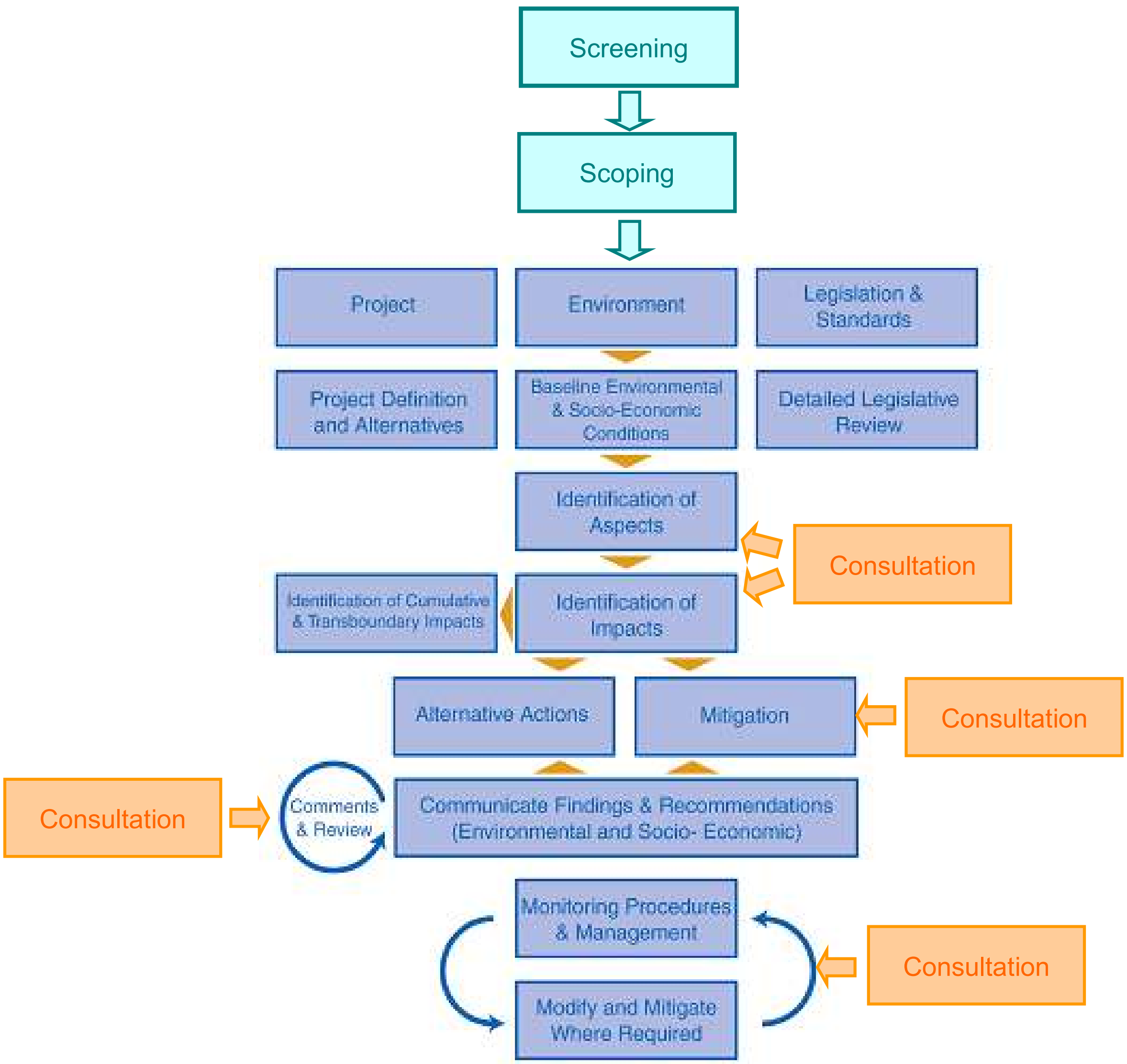

Figure 5.1: The EIA Process

The key to minimising the impact of a project is the application of procedural mitigation measures, which when applied to potential impacts in most cases, will fully mitigate the impact. Any remaining impact is subject to additional impact specific feasible and cost effective mitigation unless the impacts are considered to be low significance impacts that do not require any further mitigation.

A description of the assessment process undertaken for the KODAP Oil Strategic Reserves depot at Vasilikos area is provided in the following sections.

5.2 EIA Scoping

EIA Scoping precedes the full impact assessment process and seeks to establish the primary areas of concern relating to a proposed project. In doing so, it informs those parties with a material interest in a project in terms of where most effort should be expended in terms of the conduct of additional baseline assessments and the development of mitigation measures to address predicted impacts. A Scoping assignment should also provide justification for why certain issues are not considered as important.

A Scoping Assignment for the project was conducted in September of 2016. It covered the key environmental and social issues associated with the proposed developments and thus informed the overall scope of the EIA.

Key environmental and social issues were established via review of the following:

- Available information in relation to activities to be undertaken for the proposed Vasilikos industrial zone development projects;
- Relevant legislation, lender institute requirements for EIA and international / industry best practice documentation pertaining to fuel storage operations; and
- An initial site investigation to understand the extent and setting of the new tank farm and preliminary consultation with KODAP.

5.3 EIA Data Gathering and Review

Environmental data, legislative requirements and project activities are assessed in greater detail to ensure that all of the proposed activities and their consequences are considered in full.

An extensive literature research was conducted in order to identify and acquire as much existing and pertinent data and information as possible. This data was reviewed and where appropriate, incorporated into the baseline conditions reporting in this ES document.

5.4 National Registration framework

The main laws and regulations concerning the proposed project are listed below:

Law No	Title	Description
77(I)/2010 KDP 327/2010 KDP 111/2007 KDP 379/2005	The Control of Atmospheric Pollution Law	The purpose of this law is the prevention, reduction and control of atmospheric pollution mainly from industrial facilities, the effective protection of public health, welfare environmental protection and conservation including flora and fauna in the Republic. This law mandates that an emissions permit is required for facilities that are subject its provisions.
56(I)/2003	The Integrated Pollution Prevention and Control Law (IPPC)	The purpose of this Law is the prevention and control of pollution as a result of large industrial plants operation. The Law provides for measures to prevent pollution; if prevention is not feasible, then, provisions for the reduction of pollutants release/ emissions to air, water, and soil. It also contains measures for effective waste management, mitigation measures for the reduction of pollution, rational use and conservation of natural resources and energy ultimately, aiming at effective conservation and protection of the environment. Furthermore, the law prescribes the obligation set for industrial units so as to obtain permits and authorisation with regard to pollutants emissions, solid and liquid waste disposal
215(I)/2002	Management of Solid and Hazardous Waste Law	The Law aims at harmonizing the existing legislative frame of Cyprus with a number of European Community Directives with regard to the management of solid and hazardous waste. It also includes provisions for the handling and disposal of solid and hazardous waste so as to ensure a high level of environmental protection, by the implementation of all necessary measures required for their effective management, at

		national level.
13 (I)/2004	Water Protection and Management Law	The law aims at harmonisation of National legislation with European Community Directives 76/464/EC and 2000/60 regarding surface water pollution from hazardous substances (hazardous substances index is listed in appendices I and II of the legislation).
P.I 771/2003 The Port Reception Facilities for Ship-generated Waste and Cargo Residues Regulations, 2003	Regulations on facilitating the acceptance and prohibiting rejection into the sea of ship refuse and of cargo remnants	The law entered into force on the 1st of May 2004 and repealed as from that date the previous regime governed by the Recognition of Reception Facilities for Oil Residues Regulations of 1993-1995 (P.I.282/93 as amended). Amendment Law 38(III)/2003 made some relevant adaptations to the basic MARPOL Ratification Law 57 of 1989.
P.I 772/2003	Water Pollution Control (Discharge of Urban Waste Water) Regulations	The aim of the Regulations is to protect the environment from the adverse effects of urban waste water discharges. For this purpose, it concerns the collection, treatment and discharge of urban waste water, treatment and discharge of waste water from certain industrial sectors.
P.I. 508/2002	Water Pollution Control (Discharge of Dangerous Substances in Ground Waters) Regulations	The present Regulations are issued in compliance with Council Directive 80/68/EEC. Aim of the Regulations is to prevent the pollution of groundwater by substances belonging to the families and groups of substances in lists I or II in the Annex to these Regulations, and as far as possible to check or eliminate the consequences of pollution which has already occurred.
P.I. 513/2002	Water Pollution Control (Pollution caused by Certain Dangerous Substances	The Regulations are issued in compliance with Council Directive 76/464/EEC. The provisions of these Regulations will apply to inland surface water and internal coastal waters. All discharges into the waters, which are liable to contain any such substance listed in the Annexes, will require prior authorisation by the Minister. Dangerous substances groups are listed in appendices I and II (part

		of the legislation).
P.I. 512/2002 and P.I. No. 9/2001	Water Pollution Control (Quality Required of Shellfish Waters) Regulations	The present Regulation is issued in compliance with Council Directives 79/923/EEC and 91/692/EEC.
P.I. 504/2002	Water Pollution Control (Dangerous Substances Discharge) Regulations	The present Regulations are issued in compliance with Council Directive 76/464/EEC and Council Directive 86/280/EEC. Aim of the Regulations is to eliminate pollution of the waters above referred by the dangerous substances in the families and groups of substances in Annex I and to reduce pollution of the said waters by the dangerous substances in the families and groups of substances listed in Annex II. The provisions of these Regulations will apply to inland surface water and internal coastal waters. All discharges into the waters, which are liable to contain any such substance listed in the Annexes, will require prior authorization by the Minister.
106(I)/2002). P.I 99/2000 and P.I 45/1996	Water and Soil Pollution Control Law	The law aims at protecting surface and underground waters and soil from manmade and industrial polluting activities and at controlling the disposal of liquid and solid industrial waste. Specific measures are prescribed for the prevention of pollution and the adoption of an overall approach in granting licenses to industrial plants and cattle breeding facilities that cause pollution of waters and soil
P.I. 8/2001	Water Pollution Control (Water Quality Standards for Certain Hazardous Substances) Ordinance, 2001	The Ordinance issued by the Minister of Agriculture, Natural resources and Environment, sets the water quality standards for certain hazardous substances that may be traced in inland surface waters and coastal waters. The concentrations of these substances must not exceed those set out in the Second and Third Table annexed to the text of the Ordinance. The determination of the measurement techniques for the concentration of hazardous substances is also included in the above-mentioned Tables.

188(I)/2002, Amendments: 53(I)/2004, 161(I)/2005, 54(I)/2004, 17(I)/2007, 77(I)/2010.	Air Quality Law	The Law aims to: (a) Define and establish ambient air quality objectives in the Republic, (b) Assess air quality based on common methods and criteria of the EU (c) Obtain adequate information on ambient air quality and ensure that it is made available to the public (d) Maintain the air quality where it is good and improve it in other cases.
P.I. 193/2004	Air Quality (Annual Emission Ceilings for Certain Atmospheric Pollutants) Regulations	The aim of these Regulations is the reduction of emissions of certain pollutants causing acidification and eutrophication and also the reduction of emissions of substances which are precursors of ozone. The scope is to take a step further so as to achieve the long-term objective of not overshooting the critical levels of pollution and to reach an effective protection of public health caused by the well-known risks of atmospheric pollution, taking as reference the year 2010.
P.I. 170/2004	Control of Atmospheric Pollution (Non Licensable Installations) Regulations	The present Regulations aim at setting forth maximum emission limits and operating conditions for a series of plants for which a gaseous emission permit is not required, as prescribed under the Control of Atmospheric Pollution Law, 2002 (Law No. 187(I)/2002).
P.I. 76/2003 (Alignment with Council Directive 94/63/EC)	Control of Atmospheric Pollution (Control of Volatile Organic Compounds Emissions Resulting from the Storage of Petrol and its Distribution from Terminals to Service Stations) Regulations	The present Regulations aim to prevent and reduce the direct or indirect effects of emissions of volatile organic compounds resulting from the storage of petrol and its distribution from terminals to service stations in the environment, mainly into air, and the potential risks to human health using appropriate technical measures.
158(I)/2004 Amendment: 175(I)/2007	Ozone-Depleting Substances Law	

P.I. 622/2007	Ozone-Depleting Substances (Relative Works Performance) Regulations	The present Regulations set forth the criteria for the institutions which will evaluate and certificate qualified workers dealing with works connected to ozone-depleting substances.
No 89(I)/1996, No 158(I)/2001, No 25(I)/2003, No 41(I)/2003, No 89(I)/2003	The Health and Safety Law	
119(I)/2004	Law for the free access to the information regarding the Environment	The public may apply and obtain information concerning air and water quality, soil, biodiversity etc.
140(I)/2005	Environmental Impact Assessment of Certain Works Law	This Law provides for the compulsory impact assessment of certain establishments or projects which due to their potential and substantial environmental impacts need a full EIA study. The projects must be evaluated before any construction works are initiated or a license is issued by the competent administrative authority.
152(I)/2003, 81(I)/2005	The law on the protection and Management of wild birds and game	With the purpose of aligning the Cypriot legislation with the European legislative frame concerning the conservation of wild birds and natural habitats, this Law sets measures relating to the protection, conservation, management and control of all species of naturally occurring birds in the wild state in the Cypriot territory and lays down rules for their exploitation.
224(I)/2004	The law on the assessment and Management of Environmental noise	On a European level, a number of legislative measures have been enacted for regulating noise from various sources, such as occupational noise, noise from equipment for outdoor use as well as for the assessment and management of environmental noise. The main aim of the present law is to define a common approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including disturbance, due to exposure to environmental noise.
153(I)/2003	Law on the protection and Management of Nature and	

	Wildlife	
24(I)/1988	The law on the convention of European Wildlife and Natural Habitats	
30(I)/2002, 29(I)/2003, 258(I)/2004	The law on the basic noise requirements	
Fisheries Law (Chapter 135) Amendments: 170/1990, 22(I)/1994, 102(I)/200, 61(I)/2001, 106(I)/2004, 63(I)/2005, 132(I)/2007	Fisheries Law (Chapter 135)	Mainly deals with fishing licence Includes provisions for subjects such as issue, expiration, forfeiture and cancellation of licence. Also, strictly prohibits the use of poisons and explosives for fishing purposes
Aquaculture Law of 2000 (N.117(I)/2000). Amendments: N. 189(I)/2002, N. 181(I)/2010	Aquaculture Law of 2000	The Law sets forth a steering Committee in order to promote policies on aquaculture. It also sets the requirements for obtaining a fishing license and also the specific terms for the proper functioning of the aquaculture farm.
Fisheries Regulations, 1990 (P.I. 273/1990). Amendments: P.I 145/91, P.I. 94/94, P.I. 194/2000, P.I 453/2004, 354/2005, 32/2009	Fisheries Regulations, 1990	The text contains: Short title; Interpretation; Application for fishing licence; Form of licence (sample form in Schedule I); Number of the vessel; Vessel marking; fishing gear marking; Powers of the Officer (Fisheries Department) in issuing licences; Nets and conditions of use; Casting of the nets to the bottom of the sea; Measuring of the mesh; Information to be given to the Director of the Fisheries Department; Taking of small fish; Fishing in inland waters; Protection of turtles and other species; protected marine area of Lara; Pollution; Importation of fish; Diving apparatus; fishing by means of lights; Long fishing lines and fish traps; Fish farms; Certain prohibitions for fishing vessels; Moving of trawlers; Vessels fishing outside the Republic; Appeals; Revocation; Schedules
Aquaculture (General) Regulations, 2000 (P.I 274/2000) Amendments: P.I. 533/2002, P.I. 911/2003, P.I. 248/2010		
Chapter 31 & Antiquities Law subsequent amendments: 48 of 1964, 32 of 1973, 92(1) of 1995, 4(1) of 1996		

5.5 Environmental Aspects and Impacts Identification

5.4.1 Definition of Environmental Aspects

The definition of environmental aspects adopted for this EIA is namely that derived by ISO 14001: 2008 EMS – Specification with Guidance for USE. An environmental aspect is denoted where an activity has the potential to interact with the environment. A socio-economic aspect can be considered to occur when an activity has the potential to interact with the social or economic environments. These definitions have been used in the identification of the proposed Project's environmental, socio-economic and legal aspects.

5.4.2 Identification of Environmental and Socio-Economic Aspects

In order to identify environmental and socio-economic aspects for the Project, it was necessary to first identify the Project activities. Following identification of all Project activities, environmental and socio-economic receptors were identified. The key input for the identification of environmental and socio-economic receptors included:

- The policy and legal framework; and
- The environmental and socio-economic baselines (**Chapter 4**).

To identify project aspects, all proposed activities, have been considered in terms of their direct or indirect potential to:

- Breach relevant policy, legal and administrative frameworks and national legislation, relevant international legislation, standards and guidelines, and corporate environmental policy and management systems,
- Interact with the existing natural and social environment, and
- Interact with the existing socio-economic environment.

Identified environmental and socio-economic aspects are presented in **Chapter 6** of the report.

5.4.3 Definition of Environmental and Socio-Economic Impacts

ISO 14001 defines an environmental impact as:

"*Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services.*"

An environmental or socio-economic impact may result from any of the identified project aspects (i.e. activity-receptor interaction). **Table 5.1** illustrates the links between activity, aspect and impact.

Table 5.1: Example of Activity, Aspect and Impact

Activity	Aspect	Impact
Use of trucks during construction	Exhaust emissions	Deterioration of air quality, and contribution to ground level ozone
	Fuel oil leaks	Deterioration of soil and groundwater quality

Impacts may be direct or indirect. Indirect impacts are often produced away from a project area as the result of a complex pathway. In addition impacts may be further categorised as residual, cumulative and trans-boundary.

5.6 Determining Environmental and Socio-Economic Impact Significance

5.5.1 Introduction

Once all Project environmental and socio-economic aspects are identified, the level of impact that may result from each of the activity-receptor interactions is assessed. The level of impact is assessed assuming normal mitigation or impact control that are intrinsic to the construction and operation of a tank farm (e.g. the impact of vehicle emissions on air quality is considered, assuming the use of transport related pollution controls such as catalytic converters and the use of low sulphur fuels). Those impacts, which are considered significant following implementation of best practice mitigation measures, are subject to further consideration.

The following flow diagram illustrates the process of addressing potential environmental and socio-economic impacts (**Figure 5.2**).

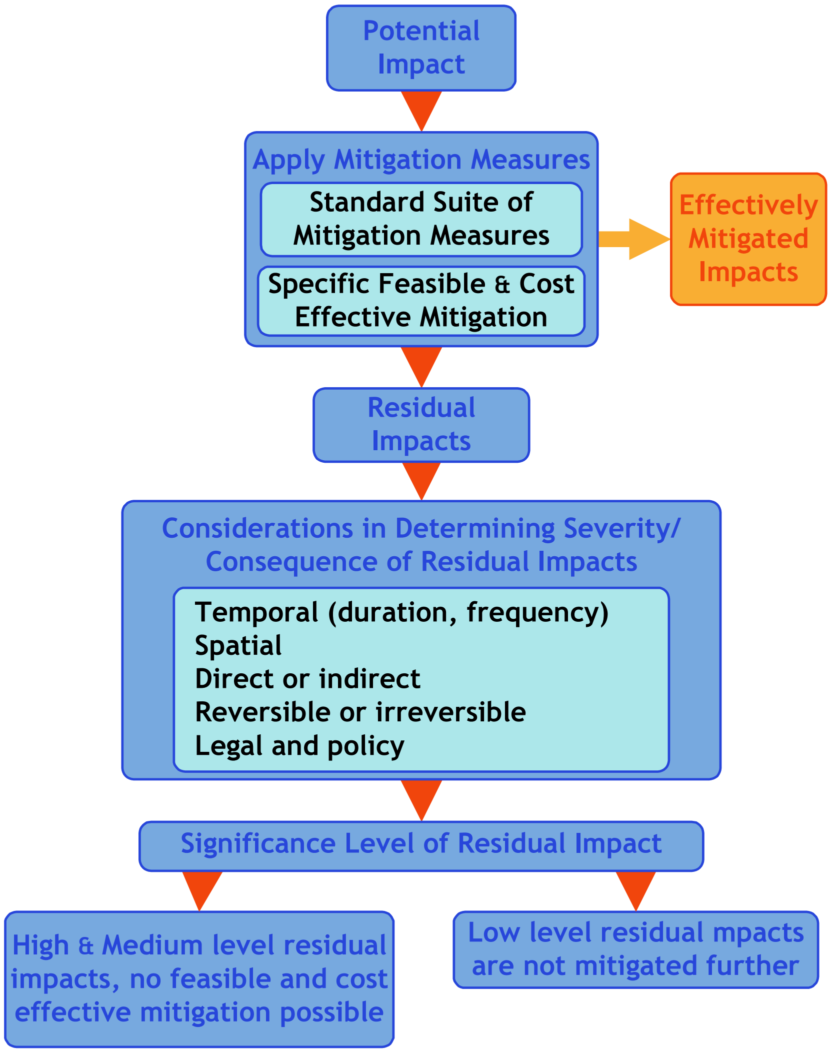

Figure 5.2: Flow Diagram Illustrating the Application of Mitigation Measures and Assigning Level of Significance of Impacts

5.5.2 Impact Significance

The significance of the impact is expressed as the product of the severity and probability of occurrence of the activity, expressed as follows:

Significance (level of impact) = Severity X Probability

The level of risk is then determined using the matrix below (**Table 5.2**) where:

- **H - Impact of High Significance**, no further feasible or cost effective mitigation is possible, compensation or offset mitigation must be provided;
- **M - Impact of Medium Significance**, confirm that the residual impact has been subject to all feasible and cost effective mitigation;
- **L - Impact of Low Significance**, not mitigated further;
- **N - Negligible impact, no impact.**

Table 5.2: Level of Impact Significance

	Probability				
Severity	**1**	**2**	**3**	**4**	**5**
4	L	L	M	H	H
3	N	L	M	M	M
2	N	L	L	L	L
1	N	N	N	L	L

When assessing impacts, the following have been considered:

- Positive or negative;
- Occurring directly or indirectly from Project Activities;
- Cumulative effects;
- Transboundary effects;
- Magnitude of impact;
- Geographical extent of the impact;
- Duration and frequency of the impact; and
- Sensitivities of the receiving Receptor and impact reversibility.

To assist in determining and calculating the significance of an impact, impact assessment matrices have been developed based on aspect identification. The results of the EIA process are presented in **Chapter 6** of this report.

5.5.3 Impact Severity

5.5.3.1 Introduction

The adoption of consistent and robust criteria for assessing severity is an important element in the EIA process. There are a number of factors that are important in considering the severity of an impact. These include:

- the magnitude of the impact;
- the sensitivity and value of the resource or receptor affected;
- compliance with relevant laws, regulations, standards or Company policies;
- effects on Government plans or policies; views of stakeholders; and
- likelihood.

It should be noted however that it is often difficult to compare environmental impacts consistently across different environments, thus in evaluating the environmental aspects; emphasis is placed on specific cause and effect relationships.

Scientific evidence as well as predications based on observations of previous similar activities can and have been used in the impact assessment process. Where it has not been possible to fully quantify the effect that an activity may have on the environment or a component of the environment, or where there is a lack of scientific knowledge, qualitative judgement can and has been used. Such judgements have been based on a full understanding of the proposed Project, the impact assessment team's experience in assessing tank farm operations and the team's knowledge of the environment in which the project is to take place.

For the KODAP Oil strategic reserves depot EIA study, four categories of severity have been adopted. The criteria take into account the degree to which impacts can be quantified and compared with accepted limits and standards (at the "quantitative" end of the spectrum) or a combination of the magnitude of change caused by the project in combination with the value/sensitivity of the receptor/resource (at the "qualitative" end of the spectrum).

Table 5.3 below details the environmental and socio-economic severity ranking used throughout the EIA.

Table 5.3: Environmental and Socio-economic Impact Severity Rankings

Consequence and Ranking	Description
Catastrophic	Massive effect – Persistent severe environmental damage or severe nuisance extending over a large area. In terms of commercial or recreational use or nature conservation, a major economic loss for The Company. Constant, high exceedance of statutory prescribed limits.
4 Major	Major effect – Severe environmental damage. The Company is required to take extensive measures to restore polluted or damaged environment to its original state. Extended breaches of statutory or prescribed limits.
3 Medium	Localised effect – No exceedance but close to breache of statutory or prescribed limits. Affects a neighbourhood. Recovery of limited damage within one year.
2 Minor	Minor effect – No exceedance of statutory or prescribed limit. No permanent effect on the environment.
1 Negligible	Slight effect – Local environmental damage. Within project boundary. Negligible financial severity.
0 None	No impact
+ Positive	Beneficial impact – enhances the environment and baseline conditions.

The definitions presented above apply throughout the ASIA and across all assets. It is, however, necessary to define severity criteria for individual environmental topics, taking into account of the "generic" definitions presented above. Defining the severity criteria for individual topics facilitates the process of making the EIA transparent. The criteria need to be consistent, so that a moderate impact with respect to one environmental topic is broadly equivalent to moderate impact with respect to another. In the following, the severity criteria for the following topics will be presented:

- impacts on soils;
- impacts on surface water;
- impacts on groundwater resources;
- impacts on climate/air quality;
- impacts on biological resources;
- noise impacts; and
- impacts on landscape and visual impacts

5.5.3.2 Severity criteria for Impacts to Terrestrial Soils and Marine Sediments

Soils

The severities of impacts on soils are related to:

- Erosion;
- Productivity loss;
- Soil pollution

The severity of impacts on soils is typically evaluated using professional judgement and recognised soils science techniques, taking account of the following factors (see also **Table 5.4**):

- the magnitude of the impact, as determined by its intensity, its areal extent in space, duration, and the likelihood of its occurrence;
- the vulnerability of the particular soil to the change caused by the impact;
- the methods planned for protection of soil resources during construction and their replacement during reinstatement; and
- the ability of the soil to recover from the impact.

It should be noted that the assessment criteria apply only to those areas of soil that will be disturbed and then subsequently reinstated. The severity of impacts to soil resources lost to permanent structures is primarily in terms of impacts to ecology and land use and is addressed elsewhere in this Section.

For soil erosion, existing soil characteristics in terms of its erodibility provide the starting point. Potential erodibility for different soils in the project area is based on rainfall, soil structure, texture, permeability and organic matter. Terrain also plays a role, together with other factors such as vegetation cover and human modification.

Soil productivity is primarily related to the topsoil and is a function of physical structure, chemistry/mineral constituents, and biological activity. Thickness of the topsoil layer is also a factor. Disturbance during stripping, storage and replacement has an influence on the above factors that varies between soils. Should physical mixing of topsoil and subsoil, of lesser or even zero productivity, occur (a significant risk where topsoil layers are less than 15 cm) this too will affect productivity. Assessing the scale of impact is therefore based on a combination of knowledge of the soils in the project area and likely recovery periods based on previous experience.

Table 5.4: Severity Criteria for Physical Impacts on Soil – soil erosion

Impact Type	Minor	Moderate	Major
Soil erosion	Soil erosion predicted to occur at approximately the same rate as soil formation	Soil erosion predicted to be visibly active but no rill and gully information evident	Rill and gully formation predicted to be evident to the point where it threatens the neighboring land uses and/or pipeline corridor
Reduced soil productivity	Productivity losses predicted to last less than one year after construction or completion of the reinstatement programme	Productivity losses predicted to generally last less than three years after completion of reinstatement (but more than one year for arable land)	Productivity losses predicted to last more than three years after end of reinstatement for arable farmland and areas of high ecological value, and more than seven years in forest and other natural areas with no formal land use or designated ecological value

The magnitude of the pollutant release and the size of the affected area are the two parameters that define the severity of the soil pollution (**Table 5.5**).

Table 5.5: Severity Criteria for Physical Impacts on Soil – soil pollution

Impact Type	Affected area : construction site	Affected area : < 1km from the construction site fence	Affected area : > 1km from the construction site fence
Small release	Small	Small	Medium
Medium release	Small	Medium	Severe
Large release	Medium	Severe	Severe

Marine Sediment Quality

Impacts to marine sediment can either be from physical disturbance or through pollution. The severity criteria used in this assessment are outlined in **Table 5.6.**

Certain project activities could potentially lead to changes in sedimentation patters and coastal morphology. Severity criteria for such impacts are developed in the respective sections of this EIA since they are specific to certain locations and do not have a project wide context.

Table 5.6: Severity Criteria for Impacts to Marine Sediments

Impact Type	Minor	Moderate	Major
Marine Sediment Disturbance	Short-term and/or limited to immediate area (within 100m) of project footprint	Short-term and/or extends to limits of jetty navigational exclusion zone	Long-term and/or extends beyond navigational exclusion zone
Sediment Contamination	Low levels, non harmful to benthic fauna, 'diluted' by sediment reworking by organisms and water movement	Levels that are detectable throughout the navigational exclusion zone but not noticeably harmful to benthic fauna	Levels that are detectable beyond the navigational exclusion area have a noticeable effect on benthic fauna distribution or require cleanup.

5.5.3.3 Severity Criteria for Impacts on Air Quality

The project is required to comply with Cyprus Air Quality standards (Error! Reference source not found. **& Table 5.8**). The primary goal of these standards is to protect human health, and the well being of ecosystems.

Two sets (**Table 5.9** & **Table 5.10** below) of severity criteria can be used: quantitative and qualitative.

The first set (**Table 5.9**) is for evaluating the predicted ground level concentrations with the respective Cyprus air quality standards. In applying these standards, existing ambient atmospheric concentrations are considered. Provision is also made for the fact that no single emission source (or complex) should 'use up' the whole 'allowance' implied by the standard. For this reason, the threshold between a moderate and a major impact is set at 70% of the standard, as opposed to 100%, so that the project, together with the other emission sources in the area is unlikely to contribute to a cumulative exceedance of the standard.

The second set of severity criteria (**Table 5.10**) can be used to allow a qualitative assessment. In these circumstances, the assessment has considered such factors as known emission estimations provided by the sponsors of the project, the proximity of sensitive receptors, local dispersion characteristics and professional judgement based on previous experience of similar conditions, to make the qualitative assessment.

Table 5.7: Limit Values for SO_2, NO_2, Nox, CO, PM_{10}, Lead and Benzene for the protection of human health (KDP 327/2010)

Component	Averaging Period	Limit Value	Tolerance Margin	Date by which limit value is to be met
Sulphur dioxide SO_2	1 hour	**350 μg/m^3** , not to be exceeded more than 24 times a calendar year	150 μg/m^3 (43%)	_[(1)]
	24 hour	**125 μg/m^3**, not to be exceeded more than 3 times a calendar year	None	_[(1)]
Nitrogen dioxide NO_2	1 hour	**200 μg/m^3**, not to be exceeded more than 18 times a calendar year	50% on July 1999, decreasing on 1 January 2001 and every 12 months thereafter by equal annual percentagesto reach 0% by 1 January 2010	1 January 2010
	Calendar year	**40 μg/m^3**	50% on July 1999, decreasing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0% by 1 January 2010	1 January 2010
Carbon Monoxide CO	8 hours max [(3)]	**10 μg/m^3**	60%	_[(1)]
Particulate Matter PM_{10}	24 hour	**50 μg/m^3**, not to be exceeded more than 35 times a calendar year	50%	_[(1)]
	1 hour	**40 (20) μg/m^3**	20%	_[(1)]
Benzene	Calendar year	**5 μg/m^3**	5 μg/m^3 (100%) on 13 December 2000, decreasing on 1 January 2006 and every 12 months thereafter by 1 μg/m^3 to reach 0% by 1 January 2010	1 January 2010
Lead	Calendar year	**0.5 μg/m^3**	100%	_[(3)]

(1) Already in force since 1 January 2005

(2) The maximum daily eight hour mean concentration will be selected by examining eight hour running averages, calculated from hourly data and updated each hour. Each eight hour average so calculated will be assigned to the day on which it ends i.e. the first calculation period for any one day will be the period from 17:00 on the previous day to 01:00 on that day; the last calculation period for any one day will be the period from 16:00 to 24:00 on that day

(3) Already in force since 1 January 2005. Limit value to be met only by 1 January 2010 in the immediate vicinity of the specific industrial sources situated on sites contaminated be decades of industrial activities. In such cases, the limit value until 1 January 2010 will be 1.0 μg/m^3. The area in which higher limit values apply must not extend further than 1000 m from such specific sources.

Table 5.8: Upper and lower assessment thresholds (KDP 327/2010)

Component	Averaging Period	Assessment threshold (percentage of limit value)		Exceedence frequency per year
		Upper	Lower	
Sulphur dioxide SO_2	24 hours	75 μg/m^3 (60% of limit value)	50 μg/m^3 (40% of limit value)	3 times each year
Nitrogen oxides NO_x	1 hours	140 μg/m^3 (70% of limit value)	100 μg/m^3 (50% of limit value)	18 times each year
NO_2	1 year	32 μg/m^3 (80% of limit value)	26 μg/m^3 (65% of limit value)	18 times each year
NO_x	1 year	24 μg/m^3 (80% of limit value)	19.5 μg/m^3 (65% of limit value)	18 times each year
Carbon Monoxide CO	8 hours	7 μg/m^3 (70% of limit value)	5 μg/m^3 (50% of limit value)	
Particulate Matter PM_{10}	24 hours max	35 μg/m^3 (70% of limit value)	25 μg/m^3 (50% of limit value)	35 times each year
	1 year	28 μg/m^3 (70% of limit value)	20 μg/m^3 (50% of limit value)	
Particulate Matter $PM_{2.5}$	1 year	17 μg/m^3 (70% of limit value)	12 μg/m^3 (50% of limit value)	
Lead	1 year	0.35 μg/m^3 (70% of limit value)	0.25 μg/m^3 (50% of limit value)	
Benzene	1 year	3.5 μg/m^3 (70% of limit value)	2 μg/m^3 (40% of limit value)	

Table 5.9: Quantitative Severity Criteria for Modelled Impacts on Air Quality

Minor	Moderate	Major
<1% of the Cyprus Air Quality Standard (excluding background concentrations)	1-70% of the Cyprus Air Quality Standard (including background concentrations)	>70% of the Cyprus Air Quality Standard (including background concentrations)

Table 5.10: Qualitative Severity Criteria for Modelled Impacts on Air Quality

Minor	Moderate	Major
Off-site receptor is in the vicinity of the activity (ie within 5 km). Emissions are anticipated to be transient, short-term and infrequent in nature. Estimated emissions, with respect to the background air quality concentration and likely dispersion and meteorological conditions are low in magnitude.	Off-site receptor is in the vicinity of the activity. Estimated emissions, with respect to the background air quality concentration and likely dispersion and meteorological conditions, may result in elevated short-term pollution concentrations at receptors.	Off-site receptors are in the vicinity of the activity. Estimated emissions, with respect to the background air quality concentration and likely dispersion and meteorological conditions, may result in elevated ling-term concentrations at receptors.

The qualitative criteria are applied on the basis of what is known about the project in terms of emissions and dispersion characteristics, together with professional judgement and documented experience of similar operations elsewhere.

5.5.3.4 Severity Criteria for Impacts on Marine Water Quality

Severity criteria for impacts on marine water quality are largely based on compliance, together with the diluting capacity of the receiving water and quality standards to protect its use (**Table 5.11**). In this context, the severity criteria for impacts on marine water quality are summarised in **Table 5.12**.

Table 5.11: Discharge Quality Standards

Parameter	Cyprus Limit
pH	6,5-9,0
COD (mg/l)	30
BOD5 (mg/l)	10
TSS (ppm)	30
Zinc (ppm)	0,1
Copper (ppm)	0,1
Cadmium (mg/l)	0,2
Mercury (mg/l)	0,05
Lubricating Oils (mg/l)	Nil
Temperature (^oC)	Not to exceed 10 ^oC above ambient water temperature

Table 5.12: Severity Criteria for Impacts on Marine Quality

Minor	Moderate	Major
Effluent within discharge limits; rapid dilution capacity in receiving water.	Effluent within discharge limits; poor dilution capacity in receiving water; likely exceedance of environmental quality standards inside exclusion zone.	Breaching of effluent standard. Discharge causing an exceedance of environmental quality outside exclusion zone.

5.5.3.5 Severity Criteria for Impacts on Biological Resources

Value of Resources

Habitats are assessed according to widely accepted criteria of which the most important are naturalness, extent, rarity ad diversity; these and others are summarised below in **Table 5.13**.

Species are similarly assessed according to accepted criteria such as rarity and the extent to which they are under threat. The importance of species to wider ecological communities is also considered and the protection of species under international and national legislation is also taken into account.

Table 5.13: Criteria for the Evaluation of the value and Sensitivity of Affected Habitats and Species

- The presence of any habitat, plant or animal species that is internationally, nationally, regionally or locally rare, especially species protected under Cypriot legislation
- The presence of any habitat, plant or animal communities, which are internationally, nationally, regionally or locally uncommon or suffering serious reduction nationally or locally.
- The diversity of the habitats and their individual species richness are important. In general, the greater the total number of species recorded, the greater the conservation interest of the area. The presence of nationally or locally important population of a particular species; an assessment of whether the habitat is a representative example of special interest or value.
- The 'naturalness' of the habitat. Naturalness and diversity can be strongly correlated and recreated habitats tend to be more species poor than their natural or semi-natural equivalents.
- The fragility and sensitivity of the habitat and its ability to recover (either naturally or with assistance) from disturbance. This criterion is linked also to size, naturalness and rarity but generally fragile sites are usually highly fragmented, decreasing rapidly in extent and number and are difficult to recreate.
- The recorded history of the site. The loss of an irreplaceable biological record would be particularly significant. Such records may also be of cultural and historical value.
- Whether at the local level the habitat is an ecological corridor between other isolated habitats of ecological importance.
- Whether a species has a seasonally variable vulnerability due, for example, to breeding, critical feeding times or migratory passage.
- Whether any species has cultural severity (for example, as a resource utilised by local settlements).
- The amenity value of the site.
- The research value and education potential of the site

For the purposes of the EIA, it is useful to place some sort of value (low, moderate, high) on the resources that might potentially be affected using criteria like those above. Although this is to some extent subjective, expert judgment (and stakeholder consultation) will ensure a reasonable degree of consensus on the intrinsic value of resource.

Magnitude of Impact

The assessment of the relative severity of ecological impacts is a subjective judgment and it is often difficult to attach define levels of severity to impacts in the way that quantitative prediction allows. Criteria that have been used to assess the magnitude of ecological impacts are presented in **Table 5.14**.

Table 5.14: Assessment Criteria for the Magnitude of Ecological Impacts

➢ A High Magnitude Impact: affects an entire population or species in sufficient magnitude to cause a decline in abundance and / or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) would not return that population or species, or any population or species dependent upon it, to its former level within several generations. A major impact may also affect a subsistence or commercial resource use to the degree that the well being of the user is affected over a long term. In the case of fish an impact over one season/generation would be significant.
➢ A Medium Magnitude Impact: affects a portion of a population and may bring about a change in abundance and / or distribution over one or more generation *, but does not threaten the integrity of that population or any population dependent on it. Moderate Impacts to the same resource multiplied over a wide are would be regarded as a Major Impact. A short-term effect upon the well being of resource users may also constitute a moderate impact.
➢ A Low Magnitude Impact : affects a specific group of localised individuals within a population over a short time period (one generation * or less) , but does not affect other trophic levels or the population itself.
* These are generations of the animal/plant species under consideration not human generations. It should be noted that the reinstatement and recovery potential of an affected habitat also needs to be considered in applying the above criteria.

Impact

The severity of ecological impacts is then a combination of the conservation value of the habitat/species affected (**Table 5.13**) and the magnitude of the impact (**Table 5.14**). A convenient way of representing the overall severity is through a matrix of magnitude versus sensitivity / value (**Table 5.15**).

Table 5.15: Overall Severity Criteria for Ecological Impacts

	Low magnitude impact	**Medium magnitude impact**	**High magnitude impact**
Low value /sensitivity or locally important habitat or flora/fauna	MINOR	MINOR	MINOR
Moderate value /sensitivity or nationally important habitat or flora/fauna	MINOR	MODERATE	MAJOR
High value /sensitivity or internationally important habitat or flora/fauna	MODERATE	MAJOR	MAJOR

5.5.3.6 Severity Criteria for Impacts to Surface Water Resources

Terrestrial Water Resources

The severity of any potential impact on surface water resources will depend on the present (or designated) use of the resource (e.g. for drinking supply, fishing etc) or its importance to ecology or amenity, together with the nature and magnitude of change caused by the Project.

The assessment of impacts to water resources is based on the following principal issues:

- compliance with relevant standards and legislation for effluent discharges;
- compliance with relevant standards and legislation for ambient surface water quality; and
- avoidance of aquatic and marine ecological impacts.

For water quality issues, the basic premise is that the standards must be complied with. Non-compliance would comprise a major environmental impact, while full compliance is deemed a minor impact.

During construction activities, there are several generic types of potential impact as follows:

- impacts associated with planned discharges of treated wastewater (eg at construction camps);
- ‘disturbance’ of watercourses directly through physical works, and indirectly due to run-off containing suspended solids from working and reinstated areas; and
- pollution resulting from accidental spillages.

The standards for all discharges will be set according to the existing use of the receiving water.

Three types of impact criteria are discussed in the following:

- impacts on freshwater quality;
- impacts due to physical disturbance of surface water resources; and
- impacts on marine water quality.

Severity criteria for impacts to freshwater quality (and secondary impacts to water users) are therefore based largely on compliance with standards, together with the quality of the receiving water and its ability to dilute the effluent. Severity criteria are summarised in **Table 5.16**.

Table 5.16: Severity Criteria for Impacts to Freshwater Quality

Minor	Moderate	Major
Effluent quality within discharge limits; rapid dilution achieved to levels where no discernible impacts to aquatic ecology are likely; discharge to any water Group.	Effluent quality within discharge limits; poor dilution capacity in receiving water; Group II or III water.	Breaching of effluent discharge standards.

Group 1 - watercourses with no salmon spawning and of insignificant importance for fisheries.
Group II - watercourses with insignificant salmon spawning and of minor importance for fisheries.
Group III - watercourses with significant salmon spawning and of major importance for fisheries and/or Red Data Book species.

The second generic category of impact (ie disturbance of watercourses directly through physical works) does not lend itself to being quantified either in terms of standards or impact prediction, for example:

- there are no standards which govern the temporary mobilization of sediment in a stream during construction works near to or in a watercourse; and
- even if there was a standard, predicting the resultant concentration would be an extremely imprecise exercise.

Assessing such impacts is therefore an exercise in professional judgement. **Table 5.17** summarises how this judgement has been applied. A further consideration is whether much of the groundwater is shallow and contiguous with surface waters. As a result, accidental spillages have the potential to cause impacts to both surface and groundwater.

