DESFA
Hellenic Gas Transmission System Operator S.A.

Cumulative Impacts Assessment for the 2nd Upgrade of the LNG Terminal in Revithoussa Island, Greece

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Acronyms

Acronym	***Description***
CIA	Cumulative Impact Assessment
ESIA	Environmental and Social Impact Assessment
ETA	Environmental Terms Approval
IIILS	High high high level Switch
IILS	High high level Switch
ILS	High level Switch
LLLLS	Low low low level Switch
LLLS	Low low level Switch
LLS	Switch Low
LNG	Liquefied Natural Gas
MEECC	Ministry of Energy, Environment and Climate Change
ORV	Open Rack Vaporizer
SCV	Submerged Combustion Vaporizer
VESCs	Valuable Environmental and Social Components

1 Introduction

The scope of the present report is to document the cumulative impacts from the construction and operation of three distinctive projects planned for the upgrade of the LNG Terminal Facilities at Revithoussa Island. These projects are:

1. Construction of a 3rd Tank of 95.000m³ LNG capacity
2. Installation of a new ORV unit
3. Maintenance and Upgrade of the Jetty Facilities of the island.

IFC provides the following definition of cumulative impacts (International Finance Corporation, 2013):

> **"Cumulative impacts are those that result from the successive, incremental, and/ or combined effects of an action, project, or activity when added to other existing, planned, and/ or reasonably anticipated future ones. For practical reasons, the identification and management of cumulative impacts are limited to those effects generally recognized as important on the basis of scientific concerns and/or concerns of affected communities."**

Cumulative and combination effects may result from various types of interaction:

- a combination of different types of effects at a specific location;
- a combination of effects of the same type at different locations, which are not necessarily significant individually, but which collectively may constitute a significant effect;
- the interaction of different effects over time; and
- The cumulative interaction between effects from the proposed development and other existing or planned projects in close proximity.

Examples of cumulative impacts include the following:

- Effects on ambient conditions such as the incremental contribution of pollutant emissions in an air shed.
- Increases in pollutant concentrations in a water body or in the soil or sediments, or their bioaccumulation.
- Increases in sediment loads on a watershed or increased erosion.
- Interference with migratory routes or wildlife movement.
- Increased pressure on the carrying capacity or the survival of indicator species in an ecosystem.
- Secondary or induced social impacts, such as in-migration, or more traffic congestion and accidents along community roadways owing to increases in transport activity in a project's area of influence.

2 Description of Projects

2.1 Introduction

The present section provides a very short technical description of all three projects that are to be implemented in the area of Revithoussa Island. Moreover, the construction and operation phases are described in the relevant paragraphs. Further details are provided in the source documents, ie the approved ESIAs of the projects.

The scope of this section is on the one hand to present the technical background of the three projects and on the other hand to provide an overview of the two distinguished phases of the projects, ie construction and operation, so that the reader can understand the mechanisms with which the projects could impose negative impacts to the VESCs.

The Liquefied Natural Gas (LNG) Terminal at Revithoussa is one of the most significant national assets and one of the thirteen (13) LNG terminals operating in Europe and the Mediterranean Sea. The Terminal is located on the island of Revithoussa, 500m from the shore of Agia Triada in the Pachi Gulf of Megara, 45km west of Athens.

The LNG Terminal at Revithoussa is designed and operated according to the strictest safety specifications and standards with respect to the workers on the island and the inhabitants of the broader area. The utilized process technology of the liquefied natural gas is environmentally friendly and the Greek and European Regulations are applied strictly. The application of high safety standards and the uncompromising respect to the environment are checked and certified by independent official organizations as the Terminal is certified according to the OHSAS18001 and ISO14001 standards.

The LNG Terminal of DESFA is a major energy asset for Greece as it secures energy supply, provides operational flexibility and enhances the capacity of meeting consumer peak demands.

In April 2009, the strategic role of the LNG Terminal was strengthened by completing and operating the High Performance Electricity and Heat Co-generation Unit. This Unit, with natural gas fuel, generates 13MW of electricity and ensures the electrical autonomy and sufficiency of the LNG Terminal. The recovery capability of 14MW