Table 5.17: Assessment Criteria for Physical Disturbance to Surface Water Resources

Watercourse Quality.	**Importance for Salmon and Fisheries.**	**Disturbance limited to immediate working area, visible sediment predicted in watercourses for less than three weeks after construction and no obscuration of the bed.**	**Disturbance limited to within 1km of working area, visible sediment predicted in watercourses for longer than three weeks but less than three months after completion of construction and reinstatement but no obscuration of bed.**	**Disturbance' apparent >1km downstream, visible sediment predicted in watercourses for longer than three months after completion of construction and reinstatement and obscuration of bed.**
Highly polluted or polluted receiving water and/or little or no community use/natural value.	**Group I** watercourses with no salmon spawning and of insignificant importance for fishery.	Minor	Minor	Moderate
And/or				
Slightly polluted	**Group II**	Minor	Moderate	Major
receiving water and/or moderate with degree of	watercourses with insignificant salmon spawning			
and/or				
High quality	**Group III**	Moderate	Major	Major
Receiving water and/or important community/nature conservation resource.	Watercourses with significant salmon sprawning and of major importance for fishery and/or includes Red Data Book species			

So, within these criteria, a major open cut crossing in soft deep sediment material of a high quality water resource containing downstream fisheries and agricultural abstraction would be likely to cause a Major impact. Conversely, a crossing in a sand/gravel bed with no downstream users or nature conservation value would lead to a Minor impact.

Marine Water Quality

As for terrestrial water resources, severity criteria for impacts to marine water quality are largely based on compliance, together with the diluting capacity of the receiving water and quality standards to protect its use. In this context, the severity criteria for impacts to marine water quality are summarised in **Table 5.18**.

Table 5.18: Severity Criteria for Impacts to Marine Water Quality

Minor	Moderate	Major
Effluent within discharge limits; rapid dilution capacity in receiving water.	Effluent within discharge limits; poor dilution capacity in receiving water; likely exceedance of environmental quality standards inside exclusion zone.	Breaching of effluent standard. Discharge causing an exceedance of environmental quality outside exclusion zone.

5.5.3.7 Severity Criteria for Impacts to Groundwater Resources

Severity of impacts to groundwater can be based on a combination of the quality of the resource and the scale of impact or risk to it.

Impacts to groundwater are considered important in the context of impacts to the direct users of the resource. For example, ground water contamination or excessive abstraction within a sanitary protection zone would cause impacts to humans relying on that water source. As a result of some of the environmental characteristics that may lead to potential impacts to groundwater are also important in the context of it providing a pathway for effects to reach surface waters.

Based on the above considerations, assessment criteria for impacts to groundwater have been established taking account of the following combination of factors:

- whether the area is protected in some way, and its proximity to a surface water course; and
- the nature of activities proposed and potential for, or risk of, different types and magnitudes of impacts occurring.

The criteria are set out in **Table 5.19**.

Table 5.19: Assessment criteria for groundwater resources

	General construction activity, trenching dewatering. Small temporary or permanent abstraction.	Locating construction camps, storage areas for fuels/chemicals. Small spill (< 1 t) oil. Construction camp or operational discharge to soak away. Large, temporary construction phase abstraction.	Large spill of oil (> 1 t) or chemicals.
Low sensitivity: an unconfined aquifer, and more than 1000 m from any surface water resource.	**Minor**	**Minor**	**Moderate**
Moderate sensitivity: an unconfined aquifer, within 1000 m of a surface water resource..	**Minor**	**Moderate**	**Major**
High sensitivity	**Moderate**	**Major**	**Major**

5.5.3.8 Severity Criteria for Noise Impacts

Cyprus Legislation does not specify noise limits as such, although some guidance can be taken from the 'maximum levels' discussed below, based on the recommendations of a number of International Organisations.

A number of International Organisations like WHO, and the World Bank have recommended noise criteria (maximum levels) which guarantee the adequate protection of human health. These criteria include:

- night time limit of Laeq of 35-45 dB(A) (23:00 to 07:00) (potential for sleep disturbance)
- a limit of Laeq of 55 dB(A) (potential for noise nuisance, reduced productivity at work)
- a limit of Laeq of 65 dB(A) (potential for health problems -blood pressure increase, headaches, etc.)

In the following the adopted criteria for the construction and operational phase of the project are presented.

Construction Noise

Noise during construction / installation activities has been considered by assuming construction /installation plant noise levels. The assessment has been developed using the current best estimate of activities, scheduling, plant and plant utilisation based on experience from similar activities. The duration of construction noise has also been considered.

The adopted noise limits adopted in this study are those included in the Guidelines for noise control of the Surrey Council, England (1991) which recommends that the maximum noise levels at façade of a building close to the construction works should not exceed the following levels:

Table 5.20: Maximum noise levels during construction works

Period	Maximum Noise Level at the façade (Laeq-1h)	Maximum instant level dB(A)
Monday-Friday 07:30 – 18:30	75	80
Monday – Friday 18:30 – 22:00	65	70
Monday – Friday 22:00 – 07:30	45	50
Saturday 07:30 – 13:00	65	70
Saturday 13:00 – 22:00 Sunday & holidays 07:30 – 22:00	55	60

At this study during the daytime (07:00 – 16:00) a limit of 75 dB Laeq at the façade of the building has been used as the maximum acceptable construction noise criterion outside dwellings.

Operational Noise

Guidance on daytime noise levels in community areas during the day have been proposed by the World Health Organisation. A guidance noise level of 55dB Laeq, 16h is proposed to protect the majority of people from being seriously annoyed during the daytime and evening. A preferred value of 50 db Laeq, 16h is suggested to prevent moderate annoyance. Higher values might be expected to be acceptable at outdoor recreational areas, such as the Zygi community which is the closest residential area to the project area, since the listener will only be exposed to the noise for a small proportion of each day. The WHO provides no guidance on this aspect of assessment. For the purpose of this assessment a stringent noise criterion of 55 db Laeq, 16 h is applied in frequently used recreational areas.

Noise Severity Criteria

Since impact assessment criteria are required to enable the minor, moderate and major impacts to be identified, it is necessary to determine a lower limit for the minor and moderate impact bands below which noise impacts are unlikely. Effectively this is a level at which no impact is expected. An upper limit is then required for each impact severity category. These limits are based on the considerations set out in the preceding text.

Taking the above standards into consideration the noise impact severity criteria used in this EIA are summarised in **Table 5.21**.

Table 5.21: Severity Criteria for Noise Impacts

Impact Type	Minor	Moderate	Major
Construction activity – noise levels at receptor	Daytime noise levels (07:30 – 22:00) 55 to 75 dB for less than 4 weeks	Daytime noise levels (07:30 – 22:00) 55 to 75 dB for 4 weeks or more	Daytime noise levels (07:30 – 22:00) greater than 75 dB
	Night-time noise levels (22:00 – 7:30) 45 dB for less than 4 weeks	Night-time noise levels (22:00 – 7:30) 45 dB for 4 weeks or more	Night-time noise levels (22:00 – 7:30) greater than 45 db
Operational phase (assumed continuous over 24 hrs) – noise levels at residential receptor	40 to 45 dB and < 3db(A) increase in ambient-no project action required	40 to 45 dB and >3db(A) increase in ambient – impacts to be reduced the greater they are above ambient	45 dB, or if ambient is already above 45 dB increase in ambient of >3dB(A) – impacts unacceptable
			Maximum noise levels 75 db Lamax during the day and 55 db Lmax during the night
Operational Phase – noise levels at nearest industrial or commercial receptors			> 75 dB during the day or night
Operational Phase – daytime noise levels at frequently used recreational areas	55 to 60 dB	> 60 but < or equal to 75 dB	> 75dB

5.5.3.9 Severity Criteria for Impacts on Landscape and Visual Amenity

Impacts upon landscape and visual amenity will potentially result from the construction and operation of the development.

The level of severity of landscape and visual effect depends on the sensitivity of the landscape or viewer to change and the magnitude of change .

The sensitivity of the landscape depends on its inherent condition or quality, value and capacity to accommodate change, and on specific values (such as designations) that apply. The sensitivity of viewers depends on their occupation and viewing opportunity. Sensitivity is described as low, moderate and high. The definitions outlined in **Table 5.22**.

Table 5.22: Sensitivity Definitions

Sensitivity	Receptor	Definition
Low	Landscape	A landscape which is not valued for its scenic quality and is tolerant of change
	Visual	Visual with a passing interest in their surroundings, eg. motorists or workers
Moderate	Landscape	A moderately valued landscape, perhaps a locally important landscape, tolerant of some change
	Visual	Viewers with a moderate interest in their environment such as users of recreational facilities
High	Landscape	A landscape of particularly distinctive character or one which is nationally valued for its scenic quality
	Visual	Viewers with proprietary interest and prolonged viewing opportunities such as residential receptors

The magnitude of impact on landscape or visual receptors depends on the nature and scale of the development, and the overall impact within a particular view, which may be very small if it is at some distance. The magnitude of impact is described as being imperceptible, low, moderate or high. The definitions outlined in **Table 5.23** apply.

Table 5.23: Magnitude Definitions

Magnitude of Impact	Receptor	Definition
Low	Landscape	A small change in components of the landscape
	Visual	Few viewers affected by minor changes in views
Moderate	Landscape	Moderate changes in landscape components
	Visual	A moderate number of viewers affected by moderate chamges in views
High	Landscape	A notable change in landscape characteristics over an extensive area
	Visual	A large number of viewers affected by major changes in view

Impact severity is determined by combining the sensitivity of the landscape or viewer with the magnitude of change expected as a result of the development. Thus a substantial impact will usually occur where both the sensitivity of the landscape or viewer and the magnitude of the impact are high. Each case is assessed on its own merits as other factors also need to be considered (quality or condition of the landscape, landscape value, and its capacity to accommodate development), so the table below is an approximate guide. Professional judgment and experience is used to determine impact severity, definitions of which are set in **Table 5.24** below.

Table 5.24: Landscape and Visual Amenity Impact Severity Criteria

Landscape or viewpoint sensitivity	**Magnitude of change in landscape or view**		
	Low : Small changes in the landscape or view	**Moderate** : Introduction of noticeable new features into the landscape or view of the site itself, or obstruction of a noticeable part or elements of views beyond the site	**High** : Introduction of substantial new features into the landscape or view of the site itself, or obstruction of a substantial part or important elements of views beyond the site
Low	**Minor**	**Minor**	**Moderate**
Moderate	**Minor**	**Moderate**	**Major**
High	**Moderate**	**Major**	**Major**

The Table is a guide only. Each case is assessed on its own merits using professional judgement and experience

Impacts on visual amenity are clearly distinguished, although closely linked to impacts on landscape character and landscape resources.

5.5.3.10 Severity Criteria for Impacts on Traffic and Infrastructure

The level of severity for traffic impacts is dependent on the sensitivity of the receptors (i.e. road network, pedestrian and cyclist conditions) and the magnitude of the change. The traffic impact severity criteria to be used in the assessment are summarised in **Table 5.26** below.

Table 5.25: Traffic Impact Severity Criteria

Potential Impact	**Severity Criteria**		
	Low/Negligible	**Moderate**	**High**
Traffic Conditions	<5% increase in traffic flows	5 – 10% increase in traffic flows	>10% increase in traffic flows
Pedestrian and cyclist conditions	<10% increase in traffic flows	10 - 30% increase in traffic flows	>30% increase in traffic flows
HGV effects	<50% increase in HGV flows	50 - 100% increase in HGV flows	>100% increase in HGV flows
Traffic related air quality and noise	<10% increase in traffic flows	10 - 30% increase in traffic flows	>30% increase in traffic flows

5.5.4 Probability

To assign probability to each activity, five criteria are defined and ranked. The criteria for probability are shown in **Table 5.26** below. Level five “certain” represents the highest probability that the activity will occur or is a normal operating activity or event.

Table 5.26: Probability Categories and Ranking for Environmental and Socio-Economic Impacts

Category	Ranking	Definition
Certain	5	The activity will occur during normal construction/operating conditions
Very Likely	4	The activity is very likely to occur during normal construction/operating conditions
Likely	3	The activity is likely to occur at some time during normal construction/operating conditions
Unlikely	2	The activity is unlikely, but may occur at some time during normal construction/operating conditions
Very Unlikely	1	The activity is very unlikely to occur during normal construction/operating conditions but may occur in exceptional circumstances

The various risks are assigned a level of importance based on severity and probability. For each impact a severity ranking between 1 and 5 is assigned using the impact table above (**Table 5.3)**. The probability ranking is assigned between 1 and 5 (**Table 5.26**).

5.5.5 Cumulative Impact Assessment

Chapter 6 presents an assessment of any cumulative impacts, which are likely to result from the Project in combination with any other existing or planned projects or activities. The following criteria have been taken into consideration during the cumulative impact assessment:

- Time and geographic boundaries;
- Interaction between the Project's environmental impacts; and
- Interactions between the Project's environmental impacts with those of other projects or activities.

5.5.6 Environmental and Social Management Plan (ESMP) and Monitoring Schedule

Chapter 7 of the EIA includes an Environmental and Social Management Plan (ESMP). The ESMP is the mechanism for ensuring that measures developed for the protection of the natural and human environment through the EIA process are implemented in an appropriate and timely manner. The plan also provides a framework for the monitoring of such measures to:

- Ensure they are carried out in accordance with the EIA; and
- Demonstrate their effectiveness, or identify areas where supplementary measures may be required.

The former point is to be verified through an audit and inspection programme, to demonstrate appropriate implementation of the ESMP. The latter point is particularly important to prevent, minimise, mitigate or compensate for adverse environmental and social impacts. The ESMP also defines the responsibilities of key parties within the project team. The ESMP encompass the requirements and objectives of an appropriate suite of management plans:

- Environment:
  - Waste Management Plan;
  - Resource Consumption Management Plan;
  - Hazardous Materials Management Plan; and
  - Traffic and Transport Management Plan.
- Socio-Economic:
  - Public Consultation and Disclosure Plan;
  - Archaeological and Cultural Heritage Management Plan including provision for a "Watching Brief";
  - Occupational Health and Safety Plan ; and
  - Community Safety Plan.

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Chapter 6

Impacts, mitigation management and monitoring

Contents

6. IMPACTS AND MITIGATION MANAGEMENT AND MONITORING

6.1 Introduction

This Chapter examines the potential environmental and socio-economic impacts associated with the proposed development works. The assessment addresses the main project activities as defined in **Chapter 3**.

Overall, the proposed fuel farm development is not considered to constitute a significant risk to either environmental or social and community receptors.

Environmental and social management of the fuel farm construction and operation will have several aspects as follows:

- Construction programme management; and
- Ongoing fuel farm operations management upon completion of the construction.

Responsibility for delivery of the environmental and social management provisions outlined in this chapter will be as follows:

- KODAP and its subcontractors - construction programme; and
- KODAP operations

KODAP will develop a **Construction Programme Environmental and Social Management Plan (ESMP)**. Once the construction programme is finished the Construction Programme ESMP will no longer be maintained.

The operator of the tank farm will develop a **Tank Farm Operations Environmental and Social Management Plan (ESMP)** in accordance with the provisions of EMAS - Environmental Management System, and it is expected that the construction and operation of the fuel farm will comply with the EMS requirements. KODAP may elect to gain accreditation for its management system some time in the future but it is not proposed to pursue this in the short term rather the principles of the standard will be applied including regular monitoring and auditing of the performance of the management provisions and implementation of corrective actions if and as required.

In the following sections, recommendations are made with respect to minimum requirements of a number of issue-specific control plans for both the construction and operation phases of the KODAP new fuel farm development project.

It should be noted that at the time of writing, details in respect to some aspects of the project design were not available and therefore, it has not been possible to complete a quantitative impact assessment. In such instances, a qualitative assessment has been made of the potential for impacts and their likely significance and recommendations are made in regards to future work programmes that should be undertaken by the sponsor of the project to address the information gap.

6.1.1 Construction Phase

As discussed in **Chapter 3**, development works at KODAP fuel farm will last approximately 12 months. In summary, the construction programme will include:

- Site clearing and levelling ;
- Civil construction works;
- Mechanical erection of steelwork;
- Tanks construction;
- Building construction;
- Pipe racking construction and piping installation;
- Mechanical equipment installation;
- Electrical and instrumentation installation; and
- Fuel farm handover

At any one time, an average of 75 construction workers are anticipated to be on site. During the peak construction period, 150 construction workers are anticipated to be on site.

The construction phase is considered to have a potential to interact with the following environmental and social / community receptors:

- Environmental:
    - Air quality;
    - Water resources (surface and groundwater);
    - Soils and land;

  - Habitat (flora and fauna (birds)); and

- Socio-Economic & Community:
  - Local community (noise);
  - Local traffic and infrastructure;
  - Public health and safety; and
  - Construction workforce health and safety

The following sections elaborate on the nature of the anticipated construction phase activity-receptor interactions, the mitigation measures that will be employed to address and reduce impacts to an acceptable level and the management and monitoring activities that will be conducted in order to demonstrate that the mitigation measure are effective.

A Construction Programme Environment Officer will be appointed to manage all environment and social monitoring requirements for the construction programme. Monitoring, recording, reporting and corrective action development and implementation will be conducted in accordance with the Construction Programme ESMP as developed by KODAP.

6.1.2 Operational Phase

Operation of KODAP fuel farm is considered to have a potential to interact with the following environmental and socio-economic / community receptors:

- **Environmental:**

- Air quality;
- Water resources (surface and groundwater);
- Soils and land; and
- Fauna (birds);

- **Socio-Economic & Community**:

- Local community (noise);
- Local traffic and transport infrastructure;
- Employee health and Safety; and

- Public health and safety;
- Increased social disturbance

The following sections elaborate on the nature of the anticipated operation phase activity-receptor interactions, the mitigation measures that will be employed to address and reduce impacts to an acceptable level and the management and monitoring activities that will be conducted in order to demonstrate that the mitigation measure are effective.

An Operations Environmental Officer will be appointed to manage all environment and social monitoring requirements during the fuel farm operations.

6.2 Ambient Air Quality

6.2.1 Introduction

The aim of this section is to describe the existing air quality in the vicinity of the proposed tank fuel farm, and to assess the potential impacts of the construction and operation of the fuel farm on air quality. The assessment considers potential changes to local air quality in relation to EU Limit Values for the protection of human health and ecosystems, and the potential generation of nuisance dust and odours.

As it is referred in **Chapter 4 – Section 4.1.17,** the department of Labour Inspection (DLI) has established a network of nine advanced monitoring stations and handles the matters of Ambient Air Quality, and how the limit values for the concentrations of various pollutants in the atmosphere are determined.

The industrial air quality monitoring station, located at Zygi village, Larnaca, records pollutant levels as a result of the industrial activity in the greater Vasilikos area (EAC power stations, VCW plant etc).

Data on ambient air quality from the Department of Environment and the DLI show no significant issues for the last 6 months. Levels of nitrogen oxides, sulphur dioxide, benzene, and ozone concentrations have been found to comply with available World Health Organisation and EU ambient air quality standards at the sampling location near project area.

During the construction phase, the fuel farm has the potential to generate adverse, but temporary, impacts on local air quality as a result of construction traffic and plant exhaust emissions, and also nuisance dust from construction activities. A quantitative and qualitative assessment of the impacts during the construction phase has been undertaken in this study.

During the operation phase, the fuel farm has the potential to affect both local and regional pollution as a result of emissions to air from a variety of stationary and mobile sources including tank losses, and diesel engines. The potential contribution of the fuel farm to pollutant emissions has been assessed quantitatively, and their impact on local air quality has been assessed using computerised modelling.

The pollutants considered in this study were chosen by reference to relevant EU legislation and considering the principal types of emissions at petroleum products storage depots (**Table 6.1**).

The pollutants considered are:

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- Nitrogen Dioxide (NO_x);
- Particulates with aerodynamic diameters less than 10 μm (PM_{10});
- Volatile Organic Compounds (VOCs);
- Benzene;
- Sulphur Dioxide (SO_2);
- Carbon Monoxide (CO);

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- Dust;
- Nitrogen Dioxide (NO_x);
- Sulphur Dioxide (SO_2);
- Carbon Monoxide (CO);

All pollutants except VOCs and dust are covered by EU legislation for managing local air quality, and have human health impacts. VOCs are included to assess the contribution made by the fuel farm to the regional emissions of ozone precursors and also as a measure of the odour creation potential of the storage facility.

Table 6. 1: Pollutants – Sources and effects

Pollutant	Main Sources	Impacts	Assess	Comments
Benzene & VOCs	Fuel vapours; Incomplete combustion of fuel	Carcinogenic (Benzene)	YES	Fuel farm tank emissions and combustion are potential sources
CO	Incomplete combustion of fuel	Reduces capacity of blood to carry oxygen	YES	Combustion/transport sources at fuel farm
Oxides of Nitrogen	NO formed during combustion in air. NO2 formed by oxidation of NO	Impaired lung function; acidification and eutrophication of soils	YES	Combustion / transport sources present at fuel farm
Ozone (O_3)	No man-made sources. Formed through chemical reactions in presence of sunlight	Eye, nose and throat irritation, chest infection; affects crop growth	NO	No assessment required in relation to local air quality due to lack of sources
PM_{10}	Industrial processes, especially mineral and ferrous metals. Combustion processes. Chemical reaction in air	Affects the respiratory and cardiovascular systems, asthma and mortality	YES	Combustion/transport sources present at fuel farm
SO_2	Predominant source is combustion of sulphur-containing fossil fuels, principally coal and heavy oils. Some industrial processes	Constriction of airways by stimulating nerves in the lining of the nose, throat and lungs	YES	Diesel engines are potential source
Lead	Road traffic was main contributor before general sale of leaded petrol was banned on 1 January 2000. Industry contributes to lead emissions but to a lesser extent	Affects the synthesis of haemoglobin, kidneys, joints and the reproductive system. Can cause damage to the nervous system	NO	No significant sources of lead associated with this project
Dust	Natural sources, industrial processes, construction activities	Nuisance dust soiling of surface. Corrosion of artifacts leading to faults or abrasion or contamination. Can affect growth of vegetation	YES	Construction activities are a potential source

6.2.2 Assessment methodology

The area of interest is broadly defined as the region within a 5 km radius of the proposed facility. This includes the residential areas of Mari village at approx. 2 km to the northwest of the boundary of the proposed installation and Zygi, approximately 2.5 km to the east. Outside of the area, the contribution from the fuel farm is expected to be relatively small.

The assessment of construction impacts involves the identification of those activities which are likely to result in the generation of dust and other air emissions, and the identification of potential receptors in the vicinity of those activities.

The assessment of local air quality impacts during the operation of the fuel farm requires the calculation of ground level pollutant concentrations, both prior to and subsequent to the proposed development. The calculation of ground level concentrations requires that pollutant emission sources be identified and quantified.

Ground level pollutant concentrations in the study area are considered to have two contributions:

- Contributions from emission sources on the proposed fuel farm;
- Contributions from all other emissions sources

Of these contributions, the former are explicitly included in the modelling exercise, the latter are implicitly included via the estimation of background pollutant concentrations.

Emissions sources considered for this assessment include:

- Storage tanks related emissions (VOCs)
  - Including working losses, breathing losses, seal losses
- Diesel generators (NOx, PM_{10}, CO, SO_2)
  - Emergency – routine testing only
- Traffic Emissions (NO_x, PM_{10}, Benzene)

The quantities of pollutants emitted from the above sources depend on the level of activity at the fuel farm. The steps required to calculate their contribution to ground level concentrations in the study area include:

- Estimation of emissions of the relevant pollutants for each scenario based on operational data;
- Representation of the spatial distribution of the emissions to an appropriate level of detail;
- Atmospheric modelling using the AERMOD 9.1.0 model together with appropriate meteorological data; and
- Comparison of model results with relevant assessment criteria.

For the atmospheric modelling, information is required on both the quantities of pollutants released and their release location and characterisation.

For VOCs releases from the storage tanks, the TANKS 4.0.9d Software (of the US Environmental Protection Agency) has been chosen for the calculation of their emissions rates.

For the VOCs emissions, it is the total amount released in a year that is of concern for both regional and local impacts. Therefore, its distribution throughout the year is of secondary importance. Emissions of VOC (and by definition benzene) are therefore modelled at their annual average.

For the diesel generators, their sporadic operation means that it is not possible to predict the diurnal profile or seasonality. However, it has been assumed that testing of the engines will take place during the daytime.

The wind roses for Vasilikos region show that north-westerly and westerly winds are dominant (**Chapter 4 – Section 4.1.9**). Surface winds are prevailing gradient winds modified by local land and sea breeze effects that extend 15 – 30km depending on their strength. Winds are mainly light to moderate. The maximum sea breeze during the day is Force 4 (5.5– 7.9 m/s). The maximum land breeze during the night is Force 2-3 (1.6 – 5.4 m/s). Strong winds and gales are of short duration.

NO_2 is not emitted from combustion sources in significant quantities. Typically less than 5% of NOx emissions are NO_2 and 95% are NO. NO_2 is formed by oxidation of NOx in the atmosphere, primarily by reaction with ozone. EU Limit Values for the protection of human health relate to NO_2 rather than NO. For the purposes of this study it is assumed that 50% of the emitted NOx is converted to NO_2. This is considered to be a conservative estimate for the points of maximum NOx impacts, which lie within 2 km of the site.

The air quality assessment criteria used in this study are based on the air quality limit values or assessment criteria for the concentration of pollutants in ambient air or the relevant emissions ceilings. There is no generally accepted guidance available on the significance of air quality impacts and the judgment of significance is usually based on the expertise of the air quality specialist.

For this study, the assessment of significance will be made on a pollutant specific basis, which will take into account:

- the level of background concentration or emissions (except odours, where background concentrations are considered negligible);

- the process contribution (PC) as a percentage of the relevant limit value or ceiling i.e. the contribution of the fuel farm alone;
- the predicted environment contribution (PEC) as a percentage of the relevant standard or ceiling i.e. the total concentration in ambient air, taking into account the process contribution and the background concentrations; and
- for local air quality, whether the pollutant is a threshold pollutant i.e. there is a defined level below which effects are not seen – this is true for NO_2, but not true for particulates or carcinogenic substances such as benzene.

For annual average measures, where the process contribution is less than 1% of the relevant standard, the significance of the impact of the process will be considered to be negligible whether background concentrations exceed the standard or not. For short term measures, including odours, where the process contribution is less than 10% of the relevant standard or ceiling, the significance is considered negligible.

Table 6. 2: Significance criteria

Factor	Significance			
	Major	Moderate	Minor	Negligible
Local air quality: long term averages	PEC>70% of limit value and PC>10% or PC>50%	PEC<70% of limit value and PC<=50% (25% of threshold pollutants) or PEC>70% and PC<10%	PC<=10% of limit value and PEC<=70%	PC<=1% of limit value
Local air quality: short term averages	PEC>70% of limit value and PC>25% or PC>50%	PEC<70% of limit value and PC<=50% (25% of threshold pollutants) or PEC>70% and PC<25%	PC<=25% of limit value and PEC<=70%	PC<=10% of limit value
Regional air quality	PEC>70% of limit value and PC>10%	PEC<=70% of limit value and PC<=50% (25% of threshold pollutants) or PEC>70% and PC<=10%	PC<=10% of limit value and PEC<=70%	PC<=1% of limit value
Odours	PEC>50% of indicative criterion	PEC<=50% of indicative criterion	PEC<=25% of indicative criterion	PEC<=10% of indicative criterion

6.2.3 Emission sources

Fixed roof tanks

Fixed roof tanks are proposed for the storage of Jet Fuel and Diesel fuel. All tank storage is at ambient pressure and unheated.

Losses from the fixed roof tanks proposed for the storage of petroleum products were estimated using the emission factors in AP-42(2), Chapter 7, applying the TANKS Software of US-EPA. The losses considered were breathing losses and working losses. Breathing losses occur as a result of the expulsion of vapours due to the expansion and contraction of tank vapours due to diurnal temperature and barometric pressure variations. Working losses occur as a result of the loading and unloading operations changing the tank liquid level. For instance, during loading, as the liquid level rises, the pressure level within the tank increases and exceeds the relief pressure and vapours are expelled. **Table 6.3** shows the emission estimates for fixed roof tanks.

Table 6. 3: VOC Emissions from Fixed Roof Tanks Storing Diesel, Heating Diesel and Jet A1fuel

Product	Tank Dimensions (Height X Diameter) (m)	Year	Annual Throughput (tonnes)	No of Tanks	Loss per Tank per year (tonnes)	Total Losses per year (tonnes)
DIESEL	22 X 45	2030	93,312	3	0.4	1.2
HEATING DIESEL	22 X 45	2030	31,104	1	0.4	0.4
JET A-1	22 X 45	2030	186,624	3	1.09	2.18

Internal Floating Roof tanks

Internal Floating Roof (IFR) tanks are proposed for the storage of Mogas fuel.

Losses from the IFR tanks proposed for the storage of Mogas fuel were estimated using the emission factors in AP-42(2), Chapter 7, applying the TANKS Software of US-EPA. Losses from the IFR tanks were withdrawal losses and standing storage losses. Withdrawal losses occur as the liquid level is lowered and product remaining on the inner tank wall evaporates. Standing losses occur through rim seals and deck fittings. **Table 6.4** shows the emission estimates for fixed roof tanks.

Table 6.4: VOC Emissions from IFR Tanks Storing MOGAS fuel

Product	Tank Dimensions (Height X Diameter) (m)	Year	Annual Throughput (tonnes)	No of Tanks	Loss per Tank per year (tonnes)	Total Losses per year (tonnes)
MOGAS	22 X 45	2030	124,416	4	4.766	19.064

Traffic Emissions

The calculation of emissions from traffic during the construction phase, requires knowledge of traffic volumes, speeds and fleet mix, including data on the types and ages of vehicles. **Chapter 4 (Section 4.2.5)** has provided information on the volume of cars, light goods vehicles (LGV), heavy goods vehicles (HGV) and buses on a number of roads that ultimately will serve the project. However, information on vehicle speeds, fuel types and ages is, at present, unavailable, for either the present or future Cyprus fleets.

Therefore, as a first approximation, the assessment of the impact of traffic emissions has simply considered the potential changes in emissions that would result from the addition of HGVs, associated with the transport of products to the fuel farm, onto the existing traffic levels. Since the level of traffic on Cyprus' roads is likely to increase in the future, this will provide an upper bound on the percentage change in emissions.

6.2.4 Construction impacts, mitigation and residual impacts

Potential impacts

Dust is generally considered to refer to particulate matter in the size range 1 to 75 μm in diameter, and is produced through the action of abrasive forces on materials. Fine dust particles (PM_{10}) are defined as particles less than 10 μm in diameter, and are of the most concern regarding health effects. In general, the majority of construction dust is larger in diameter than 10 μm. Particles larger than 10 μm are not associated with adverse effects on human health but can cause nuisance to local residents and are potentially damaging to sensitive ecosystems.

Research has shown that whilst small particles (<10 μm) can travel distances in excess of 1 km, the majority of large dust particles (greater than 30 μm) are deposited within 100 m of sources; intermediate sized particles (10 to 30 μm) are likely to travel up to 200 to –500 m. Therefore, it is considered that the potential for dust to cause impacts is likely to be limited to around 100 m from construction works with dust generation potential.

In general, construction activities associated with the greatest potential for dust generation are:

- Earthworks including excavation, handling on site and deposition;
- Handling and storage of materials (including loading and unloading);
- Haulage roads and unsealed site surfaces (including vehicles travelling along them);
- Wind blow across disturbed site surfaces and materials;
- Mechanical operations such as crushing, drilling, concrete mixing and cutting.

The potential for the generation of dust, and its transport offsite, is greatest during dry, windy weather. Therefore, taking into consideration the climate of Cyprus, a conservative approach has been adopted in this study, and receptors for dust impacts are considered to be properties within 500 m of dust generating activities.

The identified sensitive receptors in the study area are shown in **Table 6.5** below. These locations were also used for the calculation of the resulting air pollution concentrations due to the terminal.

Table 6. 5: Sensitive Receptors

RECEPTOR	X coordinate	Y coordinate	Location
PENTAKOMO	522173.00	3844159.00	7.3 km west of the site
AGATA	523328.00	3848624.00	7.8 km north-west of the site
KALAVASOS	527176.00	3847880.00	5 km north of the site
MARI	527342.00	3844385.00	1.9 km north-west of the site
MARONI	532594.00	3846313.00	4.8 km east of the site
TOCHNI	529662.00	3848852.00	5.8 km north east of the site
CHIROKITIA	530795.00	3850667.00	7.6 km north east of the site
AGIOS THEODOROS	535176.00	3850899.00	10 km north east of the site
GOVERNORS BEACH	524973.00	3841609.00	4.3 km west of the site
EAC VASILIKOS	526668.00	3843104.00	2.4 km west of the site
NAVAL BASE	525889.00	3842533.00	3.5 km west of the site

Using the above criterion, there are no potential receptors adjacent to the fuel farm boundaries. (**Figure 6.1**) The residential properties are at approx. 2 km to the northwest of the boundary of the proposed installation and Zygi, approximately 2.5 km to the east.

Moreover the total fugitive dust emissions estimated for the entire 12 month construction period (**Table 3.14**) will contribute very little to the mean 1-hour PM_{10} and $PM_{2.5}$ concentrations recorded in the area (PM_{10} = 49.1μg/m^3 and $PM_{2.5}$ = 17.9 μg/m^3).The existing dust levels at the fuel farm boundaries are high because of the existence of Vasilikos Cement Works and the uncovered areas. It is considered that, existing dust levels will not be affected by construction phase of the project.

Figure 6. 1: Dust emissions from construction phase

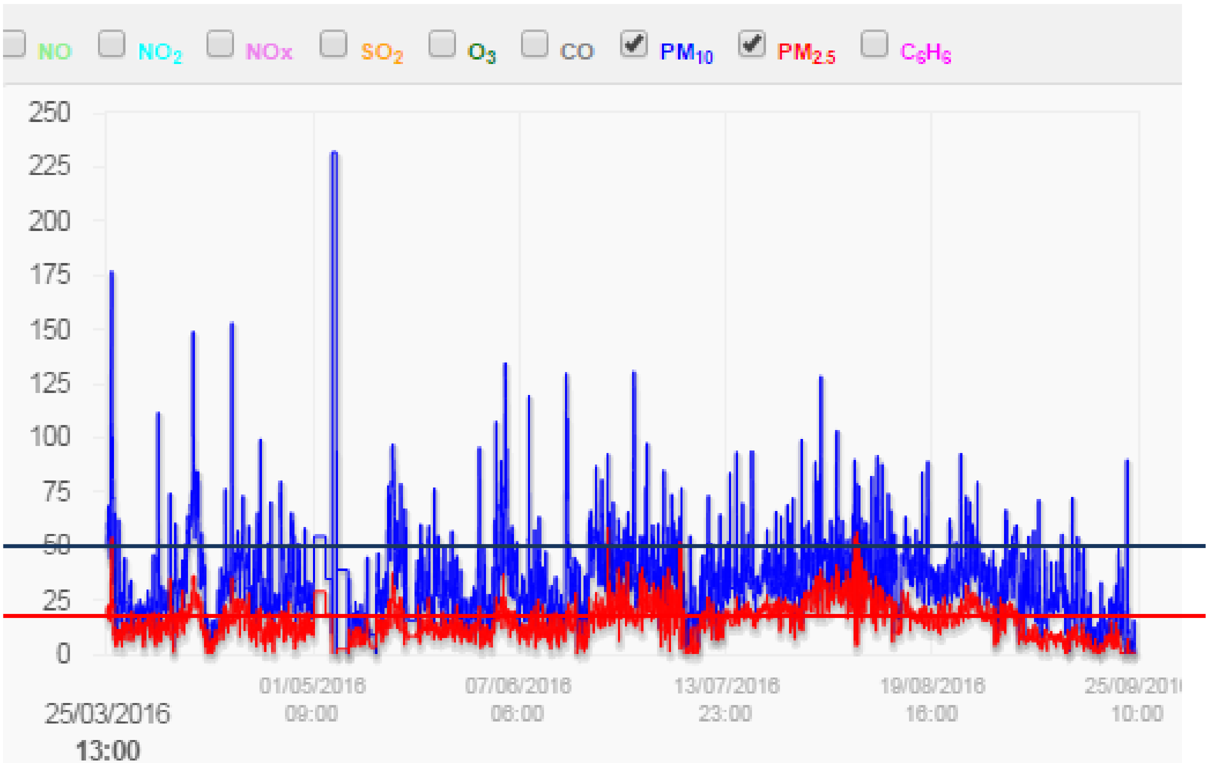

Figure 6.2: 1-hour PM_{10} and $PM_{2.5}$ concentrations at Zygi station

The generation of emissions and PM (dust) during construction will have a direct negative impact on air quality. The extent of the impact will be local as air quality will be affected beyond the Project site, but will not impact air quality beyond the Port of Cape Town. The duration of the impact will be short-term, confined to the construction phase, about 12 months, and will be reversible. The intensity of the impact will be low, given the relatively low volumes of emissions and PM (dust) generated. Taking the local extent, short- term duration and low intensity into consideration, the impact magnitude is considered to be low. Given the definite likelihood, the overall pre-mitigation impact significance is considered Minor

Table 6.6 below gives a summary of the construction impact on air quality.

Table 6.6: Construction Impact: Air Quality

Nature: Construction activities that increase emissions and dust particulate matter in the atmosphere would result in a **direct negative** impact on air quality. **Impact Magnitude** – **Low** • **Extent**: The extent of the impact is **local** as the potential impact will be beyond the Project Site, but only affect the Vasilikos port area. • **Duration**: The duration would be **short-term** for approximately 12 months. • **Intensity:** The intensity is likely to be **low** given that the scale of the construction activities. **Likelihood**: There is a **definite** likelihood of increased dust and emissions. **IMPACT SIGNIFICANCE (PRE-MITIGATION) – MINOR** **Degree of Confidence:** The degree of confidence is **high**.

The potential for fugitive dust from the proposed construction works depends fundamentally on the effectiveness of control measures. It is considered that by applying appropriate control measures, combined with on-site management and monitoring of site operation activities, the potential for dust generation and therefore the potential for dust effects would be minimised.

Mitigation Measures

Good site management practices during the construction works will help to prevent the generation of airborne dust. It should be the responsibility of the nominated contractor to ensure that sufficient precautionary measures to limit dust generation are in fact taken.

To ensure that atmospheric dust, contaminants or dust deposits generated by the construction work do not exceed levels which could constitute a nuisance to local residents or damage to equipment, it is proposed that visual inspections of site boundary levels of dust be undertaken. A trained and competent person should carry out monitoring on a weekly basis. However if dry windy weather prevails then the rate of monitoring should be increased to daily initially, and 4 times per day if levels remain high.

The mitigation measures described below should be implemented as necessary. If, despite the implementation of best practicable means of dust/odour mitigation, levels of dust soiling remain unacceptable, the site manager should ensure the cessation of dust generating construction activities.

The prolonged storage of debris on site, in temporary stockpiles should be avoided. Vehicles removing demolition or site clearance materials must have their loads effectively sheeted on all sides. Crushing of material for reuse, transportation or disposal should be undertaken as far away as possible from sensitive receptors. Excavation faces, when not being worked, should be sheeted.

The number of handling operations should be minimised, ensuring that dusty material is not moved or handled unnecessarily. Fine material should be delivered to site in bags. Drop height must be kept to a minimum.

Stockpiles should be located away from potential receptors, with slopes at angles less than the natural angle of repose of the material. Stockpiles should be sheeted, contained within wind barriers or potentially damped down. However, since water is a relatively scarce resource on Cyprus, watering of dusty materials should only be used sparingly. If long term stockpiles are required, consideration should be given to the use of chemical bonding agents.

Hardstanding areas for vehicles entering, parking and leaving the site should be provided, with wheel washing facilities at access points. Site roads should be cleaned regularly, and damped down if necessary. Site vehicle movements should be kept to a minimum and, where possible, restricted to paved haulage routes. Vehicle speeds should be limited to 20 km/h or less on surfaced roads, and 10 km/h on unpaved surfaces.

If required, cleaning of public roads used for transport of materials should be undertaken.

No fires will be lit on site, and no toxic materials will be burned.

Residual Impacts

With the implementation of appropriate dust mitigation measures, it is concluded that the potential for dust impacts is low.

6.2.5 Operational impacts, mitigation and residual impacts

Petroleum Product Storage Tanks and Loading Operations

The maximum ambient concentrations of the VOCs over the 5 years of meteorological data were calculated and are presented as concentration isopleths in the figures below, as well as in a table with the maximum concentrations expected at the various receptors (**Appendix C**).

Figure 6.3 shows the maximum annual average benzene concentrations around the terminal. As can be seen, the maximum levels are well below the annual guideline of 5 μg/m^3 and the recorded benzene concentrations in the area (**Figure 6.4**).

The modelled annual benzene concentrations at all the identified sensitive receptors are shown in **Table 6.7**.

Table 6.7: Annual benzene concentrations - Sensitive Receptors

RECEPTOR	X coordinate	Y coordinate	Concentration (μg/m^3)
PENTAKOMO	522173.00	3844159.00	$6*10^{-5}$
AGATA	523328.00	3848624.00	$1.3*10^{-4}$
KALAVASOS	527176.00	3847880.00	$8.2*10^{-4}$
MARI	527342.00	3844385.00	$8.3*10^{-4}$
MARONI	532594.00	3846313.00	$6.1*10^{-4}$
TOCHNI	529662.00	3848852.00	$3.7*10^{-4}$
CHIROKITIA	530795.00	3850667.00	$1.9*10^{-4}$
AGIOS THEODOROS	535176.00	3850899.00	$3.9*10^{-4}$
GOVERNORS BEACH	524973.00	3841609.00	$1.57*10^{-3}$
EAC VASILIKOS	526668.00	3843104.00	$1.31*10^{-3}$
NAVAL BASE	525889.00	3842533.00	$1.43*10^{-3}$

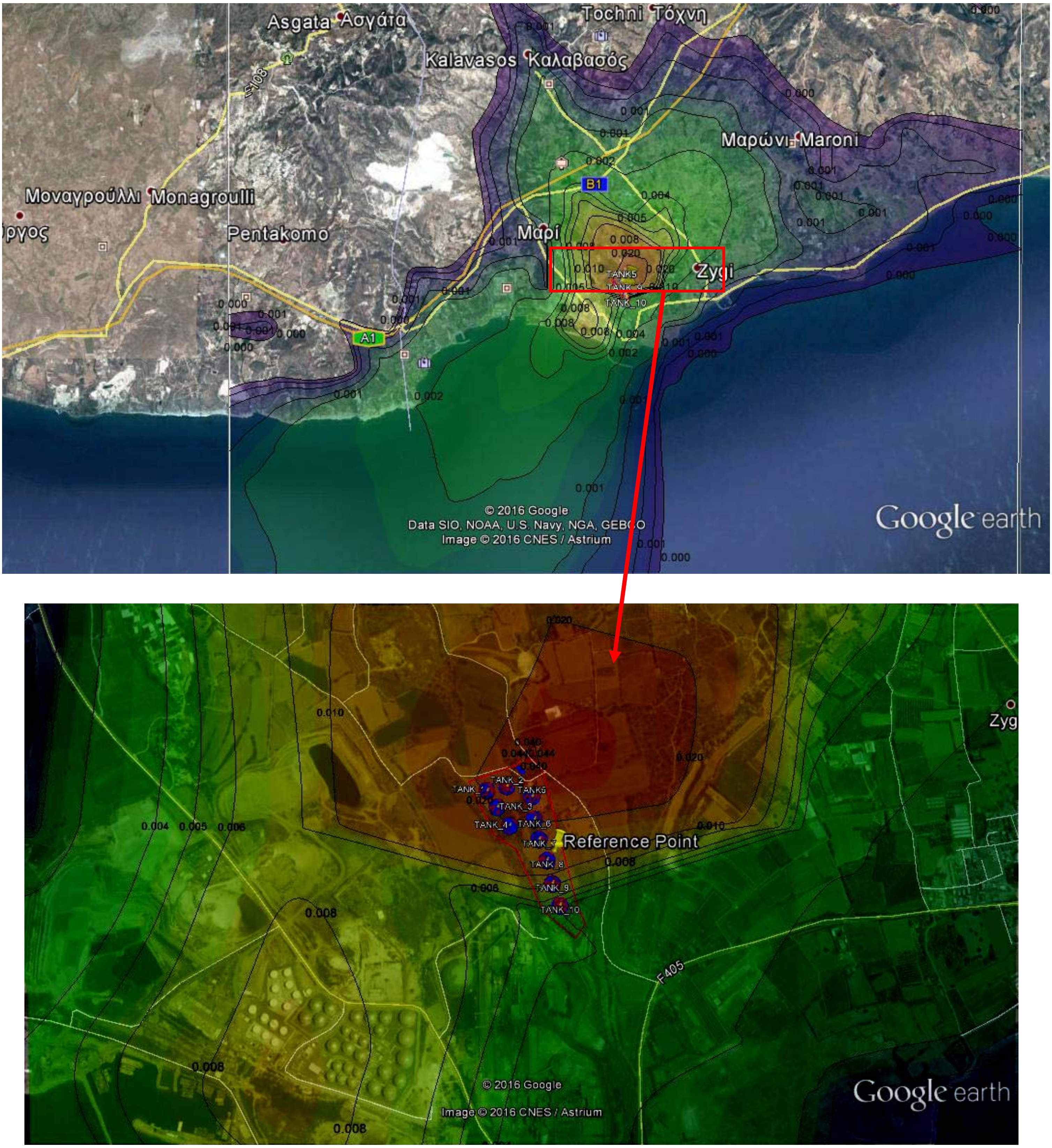

Figure 6.3: Maximum Annual Benzene Ground Level Concentrations (Limit: 5 μg/m^3)

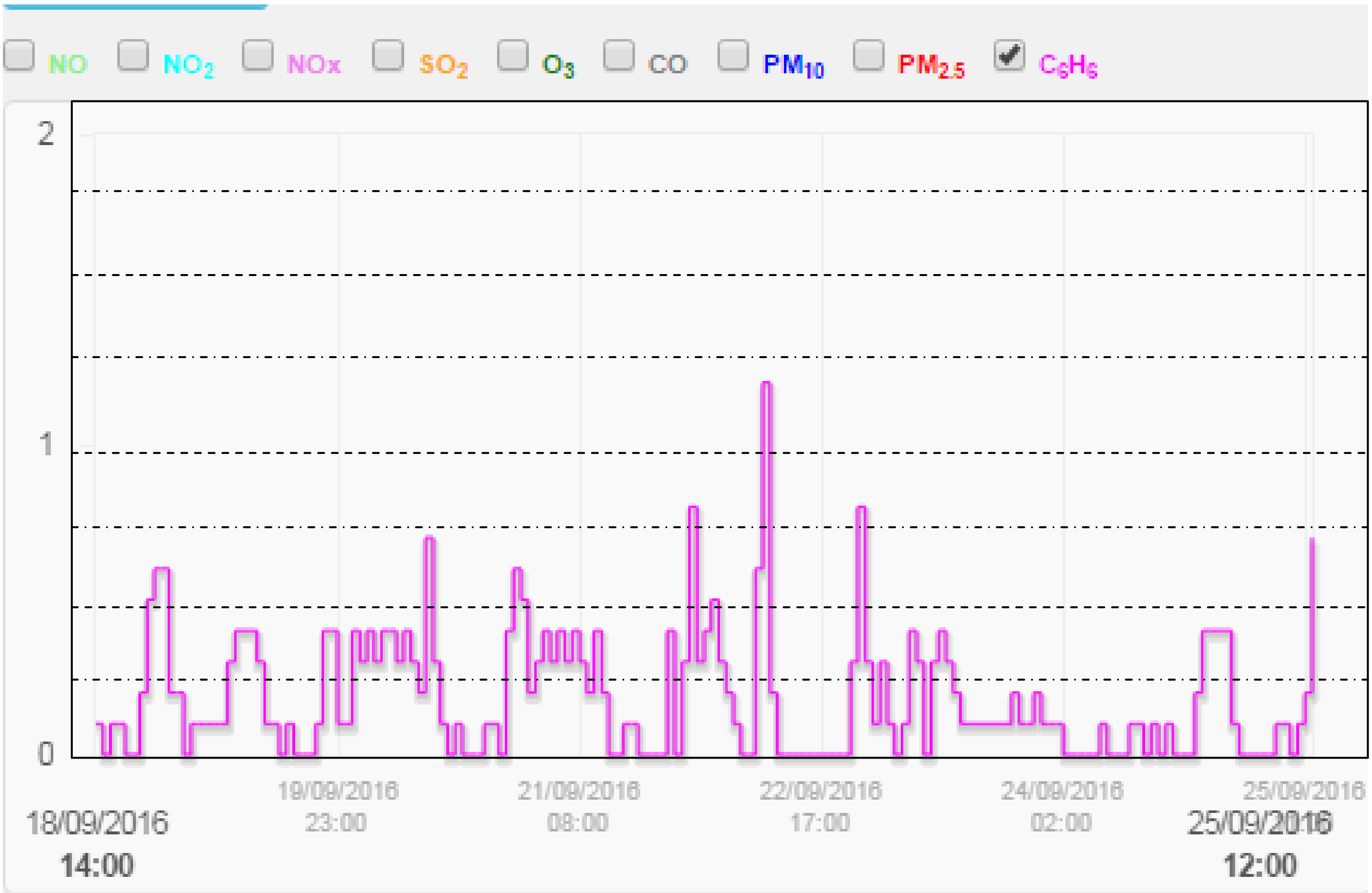

Figure 6.4: Benzene Ground Level Concentrations at Zygi station

The vapour emission rates, and hence the ground level concentrations resulting from these emissions, are dominated by the releases of Mogas and JET A-1 tanks, from storage operations. These are considered to be a potentially minor adverse impact to air quality.

Benzene

There are no EU Limit Values for total VOC concentrations in ambient air. Therefore, the concentrations of VOCs have been used to estimate the concentration of benzene in ambient air, for which the EU Limit Value is 5 μg/m^3 to be achieved by 2010.

Benzene is present in small quantities in gasoline and jet fuel, but in negligible quantities in distillate fuel oils. The maximum quantity of benzene in gasoline in Cyprus is 1 % v/v, in line with EU policy. This gives a benzene concentration of less than 1.5 % w/w. It is, therefore, possible to estimate benzene concentrations in air by assuming that there is also 1.5 % w/w of benzene in the VOC vapour emissions from the fuel farm.

Assuming 1.5% of the vapours are benzene, the maximum concentrations of benzene at the sensitive receptors (**Table 6.8**) do not exceed 0.0016 μg/m^3, less than 0.03% of the EU Limit Value. In the presence of low background concentrations, this is considered to be a potentially minor adverse impact on air quality.

Given this minor impact, no mitigation measures are required for VOC emissions from storage and loading operations beyond those included in the preliminary design, most importantly the use of fixed roof tanks for aviation fuel storage and vapour recovery units for loading operations.

Fugitive emissions of vapours, e.g. from pipework and spillages on site, have not been quantified for this assessment. The site environment manager should have responsibility for ensuring that good working practices are enforced on site. Spillages should be minimised and recovered as soon as possible to prevent evaporative losses. Pipework and associated fittings, valves and flanges etc, should be inspected for leaks on a regular basis and maintained in good condition. Replacement of faulty fittings should be made promptly.

Traffic

Since the operation of the project is not related to transport of fuel products with HGVs, no contribution to traffic air emissions is anticipated.

Regional Air Quality

The Cyprus Emissions Inventory, supplied by the Ministry of Labour and Social Insurance of Cyprus, provides total emissions of certain pollutants for Cyprus.

Emissions of sulphur dioxide and VOCs currently exceed the emission ceilings. Road transport emissions dominate the VOC emissions total; electricity generation dominates the sulphur dioxide emissions. The storage and distribution of petroleum products account for less than 5% of the total VOC emissions.

The total emissions of organic compounds from the fuel farm are predicted to be less than 1% of the annual ceiling limit for VOCs during the operation of the OSRD (**Table 6.9**). It is therefore concluded that the impact of the operation of the plant on VOC emissions, and hence its ozone generation potential, is negligible.

Table 6.8: Cyprus Annual Emissions

Pollutant	Emission Ceiling kt/year	2016 Kt/year	2016 % of Ceiling
VOCs	14	0.023	0.16

The annual concentrations of all the identified VOCs (shown in the emissions **Table 6.9**) were used for the calculation of the cumulative long-term health risk index. The cumulative long-term health risk index is the sum of the fractions of all the compounds' concentrations divided by their respective guidelines. It can be seen that the cumulative index did not exceed the value of 1 at any of the locations in the study area. The maximum concentrations for each compound, including the carcinogenic risk and cumulative health index, are presented in **Table 6.9** for each of the identified receptors around the terminal. As is evident, all of the maximum concentrations for every compound and receptor are well below their respective guidelines, including the carcinogenic risk and cumulative health index.

6.2.6 De-commissioning impacts, mitigation and residual impacts

The impacts of the de-commissioning of the fuel farm on local air quality are anticipated to be low.

Potential dust impacts are predicted to be of the same level as the construction impacts and, therefore, with the application of best practicable means, are not anticipated to be of significance.

There is the potential for the release of VOCs during tank de-commissioning. However, any residual material in the tanks is likely to be of low volatility. Therefore, the impacts on local air quality are anticipated to be no greater than the operational impacts and are considered to be of negligible or minor significance.

Table 6.9: Estimated Maximum Concentrations at Receptors around the OSRD

Receptors	Co-ordinates (UTM)		Hexane (-n)	Isooctan e	Benzene	Toluene	Ethyl-benzene	Xylene (-m)	Isopropyl Benzene	1,2,4-Trimethyl benzene	Cyclohexane	Carcinogenic Risk (x10-6)	Long-term Health Risk Index
	x	y	(μg/m3)	(μg/m3)	(μg/m3)	(μg/m3)	(μg/m3)	(μg/m3)	(μg/m3)	(μg/m3)	(μg/m3)		
PENTAKOMO	522173	3844159	1.34E-04	2.57E-08	6E-05	2.87E-04	2.95E-05	3.41E-04	2.41E-06	2.33E-04	1.92E-05	1.41E-02	4.65E-04
AGATA	523328	3848624	9.58E-05	1.83E-08	1.3E-04	2.05E-04	2.10E-05	2.43E-04	1.71E-06	1.66E-04	1.37E-05	1.00E-02	3.31E-04
KALAVASOS	527176	3847880	5.19E-04	9.94E-08	8.2E-04	1.11E-03	1.14E-04	1.32E-03	9.29E-06	9.01E-04	7.43E-05	5.43E-03	1.80E-04
MARI	527342	3844385	4.40E-04	8.42E-08	8.3E-04	9.39E-04	9.65E-05	1.12E-03	7.87E-06	7.63E-04	6.30E-05	4.60E-03	1.52E-04
MARONI	532594	3846313	4.45E-04	8.52E-08	6.1E-04	9.51E-04	9.77E-05	1.13E-03	7.97E-06	7.73E-04	6.37E-05	4.66E-02	1.54E-03
TOCHNI	529662	3848852	5.32E-04	3.64E-08	3.7E-04	5.46E-04	4.62E-05	7.57E-04	4.71E-06	3.76E-04	4.45E-05	1.06E-02	3.50E-04
CHIROKITIA	530795	3850667	8.21E-04	6.99E-08	1.9E-04	3.68E-04	7.05E-05	5.36E-04	2.75E-06	2.67E-04	5.43E-05	3.36E-02	1.11E-03
AGIOS THEODOROS	535176	3850899	7.30E-04	6.42E-08	3.9E-04	9.18E-04	8.56E-05	2.67E-03	5.57E-06	7.13E-04	5.80E-05	3.95E-03	1.25E-03
GOVERNORS BEACH	524973	3841609	1.87E-03	2.14E-07	1.57E-03	2.33E-03	2.05E-04	3.00E-03	2.19E-05	2.03E-03	1.65E-04	8.76E-02	3.42E-04
EAC VASILIKOS	526668	3843104	9.12E-05	1.84E-08	1.31E-03	1.95E-04	2.15E-05	2.23E-04	1.81E-06	1.96E-04	1.47E-05	1.94E-02	6.29E-04
NAVAL BASE	525889	3842533	9.33E-05	1.77E-08	1.43E-03	2.01E-04	2.09E-05	2.28E-04	1.61E-06	1.53E-04	1.27E-05	1.39E-02	4.23E-04
Guideline	-	-	-	-	5	-	-	-	-	-	-	1 x10-6	1

6.2.7 Summary

Uncertainties

The assessment of the impacts of the fuel farm on local and regional air quality has been based, to a large degree, on assumptions regarding emission levels. However, for the majority of emissions, the predicted impact is sufficiently low to provide a level of confidence in the robustness of the conclusion i.e. where the impact is less than 1% of the standard, even a 100% uncertainty level in the emission estimate has no significant impact on the conclusion regarding its impact on receptors.

In addition to emission estimate uncertainties, there are uncertainties associated with the modelling of the dispersion of pollutants in regions of complex terrain and coastal meteorological effects.

However, wherever possible, the assessment has been based on conservative assumptions i.e. those considered most likely to overestimate air quality impacts. The overall conclusion of the air quality impact assessment is that, the land based operations of the Energy Centre are unlikely to impact on air quality at relevant receptor locations, but that shipping emissions require further assessment.

Construction

A qualitative dust impact assessment has identified potential dust generating activities during the fuel farm construction and potential receptors for offsite dust impacts.

Potential receptors for dust include residential properties in the vicinity of the fuel farm and the adjacent agricultural land. Background dust deposition levels are expected to be elevated due to the dry climate of Cyprus and, as a result, the sensitivity of human receptors to dust nuisance is predicted to be low.

The overall assessment conclusion is that, with the application of best practicable means, adverse impacts due to construction dust or nuisance effects are unlikely to occur.

Emissions from Storage Operations

A quantitative assessment of the impacts of VOC emissions from the storage and loading operations at the fuel farm has been undertaken. The assessment has considered the magnitude of potential losses from storage tanks through breathing losses, working losses and fittings losses.

The assessment, based on conservative estimates of the impact of emissions from the site, has concluded that, as a worst case, the impact of the fuel farm on air quality is likely to be of negligible significance.

Traffic

Since the operation of the project is not related to transport of fuel products with HGVs, no contribution to traffic air emissions is anticipated.

6.3 Geology, soils, contaminated land and hydrology

6.3.1 Introduction

The section describes the potential impacts associated with the construction and operation of the proposed development to the existing geology, hydrogeology and soils in the project area.

6.3.2 Assessment Methodology

Baseline information and potential project-related impacts regarding geology, soils and hydrology have been assessed and complied through a desk-based review of information currently available on the site and the design of the facility. This includes:

- Baseline Conditions for geology and hydrology;
- Project impacts on soils, land and geological formations;
- Potential impacts of operations on geology, soil,, land or alternations in the hydrology of the area

6.3.3 Construction Impacts and Mitigation and Residual impacts

Potential impacts

Construction activities impacts on geology, soils and land are likely to be restricted to:

- Leaking of fuels or lubricants from construction machinery into the soil or groundwater (sea water);
- Runoff of rainwater from hydrocarbon-stained machinery leaching into soil or groundwater;
- Spills of bitumen, sealants and other substances used in the construction of the facility; and
- Waste and effluent generation

Even after delivery of a “clean site”, the proposed site preparation works will inevitably involve the importation of some aggregates, topsoil and subsoil. Although it is not yet possible to estimate the volume of soils and rock at the site that will need to be moved to produce the flat terraces required for the facility layout, it is intended that this will be reused on site to the greatest extent possible, either as fill or bund material or through its inclusion in landscaping when it is of an appropriate condition. A core objective of the project is to maximise the use of site-won soils and secondary aggregates, and to this effect, a neutral cut and fill mass balance is proposed.

Preparation of the site will require particularly large amounts of soil handling and possibly blasting to allow the final landform to be established.

Clean sand to be imported for foundations and the bund floor membrane beds will be obtained from an off site quarry.

A number of other generic activities that could potentially impact upon (or be impacted upon by) the geology and soils of the site will still arise, as outlined in **Table 6.10**.

The construction of the facility will produce a variety of waste products as presented in **Chapter 3**. The initial solid waste generated on site will be the cleared vegetation (although sparse) and soil overburden from levelling and grading of areas of the site. Some building rubble will be produced throughout the construction phase from activities such as the construction of buildings and concrete pouring. Packaging material will be accumulated from unpacking of facility components.

All wastes generated from the project will be categorised as either non-hazardous or hazardous following an assessment of the hazard potentials of the material in line with national legislative requirements.

Table 6.10: Summary of Potential Impacts and Mitigation

Activity	Potential Impact	Proposed Mitigation	Residual Impact
Piling for tank foundations	May cause arisings of contamination	All pile arisings to be assessed for contaminants before decision made as to reuse or appropriate disposal	Minor adverse
Excavation of materials		Clean excavated materials to be reused on site, preserving valuable resources	Neutral
Regrading of the cliff face and slope stability improvements	Stabilisation of unstable land	None	Minor beneficial
	Production of additional waste materials	Reuse	Minor adverse
Importation of fill material, topsoil and subsoil	Loss of valuable aggregate and soil resources from elsewhere in the Authority Area	Reuse material from within the site as much as possible	Moderate adverse
Re-profiling of ground levels	Improvements to Landform	None	Neutral

Grading, compaction and concreting works	Destruction of remnant natural drainage profiles resulting	Good design of drainage channels will reduce the impact	Minor adverse
	Decreased infiltration rates and increased storm water runoff		Minor adverse
Dewatering during construction of foundations	Potential impacts to the environment	Use of settlement ponds would allow sediment to drop out. Water could then be recycled as far as practicable or allowed to flow to lakes via silt fences and/or hay bale dykes and tested to ensure they meet minimum discharge standards	Minor adverse
Spills and accidental discharged	Potential impacts to groundwater and slight risk to sea water	All potentially hazardous materials will be managed in accordance with good construction practice, including the use of appropriate handling, storage and spill response	Minor

Hazardous Wastes

The construction phase will require the use of hazardous materials such as fuels and greases to fuel equipment and vehicles and maintain equipment. These substances will be stored on-site in temporary aboveground storage tanks. All fuels storage tanks will be locked, and fuels on site in drums will be stored in a locked container within a fenced and secure temporary staging area. Trucks and construction vehicles will be serviced off-site. The use, storage, transport and disposal of hazardous materials used for the Project will be carried out in accordance with all applicable national regulations. Material Safety Data Sheets for all applicable materials present on site will be readily available to on-site personnel. It is proposed that the construction contracting company supply the required temporary ablution facilities and be responsible for the removal and treatment thereof. KODAP will be responsible to ensure that the contracting company is accredited and has the necessary permits to remove the sewage. The sewage will be treated in accordance with the municipal sewage works policies and guidelines. There is potential for waste, effluent and sewerage stored on site to leach into the soil causing harm.

Non-hazardous Wastes

Construction waste will most likely consist of concrete (from buildings, bunds and foundations) and scrap metal. All concrete mixing will be undertaken on impermeable plastic lining to prevent contamination of the soils and surrounding areas. The management of construction solid waste is detailed in the Environmental Management Programme (EMPr) and will incorporate reduction, recycling and re-use principles.

All construction debris will be placed in appropriate on-site skips and periodically disposed of by a licensed waste contractor in accordance with applicable national regulations. The construction contractor will remove refuse collected from the designated waste storage areas at the site at least once a week. All rubble generated during the construction phase will be removed from the site regularly to a licensed landfill site.

The nature of the impact will be direct negative. Overall, given that the site will be presented to the project as clean, none of the land affected by the project is protected or currently in production, a cut-fill mass balance will be implemented, and there are no sensitive groundwaters present, the overall impact of the construction works on the geology, soils and hydrogeology is expected to be of only minor adverse impact.

The extent will be on-site, as leaks and spills would largely be confined to the site area. The duration will be long-term, as impacts could last many months for clean up or rehabilitation. The intensity is considered low given the scale of the potential impact. Considering the on-site extent, long-term duration and low intensity, the impact magnitude is considered Low to Medium. The impact is likely to occur, therefore the overall pre-mitigation impact significance is considered Minor - Moderate. **Table 6.11** below provides a summary of the impact.

Table 6.11: Construction impact: Soil or groundwater contamination

Nature: Construction activities could result in a direct negative impact on existing soil and groundwater conditions on the site.

Impact Magnitude: Low - Medium

- **Extent:** The extent of the impact to the soil will likely be confined to on-site, unless operations (e.g.: loading, refuelling etc.) involving hydrocarbons or other potential contaminants are conducted outside of the site.
- **Duration:** The duration of the impact would be long-term.
- **Intensity:** The intensity is likely to be low - medium.

Likelihood: The likelihood of this impact occurring is **possible/likely**.

IMPACT SIGNIFICANCE (PRE-MITIGATION): Minor - MODERATE
Degree of Confidence: The degree of confidence is high.

Mitigation Measures

Mitigation measures during construction may include, as appropriate:

- All fuel storage equipment (e.g. tanks) should meet appropriate internationally-recognised standards for structural design and integrity, (e.g. American Petroleum Institute (API) standards 650, 652, 653 and2610);
- All fuel storage tanks will be fitted with leak detection technology;
- Install shutdown valves (e.g. automatic pressure-activated values, to shut down or isolate ruptured tanks and pipes);
- Impermeable bunds with a capacity of 110 percent of the tank(s) which they enclose will be constructed.
- Ensure that staff are adequately trained in spill prevention, containment and response;
- Design and install an appropriate stormwater catchment system to prevent hydrocarbon-contaminated water from leaving site;
- A suitable area for the temporary waste storage areas and secure waste skips must be selected, away from drainage lines;
- A Waste Management Plan (WMP) for the Project will be developed. This will follow the principles of waste minimisation at source, segregation for reuse, recycling, treatment or disposal;
- Construction waste management will be governed by an EMPr and will incorporate reduction, recycling and re-use principles;
- Material Safety Data Sheets for all applicable materials present on site will be readily available to on-site personnel;
- All wastes produced from Project activities on site will be transferred to designated temporary storage areas and where possible into secure containers;
- Solid wastes will be segregated to facilitate reuse and recycling of specific materials;
- All wastes that cannot be reused or recycled will be collected by approved waste contractors and transferred to an appropriately licensed waste management facility for treatment and disposal;
- Effluent from the washing-down of concrete mixing and handling equipment will be contained within a bunded area of 110 percent capacity of the stored material.

This effluent will then be treated as hazardous waste and disposed of by a licensed contractor;

- All hazardous and liquid waste materials e.g. fuel for generators, including any contaminated soils will be stored in a bunded area of 110 percent of the stored material's capacity and disposed of by a licensed contractor;
- Fuels on site in drums will be stored in a locked container within a fenced and secure temporary staging area;
- Trucks and construction vehicles will be serviced off-site;
- Effluent and stormwater run-off will be discharged away from any identified drainage lines;
- All concrete mixing be undertaken on impermeable plastic lining to prevent contamination of the soils and surrounding areas;
- All construction debris will be placed in appropriate on-site storage containers and periodically disposed of by a licensed waste contractor in accordance with applicable local regulations;
- The construction contractor will remove refuse collected from the designated waste storage areas at the site at least once a week;
- All rubble generated during the construction phase will be removed from the site regularly to a licensed landfill site

6.3.4 Operational Impacts and Mitigation and Residual Impacts

Potential impacts

Operational impacts on geology and soils are likely to be restricted to risks of spills of stored materials leading to contamination of site soils and potentially perched groundwater:

- Minor spills or leaks of hydrocarbons may occur due numerous reasons, including:
  - Pipeline leak;
  - Decoupling of filler points;
  - Faulty valves;

- Vehicles or equipment colliding with fuel equipment;
- Failure of emergency shut-off equipment

- Waste and effluent

This risk will be minimised through the use of lined bunds, the drainage system (collecting separately storm water, oily water and sewer), oil separator and other protection measures as discussed in Section 3 - Project description, as well as the implementation of formal spill response planning as outlined in **Chapter 8**. The separator would be installed to treat contaminated surface runoff and unintentionally contaminated water from the fuel storage terminal more specifically the bund area. This is to ensure to that contaminant concentrations are within the limits for disposal to the sewer. Areas that might be subject to minor contamination such as the concrete hard standing area within the fenced area will be pumped to the First Flush Basin (FFB) and after a storm event will be pumped to the site separator.

The impact will be direct negative in nature. The extent will on on-site as minor spills would be confined to the site. The duration will be long-term as some spills may take months to rehabilitate and clean-up. The intensity is considered medium due to the potential scale of the spill and the toxic nature of the hydrocarbons. Given the on-site extent, long-term duration and medium intensity the overall impact magnitude is considered Medium-Low. The impact is likely to occur and therefore the overall pre-mitigation impact significance is considered Moderate-Minor.

Table 6.12 below provides a summary of the impact.

Table 6.12: Operations impact: Soil contamination

Nature: Operations could lead to minor fuel or oil spills resulting in a **direct negative** impact to the soil on the site, and groundwater (sea water).

Impact Magnitude: Medium-Low

- **Extent**: The extent of the impact on the soil is **on-site**.
- **Duration**: The duration of the effect of soil and/or groundwater contamination would be **long-term** as the remediation of the oil spill may take months to effect, and may have limited success leaving lasting (residual) impacts.
- **Intensity:** The intensity of soil or groundwater contamination would be **medium**.

Likelihood: It is **likely** that minor spills of petroleum hydrocarbons will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION): MODERATE-MINOR

Degree of Confidence: The degree of confidence is **high**.

Mitigation Measures

The storage tanks will be founded on a raft type foundation reinforced by concrete piles. Bunds have been designed to contain 110 percent of the nominal capacity of the largest tank contained within the bund. To achieve this bund walls are required to be 3.0m high.

All storage tanks will be designed and built to meet the API 650 Welded Steel Tanks of Oil Storage standard in order to cater for seismicity.

Mitigation measures during operation may include, as appropriate:

- Regular and precise wet stock inventories will be conducted to timeously identify discrepancies and potential leaks;
- A spill response plan will be prepared to quickly react to and contain as far as possible any spills emanating from fuel infrastructure on site. This should be risk-based and include all necessary equipment, appropriate training prerequisites for staff and critical checks;
- Infrastructure and equipment using or storing hydrocarbons will be routinely maintained and regularly inspected through a Preventative Maintenance Programme in order to minimise the chance of hydrocarbon spills;
- Warning signs and appropriate barricading will be placed around vulnerable fuel-carrying infrastructure;
- Operation waste management will be governed by an EMPr and will incorporate reduction, recycling and re-use principles;
- Material Safety Data Sheets for all applicable materials present on site will be readily available to on-site personnel;
- All wastes produced from Project activities on site will be transferred to designated temporary storage areas and where possible into secure containers;
- Solid wastes will be segregated to facilitate reuse and recycling of specific materials;
- All wastes that cannot be reused or recycled will be collected by approved waste contractors and transferred to an appropriately licensed waste management facility for treatment and disposal;

- A network of simple groundwater monitoring wells should be installed across the site including the tank farm and dispending areas. These wells should be located where they can be used to determine the potential for contaminants to migrate onto or off of the site, i.e.by installing these close to the site boundaries, and where they can facilitate in the identification of potential unknown releases of product from tanks or piping, i.e.by installing these adjacent to the tanks/piping. Wells adjacent to tanks should be located outside of but as close as possible to bund walls. However the installation of wells prior to construction is not advised given the propensity for wells to be destroyed by heavy construction equipment.

Residual impacts

Should the recommended mitigation measures listed above be implemented, the residual impact significance from the construction and operational phases will be reduced to from Moderate to Minor.

6.3.5 Non-normal operations

Seismic issues are addressed in detail in as a part of the engineering design of the facility. In the event of a serious earthquake or industrial accident, the loss of integrity of the fuel storage tanks would result in significant contamination issues and would be considered a significant adverse impact.

6.3.6 De-commissioning Impacts and Mitigation and Residual Impacts

On decommissioning the site will be cleaned of all contaminants and returned as closely as possible to its original baseline condition, in accordance with applicable legislation in operation at the time. Impacts associated with decommissioning are considered to be moderate beneficial if such an approach is implemented.

6.3.7 Summary

Impacts of construction are considered to be of moderate adverse significance given the nature of the area and the local groundwater resources. Impacts during normal operation are also considered to be only of minor adverse significance, although impacts arising as a result of loss of integrity of the fuel tanks would be considered a major adverse impact. However should the proposed mitigation measures be implemented the impact significance from the construction and operational phases will be reduced to Minor.

6.4 Water Resources

6.4.1 Introduction

Containment and treatment of contaminated water and spills will be required to avoid significant adverse impact on water resources, including groundwater and the seawater as well as health and safety hazards to site employees and other people in the affected zone.

Spill of material, spill management plans and hazard identification are addressed in **Chapter 8**, and will not be discussed further in this section.

This section covers current surface water resources, existing drainage infrastructure on site, impacts of site preparation and construction, site drainage, water demand requirements, sewerage and waste water generation during operation.

Water use on site will be limited to domestic use as no processing on the site will take place that will require the use of water.

6.4.2 Assessment Methodology

Baseline information and potential project-related impacts regarding surface water resources and drainage have been assessed and complied through a desk-based review of information currently available on the site and the design of the facility. This includes:

- Baseline Conditions for surface drainage and watercourses,
- Project impacts on any existing surface drainage features and watercourses,
- Potential impacts of operations on surface drainage

6.4.3 Construction Impacts, Mitigation and residual Impacts

Potential Impacts

During the construction programme, the primary potential source of contamination that could pollute surface water drainage is spills of oils, fuels and / or other hazardous chemicals. Such spills, if not properly contained and cleaned-up may also impact groundwater resources. During the construction programme, KODAP will implement an Erosion and Sediment Control Plan that will reduce the potential for adverse impacts to water quality associated with mobilised sediments and wind blown dust.

A **Fuels and Hazardous Materials Control Plan** will be prepared and implemented which will include control measures to prevent the potential for an uncontrolled release of hydrocarbons or other hazardous chemicals into the environment. A Construction Emergency Response Plan will detail the responsible person for managing spill response and clean-up equipment. With these in place, residual impacts on surface and groundwater resources are expected to be low.

Once operational, the fuel farm will be equipped with a storm water system that will collect surface water run-off. Surface water runoff and stormwater will be subject to a high level of treatment (oil interceptors and retention pond) before being discharged to the Vasilikos River and furthermore to the Vasilikos bay. Discharges from the fuel farm and from the car park will be regularly sampled and analysed for particulates, metals, hydrocarbons and potentially, salts and nutrients. With these control measures in place, residual impacts to surface water resulting from contamination of surface water run-off from the tank farm are considered to be low.

During fuel farm operations, groundwater resources are, as per the construction programme, at risk from contamination in the event of a spill or should existing contamination be mobilised as a result of future ground disturbance. These risks will be minimised through the development and implementation of KODAP Tank Farm operations Fuel and Hazardous Materials Management Plan, the Emergency Response Plan and the Contaminated Land Control Plan. With these control measures in place, residual impacts to groundwater resulting from contamination are considered to be low.

The discharge of any effluents during construction, including site drainage, will be the responsibility of the Contractor who should reach agreement with the relevant Ministry with regard to the detailed methods of disposal. Standard good working practices such as the mitigation measures discussed below should ensure that any impacts due to the water discharging from the site would be insignificant.

Construction activities may cause changes to surface water drainage due to the creation of soil piles. Any runoff may have a high suspended solids content and may require further treatment. The Contractor should be required to protect the lakes in the vicinity of the site from potential contamination during the construction phase.

Mitigation

Mitigation measures during construction may include, as appropriate:

- Oil storage tanks should be located on an impervious base provided with a dyke to give a containment capacity of at least 110 per cent of the tank volume. All valves and couplings to be located within the bunded area.

- Any surface water contaminated by hydrocarbons which are used during the construction phase should be passed through oil/grit interceptor(s) prior to discharge.

- Measures should be taken to ensure that no leachate or any surface water that has the potential to be contaminated, is allowed to enter directly or indirectly any water course, underground strata or adjoining land.

- Water inflows to excavated areas should be minimised by the use of lining materials, good housekeeping techniques and by the control of drainage and construction materials in order to prevent the contamination of ground water. Site personnel should be made aware of the potential impact on ground and surface water associated with certain aspects of the construction works to further reduce the incidence of accidental impacts.

- Refuelling of construction vehicles and equipment should be restricted to a designated area with properly designed fuel tanks and bunds and proper operating procedures.

- All channels permanent and temporary, and any temporary evaporation ponds utilised in site drainage should be maintained to prevent flooding and overflowing, and protected where necessary against erosion.

- All temporary hard/compacted areas and exposed surfaces or storage areas should be designed to discharge to evaporation ponds. They should not discharge to natural watercourses, or be allowed to flow off site in an uncontrolled manner.

Chemical Contamination

- Fuel/oil tanks and chemical storage tanks/areas on all lands utilised by the contractor should be provided with locks and be placed on compacted areas, within bunds that have a capacity equal to 110 percent of the storage capacity of the largest tank, to prevent spilled fuel oils from leaking off site.

- Oil interceptors should be provided in any drainage system downstream of possible oil/fuel pollution sources. The oil interceptors should be emptied and cleaned regularly to prevent the release of oils and grease into the stormwater drainage system. Waste materials should be taken to an approved disposal site.

Sewage

- Portable chemical toilets and sewage holding tanks should be placed on site to accommodate sewage generated by the construction workforce. A licensed contractor should provide appropriate and adequate portable toilets and should be responsible for appropriate disposal and maintenance.

Spills

- Ensure that handling and storage of any potentially contaminating material takes place only in designated areas designed to ensure that there can be no direct discharge to watercourses, the drainage system, or off the site.

- Ensure that no washdown areas are located adjacent to any watercourse, or open drain and ensure in so far as practicable, that washdown waters are collected and directed to an evaporation pond.

- Ensure that a spill management plan is in place at all sites.

6.4.4 Operational Impacts, Mitigation and residual Impacts

Water resource consumption on site will be made up of potable water supply, service water supply and provision of water for fire fighting.

Drainage of the site will entail sanitary sewers, clean water systems, oily water system, fuel spill collection, and laboratory chemical waste.

These are outlined below in further detail.

Potable Water

Water required for domestic use will be taken from the potable water supply to the site. Potable water will be sourced from the main public water supply via an existing line. The supply will be metered at this point. It is understood that the water requires no further chlorination or treatment.

Potable water will pass to a potable water tank, which will act as a buffer tank between the public supply and the terminal's users. The tank will have a working storage capacity of 35 m^3, equivalent to 1 day supply at anticipated consumption levels.

Potable water will be supplied to header tanks in various buildings within the terminal for the provision of drinking water and sanitary facilities. Potable water will also be supplied to safety showers and eyewash stations throughout the terminal. The system storage tank will be sized on the basis of 40 persons being engaged at the site, each with a usage allowance of 400 litres per person per day.

For the terminal the calculated daily potable water demand is 16 m^3/day, giving an average rate of 2 m^3/h. The expected peak demand is calculated as two thirds of the daily demand over a two hour period, plus a 20% margin. This gives a peak rate of 6 m^3/h (based upon expected distribution of personnel and usage of showers, toilets etc.). This allows for some topping up of header tanks coincident with the use of a Safety Shower. Potable water pumps will be provided to distribute potable water to the various users around the terminal. Consumption of potable water will be monitored by tank level measurement.

Service Water

The terminal service water will be sourced from the potable water supply. Service water will be supplied to Utility Stations throughout the terminal for washing and flushing during maintenance.

Service water will pass firstly to a service water tank. This tank will have a nominal capacity of 2,000 m^3 , providing enough water to flush the firewater headers after testing of some of the large deluge system in the event of a fire.

Service water pumps are provided to distribute service water around the terminal.

Fire Water System

The fuel farm facilities will be provided with a hybrid firewater system, supplied with seawater and fire retardant foam (**Section 3.10**).

Sanitary Sewer

Sanitary waste from buildings will be routed to a septic tank. When it will be full, the septic tank will be evacuated by a licensed company.

Surface Drainage

Three pipeline grids will be constructed under the ground of the fuel farm site that will collect and transfer the water streams that will be formed due to the rainwater flow and the aqueous mixtures that will emerge in cases of fluid substances spills. Details are given in **Chapter 3**.

The drainage pipeline grid will be installed along the internal road paths and it will lead the water quantities to a retention tank that will be constructed in the fuel farm site. The outlet of the retention tank ends up to the area adjacent to the fuel farm, near the Vasilikos River.

The sewage pipeline has two branches that end up to a common pipe through which the sewage will be forwarded to the hydraulic network where all the sewage sources will be collected for further processing.

The clean water system will collect water that is known to be free of any contaminants such as grease, oil, petroleum products or chemicals. Such sources as:

- Surface water draining off uncontaminated hardstand areas, i.e. roads and buildings.

- Overflows from any of the water tanks.

Rain water will be routed to the drainage pond that will be also used as regulator of the water flow rate at the oil interceptors. Water from the common oil product storage area will be routed to the oil interceptors. Any oil contamination will be skimmed of and directed to the coalescence separator (**Section 3.11**).

Oily Water System

An oily wastewater drainage system will drain all areas where oil spillages could occur. The design will incorporate one oil interceptor and traps. This will discharge with the other surface water discharge to the storm water drains. The discharge from the oil interceptor will contain no visible oil or grease (i.e. less than 10 ppm, approx. 5 ppm).

Water that is, or can be, contaminated with oil will be kept separate from the clean water system. This water is collected from:

- Fuel tanks retention area;
- Maintenance workshop;
- Pump station;
- Parking lots;

Oily water will be collected in several local sumps and the contents will be sent to the oil separator. Once the oily product has been removed, the remaining water will be sent to the septic tank, after quality checks have been carried out.

Fuel Product Spill Collection

The oil product storage area is designed with bunded areas provided for all the tanks. Any spill will flow by gravity into spillage collection gulley to a sump and the bunds are sized to accommodate 110% of the largest tank.

Depending on the size of the spill and on potential contamination, the product will either be pumped back into the tank or sent to the coalescence separator. In case of a major spill oily water will be diverted to drainage pond.

Laboratory Chemical Waste

Laboratory chemicals and waste will be collected in a dedicated sump and periodically emptied in a vacuum truck. The anticipated sump capacity is nominally 2 m^3.

Mitigation

It is not anticipated that the site will generate any continuous process wastewater. Principal wastewater discharges will be from drainage and surface water runoff. To reduce the possibility of contamination of surface waters and consequences, mitigation measures will be required.

The Environment Department of the Ministry of Agriculture, Natural Resources and the Environment will set limits on the quality of water that is discharged from the site under the permit issued in accordance with the IPPC Directive.

All aqueous process effluents will be discharged to sewer and will be in accordance with Environment Department limits.

The use of oil interceptors on all areas susceptible to oil spillage prevents the release of visible oil. The effluent from the oil interceptors will be monitored for oil in water content, which will be limited to below 10 ppm (approx. 5 ppm).

All oil and chemical storage tanks and areas where drums are stored will be surrounded by an impermeable bund. Single tanks will be within bunds sized to contain 110 per cent of capacity and multiple tanks or drums will be within bunds sized to contain 110 per cent of the capacity of the largest tank. Permanently fixed taps, filler pipes, pumping equipment, vents and sight glasses will also be located within the bunded area. Taps and valves will be designed to discharge downwards and will be shut and locked in that position.

The surface water drainage system will drain areas of the site unlikely to be contaminated with oil and discharge the water to the nearby storm water drain. The majority of the surface water drainage will be uncontaminated and typical of surface water run off from areas of paved road.

An oily wastewater drainage system will drain all areas where oil spillages could occur. The design will incorporate oil interceptors and traps. These will discharge with the other surface water discharge to the storm water drain. The discharge from each oil interceptor will contain no visible oil or grease (i.e. less than 10 ppm - approx. 5 ppm).

The areas liable to oil spillage are:

- the oil unloading and loading area ;
- the bunded areas around the storage tanks, and
- the car parking areas.

Adequate facilities for the inspection and maintenance of oil interceptors will be provided and the interceptors will be regularly emptied and desludged to ensure efficient operation. The sludge will be disposed of off-site by a qualified contractor.

All elements of the treatment systems will be regularly monitored to ensure optimum performance and maintenance.

Discharges

Any potentially contaminated water streams should be segregated from non- contaminated water streams. The site should operate and maintain best possible housekeeping practices for the facilities. Spill prevention and control plans should be developed and maintained at all times.

6.4.5 De-commissioning Impacts, Mitigation and residual Impacts

Decommissioning of the fuel farm will have a minor impact on surface drainage, as there are no terrestrial drainage features to be affected.

Drainage for decommissioning will need to be addressed with an approach similar to that of the construction management to ensure surface drainage does not discharge contaminants into the receiving environment.

Site clearance will have to be undertaken to ensure all liquid and hazardous waste are removed from the site. Any liquid or hazardous material or equipment will need to be covered to ensure they are not exposed to rainfall and cause sedimentation of the receiving environment.

Any stockpiles of soil, spoil or other loose material need to also be covered to ensure they are not exposed to rainfall.

The site, once cleared will need to be graded appropriately to allow the site to drain to the Vasilikos river. It is likely that surface water will need to be collected into a stabilised channel and discharge into a detention pond to allow any sediment to settle out before this water is discharged into the lake environment.

The retention settling pond and channel should be maintained to ensure that they continue to achieve their function.

6.4.6 Summary

There is little to no surface water features that will be lost or affected by this project, and as such, there is no significant aquatic ecology under threat.

Construction and development of the project will need to be subject to standard management practices to avoid and reduce any impacts of construction on the receiving environment.

Drainage of the operational site has been undertaken to ensure that ‘normal’ drainage and ‘non-normal’ drainage (i.e. spills, fire fighting waters) are collected and are subject to primary treatment prior to discharge to the receiving environment.

Water resource consumption, waste water effluent/ waste water generation will be limited on the site due to the small work force and the absence of water- utilising processes on the site and thus impacts should be minor.

6.5 Landscape and Visual

6.5.1 Introduction

This section assesses the existing landscape setting for the proposed fuel farm together with potential impacts to landscape form, character and visual amenity that may result from the proposed development.

6.5.2 Assessment Methodology

The assessment has been undertaken in consideration of the site's sensitivity, the magnitude and significance to the proposed development in the light of landscape and visual effect over an immediate radius of 5 km. The criteria against which these individual components have been measured are set out in the relevant paragraphs.

It should, however, be borne in mind that any assessment of landscape and visual amenity can, by its very nature, only be subjective as it relies on an individual's sensitivity and perception of the landscape together with their personal attitude towards change and the level of magnitude of that change.

The assessment covers the following conditions:

- Landscape character;
- Scenic attractiveness of the area;
- Concern levels which will outline the degree of public importance placed on the landscape as viewed from transit points and fixed view points;
- Landscape visibility; and
- Scenic quality.

As part of the constructional and operational phases, the cumulative effects of the works has been assessed in conjunction with other projects in the area, such as the Vasilikos Cement Works facilities. Any impacts that are identified have been assessed for their significance and appropriate mitigation will be proposed.

6.5.3 Construction Impacts and Mitigation and Residual Impacts

Landscape Character

Whilst there will be some loss of greenfield land, much of the proposed facility will be constructed on land, which has already been cleared. Given the size of the land take, the characteristics of the wide area (industrial area) and the value of the landscape, the impact on the landscape is considered low.

Visual Amenity

The proposed site will have the appearance of a typical construction site and therefore the following activities are anticipated to impact on local visual amenity:

- presence of exposed un-vegetated earthworks;
- use of construction plant, mobile cranes, site vehicles, other construction equipment and cleared/disused land;
- temporary road and path diversions and changes in traffic flows;
- on site lighting;
- marine impacts due to the physical presence of vessels required to install offshore facilities and pipelines.

Although this activity may be visible from outside the site, particularly in the immediate vicinity, the significance of any impacts will be reduced as the activities will be viewed against the backdrop of the existing structures on site (Vasilikos Cement Works)

Mitigation measures to be adopted during construction to minimise impacts should include the following:

- works design to avoid unnecessary land take and earth removal;
- control of night time construction lighting;
- maintenance of tidy and contained site compounds; and
- spreading of topsoil, reseeding and planting as soon as possible after sections of work are complete.

On implementation of these mitigation measures, it is considered that the overall visual impact of the proposed construction works will be a moderate adverse impact.

6.5.4 Operational Impacts and Mitigation and Residual Impacts

Landscape Character

The new facility will operate within the Vasilikos industrial area, and therefore the overall impacts of operation on landscape are considered to be low.

Visual Amenity

The proposed development will give rise to changes in the views of the site as a result of the introduction of new infrastructure, transport and people movements together with lighting, both onshore and offshore.

The proposed layout and dimensions of the fuel farm proposed facilities is discussed in **Section 3 - Project Description**. In particular, there are four elements of the proposed facility that could potentially have significant visual impacts, namely the storage tank(s), the pump stations, the buildings and the parking area.

For a major facility as is the case with the proposed fuel farm, with its paramount need for safety and security, there are few mitigation measures which should ameliorate visual impacts, which are considered to be moderate adverse.

A limited amount of landscaping should be undertaken which should partially filter views as trees grow and thus the visual impact would be most noticeable immediately after construction, before reseeding or replanting matures and takes effect (especially along the ground dyke).

The size of the fuel tanks imposes the need of constructing visual obstacles that will screen as much as possible the facilities. Also, the high ground dyke both at east and west, will screen a significant part of the facilities mainly from the side of them that will be visible by local residents and the visitors of the area. Similarly, the major infrastructure at the site, the tanks, are required to be painted white to minimise thermal input into the tanks causing air emissions.

Night time lighting of the plant will mean that there will also be an element of limited light pollution since the ground dyke will form an adequate light obstacle toward the local road network. This is considered to be a (due mainly to the construction of the dyke) minor impact.

6.5.5 Decommissioning Impacts and Mitigation and Residual Impacts

It would be expected that at the end of the facility's useful life it will be decommissioned and demolished with all site structures removed. However after the completion of this process the landscape character will still be affected as the terraced and level site will not fit in with the rolling character of the natural landscape.

6.5.6 Summary

Overall the magnitude of the landscape character and visual amenity impacts are considered to be low at that whilst the landscape will be subject to moderate changes due to the presence and size of the facility, these impacts will be moderated as the landscape is already degraded by other existing industrial premises in the area and as the area is well screened by natural topography.

6.6 Terrestrial Ecology

6.6.1 Introduction

This section assesses the potential impacts that would arise as a result of the proposed development.

As the general area is heavily industrialised, the potential for endangered or protected habitats is generally considered low.

6.6.2 Assessment Methodology

This study is primarily desk-based, although a preliminary walkover of the site to ground-truth the previous survey findings and to identify the need for any further studies as part of the project FEED studies.

The study area for the assessment has included the site itself and a radius of 2 km around the site from the east to west coast.

The site walkover was undertaken to confirm the outcome from the desk study and to identify any additional flora and fauna species. This was completed in two half-day visits in September 2016.

It should be noted that the data search for baseline conditions could only provide information on habitats and species already recorded and cannot be taken to represent a complete overview of all species present in the study area.

Since the site was only visited on two half-days, seasonal variations have not been observed and only a selection of all species that potentially occur within the site will have been noted. Therefore, the site visit observations simply provide a general assessment of potential nature conservation value and some species will not have been noted.

The criteria used to assess the relative significance of ecological impacts are outlined in **Table 6.13** below.

Table 6.13: Assessment Criteria for the Magnitude of Ecological Impacts

Impact Level	Definition
No Impact / Negligible	There is no change in the flora and fauna of the study area from the baseline
Low Negative	Affects a specific group of localised individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself.
Moderate Negative	Affects a portion of a population and may bring about a change in abundance and / or distribution over one or more generation, but does not threaten the integrity of that population or any population dependent on it. Moderate Impacts to the same resource multiplied over a wide area would be regarded as a Major Impact. A short-term effect upon the well being of resource users may also constitute a moderate impact
Major Negative	Affects an entire population or species in sufficient magnitude to cause a decline in abundance and / or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) would not return that population or species, or any population or species dependent upon it, to its former level within several generations. A major impact may also affect a subsistence or commercial resource use to the degree that the well being of the user is affected over a long term. In the case of fish an impact over one season/generation would be significant.
Positive	An overall net ecological gain is experienced

6.6.3 Construction Impacts and Mitigation and Residual Impacts

Potential Impacts

Impacts to flora and fauna from the project will occur principally during the construction stage. This includes the potential for direct and indirect impacts on habitat, flora and fauna through:

- Direct loss of habitat due to construction of the new infrastructure;
- Direct fatality of faunal species due to collisions with moving vehicles;
- Indirect disturbance due to increased noise and dust levels and anthropogenic activity in the construction site area;
- Habitat degradation as a result of creation of wind blown dust; and increased soil erosion resulting in increased sediment loading of the nearby seawaters; and
- Increased light, noise and movement, which will negatively impact upon local faunal populations.

Dust accumulating on leaves and stems of plants will reduce their ability to photosynthesise and grow. As the flora found on the site is suited to hot semi-arid conditions with high levels dust, they are fairly tolerant to natural levels of dust.

However there is the danger, that with increased levels of dust occurring during the construction phase, there could be a negative impact on the local flora, however this impact is difficult to quantify. Minimisation of dust levels during terminal construction will be addressed through the provisions of the Air Quality section.

Despite the high probability of such impacts, given the low ecological sensitivity of the site, the overall ecological impacts on habitats, flora and fauna are considered to be of only low or negligible negative significance if mitigation and monitoring outlined below is adhered to.

It is considered that there will be no impacts on protected species as these have not been found in the area to be impacted on by the proposed projects or supporting facilities.

Mitigation Measures

A Construction Habitat Protection Plan should be developed and implemented prior to the ground disturbance for the construction programme. This should include provisions to be implemented by the Construction Programme HSE Officer, for the following:

- An additional pre-construction site walkover by an experienced ecological consultant to confirm that no species of conservation importance would be affected by the works. Should any such species be identified, a translocation programme should be put in place for those species considered to be most sensitive to disruption, and that may not be able to move off the construction site easily;

- All vegetation clearance should be undertaken with due care and attention to the species that may potentially be using the habitat. Should any nesting birds be located, either the Department of Game Reserves or Bird Life Cyprus should be contacted immediately to ensure that appropriate action is taken to ensure legislative compliance and to avoid any negative impact on breeding birds.

In addition, the following mitigation measures should be undertaken:

- The boundary of the plant site should be clearly defined before construction begins to avoid damage to vegetation adjacent to the site;

- All site preparation activities should take place within marked areas, and no construction work should be allowed outside these designated areas;
- Temporarily disturbed areas within the construction site should be re-vegetated;
- Traffic should be kept solely to the construction site and access roads;
- Dust prevention measures should be taken to reduce dust emissions from the movement of vehicles, if required;
- Temporary drainage facilities should be constructed immediately following site clearance; and
- Areas of natural vegetation within the complex should be retained where possible.

Once construction has commenced, the Construction Programme HSE Officer should undertake regular site inspections with the aim of not only verifying the integrity and effectiveness of the mitigation but also to record any fauna fatalities within the construction site (location, species, likely cause of death) affecting larger mammals, birds or reptiles.

6.6.4 Operational Impacts and Mitigation and Residual Impacts

Potential Impacts

Impacts arising during the operation phase of the facility are likely to be restricted to road casualties and impacts to flora as a result of changes to air quality. Both are likely to be low in magnitude, and hence the significance of such impacts is considered low.

Mitigation Measures

As a part of the operators EMS the contractor should develop procedures to brief new staff as a part of the site induction package about the location of important flora and fauna, and the importance of reducing the potential for road casualties.

6.6.5 Decommissioning Impacts and Mitigation and Residual Impacts

Only the generic activities associated with de-commissioning of the OSRD have been identified at this stage. The actual procedures should reflect industry best practices and Cypriot regulations in place at the time of de-commissioning.

Nevertheless, it is recognised that in de-commissioning phase significant amounts of solid and liquid wastes as well as air emissions will result. In the short term, during the de-commissioning work itself, the impacts are likely to be very similar to those experienced during the construction period. In the long term, the environment will be expected to fully recover, and therefore the mitigation measures put in place during the de-commissioning activities should focus on ensuring this long term recovery at the site.

6.6.6 Summary

As set out above, any construction/operation impacts on biological resources from the OSRD are considered to be low given the magnitude of the impacts (low), and the low sensitivity of the flora and fauna.

6.7 Noise and Vibration

6.7.1 Introduction

This section aims to identify and assess the impact of noise and vibration due to the construction and operation of the proposed fuel farm.

A prediction of the impact during construction is undertaken following the methodology of BS 5228, and information regarding the noise output of specific items of plant contained therein. The noise and vibration impacts during operation are predicted using a computer noise model, using typical values for the proposed tank farm items, and considering directional and screening effects.

This section considers the cumulative impact of the proposed fuel farm, the existing Vasilikos Cement Work and the nearby developments (Vasilikos port etc), against background noise levels at local noise sensitive receptors (NSR) and recommends mitigation options to control construction and operational impacts.

Background levels at selected NSR were established in a number of previous studies, including:

- *Globetech Labs* survey in 2010, during the Environmental Impact *Assessment Study of VTTV Marine Jetty at Vasilikos area;*
- *Globetech Labs survey in 2012 during the Environmental Impact Assessment Study for land reclamation, construction and operation of VTTV Phase III Terminal at lower Vasilikos Area.*

The measurement locations (ML) for previous baseline surveys, were agreed with the Local Authority as being representative of the local residential, commercial and industrial areas. The measurement locations are shown in **Figure 6.5**, and described below:

Figure 6.5: Background noise measurement locations

Table 6.14: Vasilikos area – mean average values

	Location	Noise Measurement (dB)	Remarks
1	Seafront west of port	52.8	
2	Seafront east of port	54.6	
3	Mari village	50.2	
4	Port – main entrance	62.6	Heavy tracks passing
5	Archirodon installations	52.6	
6	BEMRS area	50.1	

6.7.2 Legislative Guidance

A review of available local legislation has taken place, and concludes that there is none available that could suitably be applied to assess the level and significance of the noise impact of the proposed scheme. Hence the following legislative guidance is adopted for use in this assessment:

- BS 4142:1997 'Method for rating industrial noise affecting mixed residential and industrial areas,' BSI
- BS 7445: 1991 'Description and Measurement of Environmental Noise' Parts 1 to 3, BSI
- BS 5228: 1997 'Noise and vibration control on construction and open sites' Parts 1 to 4, BSI

BS 4142 'Method for rating industrial noise affecting mixed residential and industrial areas' offers guidance on the assessment of industrial and commercial noise affecting residential and industrial areas. It describes a method for assessing whether industrial noise is likely to result in complaints from nearby residents.

BS7445 'Description and Measurement of Environmental Noise' defines and prescribes best practice during recording and reporting of environmental noise. It is inherently applied in all instances when making environmental noise measurements.

BS 5228 'Noise and vibration control on construction and open sites' gives recommendations for basic methods of noise and vibration control relating to construction sites and other open sites where construction activities are carried out. It offers a methodology for predicting noise levels from construction sites.

6.7.3 Assessment Methodology

The following publications provide an indication as to acceptable environmental noise limits, and are summarised to give an indication of the criterion recommended by international bodies, which can be applied as appropriate significance criteria in this case.

In the 'Pollution Prevention and Abatement Handbook' issued by the World Bank Group in July 1998, noise limits for new installations financed by the World Bank are set out, which are summarised below. Additionally, it is stated in the handbook that an increase of up to 3 dB above the existing background levels outside the project property boundary is considered acceptable.

Table 6.15: World Bank Limits

Receptor	Maximum L_{Aeq}, dB	
	Day time	Night time
Residential, Institutional, Educational	55	45
Industrial, Commercial	70	70

In the World Health Organisation document 'Guidelines for Community Noise', guideline limit values for community noise in various specific environments are provided. Noise levels below the limits are considered necessary to minimize any temporary or long-term deterioration in physical, psychological or social functioning associated with noise exposure. The values form the basis of many international environmental noise policy limits and are summarised below.

Table 6.16: World Health Organisation Limits

Specific Environment	**Critical Health Effects**	**Maximum LAeq, dB**
Outdoor living Area (daytime + evening)	Moderate Annoyance	60
Inside bedrooms	Sleep disturbance	30
Outside bedrooms, window open	Sleep disturbance	45
Industrial, commercial	Hearing impairment	70

The maximum external night time level of 45 dB(A) is considered when assessing the significance of the predicted operational noise below.

BS 4142 provides a methodology for the assessment of industrial noise in mixed residential and industrial areas. In this case, the standard suggests obtaining an assessment level by comparing the existing background noise levels with the 'rating level', which is the predicted noise output of the proposed tank farm, corrected to account for any acoustic features such as tonal or impulsive noises. The semantics used for assessing the likelihood of complaints due to the introduction of a new industrial noise source are as follows:

- When subtracting the background level from the rating level, the greater the difference, the greater the likelihood of complaints.
- A difference of around +10 dB or more indicates that complaints are likely.
- A difference of around +5 dB is of marginal significance.

- If the rating level is more than 10 dB below the measured background noise level then this is a positive indication that complaints are unlikely.

With regard to the change in noise levels cased by increases in traffic flow, a change of 3 dB is the minimum perceptible change under normal conditions. This would arise from a doubling in traffic flow. It is generally accepted that such a change would not be perceptible, particularly if the change occurs over a long period of time. An increase in traffic flow of up to 25% will produce a 1 dB increase in noise levels, which is negligible and will produce no impact.

6.7.4 Construction Impacts, Mitigation and Residual Impacts

Construction Noise

Construction activity inevitably leads to temporary noise generation at locations in close proximity to the construction activities. However, due to the typical distances between the proposed site and the nearest receptors, and significant acoustic screening in all directions, the impact of construction activity on residents and tourists will be minimal.

Construction noise predictions can be made based on the methodology outlined in BS 5228: 1997 'Noise and vibration control on construction and open sites.

Construction noise levels are predicted as a 'free field' equivalent continuous noise level averaged over a one-hour period (LAeq,1h), and then subsequently averaged over a 12-hour working day to give the LAeq,12h.

The worst case that is taken into account is the contemporary operation of 9 construction vehicles during the civil construction works.

Table 6.17: Example Sound Pressure Levels Associated with the Fuel Farm Construction Activities

Vehicle type	Number of vehicles	Noise level (dB)[1]
Loader	1	85
Hydraulic excavator	1	87
Motor grader	1	82
Dump trucks	4	78
Road roller	1	80

The estimated sound pressure levels shown in **Figure 6.6** are worst-case estimates based on propagation attenuation only. Noise levels at the boundary of the fuel farm development will not exceed 75 dB. Due to the screening offered by the topography

[1] "Noise and vibration control on construction and open sites, Part 1 ", British Standards 5228, 1997

of the intervening land, these levels would be up to 10 dB lower at the receptor locations, which are above the World Bank limits.

The increase ambient noise levels will be a potential direct negative impact. The impact will affect receptors (people working in the area) beyond the Project site and as such the impact extent is predicted as localised. The duration of the impact will be short-term for the extent of the construction phase. The intensity of the impact will be medium as the change in ambient noise levels will be noticeable due to the frequency of the noise linked to vehicle and construction noise. Given the local extent, short-term duration and the medium intensity, the magnitude of the impact is considered low, as the impact will affect a relatively small number of receptors. With a definite likelihood of the impact occurring, the overall pre-mitigation impact significance is considered Minor.

Table 6.18 below gives a summary of the construction impact on ambient noise levels.

Table 6.18: Construction impact: Noise

Nature: Construction activities would result in a **direct negative** impact on ambient noise levels.

Impact Magnitude – **Low**

- **Extent**: The extent of the impact is **local** as the potential impact will be beyond the Project Site, but only affect the Vasilikos area transport routes.
- **Duration**: The duration would be **short-term** for approximately 12 months.
- **Intensity:** The intensity is likely to be **medium** given that the scale of the construction activities.

Likelihood: There is a **definite** likelihood of increased ambient noise levels.

IMPACT SIGNIFICANCE (PRE-MITIGATION) - MINOR Degree of Confidence: The degree of confidence is high.

Nonetheless, appropriate working practices would be adopted to minimise noise levels where practicable. Suggested mitigation measures for construction are given below.

Construction Vibration

Some construction activities can be a source of ground-borne vibration, which can be a cause for concern at the nearest receptors. Typical activities that would lead to vibration effects include compaction, breaking and piling. During piling activities, the maximum level of vibration expected at a distance of perhaps around 100 m from a drop hammer piling rig could be in the range of 2-3 m.

The impact at the nearest properties from any vibration activities is a function of the vibration source and the propagation path to the receptor; larger distances reduce the impact. Due to the large distances involved, construction vibration will not be discernible at the receptor locations. The impact of construction vibration will therefore be negligible.

Figure 6.6: Noise levels during the construction works

Mitigation Measures

In order to keep construction noise to a minimum, the appointed contractor would employ Best Practicable Means (BPM), examples of which are provided in BS 5228. Noise attenuation measures and hours of working should be agreed in advance with the Environmental Service (Ministry of Agriculture, Natural Resources and Environment).

The following mitigation measures may be employed to reduce construction noise:

- Clear lines of communication should be developed between the project team, contractors and any affected premises close to the site so that any complaints can be dealt with and warnings can be given of the likely occurrence and duration of particularly noisy events.
- In order to control the impact of construction noise to residential receptors, work should be carried out during the daytime only, where possible. If night working is required, the contractor should inform and agree the works in advance with the relevant local authority, and provide nearby residents with a point of contact during the night, for any queries or complaints.
- All vehicles and mechanical plant used for construction should be fitted with effective exhaust silencers, and regularly maintained.
- Inherently quiet plant should be used where appropriate. All major compressors should be sound-reduced models fitted with properly lined and sealed acoustic covers which should be kept closed whenever the machines are in use, and all ancillary pneumatic percussive tools should be fitted with mufflers or silencers of the type recommended by the manufacturers. This is particularly important for plant required to run 24 hours a day.
- All ancillary plant such as generators, compressors and pumps should be positioned so as to cause minimum noise disturbance. If necessary, temporary acoustic barriers or enclosures should be provided.

6.7.5 Operational Impacts, Mitigation and Residual Impacts

During the operation of the tank farm noise disturbance will be caused mainly due to the operation of hydraulic devices (various types of fuel pumps). The worst case that is taken into account is the contemporary operation of the listed devices during the typical operation of the OSRD installations. The pieces of equipment that were taken into account are the following:

Type of equipment	Number	Sound Power per unit dB(A)	Sound Pressure at 1m dB(A)
Fire fighting pump	2	110	85
Diesel pump (near tanks)	4	100	85
Service pump	1		80
Motor operated valve	6		75

Two scenarios were examined:

- Operation of the pumps during product storage in the storage tanks;
- Operation of the fire fighting pumps during fire fighting drills

Computer based prediction model

To predict the environmental noise contribution from the proposed fuel farm, a computer-based noise model has been created which incorporates the procedure set out in ISO 9613 Parts 1 & 2 'Acoustics - Attenuation of sound during propagation outdoors', and can provide an accurate visual representation of calculated noise levels.

To ensure a 'worst case' prediction at the closest to the unit receptors location, the following assumptions have been made:

- 'Down-wind' conditions
- A temperature of 15ºC and a relative humidity of 70%, resulting in low levels of atmospheric attenuation
- Hard reflective ground between the source and receiver

The software also accounts for the following effects:

- Distance propagation
- Directivity effects
- Screening effects due to existing buildings or plant, or other proposed on-site structures
- Ground effects

The model considers normal operational noise. As such, noise due to emergency facilities and other non-normal operation plant items have not been considered.

The estimated sound pressure levels shown in **Figures 6.7** and **6.8** are worst-case estimates based on propagation attenuation only.

Operational Vibration

Sources of vibration on site are minimal. Vibration may be transmitted to the floor from balanced rotating equipment such as pumps; however, the level of induced vibration will not be sufficient to propagate to the nearest sensitive receptors over the distances involved. Hence the impact of operational vibration will not be of significance.

Operational Traffic Noise

No noise impacts are anticipated as a result of the operation of the OSRD, since the depot will operate as a storage facility only.

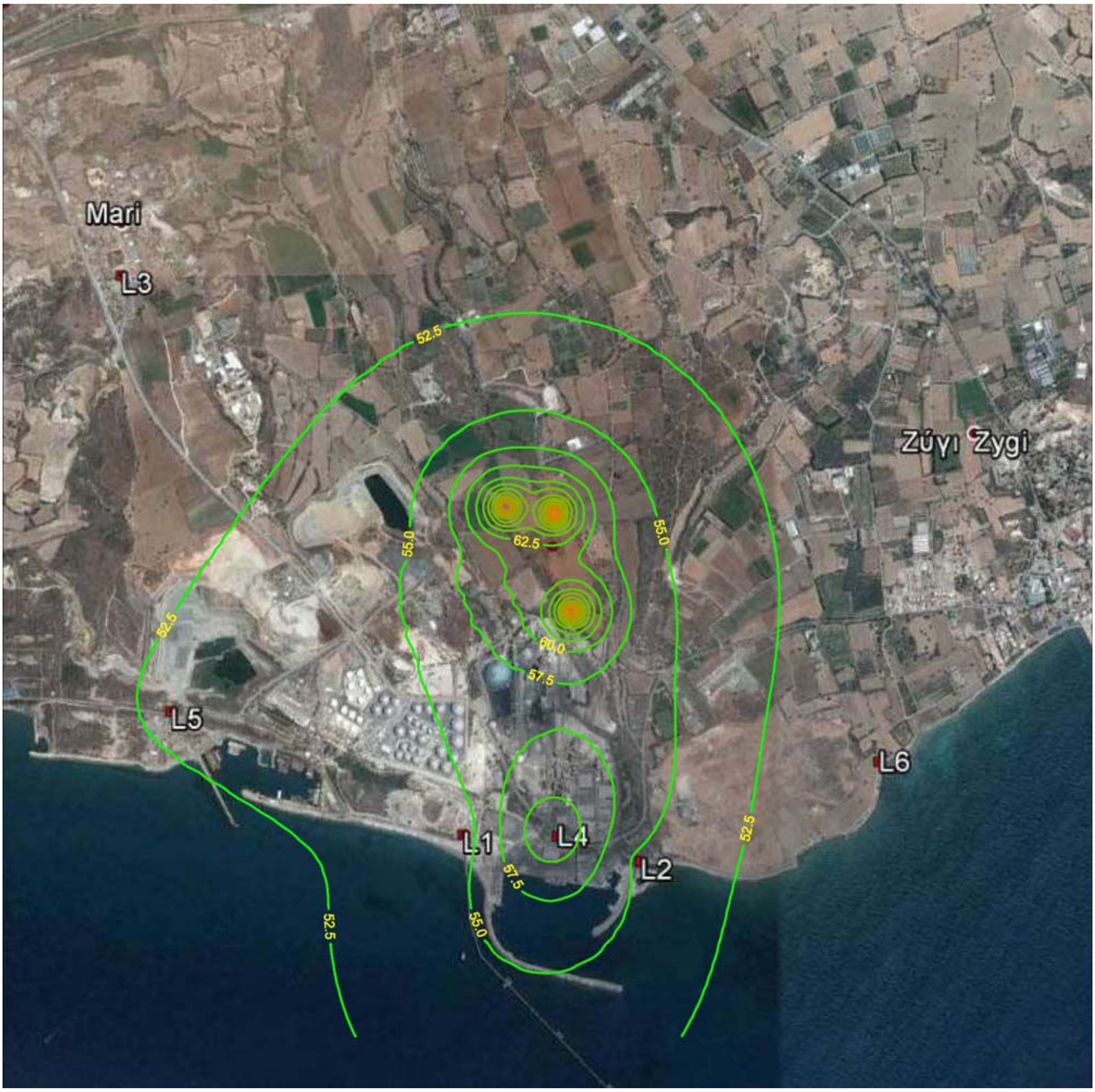

Figure 6.7: Noise levels– Operation phase : product transfer

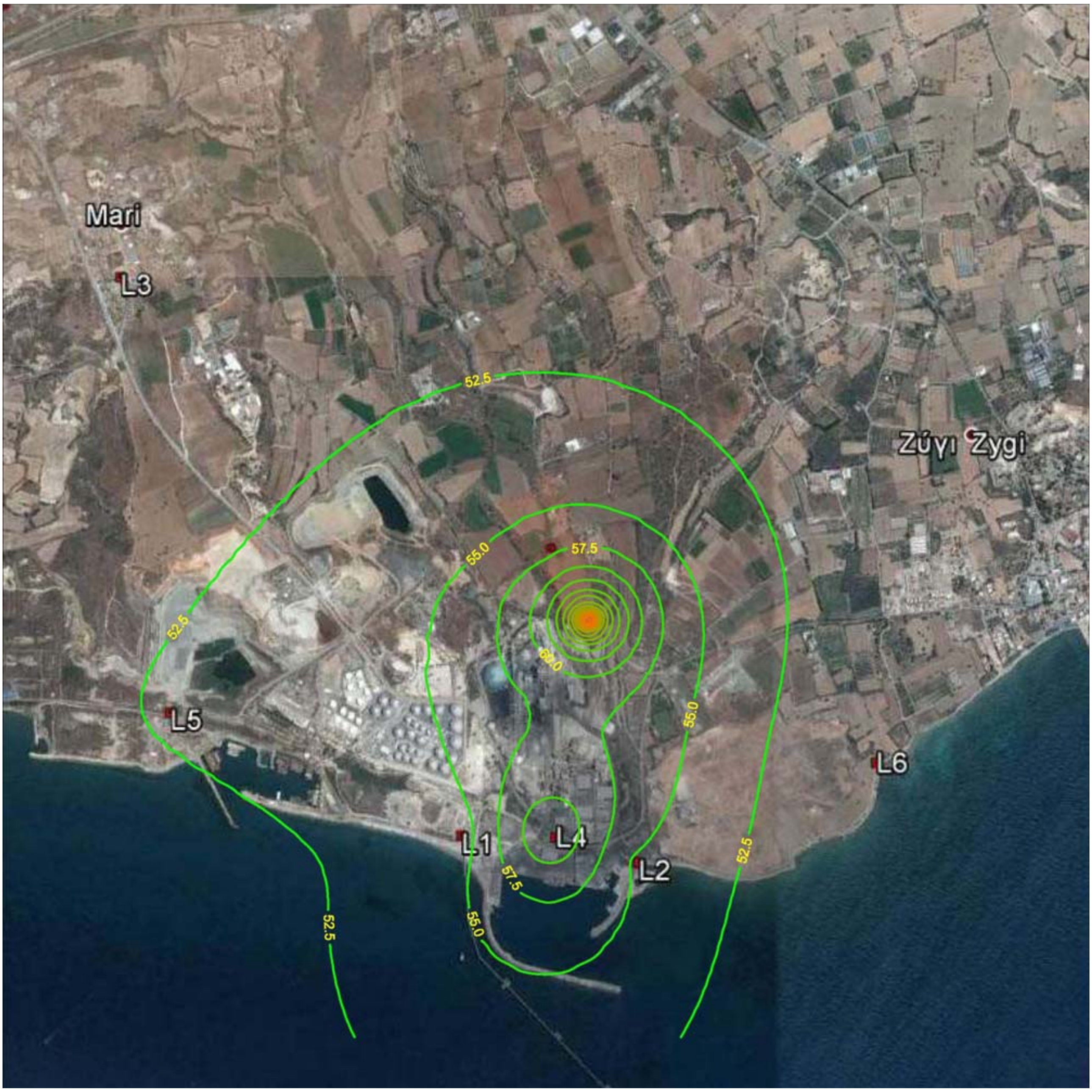

Figure 6.8: Noise levels– Operation phase : fire fighting drills

Mitigation Measures

Whilst planning noise limits have been agreed with the relevant Local Authority at the planning consent stage, plant operators should aim to better these limits and reduce noise emissions as far as possible. The following measures should serve to continually monitor and minimise the impact of noise from the proposed power plant.

A programme of continual noise monitoring, including a noise survey shortly following the commissioning of the new plant, should be agreed if required by the Local Authority. The aim of these surveys should be to ensure that plant noise levels as measured at the agreed NSR locations do not exceed the planning noise limits agreed with the local authority. Noise monitoring should be undertaken in accordance with BS4142.

Inherently quiet plant items should be selected wherever practicable. High performance acoustic enclosures should be considered for all noisy plant items where practicable.

Although emergency generators and other 'normally-off' plant items have not been included in the modelling of normal plant operation, these should be afforded the same level of noise control as all other plant.

In the interest of maintaining neighbourly relations and residential amenity, the operator should give a reasonable period of notice to residents prior to any non-normal operations that would lead to an increase is noise levels. These should be carried out between 0900 and 1700 hours during the weekdays, wherever possible.

When non-normal and emergency operations lead to noise levels in excess of the agreed planning limits, the operator should inform the local authority and residents of the reasons for these operations, and the anticipated emergency period.

6.7.6 Summary

This section of the Environment Statement identifies and assesses the impact of noise and vibration due to the construction and operation of the proposed fuel farm at Vasilikos industrial area. The assessment uses a computer model to calculate the cumulative noise levels due to the fuel farm equipment, fuel truck movements and existing noise levels from Vasilikos area near the new KODAP tank farm.

The assessment of impact has been undertaken at nearby residential receptor locations. The significance of the impact is assessed in accordance with BS 4142, World Bank and World Health Organisation criteria.

Construction noise levels will vary as construction activity changes in nature and location; however the impact of construction noise is not predicted to be of significance, due to the large distances and topographical detail between the proposed site and receptors.

A worst-case assessment of the cumulative operational noise levels of all existing and proposed sources, against pre-existing background noise levels, indicates that there will be no significant noise impact due to the construction works at the proposed fuel farm.

Similarly, it is anticipated that the impacts during the operation of the fuel farm on the adjacent houses of Zygi and Moni communities, during day and night time will be minor (according to fully objective criteria – max. acceptable noise levels at certain sensitive positions of the area) since the structural and technical design of the facilities (i.e. low noise level pumps, restrictions on vehicle movement pattern, ground dyke construction ,etc.) is fully focused on mitigating this specific source of disturbance.

Finally, both constructional and operational vibration will be negligible.

6.8 Traffic

6.8.1 Introduction

The facility will make use of the road based distribution network during each phase of the Project. The impacts from each phase of the project on the road network, and in are discussed in the following sections.

6.8.2 Construction Impacts, Mitigation and residual Impacts

During the construction phase of the facility there will be an increase in vehicle movement to and from the site. This has the potential to impact on traffic, and at the key intersections. An increase is traffic flow is related to the transportation of construction workers to and from the site, as well as the delivery of construction material and equipment into the area.

The increase in traffic could create noise, dust and safety impacts for other road users and people working within close proximity to the roads on the selected transport route. In addition, the increased volume of traffic along the transport route will increase the wear and tear on these roads and possibly lead to deterioration in road conditions. The construction equipment will be transferred from the Limassol Port. It is expected that these components will be delivered to site via the Limassol – Pafos highway and the secondary road network that will serve the OSRD, however the final route to be taken to transport these components to the facility will be finalized at a later stage. It is also anticipated that there will not be a concrete batching plant on site, therefore, concrete trucks will make multiple, frequent deliveries to the site when the tank and road loading gantry foundations are being laid.

Affected sensitive receptors include road users, business owners and port users. The construction phase of the Project will take place in a phased approach, with the installation of the full Project taking up to one year to complete, with components arriving throughout this period.

The impact on traffic during construction would be direct negative in nature. The extent would be local, as Vasilikos area and key intersections would be affected. The duration would be short-term, lasting the duration of the construction period. The intensity would be medium given the level of increased traffic anticipated for the size of construction required.

Given the local extent, short-term duration and the medium intensity, the magnitude of the impact is considered Low. The impact will definitely occur, therefore the overall pre-mitigation impact significance is considered Minor.

Table 6.19 below provides a summary of the construction impact.

Table 6.19: Construction impact: Traffic

Nature: Construction activities that increase traffic would result in a direct negative impact on existing traffic volumes and road quality.

Impact Magnitude – Low

- **Extent:** The extent of the impact is local as the potential impact will only affect the Vasilikos area and key intersections.
- **Duration:** The duration would be short-term for the duration of construction activities.
- **Intensity:** The intensity is likely to be medium given that the increases in traffic will temporarily create a nuisance and impact on the safety of other road users.

Likelihood: There is a definite likelihood of increased traffic.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MINOR

Degree of Confidence: The degree of confidence is high.

6.8.3 Operation

No impacts on the traffic are anticipated as a result of the operation of the OSRD, since the depot will operate as a storage facility only.

6.8.4 Mitigation

- A Driver Code of Conduct will be implemented stipulating and governing safe driving behaviour, which will include no use of cell phones whilst driving;
- All vehicles to not exceed the mandated speed limits of 30km/h;
- A Traffic Management Plan will be developed and implemented, with at least the following provisions included:
  - All drivers will be sensitised to potential accident risks;
  - All drivers will be periodically checked for alcohol consumption;
  - All vehicles will be regularly checked and maintained in good condition;

  - Vehicles will be correctly and safely loaded to avoid accidents, and all loads are secured and covered where they pose a risk of windblown dust or material spillage.

- If required, alternative arrangements and routes for abnormal loads will be agreed in advanced with the relevant authorities and the appropriate permits will be obtained for the use of public roads.

6.9 Increased Social Disturbance Factors

6.9.1 Introduction

The Project area is located in a predominantly industrial setting, close the industrial area of Vasilikos and the Vasilikos port. The population density of the immediate area is low and the majority of the surrounding land is used for industrial activities.

The introduction of construction activity into an area can induce social disturbance, dependent on the context and land use of the area. This change is typically linked to the presence of construction workers and machinery and equipment required for construction activities. The presence of workers on a project site can increase levels of crime and place additional pressure on the existing infrastructure and services. However, considering the scale of the construction required, there will be a relatively small workforce on site given the short construction period and the limited number of employment opportunities. KODAP intends to maximise the employment of local people, specifically into unskilled labour positions. Sensitive receptors in the area would be employees of neighbouring commercial enterprises operating in the area. KODAP has limited control over the behaviour of job-seekers, and can only enforce its policies on those employed by the Project.

6.9.2 Construction Impacts, Mitigation and residual Impacts

It is estimated that there will be approximately 110 - 150 people employed during the height of the construction phase. The construction phase will take up to 12 months, although it is not anticipated that there will be 75-80 construction workers on site for the full duration of the period. It is intended that the majority of unskilled positions will be filled with residents from the local area, thus limiting the influx of construction workers from outside the area. No construction workers will be housed on the site, as such, the potential for adverse impacts caused by workers on the surrounding area will be limited.

There is a chance that petty crimes (e.g. theft of tools and commercial items) may occur on the site and neighbouring commercial enterprises. With the movement of different construction teams on and off the site, it may be more difficult for business owners and/or workers to differentiate between construction workers and unwanted intruders on the site.

The impact would be direct (as related to construction workers) and indirect (as related to job-seekers) negative in nature. The extent would be local as the impact would be beyond the site, but confined to the Vasilikos area. The duration would be short-term, lasting the construction period. The intensity would be low given the relative small number of workers and job-seekers anticipated at the site. Given the local extent, short-term duration and the low intensity, the impact magnitude is considered low. With a low magnitude and likely occurrence of the impact, the overall pre-mitigation impact significance is considered Minor.

Table describes the construction phase impact as related to an increase in social disturbance factors.

Table 6.20 below provides a summary of the construction impact.

Table 6.20: Construction impact: Social Disturbance Factors

Nature: Increased social disturbance would be regarded as a direct (as related to workers) and an indirect (as related to job-seekers), negative impact. **Impact Magnitude – Low** • **Extent:** It is anticipated that the potential impacts of increased social disturbance factors will have impacts at the local level. • **Duration:** The impacts identified are expected to be linked to the construction period and therefore short-term. • **Intensity:** The intensity will be low given the numbers of workers and job-seekers is expected to be limited. **Likelihood – It is likely that this impact will occur during the construction phase.** **IMPACT SIGNIFICANCE (PRE-MITIGATION) – MINOR** **Degree of Confidence:** The degree of confidence is **medium** given that the extent of the influx of job-seekers is unknown.

6.9.3 Operation, Mitigation and residual Impacts

During the operations phase, there will be fewer permanent workers onsite (up to 10 permanent staff). As such, it is likely that the social disturbance factors above will not be experienced to the same extent during the operations phase.

Theft or vandalism of the facility equipment or associated infrastructure may be of some concern during the operation phase. The impact would be direct (as related to construction workers) and indirect (as related to job-seekers) negative in nature. The extent of the impact would be local, moving beyond the site but remaining within the

Vasilikos area. The duration would be long-term, lasting the full operational phase of the facility. The intensity would be negligible given the low numbers of permanent employees and the security measures that will be taken. Given the local extent, long-term duration but negligible intensity the impact magnitude is considered negligible. Although the impact is likely to occur, the overall pre-mitigation impact significance is considered Negligible.

Table 6.21 below describes the operations phase impact of increased social disturbance factors.

Table 6.21: Operations impact: Social Disturbance Factors

Nature: Increased social disturbance would be regarded as a direct (as related to workers) and an indirect (as related to job-seekers), negative impact.

Impact Magnitude – Negligible

- **Extent:** It is anticipated that the potential impacts of increased social disturbance factors will have impacts at the local level.
- **Duration:** The impacts identified are expected to be long-term as they will persist for the life of the Project.
- **Intensity:** The intensity will be negligible given the small workforce. Likelihood – It is likely that this impact will occur during the operations phase.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – NEGLIGIBLE

Degree of Confidence: The degree of confidence is **medium**.

6.9.4 Mitigation

The objectives of mitigation are to limit, where possible, social disturbance factors brought about by the construction and operation of the facility. Furthermore, mitigation should ensure that contractors manage their workers in such a way that the impacts are limited.

<u>Construction and Operations:</u>

- KODAP and its appointed contractors will develop an induction programme, including a Code of Conduct, for all workers (including contractors and their workers). A copy of the Code of Conduct to be presented to all workers and signed by each person;

- The Code of Conduct will address the following aspects:
  - respect for local residents/commercial enterprises;
  - respect for surrounding infrastructure and commercial activities;
  - zero tolerance of illegal activities by construction workers including: theft; unlicensed prostitution; illegal sale or purchase of alcohol; sale, purchase or consumption of drugs; illegal gambling or fighting;
  - compliance with the Traffic Management Plan and all road regulations; and
  - description of disciplinary measures for infringement of the Code of Conduct and company rules.
- If workers are found to be in contravention of the Code of Conduct, which they will be required to sign at the commencement of their contract, they will face disciplinary procedures that could result in dismissal. Theft should be noted as a dismissible offence;• Burgan Oil, together with the appointed contractors must develop a means of monitoring access to the site, prohibiting unauthorised access to the site and ensuring that all visitors report to the site office.
- No employment will take place at the entrance to the site. Only formal channels for employment will be used;
- KODAP will ensure there is adequate security at the site. Security will comply with the above mentioned Code of Conduct.
- KODAP must develop and implement an HIV/AIDS Policy and information document for all workers directly related to the Project. All contractors must implement this policy. The information document will address factual health issues as well as behaviour change issues around the transmission and infection of HIV/AIDS. KODAP will make condoms available to employees and all contractor workers.

6.9.5 Residual

The implementation of the above mitigation measures should reduce the construction impacts to Negligible significance, and the operations impact will remain of Negligible significance.

6.10 Waste

6.10.1 Introduction

This section aims to identify and assess the impact of waste generated as a part of the construction - operation and decommissioning of the fuel farm facilities.

6.10.2 Assessment Methodology

The significance criteria for the impacts arising from waste generation are largely based on compliance to Cypriot legislation, together with the waste type (hazardous or non-hazardous) and the adopted management method. In this context, the significance criteria for impacts from waste generation are summarised in **Table 6.22**.

Table 6.22: Significance Criteria for Impacts from Waste Generation

Minor	Moderate	Major
Non-hazardous wastes with disposal according to legislation	Hazardous wastes with likely exceedance of environmental quality standards inside exclusion zone	Hazardous and non-hazardous wastes, breaching legislation, with disposal causing an exceedance of environmental quality outside exclusion zone

6.10.3 Construction Impacts, Mitigation and residual Impacts

Table 6.23 below details the type of solid wastes anticipated to be generated by the construction activities. Wastes are characterised according to the list as defined by Cypriot legislation (Law 215(I)/2002). The list is based on the AEOLIKI's previous experience in designing and developing facilities of this nature.

Table 6.23: KODAP Fuel Farm Construction Phase Waste Production

No.	Waste Code	Waste Type	Waste Category - Law 215(I)/2002)
1	20 01 21	Spent mercury light bulbs/tubes	Fluorescent tubes and mercury-containing waste
2	16 06 05	Spent dry-charged batteries	Other batteries and accumulators
3	16 06 06	Waste sulphuric acid (electrolyte)	Separately collected electrolyte from batteries and accumulators
4	18 01 08 – 18 01 09 18 02 07 – 18 02 08	Medical wastes	Medical wastes
5		Waste chemicals	Waste chemicals general
6	13 02	Waste lubricating oil	Waste engine, gear and lubricating oils
7	13 08 99	Oiled rags	Wastes not otherwise specified
8	16 01 07	Waste oil and air filters	Oil filters
9	13 05 02	Oil sludge	Sludges from oil/water separators
10	19 13 01	Oil contaminated soil including absorbents	Solid wastes from soil remediation containing dangerous substances
11	16 06 01	Batteries – lead cell (without electrolyte)	Lead batteries
12	05 01 17 05 01 07 – 05 01 08	Bitumen, tar paper, ruberoids, insulation material	Bitumen Tars
13	20 01 28	Paints/wood dyes, adhesives	Paint, inks, adhesives and resins
14	17 01 03	Broken ceramic	Tiles and ceramics
15	16 01 07	Spent filter material not contaminated with harmful substances	Oil filters
16	19 08 05	Sludge from biological wastewater treatment facilities	Sludges from treatment of urban waste water
17	10 13 06	Waste cement	Cement dust
18	20 01 08	Food wastes	Biodegradable kitchen and canteen waste
19	17 04 05	Ferrous metal scrap	Iron and steel
20	17 04 01 – 17 04 06	Non-ferrous metal scrap	Non-ferrous metals
21	16 01 03	Tyres	End-of-life tyres
22	17 01 01	Waste concrete and reinforced concrete components	Concrete
23	20 01 38	Brush wood	Wood
24	17 02 01	Construction wood	Wood
25	20 010 01	Uncontaminated waste paper/cardboard; paper/cardboard manufacture	Paper
26	20 01 11	Waste textile clothes (working clothes)	Clothes
27	20 01 02	Uncontaminated glass / broken glass	Glass
28	20 03 01	Solid domestic wastes	Mixed municipal waste

Significant waste streams likely to be products as a part of the construction process are discussed below:

Excavated Soil: Earthworks will be required to make the site sufficiently level for the purposes of the fuel farm and to establish the level terraces required by the proposed site layout. The amount of earth material to be excavated is unknown at this stage. Where possible, excess cut material will be used as fill for foundations and inner-road formation.

Excess Excavated Material: Defined as inert material removed from the ground and sub-surface that will not be reused on site. The volume to be generated is unknown at this stage.

General Construction Waste: Comprises unwanted materials generated during construction, including rejected structures and materials, materials which have been over ordered or are surplus to requirements, and materials, which have been used and discarded. These wastes will be generated at all construction sites and will typically comprise wood waste from formwork and falsework, material and equipment packaging/wrapping, and surplus or rejected construction material. There is no firm basis for the estimation of the waste generated at any construction site, but it is expected contractors will typically incorporate waste rates of 0.03 percent to 0.05 percent for major construction items. Although the expected total volume of waste is quite limited, their storage, handling, transport and disposal has the potential to create visual, water, dust and associated traffic impacts.

Chemical Waste. Typically generated by the maintenance of equipment, scrap batteries or spent acid/alkali, used engine oils and hydraulic fluids, chemical/oil based emulsions, spent mineral oils and cleaning fluids, and spent solvents. Chemical waste may pose serious environmental, and health and safety hazards if not properly managed. These hazards may include:

- Toxic effects on workers.
- Fire hazards.
- Downstream effects on water quality from spills.
- Downstream effects on sewage treatment plants where disruption is possible if chemical wastes enter the sewerage system in large quantities.

Recyclable materials, such as iron, steel and non-ferrous scrap, welding waste, batteries and used oil will be collected and transported to recycling agencies for further processing. Wastes that cannot be utilised for reuse or recycling will be collected and transported to the Larnaka waste disposal site.

Waste materials generated during construction will include:

- Cut pipes, fixing materials;
- Oiled rags, covering/packing materials;
- Waste oil from engines and machinery;
- Polymeric wastes (including reusable containers, used pallets, etc.);
- Electric supply wastes;
- Welding slag, cinder, expanded welding electrodes;
- Pipe and other scrap metal;
- Waste timber;
- Waste paints and lacquers;
- Construction waste (cement, concrete);
- Surplus concrete, gravel;
- Abrasion sand;
- Process filters;
- Oil and air filters;
- Domestic wastes (waste food, garbage).

During the construction phase, waste materials will be separated at source where possible according to the waste classification outlined in **Table 6.23**. Waste management based on the following priority principles (each principle listed is less desirable than its predecessor) should be developed for each category of waste:

- Avoidance and minimisation of waste generation by good design.
- Good site management to minimise over-ordering and waste material generation, particularly for bulk materials.

- On-site reuse of materials thereby avoiding unnecessary transport and disposal requirements.

- Off-site recycling. Proper segregation of wastes on site will increase the feasibility of recycling elements of the waste stream by off site contractors.

- Treatment and disposal, which will need to be undertaken according to relevant regulations, guidelines and good practice.

Hazardous and non-hazardous construction wastes can, if not appropriately managed (handled, stored and disposed of), result in significant adverse environmental impacts.

Recycling

The Construction contractor should be required to develop and implement a Waste Management Plan for all construction activities. This should be based on the "3R" waste management philosophy i.e. "Reduce, Re-use, Recycle". The Constructor must avoid waste generation in the first instance. Any waste subsequently generated should be assessed to see if it can be reused, and if not, recycled, then disposed either on site or off-site. The construction contractor should use locally available service providers to assist its recycling programme. A number of local recycling companies have the technology to appropriately recycle mixed waste paper and a number of other recyclable materials.

Where disposal is the only option for waste, it should be undertaken as described in the following sections.

Non-Hazardous Solid Waste

Non-hazardous waste will be disposed of at the Larnaka waste disposal site until the new landfill at Larnaka becomes operational.

Options for managing the disposal of the non-hazardous waste soils are still to be determined as the cut-and-fill ratio is still to be finalised and geotechnical investigations undertaken to determine whether excavated material is fill material, however every effort will be made to create a neutral cut and fill balance across the site. However, materials disposed off-site, must be done so in a manner consistent with the appropriate legislation. This will mean disposal at approved disposal sites or exported off Cyprus to an approved disposal facility in another country.

Mitigation options may include disposal in coordination with ongoing remediation works carried out at abandoned quarry sites within Cyprus. Potential disposal sites may include abandoned quarry sites in the broader area of Larnaka. These quarries were originally utilised for extraction gravels and sands. Use of these sites would be subject to approval of the District Officer and the Environment Service of the Ministry of Agriculture, Natural Resources and Environment.

Hazardous Wastes

Hazardous waste management should be undertaken in accordance with the law on Solid and Hazardous Waste Management 215(I)/2002 and regulations that exist on waste oils, batteries, PCB-PCT, packaging and packaging waste, animal by-products and landfills.

Cyprus presently does not have a hazardous waste disposal facility and is reliant on safe storage of hazardous waste or export and international disposal. The construction of a national hazardous waste incinerator (in order to comply with EU requirements) is currently the subject of enquiry but at the time of writing a suitable site for the facility had not been established.

The construction contractor should make arrangements for safe on-site storage of hazardous wastes. The wastes would then be transferred under a Chain of Custody control mechanism to a licensed hazardous waste disposal contractor for international disposal.

Mitigation

A Construction Waste Control and Disposal Plan should be developed by the construction contractor prior to the commencement of enabling works on site. A description of the alternatives for waste management is provided below. It is expected that one or a combination of these options would be used to appropriately manage construction wastes.

The Construction Waste Control and Disposal Plan should introduce a Reduce, Reuse, Recycle (3R) waste management philosophy. The Construction Waste Control Plan should include:

- A minimisation / collection / storage / treatment / re-use / disposal strategy for each waste stream in accordance with European and local requirements e.g. a strategy for returning packaging waste (containers, plastic wrapping, pallets etc. to their point of origin);
- Identify potential third party re-users; and duty-of-care requirements;

- Methods for properly management (e.g. training, storing, containerising, labelling, transporting and disposing) wastes; and
- A description of the transition of control from the construction contractors to the operator.

The Construction Waste Control Plan should identify contractors with the capacity to manage and dispose of recyclables in the vicinity of the fuel farm area. It is assumed that a number of local recycling companies have the ability to recycle mixed waste paper and a number of other recyclable materials.

In light of the above controls, residual impacts associated with of disposal of construction wastes (hazardous and non-hazardous) are considered to be minor.

6.10.4 Operational Impacts, Mitigation and residual Impacts

All wastes generated by the operation of the fuel farm facility will be temporarily stored prior to transportation off-site. The temporary waste storage facilities will be located in an area enabling access for waste transportation without impending operation. All wastes stored in this site will be packed in containers, and all loading and unloading operations will be conducted in this area.

As noted previously, the types of waste associated with the project will include:

- Non-hazardous combustible solid waste such as waste paper, wood and cardboard;
- Non-hazardous, non-combustible waste such as scrap metal;
- Hazardous solid waste such as paint cans and empty chemical containers; and
- Hazardous liquid waste such as liquid oily wastes.

Non-Hazardous Wastes

All non-hazardous wastes should be stored, collected and disposed of in accordance with the requirements of the Cypriot legislation. Specific guidelines that apply include:

- Storage area shall be readily accessible to collection vehicles.
- Storage areas shall be of adequate size and capacity to accommodate the required number of containers consistent with the waste generated routine and collection schedules.
- Containers shall be clearly labeled for their intended use and equipped with lids.

- Containers and waste storage areas shall be cleaned on a regular basis.
- Waste material shall be removed to the disposal site at the earliest opportunity and as the waste is generated.

Non-hazardous waste will be disposed of at the Limassol waste disposal site until the new landfill at Limassol becomes operational.

No.	Waste Code	Waste Type	Waste Category - Law 215(I)/2002)
1	20 01 21	Spent mercury light bulbs/tubes	Fluorescent tubes and mercury-containing waste
2	19 01 10	Activated carbon	Spent activated carbon for the site Vapour Recovery Unit
3	16 06 05	Spent dry-charged batteries	Other batteries and accumulators
4	16 06 06	Waste sulphuric acid (electrolyte)	Separately collected electrolyte from batteries and accumulators
5	18 01 08 – 18 01 09 18 02 07 – 18 02 08	Medical wastes	Medical wastes
6		Waste chemicals	Waste chemicals general
7	07 03 03 – 07 03 04	Waste organic solvents	Organic solvents
8	13 02	Waste lubricating oil	Waste engine, gear and lubricating oils
9	13 08 99	Oiled rags	Wastes not otherwise specified
10	16 01 07	Waste oil and air filters	Oil filters
11	13 05 02	Oil sludge	Sludges from oil/water separators
12	19 13 01	Oil contaminated soil including absorbents	Solid wastes from soil remediation containing dangerous substances
13	16 06 01	Batteries – lead cell (without electrolyte)	Lead batteries
14	05 01 17 05 01 07 – 05 01 08	Bitumen, tar paper, ruberoids, insulation material	Bitumen Tars
13	20 01 28	Paints/wood dyes, adhesives	Paint, inks, adhesives and resins
14	17 01 03	Broken ceramic	Tiles and ceramics
15	19 08 05	Sludge from biological wastewater treatment facilities	Sludges from treatment of urban waste water
16	19 08 01	Waste generated ion the course of mechanical treatment of domestic waste water	Screenings
17	10 13 06	Waste cement	Cement dust
18	20 01 08	Food wastes	Biodegradable kitchen and canteen waste
19	17 04 05	Ferrous metal scrap	Iron and steel
20	17 04 01 – 17 04 06	Non-ferrous metal scrap	Non-ferrous metals

22	17 01 01	Waste concrete and reinforced concrete components	Concrete
24	17 02 01	Construction wood	Wood
25	20 010 01	Uncontaminated waste paper/cardboard; paper/cardboard manufacture	Paper
26	20 01 11	Waste textile clothes (working clothes)	Clothes
27	20 01 02	Uncontaminated glass / broken glass	Glass
28	20 03 01	Solid domestic wastes	Mixed municipal waste

Table 6.24: KODAP Fuel Farm Operational Waste Generation

Hazardous Wastes

Hazardous waste management will be undertaken in accordance with the law on Solid and Hazardous Waste Management 215(I)/2002 and Regulations on waste oils, batteries, PCB-PCT, packaging and packaging waste, animal by-products and landfills.

Management procedures for the handling, storage and disposal of hazardous wastes should include, but not necessarily be limited to, the following:

- Hazardous waste storage areas shall be designed to have spill containment systems.
- Hazardous waste storage areas shall be protected to avoid runoff to and from the storage area and have facilities to monitor and pre-treat any runoff.
- Containment curbs shall be maintained around the loading/unloading area.
- Containers and storage tanks shall be comprised of suitable material to permanently contain the hazardous waste and be clearly identifiable.
- Storage areas shall be inspected regularly for leakage.
- Incompatible materials shall not be stored in common containers.
- The surface impoundment area used to store hazardous wastes shall be adequately lined and monitoring and detection equipment installed to protect against potential leakages; and
- The storage areas shall be paved and appropriately lit with clear signage.

Options for disposal of hazardous waste include:

- Shipment and disposal offshore/internationally within a licensed facility.
- Where possible incineration within the adjacent cement plant kiln.

Mitigation

Mitigation measures include those measures adopted for the storage, treatment (i.e. reuse and recycling) and/or disposal of wastes, which will need to be developed into a Waste Management Plan for implementation throughout the lifecycle of the facility. It is important that this plan emphasize the avoidance of generating waste as the first step in waste management.

The environmental impacts of wastes, both hazardous and non-hazardous, generated during construction are considered to be minor, assuming that due duty of care is applied in relation to storage on site, during transportation and that appropriate disposal for the type of waste is applied. It will be important therefore to ensure that this duty of care is outlined and detailed within the contractors Waste Management Plan and that this plan is monitored to ensure these measures are maintained and enhanced where required.

6.10.5 Non-normal Operations and Mitigation

The terrestrial activities associated with the fuel farm facility have associated risks of accidents that can lead to spillages of oil, chemicals or other materials. The different phases of the project (e.g. construction, operations) and activities (e.g. vehicle movements, site levelling) have different risk profiles and have to be managed.

Liquid Hydrocarbons

Whilst spill risks at the site are discussed in **Chapter 6** of this report it is relevant to note that the clean up of hydrocarbons after a spill can create large amounts of contaminated waste in the terms of clean up material and oily sludge. The handling and disposal of this waste will need to be carefully considered. Depending on the volume of the waste, disposal via incineration would probably be the most appropriate option.

6.10.6 Decommissioning Impacts and Mitigation

It is anticipated that the majority of the project components will be in place for 25 years or more.

As a result of the lack of knowledge concerning future legislation and project developments, it is impossible to accurately predict impacts associated with decommissioning at this stage. It is known, however, that decommissioning will broadly comprise the following activities:

- Operating processes will systematically be shut down in a safe manner;
- Liquid and solid contents/wastes will be removed for treatment and disposal. For pipelines and tanks, this will entail flushing and cleaning to remove oils and gases; and
- The fate of the emptied and cleaned structures and equipment will then be decided by a feasibility study to determine the best environmental and economic solution consistent with international oil and gas industry practice.

It is anticipated, therefore, that all activities are manageable according to best practice at the time of decommissioning and as such, impacts are anticipated to be minor.

6.10.7 Summary

Based on the previous analysis, impacts form waste generated due to construction are considered to be low. However, impacts from waste due to operations are likely to be moderate. The impacts have a low risk of occurring, but if they do occur the impact could be significant.

6.11 Cumulative Impacts

6.11.1 Introduction

Cumulative impacts are a result of effects that act together (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the project under consideration (e.g. the combined effect of other similar projects in the general area). An effect to a resource in itself may not be considered significant, but may become significant when added to the existing and potential effects eventuating from similar or diverse developments in the area.

Evaluation of potential cumulative impacts is an integral element of an impact assessment. In reference to the scope for an impact assessment, IFC's Performance Standards specify that:

"Where the project involves specifically identified physical elements, aspects, and facilities that are likely to generate impacts, environmental and social risks and impacts will be identified in the context of the project's area of influence. This area of influence encompasses, as appropriate:…Cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted." (IFC, 2012).

Cumulative effects have been defined as "changes to the environment that are caused by an action in combination with other past, present and future human actions" (Hegmann et al 1999).

The preceding impact assessment chapters have assessed the impacts associated with the Project largely in isolation. As part of legislated requirement, it is important to consider cumulative impacts associated with a proposed development. This section examines whether the Project's potential impacts become more significant when considered in combination with the additional existing infrastructure, including other fuel and oil storage facilities within the area.

The following are existing developments and infrastructure at the Vasilikos Industrial Area :

- EAC's Vassilikos Power Station;
- PPT Aviation Services Ltd and Petrolina Holdings PLC, Vasilikos terminal;
- Scrap Metals Storage Yard;

- Navy Base “Evagelos Floraki”;
- Vassilikos Cement Works;
- Vouros Healthcare Clinical Waste Processing Unit;
- Vassilikos harbour;
- Vasilikos Quarry;
- Archirodon Port;
- VTT Vasilikos Plant;
- Ecofuel installations, used oil processing facilities;
- Zygi Fishing Shelter;
- EAC’s Single Point Mooring;
- Aquaculture Installations

As is evident from the above, there is extensive industrial infrastructure that already exists at the Vasilikos area.

In terms of proposed developments, the facility must be placed in the context of the Vasilkos Master Plan. According to Vasilikos Master Plan (2015) there are plans for several other facilities within the general area such as a HVDC converter station for an electrical submarine cable (the EurAsia Interconnector), a wind farm, warehouses, fish food manufacturing plants, power stations etc.

In addition, VTTV Ltd o an oil storage depot in the area, and is also planning the expansion of this depot on reclaimed land near the Vasilikos Industrial Port. Another major development is the current expansion of the existing oil storage depot owned and operated by Petrolina (Holdings) Public Ltd.

In the sections below the potential cumulative impacts are explored in terms of the proposed facility being added to the existing industrial infrastructure and fuel and oil storage facilities in the area. The discussion and associated conclusions must be understood in the context of the uncertainty associated with the proposed and known developments and the qualitative nature of the assessment.

6.11.2 Potential Cumulative Impacts

Air Quality

The installation of a facility that has ongoing emissions throughout the operations phase in an already industrial area could lead to cumulative air quality impacts. However, as assessed in the previous sections, the proposed fuel and oil storage and distribution facility is expected to have relatively low levels of ongoing emissions. Furthermore the site level post-mitigation impact significance for the lifespan of the Project is considered negligible. Therefore given that the Vasilikos area is already an industrial facility with already installations of bulk oil and duel storage, the addition of the Project is unlikely to have a cumulative impact on air quality.

Traffic

The project will not generate extra traffic of road tankers on the roads in the area. As a result the realization of the project will not have cumulative impacts on traffic.

Hazardous Installation Risks

At this stage of the study hazardous installation risks cumulative impacts cannot be assessed. No Quantitative Risk Assessment (QRA) has been undertaken to simulate a number of incident scenarios associated with the oil and fuel storage and distribution facility in the KODAP plant.

However KODAP is in the process to undertake such a study. Based on the results of the QRA study the cumulative effects of the hazardous installation risks will be assessed.

6.11.3 Conclusion

In conclusion, the additional of the oil and fuel storage and distribution facility along with existing and possible future activities within the Vasilikos area, are unlikely to have significant cumulative impacts that warrant additional mitigation measures.

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Chapter 7

Environmental Management

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7 ENVIRONMENTAL MANAGEMENT

7.1 Environmental Management Framework

This chapter of the Environmental Study is intended to provide an outline of the arrangements that will be put in place to ensure that the mitigation and other measurements to control or reduce predicted impacts are implemented and effective. These arrangements draw heavily on the environmental management system (EMS) which will have to be developed and implemented even at the construction / installation phase of the project.

KODAP will develop a Construction Programme Environmental Management Plan (EMP). Once the construction programme is finished the EMP will no longer be maintained.

KODAP will develop a Tank Farm Operations Environmental Management Plan (EMP) in accordance with the provisions of EMAS - Environmental Management System. KODAP may elect to gain accreditation for this management system some time in the future but it is not proposed to pursue this in the short term rather the principles of the standard will be applied including regular monitoring and auditing of the performance of the management provisions and implementation of corrective actions if and as required.

The following sections describe the key elements of the EMS, indicating how they will be applied to the project. The EMS will allow the sponsors of the project to control environmental impacts and will provide assurance that the environmental management is effective, through:

- Identifying environmental hazards for project activities and reducing the risks arising from such hazards to levels that are low as reasonably practical;
- Meeting or exceeding all relevant regulatory and legislative requirements and applying responsible standards of its own where relevant laws and regulations do not exist;
- Setting objectives for continual improvement in environmental performance;
- Preventing pollution and minimizing waste and emissions from the tank farm operations;
- Requiring contractors to apply the same or equivalent standards;
- Maintaining effective contingency arrangements to deal with emergencies in co-operation with the authorities, emergency services and partners of the project;

- Carrying out regular audits and reviews of environmental management and performance.

The key elements of the EMS are:

- Management, leadership, commitment and accountability;
- Occupational health, safety and environmental policy and strategic objectives;
- Organizational and resources, third party services, information and documentation;
- Hazard identification and risk management;
- Planning and conduct of work;
- System implementation and monitoring, incident reporting and investigation;
- Audit and review

7.2 Environmental Management Plan

7.2.1 Purpose of the EMP

This EMP is a delivery mechanism for environmental and social mitigation measures, as well as recommendations and commitments made in the EIA Report. The purpose of the EMP is to ensure that these recommendations are translated into practical management actions which can be adequately resourced and integrated into the project phases. The EMP is, therefore, an environmental management tool used to ensure that undue or reasonably avoidable adverse impacts of construction and decommissioning are prevented and that the positive benefits of the projects are enhanced.

The overall aims of this EMP are as follows:

- Ensure continuing compliance with national environmental legislation and KODAP's relevant policies and procedures ;
- Provide a mechanism for ensuring that measures identified in the EIA Report to mitigate potentially adverse impacts are implemented;
- Provide assurance to regulators and stakeholders that their requirements with respect to environmental and social performance will be met;
- Ensure that employees and contractors are familiar with the environmental procedures to be followed and comply with all the recommendations made within this document;
- Ensure that roles and responsibilities are clearly defined and are understood by employees and contractors; and

- Ensure that monitoring is undertaken to identify any potential negative environmental impacts.

7.2.2 Roles and Responsibilities

The EMP describes mitigation measures and is partly prescriptive, identifying specific people to undertake specific tasks, in order to ensure that impacts on the environment are minimised during the proposed project. This section outlines the roles and responsibilities of those involved project and the reporting procedures to be followed.

7.2.2.1 Construction Contractors

Contractors will be responsible for the installation of the tanks at the designated area at Vasilikos site. They will be responsible for implementing all the Health, Safety and Environment (HSE) requirements and environmental management procedures relevant to the above mentioned tasks. Adherence to these requirements and procedures will be monitored by KODAP.

The main contractor is responsible for ensuring that any incidences are reported and that the site is assessed for any contamination and if found to be present, that suitable clean-up actions/remediation strategies are implemented.

7.2.2.2 Safety Health Environmental and Quality (SHEQ) Manager

The SHEQ Manager will be a KODAP's employee who will be responsible for reviewing and approving the Contractors Health Environment and Safety Plan as well as their Safe Work Practices Procedures. The SHEQ Manager will conduct random safety audits during the installation of the tanks.

7.2.3 Communication Procedures on site

7.2.3.1 Method Statements

Any contractors employed will be required to provide method statements for specific activities on request of the authorities or the SHEQ Manager. A method statement describes the scope of the intended work in a step by step description to ensure that the SHEQ Manager understands the Contractors intentions. This will enable them to assist in devising any mitigation measures which would minimise environmental impact during these tasks. For each instance where it is requested that the Contractor submit a method statement to the satisfaction of the SHEQ Manager, the format should clearly indicate the following:

- What: a brief description of the work to be undertaken;
- How: a detailed description of the process of work, methods and materials;
- Where: a description/sketch map of the locality of work (if applicable); and
- When: the sequencing of actions with due commencement dates and completion date estimates.

Work may not commence until the method statement has been approved by the SHEQ Manager. All method statements will form part of the EMP documentation and are subject to all terms and conditions contained within the EMP main document.

Method statements for the following activities may be required:

- site layout and establishment;
- storage and use of hazardous substances;
- storage and release/ collection of effluent;
- solid waste control system; and
- fire control and emergency procedures

7.2.3.2 Record Keeping

All records related to the implementation of the EMP (e.g. method statements, audit inspection protocols, incident reports, etc.) must be filed together by the SHEQ Manager in a safe place where it can be easily retrieved. These records should be kept for two years and should, at any time, be available for scrutiny by relevant authorities.

7.2.3.3 Photographs

It is recommended that photographs be taken of the site by the SHEQ Manager, prior to, during and immediately after construction/ installation, as a visual reference. These photographs should be stored with other records related to this EMP.

7.2.3.4 Environmental Completion Statement

An Environmental Completion Statement is a report by the SHEQ Manager to the relevant authorities confirming completion of the project and compliance with the EMP conditions.

7.2.4 Environmental Management Programme (EMP)

The EMP is presented in a tabular format section under the following headings:

- Planning Phase;
- Installation/ Construction Phase;
- Operational Phase; and
- Decommissioning Phase.

7.2.4.1 Planning phase

An Environmental Management Plan (EMP) will be produced to manage the planning phase. Main issues to be addressed include:

- preparation of construction environmental management system procedures;
- assessment of contractors and sub-contractors environmental competency;
- establish legislative register related to construction activities as well as design miscellaneous issues;
- construction staff awareness on environmental and health and safety issues
- establish communication with competent authorities

7.2.4.2 Installation / Construction phase

An Environmental Management Plan (EMP) will be produced to manage all construction activities including lying of the pipelines.

The contents of the EMP will include a statement of the operator's corporate environmental policy, a description of the activity and environment, an assessment of the potential environmental effects and risks and the environmental performance objectives, standards and measurement criteria. It will include also procedures for managing the following issues:

- Air quality;
- Culture and heritage;
- Fire;
- Noise;

- Water;
- Flora and fauna;
- Visual amenity;
- Waste

An Implementation Strategy (IS) for ensuring that the environmental performance objectives and standards are met will also be included in the EP.

The IS will include:

- Specific systems, practices and procedures for reducing environmental risk;
- A description of the roles and responsibilities of personnel;
- Provision for appropriate skills and training measures;
- Provision for the monitoring, audit and review of environmental performance and the IS;
- Provision for the maintenance of records of emissions and discharges;
- Provision for an emergency response manual and provision for consultation with the relevant authorities and interested groups of persons.

Management of the impacts associated with the project's construction / installation phase places a considerable environmental responsibility on the contractors. These responsibilities will be incorporated into the contracts that will be issued for the works.

7.2.4.3 Operation phase

A single operations EMP will be produced to manage routine operations and emergency response procedures during the operational phase of the OSRD. The operations EP will include procedures for managing the following issues:

- Accidental discharges;
- Air quality;
- Fire;
- Noise;
- Rehabilitation;
- Socio-economic;
- Traffic;
- Visual amenity;
- Waste;

- Water

7.2.4.4 Decommissioning

An EMP will also be produced to manage the decommissioning phase of the project.

7.2.5 Commitments

The sponsor's commitments arising from the EMP is presented in **Table 7.1**.

PLANNING PHASE					
No.	**Topic**	**Objectives**	**Commitment**	**Timing**	**Measurement Criteria**
1	Environmental Management	Ensure appropriate procedures are place to manage environmental issues	EMP will be prepared for the installation/construction and operation phases of the development	Prior the commencement of the installation / construction	
2	Environmental Management	Ensure contractors are experienced in environmental management and suitable for the work	All primary contractors will undergo an operational audit or audit review which includes examination of environmental management procedures prior to appointment	Prior to appointment of contractors	Record of operational audit
3	Environmental Management	Ensure compliance with guidelines and commitments	Environmental audits will be undertaken during installation / construction and operations	One during installation / construction and at least two times per year during operations	Records of environmental audits
4	Environmental Management	Ensure personnel are familiar with the environmental management systems and environmental issues	All personnel going to site will undergo an environmental induction	At all times	Records of inductions and other environmental training kept.
5	Environmental Management	Ensure that competent authorities are notified of the commencement date of site activities	HSEQ Manager to notify competent authorities, in writing, prior to commencement of site preparation	Prior the commencement of the installation / construction	Proof of communication
6	Environmental Management	Approve method statements	The following method statements are required as a minimum: • site layout and establishment; • storage and use of hazardous substances; • storage and release/ collection of effluent; • solid waste control system; and • fire control and emergency procedures • Oil water separators	Method statement sign- off	Prior to commencement of construction /installation

CONSTRUCTION PHASE					
No.	**Topic**	**Objectives**	**Commitment**	**Timing**	**Measurement Criteria**
7	Accidental discharges	Ensure appropriate spill response procedures are in place	A hydrocarbon spill contingency plan (HSCP) will be prepared	Prior to commencement of construction activities	HSCP document
8	Flora and fauna	Minimise impact to sensitive habitats	Procedures adopted to minimise damage	Prior to the commencement of construction activities	Audit or procedure implementation
9	Fire	Ensure that appropriate fire management procedures are in place	Develop a fire management plan as part of the Installation EMP	Prior the commencement of offshore activities	Fire Management plan document
10	Fire	Gain local knowledge and integrate plan with existing fire management procedures	Consult with local fire authorities during development of the fire management plan	During the development of the fire management plan	Records of consultation kept
11	Air quality	Reduce greenhouse gas emissions	Construction equipment and vehicles will be regularly serviced to ensure vehicles/engines run efficiently	During installation activities	Service records kept
12	Air quality	Limit dust emissions	The Contractor will take appropriate measures to minimise the generation of dust as a result of construction works, to the satisfaction of the SHEQ Manager. Such measures may include wetting of surfaces.	During construction/ installation activities	Visible dust
13	Transport	Minimise potential for transport accidents	Procedures will be put in place to minimise the potential for transport accidents	At all times	Audit of procedure implementation
14	Vegetation, flora and fauna	Minimise impact to vegetation, flora and fauna	Minimise area of vegetation clearing during construction activities	During construction activities	Demobilisation report with photos showing extent of vegetation cleared
15	Hazardous waste	Minimise adverse impacts to public health from hazardous	Procedures will be put in place to minimise the potential for adverse health impacts from	During construction	Audit of procedure

		waste	hazardous waste	activities	implementation
16	Access control	Minimise health and safety risks to onsite personnel and the public	The site must be fully fenced to prevent unauthorised access onto the site; Potentially hazardous areas must be demarcated and clearly marked; The choice of access routes and entry to the site must minimise disturbance to other site users	During construction/ installation activities	Incident Report
17	Refuse and waste (refers to all solid waste, including construction debris wrapping materials, timber, metal etc.)	Limit the potential for site pollution and the accumulation of waste materials on site	Off-cuts must be reused where ever possible; Bins/skips shall not be used for any purpose other than waste collection and shall be emptied on a regular basis; All waste must be removed from site by a licensed contractor	During construction/ installation activities	Visual inspection of site. Relevant documentation for waste disposal must be prepared and filed (i.e. certificates of safe disposal)

OPERATION PHASE					
No.	**Topic**	**Objectives**	**Commitment**	**Timing**	**Measurement Criteria**
18	Accidental releases	Ensure appropriate spill response procedures are in place	A hydrocarbon spill contingency plan (HSCP) will be prepared covering all activities during operations	Prior to commissioning	HSCP document
19	Air emissions	Reduce greenhouse gas emissions and minimise production of incomplete combustion products	Procedures will be put in place to minimise the impacts from air emissions during operation	At all times	Audit of procedure implementation
20	Waste effluents	Reduce impacts from waste effluents	Procedures will be put in place to minimise the impacts from discharged waste effluents during operation	At all times	Audit of procedure implementation
21	Solid waste	Reduce impacts from solid waste production during operation activities	Procedures will be put in place to minimise the impacts from solid waste disposal during operation	At all times	Audit of procedure implementation
22	Noise	Reduce noise annoyance and impacts from operation activities	Procedures will be put in place to minimise the impacts from noise during operation and distillate fuel oil transport and storage	At all times	Audit of procedure implementation
23	Transport	Minimise potential for transport accidents	Procedures will be put in place to minimise the potential for transport accidents; Delivery times should be scheduled so that they do not conflict with other deliveries/ removals; There is to be sufficient turning space for delivery vehicles	At all times	Audit of procedure implementation
24	Onsite operations	Minimize occupational risk to employees.	Relevant operational staff must receive training on the correct operation of the storage tanks, as well as maintenance and repair procedures when leaks are detected; An emergency response plan must be available on site and employees must be familiar with the plan;	At all times	At discretion of facility SHEQ Manager

			The correct PPE should be used on the site. Appropriate Health & Safety signage must be placed on and around the tank		

DECOMMISSIONING					
No.	**Topic**	**Objectives**	**Commitment**	**Timing**	**Measurement Criteria**
25	Waste generation (includes solid waste)	Minimise the generation of waste	Tanks that are structurally sound will be cleaned and sold for re-use.	During decommissioning	Proof of sale documents
26	Removal of potentially contaminated soil and rubble	Reduce the potential risk associated with contaminated soil on surrounding soil and groundwater	The contaminated soil beneath the tank stand and bund must be removed and disposed of at a registered contaminated landfill site. Only non-contaminated material will be used for backfill. Records must be maintained by the Removal Contractor indicating where the material came from and where it was used. Existing groundwater monitoring wells will be used for the ongoing monitoring of groundwater. A risk analysis will be carried out to verify whether the impacted soil and groundwater require further investigation and/ or remediation. If significant contamination is observed, the remediation strategy for the site will be updated and re-evaluated in consultation with the Department of Water Affairs. After the site has been cleared and remediated the soil must be re-vegetated or covered to prevent erosion of the soils	During decommissioning and ongoing	Waste manifests Construction records Bi-annual monitoring reports Risk Analysis Report Remediation Plan
27	Noise impacts associated with decommissioning activities	Manage any potential noise impacts	Construction activities will be limited to normal working hours.	During decommissioning	Incident report

			Site personnel are to wear the appropriate PPE		
28	Dust Control	Limit dust emissions	The Contractor will take appropriate measures to minimise the generation of dust as a result of construction works, to the satisfaction of the SHEQ Manager. Such measures may include wetting of surfaces and the use of sawdust. Any complaints received from neighbours will be reported to the SHEQ Manager and measures will be taken to limit dust.	During decommissioning	Incident report
29	Access control	Minimise health and safety risks to onsite personnel and the public.	Potentially hazardous areas must be demarcated and clearly marked. The choice of access routes and entry to the site must minimise disturbance to other site users.	During decommissioning	Incident report
30	Traffic impacts associated with the delivery of required machinery	Manage any potential traffic congestion.	Delivery areas should be clearly marked to reduce any risks. Movement to and from site during daylight hours only.	During decommissioning	Incident report

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Chapter 8

Spill Contingency and Oil Spill Response Plan

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8 SPILL CONTINGENCY AND OIL SPILL REPSONSE PLAN

8.1 Introduction

Potential environmental impacts associated with potential oil spills are discussed in this section. The objectives of this section area to describe the areas of potential risk, the possible behaviour of oil spills in the area, to recommend protective measures to minimise potential damages to the environment, and to propose an outline of contents for the Oil Spill Response Plan (OSRP) for the proposed OSRD installations.

8.2 Legislation

8.2.1 European Legislation

As Cyprus is a member of the European Union, compliance with European Directives is reflected in Cypriot regulations. The European legislation applicable to the OSRD which is related either directly or indirectly to oil pollution is detailed below.

- The Council Directive Seveso-III (Directive 2012/18/EU) on the Control of Major Accident Hazards involving dangerous substances, which requires a safety management system and safety reports for top-tier establishments, as well as the development and implementation of on-site and off-site emergency plans.
- The Council Directive 2014/100/EU on establishing a Community vessel traffic monitoring and information system and repealing Council Directive 93/75/EEC
- The Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora ("the Habitats Directive").

8.2.2 International Agreements

Cyprus is also party to various international conventions that relate to oil pollution prevention and the marine environment, including the following:

- Convention on the Transboundary Effects of Industrial Accidents, Helsinki, 1992;
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention 1972), London, 1972;
- The Basel Convention for the Transboundary Movement of Hazardous Waste, ratified 17 September 1992;

- The Convention on Environmental Impact Assessment in a Transboundary Context (ESPOO), ratified 20 July 2000;
- Convention for the Protection and Development of the Marine Environment and Coastal Region of the Mediterranean Sea (Barcelona Convention), Barcelona, 1976;
- International Convention for the Prevention of Pollution from Ships, 1973, as modified by Protocol of 1978 relation thereto (MARPOL 73/78), London, 1973 and 1978;
- International Convention on Civil Liability for Oil Pollution Damage 1969 (1969 CLC), Brussels, 1969, 1976, and 1984;
- International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1971 (1971 Fund Convention), Brussels, 1971;
- Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea (HNS), London, 1996;
- International Convention on Oil Pollution Preparedness, Response, and Cooperation (OPRC), London, 1990;
- Protocol on Preparedness, Response and Co-operation to pollution Incidents by Hazardous and Noxious Substances, 2000 (HNS Protocol) which follows the principles of the OPRC Convention for hazardous and noxious substances other than oil;
- International Convention Relation to Intervention on the High Seas in Cases of Oil Pollution Casualties (Intervention Convention), Brussels, 1969;
- Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft (Oslo Convention), Oslo, 1972;
- Convention for the Prevention of Marine Pollution from Land-based Sources (Paris Convention), Paris, 1974

8.2.3 Cypriot legislation

The following pieces of legislation in Cyprus are relevant to oil spill prevention:

- Seveso III Directive has been transposed through the Regulation (347/2015) for the "Control of major accident hazards involving dangerous substances", was effective in 2002;
- Water Protection and Management Law(No. 13(I)/2004);
- Consolidated Amending Regulations of 1990 (No. 273/90) adopted on the basis of Article 6 of the Fisheries Law;
- Amendment (No. 170 of 1990) of the Fisheries Law;
- Ratification Law (No. 51 of 1979) of the Barcelona Convention regarding protection of the Mediterranean from pollution as well as its two Protocols:
  - ✓ Protocol for the protection against pollution of the Mediterranean by waste from ships or aircraft (Dumping Protocol);
  - ✓ Protocol for cooperation in the combating of pollution in the Mediterranean by petroleum products and other toxic substances (Emergency Protocol);
- Ratification Law (No. 266 of 1987). It ratifies another two Protocols of the Barcelona Convention:
  - ✓ Protocol for the protection of the Mediterranean from land-based sources;
  - ✓ Protocol concerning protected areas of the Mediterranean;
- Consolidated Amending Regulations (No. 273/90) enacted under the Fisheries Law (Chapter 135);
- Ratification Law (No. 57 of 1989). It ratified the International Convention regarding prevention of pollution of the sea by ships of 1973 and the relevant Protocol of 1978 and the Amendments of 1984;
- Regulations concerning undersea pipelines for carrying oil and other products (No. 151/1995);
- Ratification Law (No. 63 of 1989), ratifying the International Convention concerning civil liability for damage from oil pollution of 1969, and its protocol of 1976 and provisions regarding related matters;
- Ratification Law (No. 14 (III) of 1997);

- Law Regarding the Ratification of the Protocol of 1992 which amends the international Convention regarding civil liability for damages from pollution;
- Ratification Law (No. 109 of 1989). Ratifies the International Convention concerning the establishment of an international fund for compensation for oil pollution of 1971 and its protocol of 1976 and provisions regarding related matters;
- Ratification Law (No. 9 (III) of 1995) Ratifies the Agreement related to the application of the part of the XI Convention for maritime justice of December 10, 1982;
- Ratification Law No. 20(III) / 2001 ratifies the amended Convention for the Protection of Mediterranean Sea from Pollution and the related Protocols;
- Ratification Law No. 19(III) / 2001 ratifies the Protocol from the Protection of the Mediterranean Sea from Land-based activities;
- The Law No. 21(III) ratifies the Agreement betweem Cyprus, Israel, and Egypt for the cooperation in cases of major pollution accidents in the Mediterranean;

8.3 Oil products in the OSRD

Type of oil products

During the Construction Phase of the OSRD, a range of petroleum products and other substances could be expected to be present at the site as described on **Chapter 3**.

At the OSRD site, bulk petroleum products will be stored in industry-standard designed above ground tanks, within paved and bunded areas.

The following typical characteristics when spilled on water, have described by the United States Environmental Protection Agency:

- Gasoline, a lightweight material that flows easily, spreads quickly, and may evaporate completely in a few hours under temperate conditions. It poses a risk of fire and explosion because of its high volatility and flammability, and is more toxic than crude oil. Gasoline is amenable to biodegradation, but the use of dispersants is not appropriate unless the vapours pose a significant human health or safety hazard;

- Kerosene, a lightweight material that flows easily, spreads rapidly, and evaporates quickly. Kerosene is easily dispersed, but is also relatively persistent in the environment;

- No. 2 Fuel Oil, a lightweight material that flows easily, spreads quickly, and is easily dispersed. This fuel oil is neither volatile nor likely to form emulsions, and is relatively non-persistent in the environment;

- No. 4 Fuel Oil, a medium weight material that flows easily, and is easily dispersed if treated promptly. This fuel oil has a low volatility and moderate flash point, and is fairly persistent in the environment;

Thus, during the Operational Phase at the OSRD site there is the potential for petroleum products to disperse, either through floating on or sinking in water, and some products can be persistent in the environment.

8.4 Potential Spill Sources

Small spills may occur by operational errors in off-loading procedures and damage to pipelines, whilst major accidents may occur due to storage tank major ruptures, fires, bund fires and running liquid fires from spillages at loading racks.

Potential causes of accidents are classified as follows:

- Operational failures, for example, loading/unloading operations and overfilling of tanks.
- Small releases that result in major cascade events.
- Third party incidents
- Generic causes that may occur at any installation, such as corrosion and seal failures
- Site wide events (e.g. earthquakes)

8.5 Environmental Impacts

Onshore oil spills may affect soil properties and groundwater resources. As addressed in the geology and hydrogeology section in **Chapter 4**, the regional groundwater table is at a depth of 70 to 150 metres below ground level, although occasionally groundwater may be found in the near-surface gravels at about 2 to 3 metres depth. Groundwater is not currently in use in the Vasilikos area, and deep aquifers are unlikely to be affected by inland oil spills.

The proposed location of the OSRD is currently an industrialised (as described in Chapter 4) area which, according to baseline studies, does not contain terrestrial fauna or flora species of importance (**Chapter 4**).

Large oil spills may produce high visual impact affecting the nearest tourist areas such as Governors Beach, and indirectly affect the local tourism economy. Landscape recovery activities may last several years in the case of large oil spill events, and therefore efficient clean-up and containment systems should ensure a rapid response to prevent or reduce the oil spreading onto the sea and/or ground surface.

Effects of oil spills on human health are likely to arise either directly, by inhaling or touching oil products, or indirectly by ingesting contaminated seafood. Staff working on oil clean-up should use protective clothing and respiratory protection. Access to the OSRD should be controlled by surveillance camera systems and restricted by fencing the site to reduce the risk of third party accidents.

8.6 Mitigation measures

A spill prevention, containment and countermeasure action plan will need to be developed for the Construction Phase and Operational Phase of the OSRD development. This will need to include a monitoring plan of containment areas, valves, tanks and pipelines for spills. If a spill occurs, immediate action will need to be taken in accordance with the Local and National Contingency Plans. Any spills/leakage identified will need to be addressed immediately and their cause remedied.

The following protective structures and measures to prevent spills from reaching ground and sea are recommended during the Construction Phase and Operational Phase of the OSRD development.

8.6.1 Construction Phase

- Secondary containment systems for petroleum products storage tanks, spill clean up absorbent material available, soil covers, concrete paving and bunding, drain covers, designated loading/unloading areas and drain plugs;
- Fences and gates surrounding containment areas;
- Pipelines should have isolation valves, overpressure protection devices, pipeline protective measures such as crash barriers and/or bollards;
- Pipelines corrosion protection measures:

- External corrosion can be prevented by using cathodic protection and coated pipelines which avoid direct contact soil-pipeline;
- The use of inhibitors and internal coatings could prevent internal corrosion;

- Ensure that equipment conforms with the appropriate technical specification of quality and control during construction

8.6.2 Operational Phase

In addition to the provisions noted above for the Construction Phase, which should be also included in the Operational Phase, the following spill prevention or containment design features should be considered in the OSRD basis of design:

- Paved and bunded areas for groups of storage tanks, sufficient to retain at least 110% by volume of the largest tank within the bunded area;
- Settling basin for the site surface water drainage system;
- Automatic shutoff valve on discharges and
- Full containment tanks for fuel storage.

In addition to these specific measures for the OSRD, CONCAWE has proposed more general measures for spill prevention and response during operational phases at petroleum products storage facilities, including the creation of a control room to manage surveillance systems, computers and monitors, pressure monitoring systems, and automatic alarms. The use of intelligent pigs is also proposed to detect leaks and metal loss due to corrosion. Patrols should be carried out to detect maintenance requirements, potential leaks and spillage.

Additional recommendations from CONCAWE include a description of safety devices and located to detect releases. This may include electronic spill detectors, visual supervision of activities (cameras), kerbs and bunds, fire water network, double equipment, instrument protection systems and emergency systems. Resources and equipment, communication and organisation procedures, testing of emergency plans and training of personnel should also be described. A monitoring plan would allow checking the state of installations and maintenance activities.

Emergency containment systems and fire fighting strategies should also be provided.

8.7 Oil Pollution Prevention Plans

Cyprus developed a National Contingency Plan13 (NCP) in 1983, which was reviewed in 1997 and again in 2011. The Plan allows for a tiered response to oil spills around the coast of Cyprus. A regional oil spill contingency plan has also been established with Egypt and Israel. Up until early 2006, in the case of major incidents, sub-regional contingency arrangements would be activated, and the Emergency Response Centre (ERC) would be located at the Fisheries Department Headquarters in Nicosia, with the director of the Department of Fisheries taking the role of the National On-Scene Commander (NOSC).

Small spills occurring on sites would be treated with local available resources under the surveillance of the Department of Fisheries. Furthermore, if an incident occurred, an ERC would be set up at the corresponding district office (Larnaca, Famagusta, Pafos, or Limassol) to coordinate the spill response.

The Department of Fisheries and Marine Research (DFMR) of the Ministry of Agriculture and Natural Resources is responsible for oil spill control and response at the national level and for the setting up of emergency response centres (ERCs) as follows:

- The Department of Fisheries and Marine Research Headquarters responds to oil spill accidents, activates the National Contingency Plan and if necessary enforces the Sub-regional Agreement between Cyprus, Israel, and Egypt to combat oil spills;
- In case of larger oil spills which cannot be dealt with using the national equipment and resources, the Department of Merchant Shipping is responsible for coordinating international and EU assistance. Also, the Department of Merchant Shipping will liaise with EMSA in order to contract oil recovery services.

The Cyprus National Authorities also have in their possession:

- 1,550 m of Open Sea Boom;
- 1,850 m of Harbour Boom;
- 600 m of Coast Boom;
- 10 Dispersants Spraying Units;
- 11 Skimmers Units;

- approximately 22,000 litres of Oil Dispersants;
- 6 Oil Holding Tank Units;
- 3 Submersible pump units;
- 4 pressure steam cleaner units;
- 5 Oil/Water Separator Units;
- 3 Generating Sets, Oil Sorbents, Vehicles, Portable Hydraulic Winches, 3 Water Pumps, and 1 Vacuum Cleaner.

Cyprus Oil Refinery, BP and the cement factories all maintain stocks of booms, dispersants, skimmers and sorbents to varying degrees. A number of private contractors offer spill response equipment including dispersant spraying vessels.

The National Contingency Plan for Oil Pollution describes the properties of oil products likely to be spilled in the Cypriot marine environment. HFO and LFO are currently handled at Vasilikos Cement Factory, Vasilikos Power Station, Moni Cement Factory, Dhekelia Power Station, BP installations and Larnaca Oil Refinery.

The NCP also describes the antipollution equipment and products available for the Department of Fisheries and Marine Research including vessels, dispersant spraying units, skimmers, oil dispersants, pressure steam cleaners, oil/water separators, water pumps, and vacuum cleaners.

The NCP lists coastal installations and sites needing special protection classified in four categories: bathing places, water intakes, marinas and fishing shelters, fish farms/hatcheries, and sensitive areas of special protection. Sites located near the Vasilikos area, and therefore of relevant importance to be considered during the elaboration of the OSRP, are:

- ✓ Governors Beach, a bathing area located approximately 3 km to the west of the OSRD.
- ✓ Installations that have water intakes in Vasilikos area and should be informed in case of an accident: Vasilikos Power Station, Kitiana Fisheries Ltd. and Telia Aqua Marine Public Ltd. hatchery;
- ✓ Fisheries located at Zygi : Blue Island Fish Farming Ltd, Seawave Fisheries Ltd, Kingfisher Aquaculture Ltd and Alkioni;

- ✓ The Archirodon port shelter is located around 1,500 m west of the OSRD; and
- ✓ Special Sensitive Areas in the southern coast of Cyprus (Larnaca Lake Nature Reserve and Limassol (Akrotiri) Lake Nature Reserve) are not likely to be affected by small oil spills, but should be considered in case of major events.

During both the Construction Phase and Operational Phase of the OSRD, oil spill response plans (OSRPs) will need to be developed and implemented.

The aim of each OSRP should be to:

- Control potential oil releases during construction, operation, and possible residual impacts;
- Minimise the volume and movement of the spill;
- Minimise the environmental impacts;
- Maximise the response depending on oil release type and equipment;
- Maximise the effectiveness of the response by assigning responsibilities, and establishing callout procedures and staff training;

Each OSRP should contain the following sections:

- Description of the site context;
- An overview of the political, legislative framework and existing response plans;
- Emergency Management Plan;
- Description of containment and clean up equipment and location;
- Inland, marine and transboundary tiered response plans;
- Resources, roles and responsibilities;
- Staff training approaches; and
- Schedules, manuals, documents and procedures and plan implementation.

Chapter 9

Waste Management Plan

Table of Contents

9. Waste Management Plan

9.1 Introduction

The objective of the Waste Management Plan (WMP) is to delineate the way of managing waste arising from the construction and operation of the new Tank Farm of KODAP at Vassilikos.

The WMP aims to:

- Summarize the actions of waste management during the construction works of the Tank Farm;
- Indicate the rules and limits of liability of all parties involved;
- Identify the appropriate documentation and management of waste, as well as the applicable legislative provisions and licensing requirements (where applicable).

Table 9.1 and **Table 9.2** below detail the type of solid wastes anticipated to be generated by the construction as well as the operation activities of the Tank Farm.

Wastes are characterised according to the list as defined by Cypriot legislation (Law 215(I)/2002). The list is based on the AEOLIKI's previous experience in designing and developing facilities of this nature.

Table 9- 1: KODAP Fuel Farm Construction Phase Waste Production

No.	Waste Code	Waste Type	Waste Category - Law 215(I)/2002)
1	20 01 21	Spent mercury light bulbs/tubes	Fluorescent tubes and mercury-containing waste
2	16 06 05	Spent dry-charged batteries	Other batteries and accumulators
3	16 06 06	Waste sulphuric acid (electrolyte)	Separately collected electrolyte from batteries and accumulators
4	18 01 08 - 18 01 09 18 02 07 - 18 02 08	Medical wastes	Medical wastes
5		Waste chemicals	Waste chemicals general
6	13 02	Waste lubricating oil	Waste engine, gear and lubricating oils
7	13 08 99	Oiled rags	Wastes not otherwise specified
8	16 01 07	Waste oil and air filters	Oil filters
9	13 05 02	Oil sludge	Sludges from oil/water separators
10	19 13 01	Oil contaminated soil including absorbents	Solid wastes from soil remediation containing dangerous substances
11	16 06 01	Batteries - lead cell (without electrolyte)	Lead batteries
12	05 01 17 05 01 07 - 05 01 08	Bitumen, tar paper, ruberoids, insulation material	Bitumen Tars
13	20 01 28	Paints/wood dyes, adhesives	Paint, inks, adhesives and resins
14	17 01 03	Broken ceramic	Tiles and ceramics
15	16 01 07	Spent filter material not contaminated with harmful substances	Oil filters
16	19 08 05	Sludge from biological wastewater treatment facilities	Sludges from treatment of urban waste water
17	10 13 06	Waste cement	Cement dust
18	20 01 08	Food wastes	Biodegradable kitchen and canteen waste
19	17 04 05	Ferrous metal scrap	Iron and steel
20	17 04 01 - 17 04 06	Non-ferrous metal scrap	Non-ferrous metals
21	16 01 03	Tyres	End-of-life tyres
22	17 01 01	Waste concrete and reinforced concrete components	Concrete
23	20 01 38	Brush wood	Wood
24	17 02 01	Construction wood	Wood
25	20 010 01	Uncontaminated waste paper/cardboard; paper/cardboard manufacture	Paper
26	20 01 11	Waste textile clothes (working clothes)	Clothes
27	20 01 02	Uncontaminated glass / broken glass	Glass

Table 9- 2: KODAP Fuel Farm Operational Waste Generation

No.	Waste Code	Waste Type	Waste Category - Law 215(I)/2002)
1	20 01 21	Spent mercury light bulbs/tubes	Fluorescent tubes and mercury-containing waste
2	19 01 10	Activated carbon	Spent activated carbon for the site Vapour Recovery Unit
3	16 06 05	Spent dry-charged batteries	Other batteries and accumulators
4	16 06 06	Waste sulphuric acid (electrolyte)	Separately collected electrolyte from batteries and accumulators
5	18 01 08 – 18 01 09 18 02 07 – 18 02 08	Medical wastes	Medical wastes
6		Waste chemicals	Waste chemicals general
7	07 03 03 – 07 03 04	Waste organic solvents	Organic solvents
8	13 02	Waste lubricating oil	Waste engine, gear and lubricating oils
9	13 08 99	Oiled rags	Wastes not otherwise specified
10	16 01 07	Waste oil and air filters	Oil filters
11	13 05 02	Oil sludge	Sludges from oil/water separators
12	19 13 01	Oil contaminated soil including absorbents	Solid wastes from soil remediation containing dangerous substances
13	16 06 01	Batteries – lead cell (without electrolyte)	Lead batteries
14	05 01 17 05 01 07 – 05 01 08	Bitumen, tar paper, ruberoids, insulation material	Bitumen Tars
13	20 01 28	Paints/wood dyes, adhesives	Paint, inks, adhesives and resins
14	17 01 03	Broken ceramic	Tiles and ceramics
15	19 08 05	Sludge from biological wastewater treatment facilities	Sludges from treatment of urban waste water
16	19 08 01	Waste generated ion the course of mechanical treatment of domestic waste water	Screenings
17	10 13 06	Waste cement	Cement dust
18	20 01 08	Food wastes	Biodegradable kitchen and canteen waste
19	17 04 05	Ferrous metal scrap	Iron and steel
20	17 04 01 – 17 04 06	Non-ferrous metal scrap	Non-ferrous metals
22	17 01 01	Waste concrete and reinforced concrete components	Concrete
24	17 02 01	Construction wood	Wood
25	20 010 01	Uncontaminated waste paper/cardboard; paper/cardboard manufacture	Paper
26	20 01 11	Waste textile clothes (working clothes)	Clothes
27	20 01 02	Uncontaminated glass / broken glass	Glass
28	20 03 01	Solid domestic wastes	Mixed municipal waste

9.2 Waste Clasification

Waste is defined in the Cyprus Waste Law of 2011 (N.185(I)/2011) as:

- Any substance or object that the holder discards, intends to or is required to discard. Waste includes, but is not limited to, the following:
- Production or consumption residues;
- Off-specification products;
- Products whose date for appropriate use has expired;
- Materials spilled, lost or having undergone other mishap, including any materials, equipment, etc., contaminated as a result of mishap;
- Materials contaminated or soiled as a result of planned actions (e.g., residues from cleaning operations, packing materials, containers, etc.);
- Un-usable parts (e.g., reject batteries, exhausted catalysts, etc.);
- Substances that no longer perform satisfactorily (e.g., contaminated acids, contaminated solvents, etc.);
- Residues of industrial processes (e.g., slags);
- Residues from pollution abatement processes (e.g., scrubber sludge, spent filters, etc.);
- Machining or finishing residues;
- Residues from raw materials extraction and processing (e.g., mining residues, oil field slops, etc.);
- Adulterated materials (e.g., oils contaminated with polychlorinated biphenyls [PCBs], etc.);
- Any materials, substances, or products whose use has been banned by law;
- Products for which the holder has no further use (e.g., agricultural, household, office, commercial and shop discards, etc.); and
- Contaminated materials, substances or products resulting from remedial action with respect to land. Waste is categorized into three main types:
    - Hazardous waste;
    - Inert waste; or
    - Non-hazardous waste.

Per the Solid and Hazardous Waste (Waste Catalogue) Order (K.D.P. 157/2003), waste codes are used to further classify the waste types into waste streams, also referred to as waste streams. To define the waste code, the following details need to be known about the waste:

- The type of business/industrylocation that produced the waste (e.g., pharmaceutical manufacture);
- How the waste arose (i.e. the process/activity that produced it);
- A full description of the waste;
- What the constituents of the waste;
- The concentration of any dangerous substances and descriptions of the risks (risk phrases) associated with these substances; and
- The hazards are associated with the waste.

The coding of the waste is determined via a six digit number (XX YY ZZ).

- “XX” denotes a chapter number from 1 to 20 which provides general information about the group the wastes (e.g., it groups waste from the same origin);
- “YY” denotes more detailed information about the waste within the XX chapter; and
- “ZZ” denotes a number for each waste stream within the YY group. An asterisks (XX YY ZZ*) is added to the 6 digit waste code is classified a hazardous material.

For example, if determining the waste code for wooden pallet waste, then refer below for an excerpt from the Waste Catalogue (refer to Appendix A).

CHAPTER 15 Waste Packaging; Absorbents, Wiping Cloths, Filter Materials and Protective Clothing not otherwise specified

15 01	**Packaging (including separately collected municipal packaging waste)**
15 01 01	Paper and cardboard packaging
15 01 02	Plastic packaging
15 01 03	Wooden packaging
15 01 04	Metallic packaging
15 01 05	Composite packaging
15 01 06	Mixed packaging
15 01 07	Glass packaging
15 01 08	No designation
15 01 09	Textile packaging
15 01 10*	Packaging containing residues of or contaminated by dangerous substances
15 01 11*	metallic packaging containing a dangerous solid porous matrix (for example asbestos), including empty pressure containers
15 02	**Absorbents, filter materials, wiping cloths and protective clothing**
15 02 01	No designation
15 02 02*	Absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances
15 02 03	Absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02

Per the Waste Catalogue, a wooden pallet would be wooden packaging waste, therefore:

- XX = 15, as this number is the chapter designated for “Waste Packaging; Absorbents, Wiping Cloths, Filter Materials and Protective Clothing not otherwise specified”;
- YY = 01, as this is the group within Chapter 15 for “Packaging (including separately collected municipal packaging waste)”; and
- ZZ = 03, as wood is the third waste stream within the packaging group.

All waste codes will be predetermined and marked against each waste stream within the facility’s Waste Register. Refer to Appendix B for the facility Waste Register, containing all type of waste produced and stored at the temporary waste storage area at the site.

The other waste types and waste streams are defined in the following sections.

9.2.1 Hazardous Waste

9.2.1.1 Hazardous Waste Clasification

Annex III of the Cyprus Waste Law (refer to Appendix C) lists the properties of a waste that render it a hazardous waste type. For disposal, hazardous waste is required to be segregated into waste streams and coded per the Waste Catalogue (refer to Appendix A).

Certain hazardous waste streams requires special handling and, in some cases, additional monitoring. These waste streams include:

- Polychlorinated biphenyls (PCBs) and polychlorinated terphenyls (PCTs) waste;
- Used mineral oils;
- Electrical and electronic equipment waste;
- Used batteries and accumulators;
- Asbestos waste;
- Pesticide waste;
- Naturally occurring radioactive material (NORM) waste;
- Used tyres; and
- Hazardous packaging waste.

The facility Waste Register (refer to Section 3.2) lists all the waste streams, including the corresponding waste codes, generated at a facility. If any of the above waste streams are encountered and are not listed on the facility Waste Register, the Site EHS Coordinator shall be contacted immediately for handling instructions. An example of a hazardous waste stream is listed below:

Waste Type:	Hazardous
Waste Stream:	Waste oil
Description:	Used engine oil, slop oil, etc.
Waste Code:	13 07 03*

9.2.2 Unknown Waste

All waste generated at a facility should be listed on the facility Waste Register. However, if an unknown waste is encountered, it shall be treated as hazardous waste until its constituents and characteristics can be verified for proper classification, handling, storage and disposal.

9.2.3 Inert Waste

Inert waste is waste which is neither chemically or biologically reactive, and will not decompose. Examples of this are soil and stones; glass; tile and ceramics; drywall and concrete.

Wastes, which may be classified "inert waste", include:

- Selected demolition waste - although the preferred option is to re-use and recycle this material;
- Construction waste - may be inert if suitably source selected/segregated. Recycling and reuse is preferred, but the small quantities generated by many building sites often makes this uneconomic;
- Uncontaminated soils and sub-soils - not normally classified as a waste if reused; and
- Highways carriageway waste (e.g., scrapings, etc.) is usually classified as hazardous unless subject to leaching tests as heavy trafficking results in contamination from tire and oil residues, etc.

9.2.4 Non Hazardous Waste

9.2.4.1 Non Hazardous Waste Clasification

Per the Cyprus Waste Law, non-hazardous waste is waste that does not meet the definition of hazardous waste. For disposal, non-hazardous waste is required to be segregated into waste streams and coded per the Waste Catalogue (refer to **Appendix A**). Certain non-hazardous waste streams requires special handling and, in some cases, additional monitoring. These waste streams include:

- Recyclables (such as recovered paper, metal, plastic and glass);
- Used alkaline batteries; and
- Non-hazardous packaging waste.

The facility Waste Register (refer to Section 3.2) lists all the waste streams, including the corresponding waste codes, generated at a facility. If any of the above waste streams are encountered and are not listed on the facility Waste Register, the Site EHS Coordinator shall be contacted immediately for handling instructions. An example of a non-hazardous waste stream is listed below:

Waste Type:	Non-hazardous
Waste Stream:	Scrap metal (no contamination with oil/chemicals)
Description:	Empty cans, empty drums, empty aerosols (no pressure), plate, pipe, chains, wire rope, etc.
Waste Code:	17 04 07

9.3 Mixing Wastes

Mixing of waste types shall be avoided. Mixing non-hazardous waste with hazardous waste will result in the entire mixture being classified as hazardous. Mixing these wastes increases the volume that must be handled, stored, transposed and disposed of as hazardous waste.

Mixing of waste streams shall be avoided wherever possible. Mixing waste streams may lead to contaminating a potential recyclable waste stream or a waste stream that is required to be disposed of separately.

It is not recommended to rinse containers that previously held hazardous materials. If such container is rinsed, the generated liquid is classified as a hazardous waste and, therefore, will require classification by the Site EHS Coordinator for proper handling determination.

9.4 Waste Management Plan Requirements

Waste will be managed in accordance with this Waste Management Plan specific to the facility.

The types of wastes, volumes and management/disposal techniques employed will be tracked and documented per waste stream.

The Waste Management Plan (WSM) shall catalogue all waste streams specific to the facility and the systems utilized to manage the wastes. Furthermore, the Plan shall contain the following sections at a minimum:

- Waste Register;
- Waste handling, labelling, and storage;
- Waste tracking documentation;
- Waste inspection;
- Waste transportation;
- Waste disposal;
- Reporting and recordkeeping requirements; and
- Training.

9.4.1 Waste Register

The Waste Register section of the facility Waste Management Plan lists the following information for each waste stream generated by the facility:

- Waste code;
- Waste handling requirements;
- Waste collection container and labelling requirements;
- Tracking documents to be used;
- Shipping requirements;
- Disposal/recycle/reuse method; and
- Planned (licensed) waste transporter and waste disposal facility.

Once a material is determined as a waste produced by the facility, it must be classified and listed in the Waste Register. Waste shall be classified according to

Section 9.2 above. The Site EHS Coordinator is responsible for confirming the classification of each new waste stream and the plan for storage and disposal.

The Waste Register must routinely be updated as waste streams and disposal options change. This is the responsibility of the Site EHS Coordinator. It is also a good tool to use when planning storage, disposal options and frequency of disposal.

9.4.2 Unknown Waste

If a waste is unknown, technical information from Material Safety Data Sheets (MSDS) or Safety Data Sheets (SDS) or results of testing in a laboratory can be used as a basis for classification of the waste; however, **it shall be handled as a hazardous waste until determined otherwise**.

An acceptable test for unknown waste is the BS EN 12457-2:2002 Characterization of Waste – Leaching –Compliance Test for Leaching of Granular Waste Materials and Sludges.

9.4.3 Waste Handling, Labelling and Storage

Personnel designated to handle wastes is required to wear appropriate Personal Protective Equipment (PPE) while handling the waste, as specified on the Material Safety Data Sheet (MSDS).

All waste shall be separated at source per waste type and waste stream and have a pre-determined location for collection and storage in preparation for disposal. All waste containers shall be made of the material and labeled as specified in the facility Waste Register. Labels must be legible, permanent and complete with the following information:

- Waste type;
- Waste stream;
- Hazardous material label, if applicable; and
- Waste containers that include a substance or mixture of substances shall be labelled per the above requirements “hazardous material” in the languages of Greek and English.

All waste shall be stored in such a way that:

- Corrosion or wear of waste containers is avoided;
- Accidental spillage or leakage is avoided;
- Waste containers cannot break due to accident or weather, and are robust enough to withstand transport on a support vessel;
- Waste cannot be blown away or fall whilst being stored or transported; and
- Waste cannot be scavenged.

All hazardous and liquid waste shall be stored in a sealed container. On no account shall liquid waste be poured into an open waste skip. Hazardous and liquid waste storage areas must have secondary containment or another appropriate spill prevention measure.

All waste must be handled in such a way that its future handling, when it has been removed from the site, is safe both for the waste and those handling it.

Any damaged waste containers should be replaced immediately and reported to the Site EHS Coordinator and Site Manager.

9.4.4 Waste Tracking Documentation

This section of the facility Waste Management Plan documents the waste tracking processes. It is required that all wastes generated are documented, manifested and logged.

The required waste tracking documentation is dependent on the waste type, waste stream and per any additional regulatory requirements.

The following tracking documents should be maintained:

- Waste Manifest;
- Waste Disposal Log;
- Type VIII Register;
- Identification Register;
- Non-Hazardous Waste Delivery Register;

These documents are discussed further within the sections below.

9.4.4.1 Waste Manifest

A Waste Manifest is to be completed for every hazardous waste and non-hazardous wastes load. This manifest is to accompany the waste, being signed by the waste producer, site representative, waste transporter and waste disposal facility. The signed original Waste Manifest is returned to the facility by the waste disposal facility, where it is to be documented as received in the Waste Disposal Log.

Copies of any associated sampling data and/or a MSDS identifying the waste characteristics shall be attached to the manifest to accompany the waste shipment.

9.4.4.2 Waste Disposal Log

A Waste Disposal Log is required to be maintained for all wastes (both hazardous and non- hazardous) sent for disposal. This log quantifies the date of shipment, weight of each waste stream shipped, manifest number and confirmation of returned signed Identification Register (for hazardous waste loads) and Waste Manifest (for both hazardous and non-hazardous waste loads).

9.4.4.3 Type VIII Register

Per the Solid and Hazardous Waste (Waste Register) Order of 2003 (K.D.P. 158/2003), a hazardous waste producer shall maintain a Type VIII Production/Possession of Hazardous Waste Register (hereafter referred to as the Type VIII Register, refer to Appendix F). This register shall be maintained by the hazardous waste producer detailing the information contained within Identification Register (e.g., the name of the licensed waste transporter, the licensed waste disposal facility, the recovery method) every time a shipment of hazardous waste is delivered to a licensed transporter/disposal facility.

9.4.4.4 Identification Register

Per the Management of Solid and Hazardous Waste (Hazardous Waste Identification Register) Order of 2003 (K.D.P. 159/2003), all hazardous waste shipments shall be accompanied by a Hazardous Waste Identification and Tracking Register (hereafter referred to as the Identification Register).

This register shall be filled out by the waste producer and is to accompany the waste shipment at all times through to the final waste disposal facility. This register is to be signed by the waste producer, the licenced waste transporter and the licenced waste disposal facility receiving the hazardous waste (i.e. final destination of the waste).

After the waste has been received and signed by the waste disposal facility, a signed copy of the certificate shall be returned to the waste producer for close out and documentation on the Waste Disposal Log.

9.4.4.5 Non-Hazardous Waste Delivery Register

Per the Solid and Hazardous Waste (Waste Register) Order of 2003 (K.D.P. 158/2003), a waste transporter shall fill out a Type II Collection/Transportation of Non-Hazardous Waste Register (hereafter referred to as the Non-Hazardous Waste Delivery Register) for every non-hazardous waste load received from a waste producer and delivered to a waste disposal facility.

This register contains information about the waste producer, the waste stream and code of non- hazardous waste collected and the waste disposal facility to which the collected waste will be delivered. A copy of this register shall be provided to the waste producer by the waste transporter upon collection of the non-hazardous waste.

The Site EHS Coordinator is to file a copy of the transporter’s Non-Hazardous Waste Delivery Register.

9.4.5 Waste Inspection

This section of the facility Waste Management Plan identifies the process for routinely inspecting waste storage areas. Inspection of hazardous waste storage areas shall occur and be documented weekly. Any non-conformances noted (including those that are resolved at the time of observation) must be reported to the Site EHS Coordinator and documented with an action plan to bring into conformance.

9.4.6 Waste Transportation

This section of the facility Waste Management Plan documents the process for transporting wastes to storage or final disposal, whichever applies. **All waste transporters must hold a valid license, issued by the MANRE, for the waste stream they are transporting**.

The Site EHS Coordinator shall ensure the Waste Disposal Log is maintained;. Each transporter shall be provided with waste shipping documentation and associated documentation such as MSDS, sampling, etc. for the specific waste included in the shipment. The transporter is responsible for ensuring the type and quantity of waste accepted can be safely secured on the truck for the journey. All wastes shall be transported by trucks that are authorized to carry the material.

All waste shall be transported by approved waste transporter. Approved waste transporters shall have a valid license, which is issued by MANRE in accordance with the provisions of the Waste Law of 2011 (N.185 (I)/2011). A list of the approved waste transporters shall be maintained in the facility's Waste Management Plan registry. Waste transporters will be required to submit the following plans/documents to the site EHS Coordinator and site Manager for review prior to transporting any hazardous waste:

- Pollution Prevention Plan, including Emergency Response Plan for Oil and Hazardous Spill;
- Documentation of approval from MANRE for all transporters in the onshore transfer chain;
- Documentation as required for the shipment of dangerous goods per the ADR Code for all transporters in the onshore transfer chain

9.4.7 Waste Disposal

Prearranged (and approved) disposal methods and waste disposal facilities are to be documented within this section of the facility Waste Management Plan. The waste generator is not required to hold a license for waste transportation, handling and disposal but is required to use licensed waste transporters and waste disposal facilities for the disposal of all wastes generated.

The waste generator is responsible for ensuring proper disposal of its wastes from "cradle to grave". Hence, the Site EHS coordinator shall ensure legal requirements for waste management are complied with at all times, and that its subcontractors are suitable.

Copies of all waste documentation shall be maintained for a minimum of five years. All waste, including recyclable materials, shall be disposed at an approved waste disposal facility, using approved waste transporters. **Approved waste disposal facilities shall have a valid Waste Management license**, which is issued by MANRE in accordance with the provisions of the Waste Law of 2011 (N.185 (I)/2011). A list of the approved waste disposal facilities shall be maintained in the facility's Waste Management Plan registry.

9.4.8 Facility (Work Site)

The Site EHS Coordinator shall prepare the required paperwork and ensure waste is classified, packaged, labelled and stored according to legal requirements and best practice. The Site EHS Coordinator shall also arrange disposal through a licensed waste contractor as soon as practicable after receiving the waste.

At the site, waste shall be handled in a manner so as to comply with legal requirements and ensure safety of personnel. As a minimum, the following shall be complied:

- Each time the waste is stored in the designated area on site, the waste documentation, including MSDSs, will be prepared;
- Each time a waste is transported from the site to the final waste disposal facility, or to another waste transporter, the Identification Register (for hazardous waste loads) and Waste Manifest (for both hazardous and non-hazardous waste loads) must be accomplished, signed and acknowledged by each of the receiving parties;
- At the waste disposal facility, the authorized representative shall complete and sign the Identification Register (for hazardous waste loads) and Waste Manifest (for both hazardous and non-hazardous waste loads), and shall send a copy of the completed original documents to the Logistics Supervisor or designated agent;

9.4.9 Reporting and Recordkeeping

This section of the facility Waste Management Plan defines the reporting and recordkeeping requirements. The Site EHS Coordinator shall review waste and any non-conformance reports weekly, at a minimum, and follow-up on any non-conformances reported. In addition, any new or revised waste disposal practices shall be reviewed and updated within the facility Waste Management Plan and Waste Register.

9.4.9.1 Reporting Requirements

9.4.9.1.1 Internal Waste Reporting

The Site EHS Coordinator is responsible for ensuring all waste disposal information is maintained. He/she shall collect these documents at the beginning of each month for the previous month and forward it to the Site Manager.

9.4.9.1.2 External Waste Reporting

An annual report of the hazardous waste produced and treatment/disposal of the waste is required by a waste producer per the Cyprus Waste Law. This report shall be submitted to the Ministry of Agriculture, Natural Resources and Environment (Department of Environment) in the month of March of each year, containing information from the previous calendar year. The report is to contain a summary of the information within the Type VIII Registers from the year.

All original Type VIII Registers and a copy of all Identification Registers completed during the year must be included with the report. The report shall state the total volume of hazardous waste generated and disposed, its nature and origin, dates of shipment, means of transportation, final destination or waste disposal facility, and its type of waste processing.

There is no requirement per the Cyprus Waste Law for the waste producer to create a register for the transportation or disposal of non-hazardous waste. It is the responsibility of the licensed waste transporter to create a register stating the waste stream and quantity of waste being transported.

Neither is there a requirement per the Cyprus Waste Law for annual reporting from waste producers of their non-hazardous waste disposed. However, conditions of a company's environmental permits (e.g., Environmental Approval, , etc.) may state a requirement for the reporting of both hazardous and non-hazardous wastes produced and disposed. In addition, information regarding all non-hazardous wastes produced and disposed shall be presented to the Department of the Environment, if requested (e.g., during a facility inspection).

9.4.9.1.3 Non-Conformance and Incident Reporting

Any non-conformance that may endanger health or the environment shall be reported immediately to the facility Site EHS Coordinator. The Site EHS Coordinator shall then follow the appropriate Incident Reporting Procedures.

Reporting of non-conformance and corrective action(s) noted by personnel should be defined in the facility's Waste Management Plan. The management procedure for non-conformities not resolved immediately should also be defined such as how appropriate action, if any, is determined; how priority of implementation is determined; and how non-conformities are tracked to closure.

Spill response kits shall be maintained in areas where they may be needed and equipped according to the potential spill size in the surrounding area. Facility staff shall be trained in spill response for the facility location and in the use of the spill kits. Any waste generated as a result of a spill and the resulting spill clean up will be characterized and handled in accordance with the facility Waste Management Plan.

9.4.9.2 Recordkeeping Requirements

The Program and all relevant documentation such as Waste Management Plan, Waste Register, Waste Disposal Logs, MSDSs, shipping manifests, sampling reports, etc. shall be stored in a central location at the respective facility.

The facility Waste Management Plan shall define how the following records for waste management related activities are maintained, where they are to be stored and how long they are to be stored. This includes but is not limited to the following:

- Current Waste Management Plans including Waste Register, Waste Disposal Log, Shipping Paperwork and supporting documentation;
- Monthly waste and discharge monitoring reports;
- Log of non-conformances;
- Copy of waste transporter and waste disposal facility licenses, if applicable.

List of Tables

APPENDIX A

(Meteorological Data)

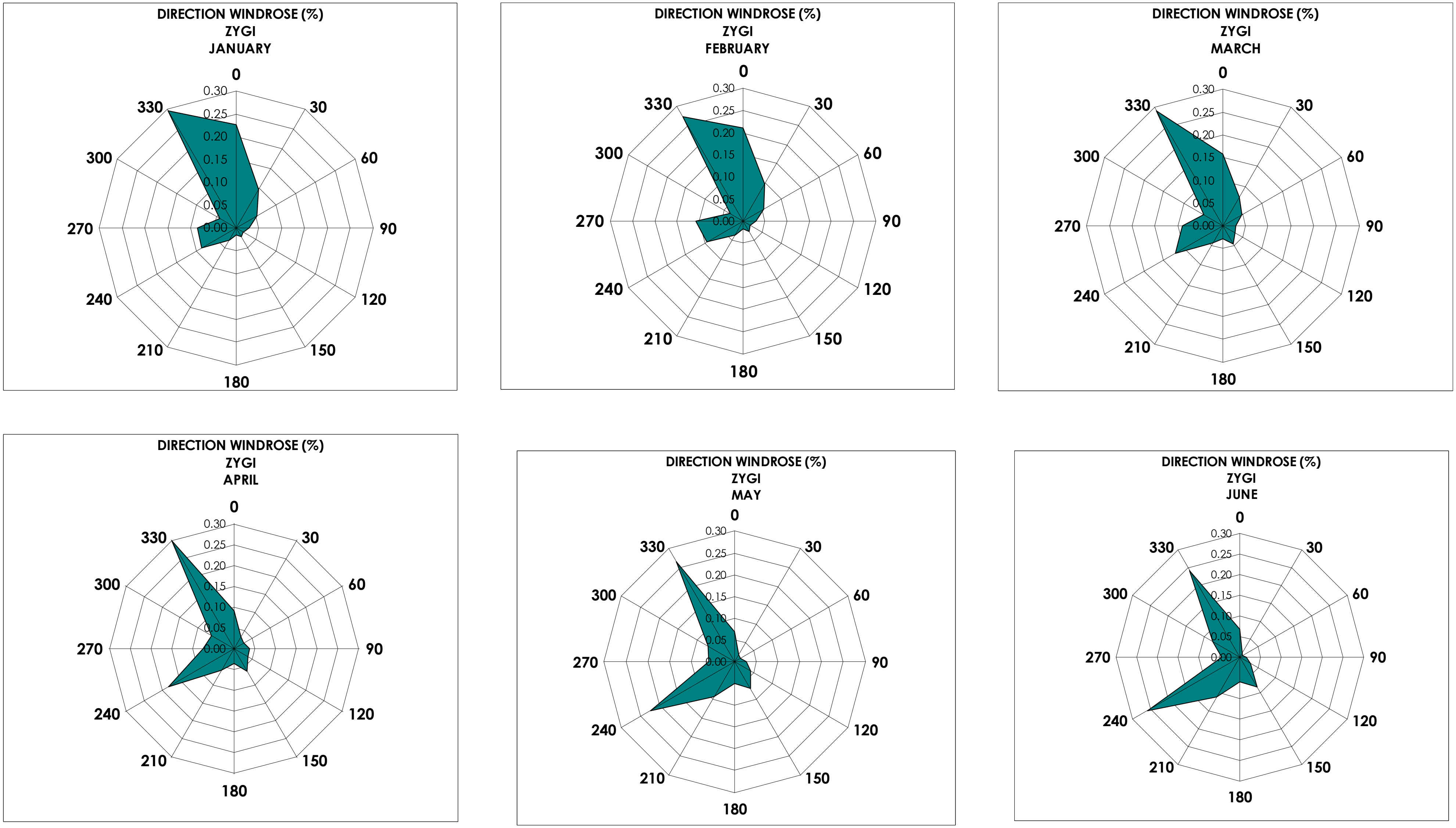


Figure B.1 – Zygi Direction Wind Rose (%) – January – June (1981 – 2011)

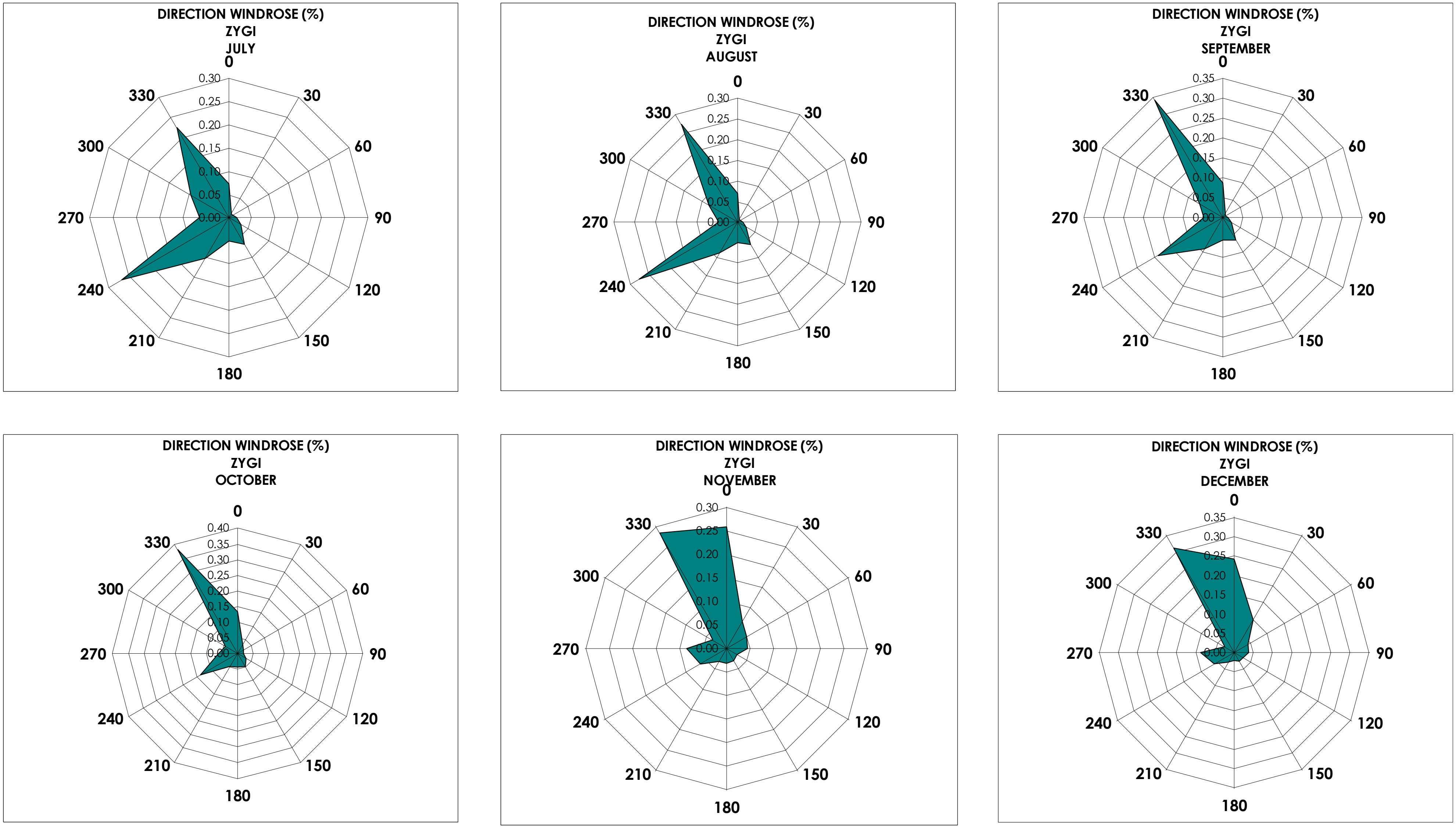


Figure B.2 – Zygi Direction Wind Rose (%) – July - December (1981 – 2011)

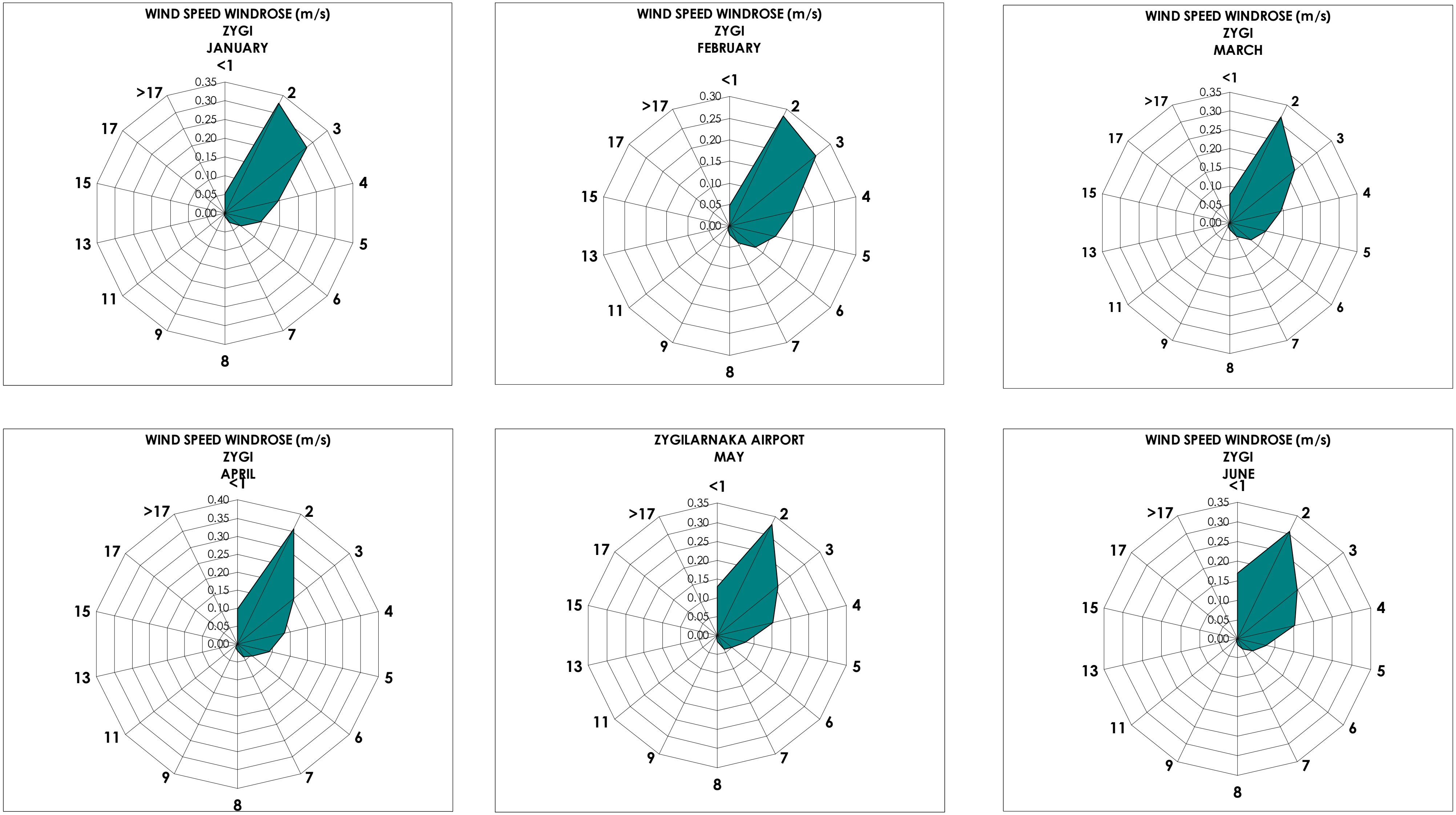
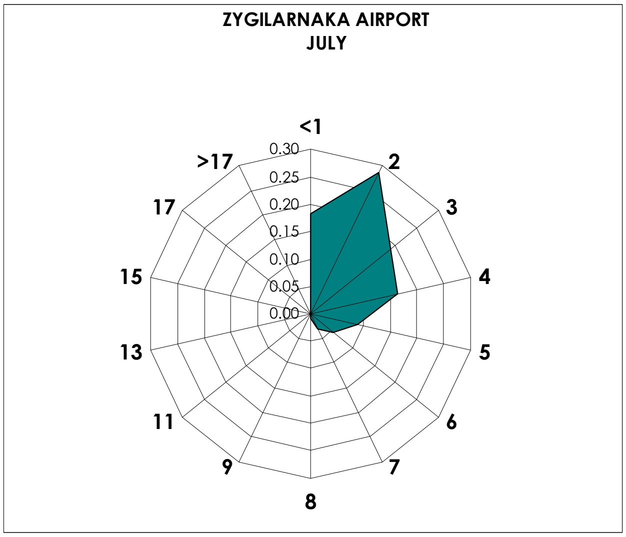
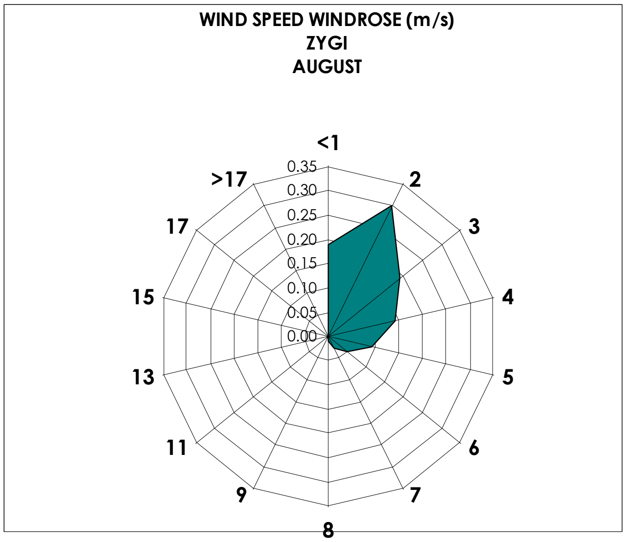
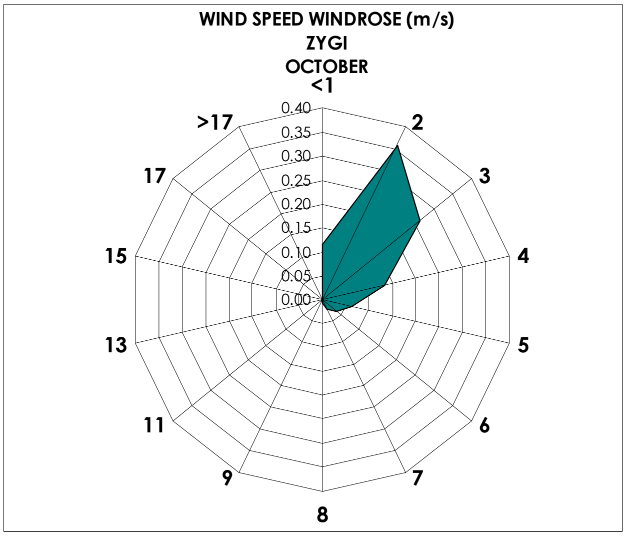


Figure B.3 – Zygi Wind Speed Rose (%) – January - June (1981 – 2011)







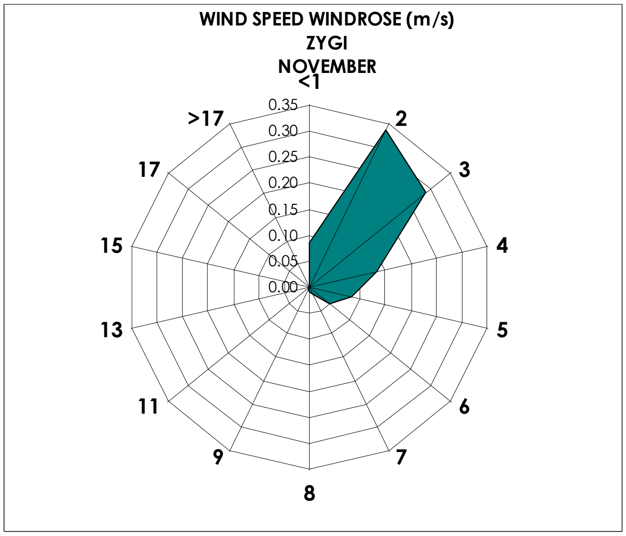


Figure B.4 - Zygi Wind Speed Rose (%) – July - December (1981 – 2011)

APPENDIX B

(Environment Data)

Flora in the surrounding area to the OSRD

No.	LATIN NAME		OBSERVATIONS
1	*Aegilops peregrina*	Gradual	
2	*Aethiorniza buibosa*	Gradual	
3	*Allium neapolitanum*	Gradual	
4	*Anagallis arvensis van arvensis*	Gradual	
5	*Anagallis arvensis van arvensis*	Gradual	
6	*Anthemis palaestina*	Gradual	
7	*Anthemis tricolor*	Gradual	ENDEMIC
8	*Asperula cypria*	Gradual	ENDEMIC
9	*Asphodelus aestivus*	Gradual	
10	*Aster squamatus*	Gradual	
11	*Astragalus cyprius*	Gradual	ENDEMIC
12	*Atractylis cancellata*	Gradual	
13	*Avena sp.*	Common	
14	*Beta vulgaris ssp.maritima*	Gradual	
15	*Biscutella dicyma vanleiccarea*	Gradual	
16	*Briza maxima*	Gradual	
17	*Bromus rubens*	Gradual	
18	*Carendula arvensis*	Gradual	
19	*Caiycotome viilosa*	Gradual	
20	*Carcopacium corymposum*	Gradual	
21	*carcuus pyonocaonarus ssp. Aibicus*	Gradual	
22	*cartina involucrata ssp.cyprica*	Gradual	ENDEMIC
23	*Carthamus sp.*	Gradual	
24	*Centaurea nvaioiepis*	Gradual	
25	*Chenopoaium muraie*	Gradual	
26	*Chrysanthemum corpnarium ven ceronanum*	Gradual	
27	*Chrysanthemum segetum*	Gradual	
28	*Cistus parviflorus*	Gradual	
29	*Cistus salviifolius*	Gradual	
30	*Convivios aithaecices*	Gradual	
31	*Convolvulus arvensis*	Gradual	
32	*Convolvulus pinifolius van pleurotus*	Gradual	
33	*Conyza bonariensis*	Gradual	
34	*Crucianella sp.*	Gradual	
35	*Crupina crupinastrum*	Gradual	
36	*Cynodon dactylon*	Gradual	
37	*Dactylis glomerata*	Gradual	
38	*Daucus carota ssp.carota*	Gradual	
39	*Echinops spinosissimus*	Gradual	
40	*Echium angustifolium*	Gradual	
41	*Emex spinosa*	Gradual	
42	*Erodium gruinum*	Gradual	
43	*Erodium malacoides*	Gradual	
44	*Erucaria hispanica*	Gradual	
45	*Eryngium creticum*	Gradual	
46	*Fagonia cretica*	Gradual	
47	*Ferula communis*	Gradual	
48	*Filago pyramidata*	Gradual	
49	*Fumana arabica*	Gradual	
50	*Fumana trymifolia*	Gradual	
51	*Fumaria densiflora*	Gradual	

Flora in the surrounding area to the OSRD

No.	LATIN NAME		OBSERVATIONS
52	*Genista sphacelata ssp.sphacelata*	Gradual	
53	*Hedypnois rhagadioloides*	Gradual	
54	*Hedysarum spinosissimum*	Gradual	
55	*Helianthemum obtusifolium*	Gradual	ENDEMIC
56	*Helianthemum salicifolium*	Gradual	
57	*Helichrysum conglobata*	Gradual	
58	*Herniaria cinirea*	Gradual	
59	*Hippocrepis unisiliquosa ssp.unisiliquosa*	Gradual	
60	*Hydnocarpus cincinnatus*	Gradual	
61	*Inula viscosa*	Gradual	
62	*Juniperus phoenicea*	Gradual	
63	*Lagcecia cuminoides*	Gradual	
64	*Lathyrus annuus*	Gradual	
65	*Lathyrus aphaca*	Gradual	
66	*Linum strictum*	Gradual	
67	*Lithodora hispidula ssp.versicolor*	Gradual	
68	*Lolium sp.*	Gradual	
69	*Lotus halophilus*	Gradual	
70	*Maivia parviflora van.parviflora*	Gradual	
71	*Malva sylvestris van.sylvestris*	Gradual	
72	*Mancragora officinarum*	Gradual	
73	*Medicago minima*	Gradual	
74	*Medicago polymorpha*	Gradual	
75	*Medicago turbinata*	Gradual	
76	*Melilotus indians*	Gradual	
77	*Mellitus sulcatus*	Gradual	
78	*Micromeria nervosa*	Gradual	
79	*Noaa mucronata*	Gradual	
80	*Notapasis syriaca*	Common	
81	*Olea europaea*	Gradual	
82	*Onobrychis venosa*	Gradual	ENDEMIC
83	*Ononis reclinata van minor*	Gradual	
84	*Ononis _ectin_ ssp. Breviflora*	Gradual	
85	*Onopordum cycrium*	Gradual	ENDEMIC
86	*Orchis fragrans*	Gradual	
87	*Oryzopsis miliacea*	Gradual	
88	*Oxalis pes-caprae*	Common	
89	*Pallenis spinosa*	Gradual	
90	*Papaver hybridum*	Gradual	
91	*Papaver rhoeas van. Oblongatum*	Gradual	
92	*Parapholis incurva*	Gradual	RELATIVELY INFREQUENT
93	*Phagnalon rupestre ssp. Graecum*	Gradual	
94	*Physanthyllis tetraphylla*	Gradual	
95	*Pinus brutia*	Gradual	
96	*Pistacia lentiscus*	Gradual	
97	*Plantago afra*	Gradual	
98	*Plantago albicans*	Gradual	
99	*Plantago amplexicaulis*	Gradual	
100	*Plantago cretica*	Gradual	
101	*Polygonum equisetiforme*	Gradual	
102	*Prasium majus*	Gradual	
103	*Raphanus raphanistrum*	Gradual	

No.	LATIN NAME		OBSERVATIONS
104	*Scandix _ectin-veneris*	Gradual	
105	*Scolymus sp.*	Gradual	
106	*Scorpiurus muricatus van subvalcsus*	Gradual	
107	*Scorzonera jacquinia van.subintegra*	Gradual	
108	*Senecio vulgaris*	Gradual	
109	*Sinacis alba*	Gradual	
110	*Soncnus oleraceus*	Gradual	
111	*Sonchus tenerrimus*	Gradual	
112	*Stepterhamenus tuberosus*	Gradual	
113	*Stipa capensis*	Gradual	
114	*Teucrium divaricatum ssp. Canescens*	Gradual	
115	*Thesium humile*	Gradual	
116	*Thymus capitatus*	Gradual	
117	*Torills purpurea*	Gradual	
118	*Torularia torulosa*	Gradual	
119	*Tragopogon sinuatum*	Gradual	
120	*Trifciium angustifolium*	Gradual	
121	*Trifciium camcestre ssp.camcestre*	Gradual	
122	*Trifollum steilatum*	Gradual	
123	*Tricilum tomentosum*	Gradual	
124	*Urginea maritima*	Gradual	
125	*Uroscermum picroices*	Gradual	
126	*Valentia hiscica*	Gradual	

A list of macrobenthic composition of fauna

Crustaceans	**1m**	**5m**	**10m**	**20m**	**25m**	**30m**	**50m**	**100m**
Callianassa tyrrhena						x	x	
Ethusa mascarone						x	x	x
Eypogarus sp.				x				
Galathea squamifera				x			x	
Galathea intermedia							x	x
Paguristes oculatus							x	
Paguristes eremita							x	
Pagurus anachoretus				x				
Pagurus cuanensis						x		
Inachus dorsettensis							x	x
Anapagurus picorniger							x	x
Pisa armata				x			x	

	1m	**5m**	**10m**	**20m**	**25m**	**30m**	**50m**	**100m**
Parthenope massena							x	
Liocardius depurator							x	x
Liocardius marculatus							x	x
Liocarcinus corrugatus							x	
Liocarcinus archuatus							x	
Anchialina agilis							x	
Apseudes latreillei							x	
Spaeroma serratum								x
Cirolana borealis							x	x
Lophogaster typicus							x	
Portunus arcuatus				x				
Upogebia pusilla						x		
Alpheus glaber							x	x
Eurynome aspera							x	x
Processa canaliculata								x
Processa edulis							x	x
Pontocaris cantaphracta							x	
Upogebia pusilla							*x*	
Diogenis pugilator							x	
Leucothoe spinacarpa							x	x
Gammaridae sp.							x	x
Echinodermata								
Acrocnida branchiata						x	x	

A list of macrobenthic composition of fauna

	1m	5m	10m	20m	25m	30m	50m	100m
Amphiura chianjei					x	x	x	
Ophiura alpida				*x*	*x*	*x*	*x*	
Ophiura lacertosa						*x*		
Psammechinus microtuberculatus						*x*		
Schisastercanaliferus							x	
Brissopsis lyrifera						x	x	
Astropecten bispinonsus						x		
Astropecten irregularis						x	x	
Astropecten platyacanthus						x		
Astropecten spinulonsus						x	x	
Gasteropoda								
Bittium reticulatum				x				
Turritelaturbona							x	
Bolinusbrandaris							x	
Philineaperta							x	
Cerithium vulgatum				**x**				
Scaphopoda								
Dentaliumdentalis							x	
Cerithium vulgatum				*x*				
Haminea hydatis					*x*		*x*	
Homalopoma sp						*x*		
Jujubinus exasperatus				*x*				
Philine quatripartita					*x*			
Smaragdia viridis				*x*	*x*			
Lamellibranchiata								
Gorbula gibba					*x*	x	x	
Glycymeris pilosa					x			
Guldia minina					*x*			
Nucula sulctuta						***x***		
Azorinuschamansolen							x	
Phaxasadriaticus							x	
Nuculasulcata							*x*	
Arca noae								
Modilulaphaseolina							*x*	
Lissopectenhyalinus							*x*	
Thyasiraflexuosa							*x*	
Acanthocadtiaechinata							*x*	
Parvicardiumxiguum							*x*	
Plagiocardiumpapilosum							*x*	

A list of macrobenthic composition of fauna

	1m	5m	10m	20m	25m	30m	50m	100m
Polychaeta								
Amphictene auricoma					*x*			
Capitellidae						*x*		
Cirratullidae					*x*			
Exogone gemmifera				*x*				
Glycera convulata						*x*	*x*	
Glicera roinereuxii						*x*		
Hesione patherina								
Jasmineira elegans						*x*		
Lubrinereis coccinea					*x*			
Lubrinereis funchalensis					*x*			
Lubrinereis impatiens					*x*		*x*	
Nainereis laevigata				*x*				
Ophelia bicornis			*x*					
Sthenelais boa		*x*		*x*				
Dentalium rubescens			*x*	*x*	*x*	*x*		
Nemertina sp					*x*			
Hermonia hystrix							*x*	
Eunice pennata							*x*	
Hyalinoicea tubicola							*x*	
Onuphis eremite							*x*	
Nephtys hombergii							***x***	
Neanthes pelagica							*x*	
Capitellacapitata							*x*	
Notomastus sp.							*x*	
Sternaspis scutata							***x***	

APPENDIX C

(Air Quality Predictions and Mathematical Modelling)

AIR QUALITY PREDICTIONS AND MATHEMATICAL MODELING

1. INTRODUCTION

KODAP is the Cyprus Organisation for Storage and Management of Oil Stocks and is a public body establish by law. As per European Union Directives, KODAP has to maintain and administrate minimum strategic fuel reserves equal to at least 90 days consumption and under the EU accession agreement Cyprus has committed to maintain 60 days fuel reserves up to the end of 2007 and 90 days reserves thereafter.

Aeoliki Consulting was commissioned by KODAP to undertake an Environmental Impact Assessment (EIA) of the proposed Oil Strategic Reserves Depot (OSRD) Project. The EIA presents the findings of the impact assessment and identifies mitigation measures that will be implemented to address significant (adverse) impacts.

Within the scope of the EIA study, AEOLIKI Consulting was also appointed to conduct a dispersion modelling and air quality impact assessment study for the terminal. The main objectives of the study were to establish the expected emissions from the facility and assess the air quality impacts of the emissions on the surrounding areas.

1.1. Terms of Reference

The main objectives of the study were to:

- Collect meteorological data and determine the meteorological conditions of the area, which may affect the dispersion of emissions;
- Establish a detailed emissions inventory that includes fugitive emissions from the tanks;
- Perform dispersion modelling, in order to determine the ground-level concentrations of pollutants such as benzene, isopropyl benzene, hexane (-n), benzene, isooctane, toluene, ethylbenzene, xylene (-m), , 1,2,4-trimethylbenzene and cyclohexane;
- Assess the impacts of air pollution with regard to existing air quality standards and carcinogenic and non- carcinogenic effects via comparisons against international standards and guidelines.

1.2. Study approach

This study was based on the following methodology:

- Firstly, the baseline characteristics of the project area were assessed based on available data, including assessing the existing air quality, analysing the local meteorology and identifying the potential sensitive receptors;
- Secondly, an emissions inventory was generated for the operational phase of the project and utilised as input into the dispersion modelling for the estimation of the resulting ground-level concentrations. The primary emissions identified were volatile organic compounds (VOCs) from the storage tanks. The storage tank emissions were estimated via the use of the US-EPA TANKS model.
- The air dispersion modelling was carried out with the latest version of the US-EPA approved AERMOD model for the prediction of the spatial and temporal dispersion patterns of the VOCs emissions from the terminal. Five years of hourly meteorological data for the project area was processed, in order to generate the meteorological parameters for input into the AERMOD model. The ground-level concentrations of benzene, hexane (-n), , isooctane, toluene, ethylbenzene, xylene (-m), isopropyl benzene, 1,2,4- trimethylbenzene and cyclohexane were generated. These ground-level concentrations were subsequently used to calculate the long-term hazard index and carcinogenic health risk. The construction phase of the project is anticipated to last for a relatively short period of time (approximately 12 months), and the impact is expected to be minor. Therefore, only a qualitative assessment was performed for the construction phase;
- Lastly, the modelled ground-level concentrations, long-term health and carcinogenic risk were compared against their respective guidelines. The air quality impacts of the operational phase were assessed according to the assessment methodology outlined in **Chapter 6**

1.3. Assumptions and limitations

The assumptions and limitations associated with this study are:

- All calculations and simulations were based on the tankage design and throughput information provided by KODAP;
- Based on the given annual fuel throughput, a constant rate of emissions was assumed;
- Information on fuel tank specific characteristics (e.g. fittings) was not available and therefore reference was made to literature;
- Predicted air pollution impacts only include those air emissions associated with the OSDR. Cumulative impacts due to other emission sources in the area were not assessed, e.g. emissions from other fuel tank farms at the Vasilikos area.

1.4. Report outline

The baseline environment, including the study area and the area's meteorology, is described in Section 2. The relevant air quality guidelines and standards are described in Section 3. The emission inventory is covered in Section 4. The air pollution dispersion modelling results are presented in Section 5, and the conclusions and recommendations can be found in Section 6.

2. BASELINE CHARACTERISTICS

2.1. Study area

The proposed plot of land to be developed is located on the north-west side of Vasilikos Cement Factory in the south coast of Cyprus approximately 25 km to the east of Limassol and 30 km to the South-west of Larnaka (**Figure C.1**).

The boundaries of this area run along Vasilopotamos river to the West and follow the existing road towards the North. Its west boundary runs parallel the existing Vasilikos road. To the South there is a common boundary with Vasilikos Cement Works plant and a small agricultural property.

At short distance there are a number of fuel tanks owned by VTTV and Petrolina companies to the south-west. The nearest residential development is Mari Village 1.7 km northwest of the site.

Vasilikos area is designated as heavy duty industrial area (**Figure C.1**). It used to be one of the main Hellenic Mining Company mineral processing complexes for copper and iron ore. Since the early seventies, industries such as Vasilikos Cement Works (VCW), Vasilikos port (currently jointly operated by VCW and Cyprus Port Authority) and Cyprus Chemical Fertilisers Industries (CCFI) were established and operated in that area. Additional industrial units and facilities were commissioned in the area during the 1990's, Vasilikos power station by Electricity Authority of Cyprus (EAC) which is the biggest power plant of Cyprus; and other small scale units. Vasilikos is also the designated area for the relocation of petroleum storage facilities currently operating at Larnaca bay.

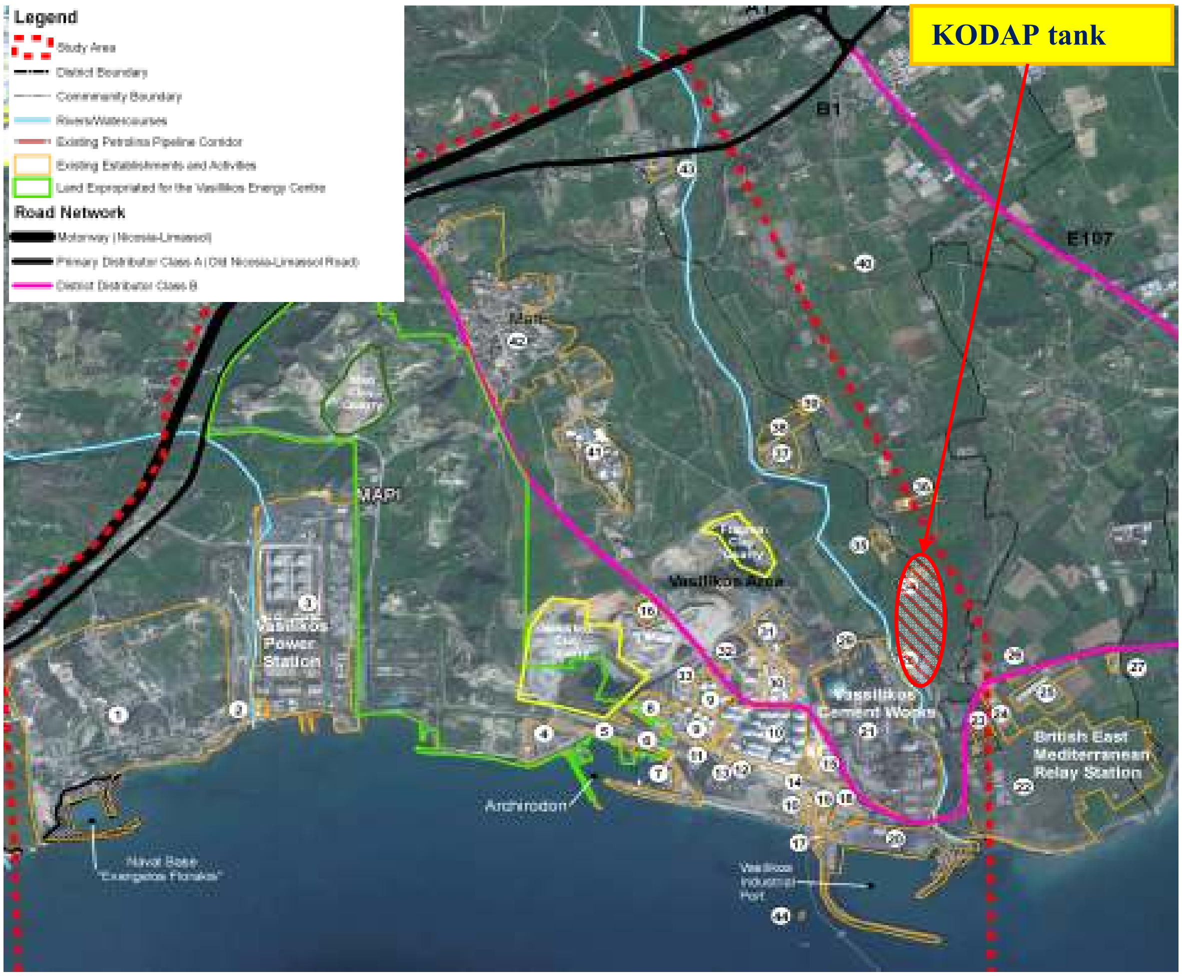


Figure C.1. Facilities and installations in the proposed development area (Source: Vasilikos MasterPlan, 2015)

The Vasilikos industrial area is classified as Heavy Industrial Zone B2. Power plants and industrial complexes are already operating in the area. A number of large scale projects were also announced and/or are currently at the conceptual/ basic design phase. There are currently four marine/naval facilities operating in the area, namely the Vasilikos port, an industrial import/export port, the Archirodon port where barges, floating machinery and fishing boats are stationed, the Zygi fishing shelter where local fishermen boats are berthed, and the 'Evangelos Florakis' base, a military naval installation.

Vasilikos area may be considered as the heart of the energy and heavy industry of the island. There are numerous, vital energy and industrial complexes in the area and the area may be described as heavily burdened, in environmental terms. The existing planning zone (B2 – Heavy Industry Zone) justifies the area as the most suitable for this type of development.

2.2. Sensitive receptors

The identified sensitive receptors in the study area are shown in **Figure C.3**, whilst their geo-reference is included in **Table C.1** below. These locations were also used for the calculation of the resulting air pollution concentrations due to the terminal.

Table C. 1: Sensitive Receptors

RECEPTOR	X coordinate	Y coordinate	Location
PENTAKOMO	522173.00	3844159.00	7.3 km west of the site
AGATA	523328.00	3848624.00	7.8 km north-west of the site
KALAVASOS	527176.00	3847880.00	5 km north of the site
MARI	527342.00	3844385.00	1.9 km north-west of the site
MARONI	532594.00	3846313.00	4.8 km east of the site
TOCHNI	529662.00	3848852.00	5.8 km north east of the site
CHIROKITIA	530795.00	3850667.00	7.6 km north east of the site
AGIOS THEODOROS	535176.00	3850899.00	10 km north east of the site
GOVERNORS BEACH	524973.00	3841609.00	4.3 km west of the site
EAC VASILIKOS	526668.00	3843104.00	2.4 km west of the site
NAVAL BASE	525889.00	3842533.00	3.5 km west of the site

2.3. Existing Air Quality

As it is referred in **Chapter 4 – Section 4.1.17**, the Department of Labour Inspection (DLI) has established a network of nine advanced monitoring stations and handles the matters of Ambient Air Quality, and how the limit values for the concentrations of various pollutants in the atmosphere are determined.

The industrial air quality monitoring station, located at Zygi village, Larnaca, records pollutant levels as a result of the industrial activity in the greater Vasilikos area (EAC power stations, VCW plant etc).

Data on ambient air quality from the Department of Environment and the DLI show no significant issues for the last 6 months. Levels of nitrogen oxides, sulphur dioxide, benzene, and ozone concentrations have been found to comply with available World Health Organisation and EU ambient air quality standards at the sampling location near project area.

2.4. Meteorology

The minimum requirements for dispersion modelling are knowledge of the wind speed, wind direction, atmospheric turbulence parameters, the ambient temperature, as well as the mixing height. The atmospheric boundary during the day is normally unstable, as a result of the sun's heating effect on the earth's surface. The thickness of the mixing height depends strongly on solar radiation, amongst other parameters. This mixing layer gradually increases in height from sunrise, to reach a maximum at about five to six hours after sunrise. Cloudy conditions, surface and upper air temperatures also affect the final mixing height and its growth. During these conditions, dispersion plumes can be trapped in this layer and result in high ground-level concentrations. This dispersion process is known as Fumigation and is more pronounced during the winter months due to strong night-time inversions, weak wind conditions and slower developing mixing layers. Dispersion models also require the atmospheric condition to be categorised into one of six stability classes, which are:

Table C. 2: Meteorological Conditions Represented by the Stability Categories.

Stability Category	Meteorological Conditions	Occurrence
A	Very Unstable	Hot daytime conditions, clear skies, calm wind
B	Unstable	Daytime conditions, clear skies
C	Slightly Unstable	Daytime conditions, moderate winds, slightly overcast
D	Neutral	Day and night, high winds or cloudy conditions
E	Stable	Night-time, moderate winds, slightly overcast conditions
F	Very Stable	Night-time, low winds, clear skies, cold conditions

Meteorological data were available at the Zygi meteorological station (at a distance of less than 1 km from the site). Five years (2010-2015) of hourly surface and upper air meteorological data was acquired. All the five years of data was combined and analysed in one data pool, in order to determine the worst-case scenarios for the most probable weather combinations and their related dispersion characteristics for the modelling simulation.

The wind characteristics for the site area are illustrated in figures in **Appendix A**, with the aid of wind roses and wind speed frequency distribution charts.

The dominant wind direction is from the southwest-to-northwest sector due to the general circulation and local thermal circulations. In general, during winter the prevailing surface winds are easterly to westerly gradient winds. With very light gradient winds, the northerly land breezes at night become predominant feature. With moderate to strong gradient winds, the land breezes are suppressed.

Wind speeds in the area exhibits seasonal variability. The strongest mean daily wind speeds at Zygi station are experienced during the period from December to June ranging from 2,6 m/s to 3,4 m/s (at 7 m agl). Lighter winds occur from July to November when wind speeds range from 1,6 m/s to 2,3 m/s (at 7 m agl).

The average monthly wind speed variation is presented in **Figure C.2.**

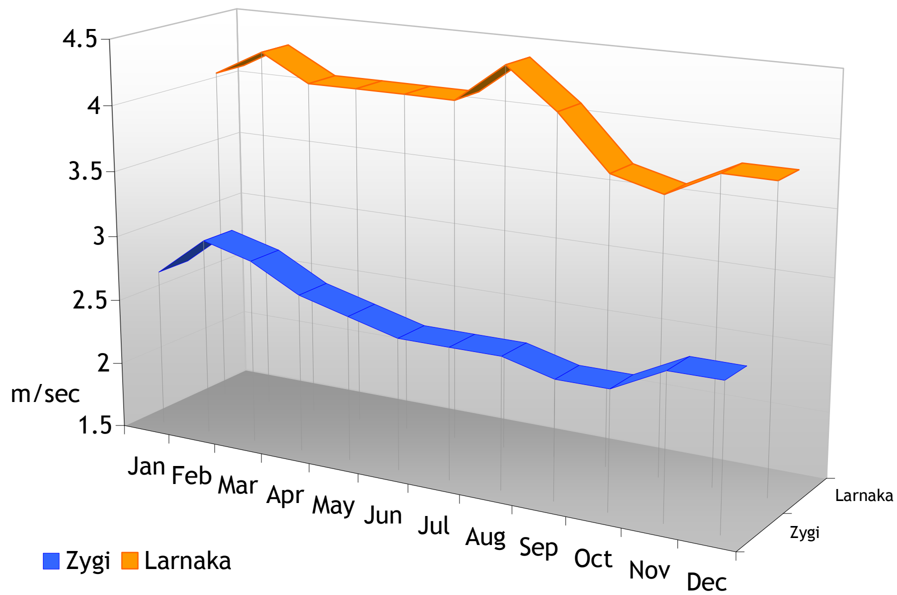


Figure C.2. Average monthly wind speed variation

The maximum mean monthly wind speed recorded was 11.8 m/sec at Zygi station and 22.7 m/sec at Larnaca airport (in February).

Table C.3 presents recorded mean hourly wind speeds and directions at the three relevant to the site meteorological stations.

Table C. 3: Average Monthly Wind Direction and Speed at Zygi station

STATION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Mean Daily Wind (Direction in Tens of Degrees, Speed in knots[1])											
Larnaca air.	**32/9**	**32/9**	**32/8**	**18/9**	**18/9**	**18/9**	**18/10**	**18/9**	**32/8**	**32/7**	**32/8**	**32/9**
Limassol Port	**36/7**	**27/7**	**27/7**	**27/7**	**27/7**	**27/7**	**27/7**	**27/7**	**27/6**	**36/5**	**36/5**	**36/5**
Zygi	**32/2.8**	**36/3.7**	**32/3.2**	**32/3.1**	**23/2.9**	**23/3.1**	**23/3.1**	**23/3**	**32/2.8**	**32/2.8**	**36/2.8**	**36/3.1**
	Highest Mean Hourly Wind (Direction in Tens of Degrees, Speed in knots)											
Larnaca air.	**24/38**	**20/44**	**22/32**	**22/36**	**22/33**	**21/38**	**20/38**	**20/34**	**21/38**	**21/36**	**19/32**	**21/38**
Limassol Port	**21/30**	**25/28**	**06/34**	**06/30**	**25/26**	**24/24**	**22/24**	**25/23**	**19/24**	**28/26**	**27/30**	**25/28**
Zygi	**20/8.5**	**28/11.8**	**4/10.8**	**24/9.0**	**24/8.2**	**3/9.6**	**24/9.6**	**23/9.2**	**24/9.2**	**25/9.6**	**27/9.6**	**36/11.8**
	Highest Gust (Direction in Tens of Degrees, Speed in knots)											
Larnaca air.	**25/68**	**25/58**	**21/47**	**26/57**	**35/47**	**21/49**	**20/49**	**20/46**	**22/49**	**23/47**	**24/63**	**24/71**
Limassol Port	**21/56**	**25/58**	**22/51**	**01/51**	**31/43**	**24/36**	**24/35**	**25/41**	**15/37**	**30/36**	**27/52**	**21/57**

[1] 1 kt = 1,152 miles/h = 1,853 km/h = 0,515 m/sec

The predominant wind directions throughout the year are NW-W (29%),SW-W (16,4%), N (13,9%), W(7,1%) and S-SW (6,4%). For more details see **Appendix A**.

The extreme wind speeds for each directional sector in the open sea predicted from ship observations (in m/s) is given in **Table C.4**.

Table C. 4: Extreme wind speeds in the open sea (m/sec)

Direction (^oN)		Return period (years)				
		1	5	10	15	20
-15	15	13.8	17.8	19.5	21.7	23.4
15	45	14.7	18.2	19.6	21.5	22.9
45	75	14.4	17.7	19.1	20.8	22.2
75	105	14.5	17.9	19.3	21.1	22.4
105	135	13.3	17.5	19.3	21.7	23.5
135	165	12.7	16.4	18.0	20.1	21.6
165	195	13.9	18.2	20.0	22.3	24.0
195	225	16.5	20.6	22.3	24.4	26.0
225	255	19.6	24.1	26.0	28.4	30.3
255	285	19.0	22.9	24.1	26.9	28.7
285	315	16.8	20.1	21.4	23.2	24.5
315	345	16.7	20.4	22.0	24.0	25.6

3. LEGISLATIVE CONTEXT AND HUMAN HEALTH ASSESSMENT CRITERIA

3.1. National Legislation

The project is required to comply with Cyprus Air Quality standards (**Table C.5** & **Table C.6**). The primary goal of these standards is to protect human health, and the well being of ecosystems.

Two sets (**Table C.5** & **Table C.6** below) of severity criteria can be used: quantitative and qualitative. The first set (**Table C.5**) is for evaluating the predicted ground level concentrations with the respective Cyprus air quality standards. In applying these standards, existing ambient atmospheric concentrations are considered. Provision is also made for the fact that no single emission source (or complex) should 'use up' the whole 'allowance' implied by the standard. For this reason, the threshold between a moderate and a major impact is set at 70% of the standard, as opposed to 100%, so that the project, together with the other emission sources in the area is unlikely to contribute to a cumulative exceedance of the standard.

The second set of severity criteria (**Table C.6**) can be used to allow a qualitative assessment. In these circumstances, the assessment has considered such factors as known emission estimations provided by the sponsors of the project, the proximity of sensitive receptors, local dispersion characteristics and professional judgement based on previous experience of similar conditions, to make the qualitative assessment.

3.2. International Guidelines

In the European Directive 94/63/EC (1994), a target reference value of 0.01 weight by weight (w/w) % of the throughput was stipulated for the total annual loss of petrol resulting from loading and storage at terminals. This directive also stipulates the hourly emission limit for the vapour recovery unit as 35 μg/Nm^3.

3.3. Health Risk Guidelines

In Cyprus, there are no thresholds for the more uncommon toxic pollutants, such as benzene, hexane, isooctane, toluene, ethylbenzene, xylene, Isopropyl benzene, etc. Internationally, concentration guidelines for toxic and carcinogenic pollutants are issued by organisations such as the World Health Organisation (WHO), the Texas Commission on Environmental Quality (TECQ) and the U.S. Environmental Protection Agency (USEPA). In the absence of national guidelines, international available guidelines were utilised in the present study.

The TCEQ Effects Screening Levels (ESLs) are not ambient air standards but are used as screening levels. They are based on data related to health effects, vegetation or corrosion effects and odour nuisance potential. The ESLs are presented as "short-term" and "long- term" exposures. Long-term ESLs are applicable to annual averaging periods, whereas short-term ESLs are given for hourly to daily periods.

The U.S. Environmental Protection Agency (US-EPA) established risk assessment guidelines in order to provide consistency and technical support between US-EPA and other regulatory agencies. The unit risk factors (URFs) and slope factors (SFs) were developed by the US-EPA for evaluating risks from carcinogenic substances.

The long term screen levels for the examined pollutants and unit risk factor for benzene are presented in **Table C.7**.

In the present study the annual guideline for the carcinogenic compounds, such as benzene, was determined as the concentration that would not increase the risk above the 1x10^{-6} level. Risks in excess of 1x10^{-4} are generally considered unacceptable by the US- EPA. Carcinogenic risks that exceed 1x10^{-6} fall within the US-EPA's range of concern. A carcinogenic risk below 1x10^{-6} is considered negligible.

Table C. 5: Limit Values for SO_2, NO_2, Knox, CO, PM_{10}, Lead and Benzene for the protection of human health (KDP 327/2010)

Component	Averaging Period	Limit Value	Tolerance Margin	Date by which limit value is to be met
Sulphur dioxide SO_2	1 hour	**350 μg/m³** , not to be exceeded more than 24 times a calendar year	150 μg/m³ (43%)	_(1)
	24 hour	**125 μg/m³**, not to be exceeded more than 3 times a calendar year	None	_(1)
Nitrogen dioxide NO_2	1 hour	**200 μg/m³**, not to be exceeded more than 18 times a calendar year	50% on July 1999, decreasing on 1 January 2001 and every 12 months thereafter by equal annual percentagesto reach 0% by 1 January 2010	1 January 2010
	Calendar year	**40 μg/m³**	50% on July 1999, decreasing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0% by 1 January 2010	1 January 2010
Carbon Monoxide CO	8 hours max (3)	**10 μg/m³**	60%	_(1)
Particulate Matter PM_{10}	24 hour	**50 μg/m³**, not to be exceeded more than 35 times a calendar year	50%	_(1)
	1 hour	**40 (20) μg/m³**	20%	_(1)
Benzene	Calendar year	**5 μg/m³**	5 μg/m³ (100%) on 13 December 2000, decreasing on 1 January 2006 and every 12 months thereafter by 1 μg/m³ to reach 0% by 1 January 2010	1 January 2010
Lead	Calendar year	**0.5 μg/m³**	100%	_(3)

(1) Already in force since 1 January 2005

(2) The maximum daily eight hour mean concentration will be selected by examining eight hour running averages, calculated from hourly data and updated each hour. Each eight hour average so calculated will be assigned to the day on which it ends i.e. the first calculation period for any one day will be the period from 17:00 on the previous day to 01:00 on that day; the last calculation period for any one day will be the period from 16:00 to 24:00 on that day

(3) Already in force since 1 January 2005. Limit value to be met only by 1 January 2010 in the immediate vicinity of the specific industrial sources situated on sites contaminated be decades of industrial activities. In such cases, the limit value until 1 January 2010 will be 1.0 μg/m^3. The area in which higher limit values apply must not extend further than 1000 m from such specific sources.

Table C. 6: Upper and lower assessment thresholds (KDP 327/2010)

Component	Averaging Period	Assessment threshold (percentage of limit value)		Exceedence frequency per year
		Upper	Lower	
Sulphur dioxide SO_2	24 hours	75 μg/m^3 (60% of limit value)	50 μg/m^3 (40% of limit value)	3 times each year
Nitrogen oxides NO_x	1 hours	140 μg/m^3 (70% of limit value)	100 μg/m^3 (50% of limit value)	18 times each year
NO_2	1 year	32 μg/m^3 (80% of limit value)	26 μg/m^3 (65% of limit value)	18 times each year
NO_x	1 year	24 μg/m^3 (80% of limit value)	19.5 μg/m^3 (65% of limit value)	18 times each year
Carbon Monoxide CO	8 hours	7 μg/m^3 (70% of limit value)	5 μg/m^3 (50% of limit value)	
Particulate Matter PM_{10}	24 hours max	35 μg/m^3 (70% of limit value)	25 μg/m^3 (50% of limit value)	35 times each year
	1 year	28 μg/m^3 (70% of limit value)	20 μg/m^3 (50% of limit value)	
Particulate Matter $PM_{2.5}$	1 year	17 μg/m^3 (70% of limit value)	12 μg/m^3 (50% of limit value)	
Lead	1 year	0.35 μg/m^3 (70% of limit value)	0.25 μg/m^3 (50% of limit value)	
Benzene	1 year	3.5 μg/m^3 (70% of limit value)	2 μg/m^3 (40% of limit value)	

The calculated ground-level pollutant concentrations were compared against the guideline concentrations in order to calculate a hazard index, expressing the carcinogenic risk. The calculated hazard indexes were then plotted as contour maps in order to indicate the zones of exceedance. Hazard indexes that exceed 1 indicate the possibility of non-cancer toxic risks due to exposure.

For the determination of the impact zone based on carcinogenic risk factors, the risk of $1x10^{-6}$ was utilised. This zone indicates that a person would have less than a one-in-a-million chance of developing cancer because of the specified chemical exposure if exposure were to occur constantly over a lifetime.

Table C.7: Air Quality Guidelines and Cancer Unit Risk Factors for Compounds Included in the Terminal's Emissions

Compound	Annual Guideline (μg/m^3) [a]	Cancer Unit Risk Factor [b]	Carcinogenic Classification [c]	
			IARC	US EPA
Hexane (HAP/VOC)	200	-	-	D
Benzene (HAP/ VOC)	4.5	7.50E-06	1	A
Isooctane	350	-	-	D
Toluene (HAP/ VOC)	1200	-	2B	D
Ethylbenzene (HAP/VOC)	570	-	2B	D
Xylene (HAP/ VOC)	180	-	3	D
Isopropyl Benzene	250	-	-	D
1,2,4-Trimethylbenzene	125	-	-	D
Cyclohexane	340	-	-	D

[a] TCEQ ESLs

[b] WHO

[c] 1, A: human carcinogen; 2A, B: probable human carcinogen. There are two sub-classifications:

- B1: agents for which there is limited human data from epidemiological studies.
- B2 agents for which there is sufficient evidence from animal studies and inadequate or no evidence from human epidemiological studies
- 2B, C: possible human carcinogen.
- 3, D: not classifiable as to human carcinogenicity.
- 4, E: evidence of non-carcinogenicity for humans.

4. EMISSION INVENTORY

The site will be used to store Mogas, Diesel, and Jet A1 fuel. **Table C.8** shows the proposed number of storage tanks and fuel throughput per tank.

Table C.8: Tankages and fuel quantities

Tankages and fuel quantities				
Tank	**Quantity (m^3)**	**Nominal capacity**	**Product**	**Throughput (m^3/yr)**
TANK 1 – 4 Internal Floating Roof	4	43,000	MOGAS	31,104@ 4 124,416
TANK 5 - 6 Fixed Roof	3	43,000	JET A1	62,208@ 3 186,624
TANK 7 – 11 Fixed Roof	4	43,000	DIESEL	31,104@ 4 124,416

The emission inventory was based on the Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources (AP-42), Section 7.1, Organic Liquid Storage Tanks (US-EPA, 2006 in DDA, 2014) and the US-EPA emissions inventory model TANKS 4.0.9d (US-EPA, 2006) was utilised. Site-specific information regarding fuel quantities, the storage tanks (dimensions, tank type, paint condition, tank fittings, etc.), the fuel contents (chemical components and liquid temperature), and meteorological data (ambient minimum and maximum temperatures, atmospheric pressure, etc.) were utilised as inputs into the model.

The fuel types that were chosen during the model runs are as follows:

Fuel	TANKS Model
Mogas	Gasoline RVP 9
Jet Fuel	Jet kerosene
Diesel	Distillate fuel oil No.2

Losses from the internal floating roof tanks proposed for the storage of Mogas and Jet A1 products were withdrawal losses and standing storage losses. Withdrawal losses occur as the liquid level is lowered and product remaining on the inner tank wall evaporates. Standing losses occur through rim seals and deck fittings. **Table C.9** shows the emission estimates for the gasoline and Jet A1 tanks. The input data used in the estimation of gasoline tank emissions are provided in **Appendix D**.

Losses from the fixed roof tanks proposed for the storage of petroleum products were breathing losses and working losses. Breathing losses occur as a result of the expulsion of vapours due to the expansion and contraction of tank vapours due to diurnal temperature and barometric pressure variations. Working losses occur as a result of the loading and unloading operations changing the tank liquid level. For instance, during loading, as the liquid level rises, the pressure level within the tank increases and exceeds the relief pressure and vapours are expelled. **Table C.9** shows the emission estimates for fixed roof tanks. The input data used in the estimation of gasoline tank emissions are provided in **Appendix D**.

Fixed roof tanks are proposed for the storage of Diesel. All tank storage is at ambient pressure and unheated.

Table C.9: Estimated Emissions Summary

Tank	Quantity	Nominal Capacity (m^3)	Throughput	Emissions
				Tankage
			m^3/yr	kg/yr/tank
MOGAS - Internal Floating Roof Tank	4	43,000	124,416	4,766
Diesel – Vertical Fixed Roof Tank	3	43,000	93,312	401
Diesel (Heating) - Vertical Fixed Roof Tank	1	43,000	31,104	401
JET A1- Vertical Fixed Roof tank	3	43,000	186,624	1,090

5. DISPERSION SIMULATION

5.1. Air Pollution Dispersion Model

The resulting ground-level concentrations due to the emissions from the OSRD were estimated with the use of a Gaussian dispersion model. The latest version of the US-EPA approved air quality model AERMOD (version 9.1.0) was utilised. The basis of this model is the straight-line, steady-state Gaussian plume equation and is used for the simulation of emissions from stacks, isolated and multiple vents, liquid tanks, waste sites, storage piles, conveyor belts, etc. The emission sources in the model can be categorised into four basic types, i.e. point sources, volume sources, area sources, and open pit sources.

There are two basic types of input needed to run the AERMOD model. Firstly, the emissions input set-up file and secondly the meteorological data file. The emissions input set-up file contains the selected modelling options, as well as source location and parameter data, receptor locations, meteorological data file specifications and output options. The meteorological data file contains all the hourly meteorological parameters used for the dispersion modelling, such as wind direction, wind speed, temperature, atmospheric stability and mixing height.

The ambient concentrations of various VOCs were modelled based on the following:

- Only the emissions from the proposed terminal were modelled. The emissions from other sources, e.g. VTTV fuel storage farm, EAC Power Station fuel storage farm, etc., were not included;
- The terminal emissions were assumed to be constant for all hours;
- Hydrocarbon spillage and abnormal events emissions were not taken into consideration;
- Five years of hourly meteorological data for the project area was utilised as input into the model;
- The study area is considered to be of elevated terrain

5.2. Dispersion results and discussion

The maximum ambient concentrations of the VOCs over the 5 years of meteorological data were calculated and are presented as concentration isopleths in the figures below, as well as in a table with the maximum concentrations expected at the various receptors.

Figure C.3 shows the maximum annual average benzene concentrations around the terminal. As can be seen, the maximum levels are well below the annual guideline of 5 μg/m^3.

The modelled annual benzene concentrations at all the identified sensitive receptors are shown in **Table C.10**.

Table C.10: Annual benzene concentrations - Sensitive Receptors

RECEPTOR	X coordinate	Y coordinate	Concentration (μg/m^3)
PENTAKOMO	522173.00	3844159.00	$6*10^{-5}$
AGATA	523328.00	3848624.00	$1.3*10^{-4}$
KALAVASOS	527176.00	3847880.00	$8.2*10^{-4}$
MARI	527342.00	3844385.00	$8.3*10^{-4}$
MARONI	532594.00	3846313.00	$6.1*10^{-4}$
TOCHNI	529662.00	3848852.00	$3.7*10^{-4}$
CHIROKITIA	530795.00	3850667.00	$1.9*10^{-4}$
AGIOS THEODOROS	535176.00	3850899.00	$3.9*10^{-4}$
GOVERNORS BEACH	524973.00	3841609.00	$1.57*10^{-3}$
EAC VASILIKOS	526668.00	3843104.00	$1.31*10^{-3}$
NAVAL BASE	525889.00	3842533.00	$1.43*10^{-3}$

The annual concentrations of all the identified VOCs (shown in the emissions **Table C.11**) were used for the calculation of the cumulative long-term health risk index. The cumulative long-term health risk index is the sum of the fractions of all the compounds' concentrations divided by their respective guidelines. It can be seen that the cumulative index did not exceed the value of 1 at any of the locations in the study area. The maximum concentrations for each compound, including the carcinogenic risk and cumulative health index, are presented in **Table C.11** for each of the identified receptors around the terminal. As is evident, all of the maximum concentrations for every compound and receptor are well below their respective guidelines, including the carcinogenic risk and cumulative health index.

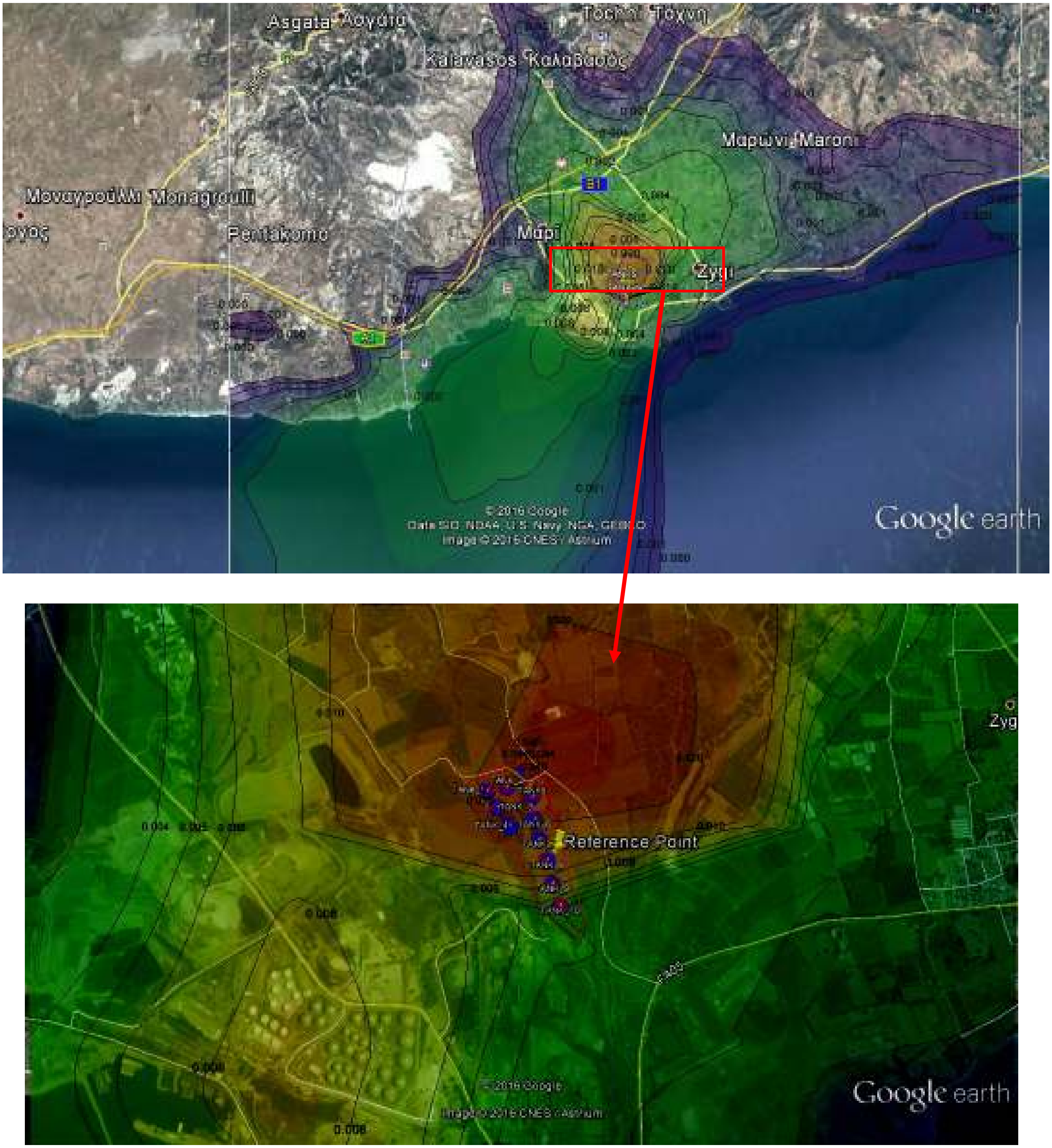


Figure C.3. Maximum Annual Benzene Ground Level Concentrations (Limit: 5 μg/m^3)

Table C.11: Estimated Maximum Concentrations at Receptors around the OSRD

Receptors	Co-ordinates (UTM)		Hexane (-n)	Isooctan e	Benzene	Toluene	Ethyl-benzene	Xylene (-m)	Isopropyl Benzene	1,2,4-Trimethyl benzene	Cyclohexane	Carcinogenic Risk (x10^{-6})	Long-term Health Risk Index
	x	y	(μg/m^3)	(μg/m^3)	(μg/m^3)	(μg/m^3)	(μg/m^3)	(μg/m^3)	(μg/m^3)	(μg/m^3)	(μg/m^3)		
PENTAKOMO	522173	3844159	1.34E-04	2.57E-08	6E-05	2.87E-04	2.95E-05	3.41E-04	2.41E-06	2.33E-04	1.92E-05	1.41E-02	4.65E-04
AGATA	523328	3848624	9.58E-05	1.83E-08	1.3E-04	2.05E-04	2.10E-05	2.43E-04	1.71E-06	1.66E-04	1.37E-05	1.00E-02	3.31E-04
KALAVASOS	527176	3847880	5.19E-04	9.94E-08	8.2E-04	1.11E-03	1.14E-04	1.32E-03	9.29E-06	9.01E-04	7.43E-05	5.43E-03	1.80E-04
MARI	527342	3844385	4.40E-04	8.42E-08	8.3E-04	9.39E-04	9.65E-05	1.12E-03	7.87E-06	7.63E-04	6.30E-05	4.60E-03	1.52E-04
MARONI	532594	3846313	4.45E-04	8.52E-08	6.1E-04	9.51E-04	9.77E-05	1.13E-03	7.97E-06	7.73E-04	6.37E-05	4.66E-02	1.54E-03
TOCHNI	529662	3848852	5.32E-04	3.64E-08	3.7E-04	5.46E-04	4.62E-05	7.57E-04	4.71E-06	3.76E-04	4.45E-05	1.06E-02	3.50E-04
CHIROKITIA	530795	3850667	8.21E-04	6.99E-08	1.9E-04	3.68E-04	7.05E-05	5.36E-04	2.75E-06	2.67E-04	5.43E-05	3.36E-02	1.11E-03
AGIOS THEODOROS	535176	3850899	7.30E-04	6.42E-08	3.9E-04	9.18E-04	8.56E-05	2.67E-03	5.57E-06	7.13E-04	5.80E-05	3.95E-03	1.25E-03
GOVERNORS BEACH	524973	3841609	1.87E-03	2.14E-07	1.57E-03	2.33E-03	2.05E-04	3.00E-03	2.19E-05	2.03E-03	1.65E-04	8.76E-02	3.42E-04
EAC VASILIKOS	526668	3843104	9.12E-05	1.84E-08	1.31E-03	1.95E-04	2.15E-05	2.23E-04	1.81E-06	1.96E-04	1.47E-05	1.94E-02	6.29E-04
NAVAL BASE	525889	3842533	9.33E-05	1.77E-08	1.43E-03	2.01E-04	2.09E-05	2.28E-04	1.61E-06	1.53E-04	1.27E-05	1.39E-02	4.23E-04
Guideline	-	-	-	-	5	-	-	-	-	-	-	1 x10-6	1

APPENDIX D

(Results - TANKS 4.0.9d)

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification	
User Identification:	KODAP MOGAS INTERNAL FLOATING ROOF
City:	VASILIKOS
State:	VASILIKOS
Company:	KODAP
Type of Tank:	Internal Floating Roof Tank
Description:	KODAP VASSILIKOS MOGAS INTERNAL FLOATING ROOF
Tank Dimensions	
Diameter (ft):	164.00
Volume (gallons):	8,217,015.71
Turnovers:	1.00
Self Supp. Roof? (y/n):	Y
No. of Columns:	0.00
Eff. Col. Diam. (ft):	0.00
Paint Characteristics	
Internal Shell Condition:	Gunite Lining
Shell Color/Shade:	White/White
Shell Condition	Good
Roof Color/Shade:	White/White
Roof Condition:	Good
Rim-Seal System	
Primary Seal:	Mechanical Shoe
Secondary Seal	Shoe-mounted
Deck Characteristics	
Deck Fitting Category:	Detail
Deck Type:	Bolted
Construction:	Sheet
Deck Seam:	Sheet: 5 Ft Wide
Deck Seam Len. (ft):	4,224.81

Deck Fitting/Status	Quantity
Access Hatch (24-in. Diam.)/Unbolted Cover, Ungasketed	1

Meterological Data used in Emissions Calculations: VASILIKOS, VASILIKOS (Avg Atmospheric Pressure = 14.75 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

KODAP MOGAS INTERNAL FLOATING ROOF - Internal Floating Roof Tank
VASILIKOS, VASILIKOS

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 9)	Jan	62.10	57.03	67.18	67.66	5.4006	N/A	N/A	66.0000			92.00	Option 4: RVP=9, ASTM Slope=3
Gasoline (RVP 9)	Feb	61.94	55.87	68.02	67.66	5.3841	N/A	N/A	66.0000			92.00	Option 4: RVP=9, ASTM Slope=3
Gasoline (RVP 9)	Mar	64.25	57.37	71.13	67.66	5.6273	N/A	N/A	66.0000			92.00	Option 4: RVP=9, ASTM Slope=3
Gasoline (RVP 9)	Apr	69.13	61.66	76.60	67.66	6.1714	N/A	N/A	66.0000			92.00	Option 4: RVP=9, ASTM Slope=3
Gasoline (RVP 9)	May	72.46	64.19	80.74	67.66	6.5665	N/A	N/A	66.0000			92.00	Option 4: RVP=9, ASTM Slope=3
Gasoline (RVP 9)	Jun	75.18	67.87	82.48	67.66	6.9023	N/A	N/A	66.0000			92.00	Option 4: RVP=9, ASTM Slope=3
Gasoline (RVP 9)	Jul	77.36	71.57	83.15	67.66	7.1824	N/A	N/A	66.0000			92.00	Option 4: RVP=9, ASTM Slope=3
Gasoline (RVP 9)	Aug	76.87	71.57	82.17	67.66	7.1187	N/A	N/A	66.0000			92.00	Option 4: RVP=9, ASTM Slope=3
Gasoline (RVP 9)	Sep	75.11	69.92	80.31	67.66	6.8943	N/A	N/A	66.0000			92.00	Option 4: RVP=9, ASTM Slope=3
Gasoline (RVP 9)	Oct	70.77	64.29	77.26	67.66	6.3637	N/A	N/A	66.0000			92.00	Option 4: RVP=9, ASTM Slope=3
Gasoline (RVP 9)	Nov	66.06	59.57	72.54	67.66	5.8242	N/A	N/A	66.0000			92.00	Option 4: RVP=9, ASTM Slope=3
Gasoline (RVP 9)	Dec	63.80	58.12	69.47	67.66	5.5789	N/A	N/A	66.0000			92.00	Option 4: RVP=9, ASTM Slope=3

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

KODAP MOGAS INTERNAL FLOATING ROOF - Internal Floating Roof Tank
VASILIKOS, VASILIKOS

Month:	January	February	March	April	May	June	July	August	September	October	November	December
Rim Seal Losses (lb):	163.8402	163.2106	172.5777	194.4178	211.0971	225.8776	238.6577	235.7103	225.5186	202.4432	180.3371	170.6973
Seal Factor A (lb-mole/ft-yr):	1.6000	1.6000	1.6000	1.6000	1.6000	1.6000	1.6000	1.6000	1.6000	1.6000	1.6000	1.6000
Seal Factor B (lb-mole/ft-yr (mph)^n):	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
Value of Vapor Pressure Function:	0.1135	0.1131	0.1196	0.1347	0.1463	0.1565	0.1654	0.1633	0.1563	0.1403	0.1250	0.1183
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	5.4006	5.3841	5.6273	6.1714	6.5665	6.9023	7.1824	7.1187	6.8943	6.3637	5.8242	5.5789
Tank Diameter (ft):	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000
Vapor Molecular Weight (lb/lb-mole):	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000
Product Factor:	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Withdrawal Losses (lb):	78.7464	78.7464	78.7464	78.7464	78.7464	78.7464	78.7464	78.7464	78.7464	78.7464	78.7464	78.7464
Number of Columns:	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Effective Column Diameter (ft):	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Net Throughput (gal/mo.):	684,751.3092	684,751.3092	684,751.3092	684,751.3092	684,751.3092	684,751.3092	684,751.3092	684,751.3092	684,751.3092	684,751.3092	684,751.3092	684,751.3092
Shell Clingage Factor (bbl/1000 sqft):	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500
Average Organic Liquid Density (lb/gal):	5.6000	5.6000	5.6000	5.6000	5.6000	5.6000	5.6000	5.6000	5.6000	5.6000	5.6000	5.6000
Tank Diameter (ft):	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000
Deck Fitting Losses (lb):	22.4781	22.3917	23.6768	26.6732	28.9615	30.9893	32.7427	32.3383	30.9401	27.7742	24.7414	23.4188
Value of Vapor Pressure Function:	0.1135	0.1131	0.1196	0.1347	0.1463	0.1565	0.1654	0.1633	0.1563	0.1403	0.1250	0.1183
Vapor Molecular Weight (lb/lb-mole):	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000
Product Factor:	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Tot. Roof Fitting Loss Fact.(lb-mole/yr):	36.0000	36.0000	36.0000	36.0000	36.0000	36.0000	36.0000	36.0000	36.0000	36.0000	36.0000	36.0000
Deck Seam Losses (lb):	470.2213	468.4144	495.2980	557.9790	605.8487	648.2687	684.9477	676.4885	647.2385	581.0119	517.5674	489.9012
Deck Seam Length (ft):	4,224.8100	4,224.8100	4,224.8100	4,224.8100	4,224.8100	4,224.8100	4,224.8100	4,224.8100	4,224.8100	4,224.8100	4,224.8100	4,224.8100
Deck Seam Loss per Unit Length Factor (lb-mole/ft-yr):	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400
Deck Seam Length Factor(ft/sqft):	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
Tank Diameter (ft):	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000
Vapor Molecular Weight (lb/lb-mole):	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000	66.0000
Product Factor:	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total Losses (lb):	735.2860	732.7632	770.2989	857.8164	924.6537	983.8820	1,035.0945	1,023.2835	982.4436	889.9757	801.3922	762.7638
Total Losses (kgs):	333.81984	332.67499	349.7157	389.44865	419.79278	446.68243	469.9329	464.57071	446.02939	404.04897	363.83206	346.29477

Roof Fitting/Status	Quantity	Roof Fitting Loss Factors KFa(lb-mole/yr)	KFb(lb-mole/(yr mph^n))	m	Losses(lb)
Access Hatch (24-in. Diam.)/Unbolted Cover, Ungasketed	1	36.00	5.90	1.20	327.4648

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: January, February, March, April, May, June, July, August, September, October, November, December

KODAP MOGAS INTERNAL FLOATING ROOF - Internal Floating Roof Tank
VASILIKOS, VASILIKOS

	Losses(lbs)				
Components	Rim Seal Loss	Withdraw Loss	Deck Fitting Loss	Deck Seam Loss	Total Emissions
Gasoline (RVP 9)	2,384.39	944.96	327.13	6,843.19	10,499.65
	Losses(kgs)				
Gasoline (RVP 9)	1082.513	429.0118	148.517	3106.808	4766.841

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification		
User Identification:	KODAP_JET_1_2_IFR	
City:	VASILIKOS	
State:	VASILIKOS	
Company:	KODAP	
Type of Tank:	Internal Floating Roof Tank	
Description:	KODAP OIL STRATEGIC RESERVES DEPOT JET FUEL INTERNAL FLOATING ROOF	
Tank Dimensions		
Diameter (ft):		164.04
Volume (gallons):		8,217,015.71
Turnovers:		**2.00**
Self Supp. Roof? (y/n):	Y	
No. of Columns:		0.00
Eff. Col. Diam. (ft):		0.00
Paint Characteristics		
Internal Shell Condition:	Gunite Lining	
Shell Color/Shade:	White/White	
Shell Condition	Good	
Roof Color/Shade:	White/White	
Roof Condition:	Good	
Rim-Seal System		
Primary Seal:	Mechanical Shoe	
Secondary Seal	Shoe-mounted	
Deck Characteristics		
Deck Fitting Category:	Detail	
Deck Type:	Bolted	
Construction:	Sheet	
Deck Seam:	Sheet: 5 Ft Wide	
Deck Seam Len. (ft):		4,226.87

Deck Fitting/Status	Quantity
Access Hatch (24-in. Diam.)/Unbolted Cover, Ungasketed	1
Automatic Gauge Float Well/Unbolted Cover, Ungasketed	1
Roof Leg or Hanger Well/Adjustable	67
Sample Pipe or Well (24-in. Diam.)/Slit Fabric Seal 10% Open	1
Vacuum Breaker (10-in. Diam.)/Weighted Mech. Actuation, Gask.	1

Meterological Data used in Emissions Calculations: VASILIKOS, VASILIKOS (Avg Atmospheric Pressure = 14.75 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

KODAP_JET_1_2_IFR - Internal Floating Roof Tank
VASILIKOS, VASILIKOS

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Jet kerosene	Jan	62.10	57.03	67.18	67.66	0.0090	N/A	N/A	130.0000			162.00	Option 1: VP60 = .0085 VP70 = .011
Jet kerosene	Feb	61.94	55.87	68.02	67.66	0.0090	N/A	N/A	130.0000			162.00	Option 1: VP60 = .0085 VP70 = .011
Jet kerosene	Mar	64.25	57.37	71.13	67.66	0.0096	N/A	N/A	130.0000			162.00	Option 1: VP60 = .0085 VP70 = .011
Jet kerosene	Apr	69.13	61.66	76.60	67.66	0.0108	N/A	N/A	130.0000			162.00	Option 1: VP60 = .0085 VP70 = .011
Jet kerosene	May	72.46	64.19	80.74	67.66	0.0120	N/A	N/A	130.0000			162.00	Option 1: VP70 = .011 VP80 = .015
Jet kerosene	Jun	75.18	67.87	82.48	67.66	0.0131	N/A	N/A	130.0000			162.00	Option 1: VP70 = .011 VP80 = .015
Jet kerosene	Jul	77.36	71.57	83.15	67.66	0.0139	N/A	N/A	130.0000			162.00	Option 1: VP70 = .011 VP80 = .015
Jet kerosene	Aug	76.87	71.57	82.17	67.66	0.0137	N/A	N/A	130.0000			162.00	Option 1: VP70 = .011 VP80 = .015
Jet kerosene	Sep	75.11	69.92	80.31	67.66	0.0130	N/A	N/A	130.0000			162.00	Option 1: VP70 = .011 VP80 = .015
Jet kerosene	Oct	70.77	64.29	77.26	67.66	0.0113	N/A	N/A	130.0000			162.00	Option 1: VP70 = .011 VP80 = .015
Jet kerosene	Nov	66.06	59.57	72.54	67.66	0.0100	N/A	N/A	130.0000			162.00	Option 1: VP60 = .0085 VP70 = .011
Jet kerosene	Dec	63.80	58.12	69.47	67.66	0.0094	N/A	N/A	130.0000			162.00	Option 1: VP60 = .0085 VP70 = .011

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

KODAP_JET_1_2_IFR - Internal Floating Roof Tank
VASILIKOS, VASILIKOS

Month:	January	February	March	April	May	June	July	August	September	October	November	December
Rim Seal Losses (lb):	0.4352	0.4333	0.4611	0.5200	0.5780	0.6303	0.6724	0.6629	0.6291	0.5454	0.4829	0.4556
Seal Factor A (lb-mole/ft-yr):	1.6000	1.6000	1.6000	1.6000	1.6000	1.6000	1.6000	1.6000	1.6000	1.6000	1.6000	1.6000
Seal Factor B (lb-mole/ft-yr (mph)^n):	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
Value of Vapor Pressure Function:	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0090	0.0090	0.0096	0.0108	0.0120	0.0131	0.0139	0.0137	0.0130	0.0113	0.0100	0.0094
Tank Diameter (ft):	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400
Vapor Molecular Weight (lb/lb-mole):	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000
Product Factor:	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Withdrawal Losses (lb):	196.8180	196.8180	196.8180	196.8180	196.8180	196.8180	196.8180	196.8180	196.8180	196.8180	196.8180	196.8180
Number of Columns:	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Effective Column Diameter (ft):	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Net Throughput (gal/mo.):	1,369,502.6180	1,369,502.6180	1,369,502.6180	1,369,502.6180	1,369,502.6180	1,369,502.6180	1,369,502.6180	1,369,502.6180	1,369,502.6180	1,369,502.6180	1,369,502.6180	1,369,502.6180
Shell Clingage Factor (bbl/1000 sqft):	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500
Average Organic Liquid Density (lb/gal):	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000
Tank Diameter (ft):	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400
Deck Fitting Losses (lb):	0.9907	0.9864	1.0496	1.1837	1.3158	1.4349	1.5308	1.5092	1.4321	1.2415	1.0993	1.0372
Value of Vapor Pressure Function:	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Vapor Molecular Weight (lb/lb-mole):	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000
Product Factor:	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Tot. Roof Fitting Loss Fact.(lb-mole/yr):	597.5000	597.5000	597.5000	597.5000	597.5000	597.5000	597.5000	597.5000	597.5000	597.5000	597.5000	597.5000
Deck Seam Losses (lb):	1.2493	1.2438	1.3236	1.4927	1.6593	1.8094	1.9303	1.9031	1.8059	1.5656	1.3862	1.3080
Deck Seam Length (ft):	4,226.8714	4,226.8714	4,226.8714	4,226.8714	4,226.8714	4,226.8714	4,226.8714	4,226.8714	4,226.8714	4,226.8714	4,226.8714	4,226.8714
Deck Seam Loss per Unit Length Factor (lb-mole/ft-yr):	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400
Deck Seam Length Factor(ft/sqft):	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
Tank Diameter (ft):	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400	164.0400
Vapor Molecular Weight (lb/lb-mole):	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000
Product Factor:	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total Losses (lb):	199.4932	199.4814	199.6523	200.0143	200.3711	200.6927	200.9515	200.8933	200.6851	200.1705	199.7864	199.6188

Roof Fitting/Status	Quantity	Roof Fitting Loss Factors KFa(lb-mole/yr)	KFb(lb-mole/(yr mph^n))	m	Losses(lb)
Access Hatch (24-in. Diam.)/Unbolted Cover, Ungasketed	1	36.00	5.90	1.20	0.8934
Automatic Gauge Float Well/Unbolted Cover, Ungasketed	1	14.00	5.40	1.10	0.3475
Roof Leg or Hanger Well/Adjustable	67	7.90	0.00	0.00	13.1362

Sample Pipe or Well (24-in. Diam.)/Slit Fabric Seal 10% Open	1	12.00	0.00	0.00	0.2978
Vacuum Breaker (10-in. Diam.)/Weighted Mech. Actuation, Gask.	1	6.20	1.20	0.94	0.1539

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: January, February, March, April, May, June, July, August, September, October, November, December

KODAP_JET_1_2_IFR - Internal Floating Roof Tank
VASILIKOS, VASILIKOS

	Losses(lbs)				
Components	Rim Seal Loss	Withdrawl Loss	Deck Fitting Loss	Deck Seam Loss	Total Emissions
Jet kerosene	6.51	2,361.82	14.81	18.68	2,401.81
	Losses(kgs)				
Jet kerosene	2.95554	1072.266	6.72374	8.48072	1090.422

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification	
User Identification:	KODAP_DIESEL_1_3
City:	VASILIKOS
State:	VASILIKOS
Company:	KODAP
Type of Tank:	Vertical Fixed Roof Tank
Description:	KODAP_OIL_STRATEGIC_RESERVES_DEPOT VASILIKOS DIESEL 1_3 TANKS FIXED ROOF
Tank Dimensions	
Shell Height (ft):	65.00
Diameter (ft):	164.00
Liquid Height (ft) :	58.00
Avg. Liquid Height (ft):	58.00
Volume (gallons):	9,165,132.91
Turnovers:	1.00
Net Throughput(gal/yr):	9,165,132.91
Is Tank Heated (y/n):	N
Paint Characteristics	
Shell Color/Shade:	White/White
Shell Condition	Good
Roof Color/Shade:	White/White
Roof Condition:	Good
Roof Characteristics	
Type:	Cone
Height (ft)	6.00
Slope (ft/ft) (Cone Roof)	0.06
Breather Vent Settings	
Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: VASILIKOS, VASILIKOS (Avg Atmospheric Pressure = 14.75 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

KODAP_DIESEL_1_3 - Vertical Fixed Roof Tank
VASILIKOS, VASILIKOS

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	Jan	62.10	57.03	67.18	67.66	0.0070	0.0059	0.0083	130.0000			188.00	Option 1: VP60 = .0065 VP70 = .009
Distillate fuel oil no. 2	Feb	61.94	55.87	68.02	67.66	0.0070	0.0057	0.0085	130.0000			188.00	Option 1: VP60 = .0065 VP70 = .009
Distillate fuel oil no. 2	Mar	64.25	57.37	71.13	67.66	0.0076	0.0060	0.0093	130.0000			188.00	Option 1: VP60 = .0065 VP70 = .009
Distillate fuel oil no. 2	Apr	69.13	61.66	76.60	67.66	0.0088	0.0069	0.0110	130.0000			188.00	Option 1: VP60 = .0065 VP70 = .009
Distillate fuel oil no. 2	May	72.46	64.19	80.74	67.66	0.0097	0.0075	0.0123	130.0000			188.00	Option 1: VP70 = .009 VP80 = .012
Distillate fuel oil no. 2	Jun	75.18	67.87	82.48	67.66	0.0106	0.0085	0.0130	130.0000			188.00	Option 1: VP70 = .009 VP80 = .012
Distillate fuel oil no. 2	Jul	77.36	71.57	83.15	67.66	0.0112	0.0095	0.0133	130.0000			188.00	Option 1: VP70 = .009 VP80 = .012
Distillate fuel oil no. 2	Aug	76.87	71.57	82.17	67.66	0.0111	0.0095	0.0129	130.0000			188.00	Option 1: VP70 = .009 VP80 = .012
Distillate fuel oil no. 2	Sep	75.11	69.92	80.31	67.66	0.0105	0.0090	0.0121	130.0000			188.00	Option 1: VP70 = .009 VP80 = .012
Distillate fuel oil no. 2	Oct	70.77	64.29	77.26	67.66	0.0092	0.0076	0.0112	130.0000			188.00	Option 1: VP70 = .009 VP80 = .012
Distillate fuel oil no. 2	Nov	66.06	59.57	72.54	67.66	0.0080	0.0064	0.0098	130.0000			188.00	Option 1: VP60 = .0065 VP70 = .009
Distillate fuel oil no. 2	Dec	63.80	58.12	69.47	67.66	0.0074	0.0061	0.0089	130.0000			188.00	Option 1: VP60 = .0065 VP70 = .009

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

KODAP_DIESEL_1_3 - Vertical Fixed Roof Tank
VASILIKOS, VASILIKOS

Month:	January	February	March	April	May	June	July	August	September	October	November	December
Standing Losses (lb):	33.5298	36.7581	49.9964	60.2606	76.0335	69.0395	58.2475	52.2235	47.3904	55.7994	47.7256	39.9753
Vapor Space Volume (cu ft):	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208
Vapor Density (lb/cu ft):	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002
Vapor Space Expansion Factor:	0.0350	0.0427	0.0487	0.0527	0.0585	0.0509	0.0393	0.0357	0.0350	0.0451	0.0455	0.0395
Vented Vapor Saturation Factor:	0.9967	0.9967	0.9964	0.9958	0.9954	0.9950	0.9947	0.9948	0.9950	0.9956	0.9962	0.9965
Tank Vapor Space Volume:												
Vapor Space Volume (cu ft):	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208	190,116.6208
Tank Diameter (ft):	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000
Vapor Space Outage (ft):	9.0000	9.0000	9.0000	9.0000	9.0000	9.0000	9.0000	9.0000	9.0000	9.0000	9.0000	9.0000
Tank Shell Height (ft):	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000
Average Liquid Height (ft):	58.0000	58.0000	58.0000	58.0000	58.0000	58.0000	58.0000	58.0000	58.0000	58.0000	58.0000	58.0000
Roof Outage (ft):	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000
Roof Outage (Cone Roof)												
Roof Outage (ft):	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000
Roof Height (ft):	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000
Roof Slope (ft/ft):	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625
Shell Radius (ft):	82.0000	82.0000	82.0000	82.0000	82.0000	82.0000	82.0000	82.0000	82.0000	82.0000	82.0000	82.0000
Vapor Density												
Vapor Density (lb/cu ft):	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002
Vapor Molecular Weight (lb/lb-mole):	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0070	0.0070	0.0076	0.0088	0.0097	0.0106	0.0112	0.0111	0.0105	0.0092	0.0080	0.0074
Daily Avg. Liquid Surface Temp. (deg. R):	521.7720	521.6127	523.9179	528.8010	532.1344	534.8453	537.0271	536.5364	534.7820	530.4437	525.7270	523.4661
Daily Average Ambient Temp. (deg. F):	52.4000	51.2050	55.5900	65.6450	72.7000	78.8050	84.1450	83.3000	79.8550	70.5600	60.9750	56.3800
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731	10.731	10.731	10.731	10.731	10.731	10.731	10.731	10.731	10.731	10.731	10.731
Liquid Bulk Temperature (deg. R):	527.3300	527.3300	527.3300	527.3300	527.3300	527.3300	527.3300	527.3300	527.3300	527.3300	527.3300	527.3300
Tank Paint Solar Absorptance (Shell):	0.1700	0.1700	0.1700	0.1700	0.1700	0.1700	0.1700	0.1700	0.1700	0.1700	0.1700	0.1700
Tank Paint Solar Absorptance (Roof):	0.1700	0.1700	0.1700	0.1700	0.1700	0.1700	0.1700	0.1700	0.1700	0.1700	0.1700	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	861.0700	1,133.9300	1,413.7600	1,755.4600	1,926.1500	1,944.5500	1,819.5500	1,731.0300	1,553.3600	1,368.3900	996.5500	818.5600
Vapor Space Expansion Factor												
Vapor Space Expansion Factor:	0.0350	0.0427	0.0487	0.0527	0.0585	0.0509	0.0393	0.0357	0.0350	0.0451	0.0455	0.0395
Daily Vapor Temperature Range (deg. R):	20.2987	24.2975	27.5231	29.8912	33.1013	29.2361	23.1547	21.1997	20.7788	25.9535	25.9332	22.7027
Daily Vapor Pressure Range (psia):	0.0024	0.0028	0.0034	0.0041	0.0047	0.0045	0.0038	0.0034	0.0031	0.0036	0.0033	0.0027
Breather Vent Press. Setting Range(psia):	0.0600	0.0600	0.0600	0.0600	0.0600	0.0600	0.0600	0.0600	0.0600	0.0600	0.0600	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0070	0.0070	0.0076	0.0088	0.0097	0.0106	0.0112	0.0111	0.0105	0.0092	0.0080	0.0074
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0059	0.0057	0.0060	0.0069	0.0075	0.0085	0.0095	0.0095	0.0090	0.0076	0.0064	0.0061
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0083	0.0085	0.0093	0.0110	0.0123	0.0130	0.0133	0.0129	0.0121	0.0112	0.0098	0.0089
Daily Avg. Liquid Surface Temp. (deg R):	521.7720	521.6127	523.9179	528.8010	532.1344	534.8453	537.0271	536.5364	534.7820	530.4437	525.7270	523.4661
Daily Min. Liquid Surface Temp. (deg R):	516.6973	515.5383	517.0371	521.3282	523.8591	527.5363	531.2384	531.2364	529.5873	523.9554	519.2437	517.7904
Daily Max. Liquid Surface Temp. (deg R):	526.8467	527.6870	530.7987	536.2738	540.4097	542.1543	542.8157	541.8363	539.9767	536.9321	532.2103	529.1418
Daily Ambient Temp. Range (deg. R):	22.5000	26.2500	28.8800	29.9100	33.2400	27.7500	20.1300	18.0000	18.5900	27.0000	29.4300	26.1200

Vented Vapor Saturation Factor												
Vented Vapor Saturation Factor:	0.9967	0.9967	0.9964	0.9958	0.9954	0.9950	0.9947	0.9948	0.9950	0.9956	0.9962	0.9965
Vapor Pressure at Daily Average Liquid:												
Surface Temperature (psia):	0.0070	0.0070	0.0076	0.0088	0.0097	0.0106	0.0112	0.0111	0.0105	0.0092	0.0080	0.0074
Vapor Space Outage (ft):	9.0000	9.0000	9.0000	9.0000	9.0000	9.0000	9.0000	9.0000	9.0000	9.0000	9.0000	9.0000
Working Losses (lb):	16.6084	16.5143	17.8767	20.7626	23.0240	24.9466	26.4939	26.1459	24.9016	21.8249	18.9458	17.6097
Vapor Molecular Weight (lb/lb-mole):	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000	130.0000
Vapor Pressure at Daily Average Liquid												
Surface Temperature (psia):	0.0070	0.0070	0.0076	0.0088	0.0097	0.0106	0.0112	0.0111	0.0105	0.0092	0.0080	0.0074
Net Throughput (gal/mo.):	763,761.0758	763,761.0758	763,761.0758	763,761.0758	763,761.0758	763,761.0758	763,761.0758	763,761.0758	763,761.0758	763,761.0758	763,761.0758	763,761.0758
Annual Turnovers:	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Turnover Factor:	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Maximum Liquid Volume (gal):	9,165,132.9090	9,165,132.9090	9,165,132.9090	9,165,132.9090	9,165,132.9090	9,165,132.9090	9,165,132.9090	9,165,132.9090	9,165,132.9090	9,165,132.9090	9,165,132.9090	9,165,132.9090
Maximum Liquid Height (ft):	58.0000	58.0000	58.0000	58.0000	58.0000	58.0000	58.0000	58.0000	58.0000	58.0000	58.0000	58.0000
Tank Diameter (ft):	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000	164.0000
Working Loss Product Factor:	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total Losses (lb):	50.1383	53.2724	67.8731	81.0232	99.0575	93.9860	84.7413	78.3693	72.2920	77.6243	66.6715	57.5850
Total Losses (kgs):	**22.762788**	**24.18567**	**30.814387**	**36.784533**	**44.972105**	**42.669644**	**38.47255**	**35.579662**	**32.820568**	**35.241432**	**30.268861**	**26.14359**

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: January, February, March, April, May, June, July, August, September, October, November, December

KODAP_DIESEL_1_3 - Vertical Fixed Roof Tank
VASILIKOS, VASILIKOS

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	255.65	626.98	882.63
	Losses(kgs)		
Distillate fuel oil no. 2	116.0651	284.6489	400.714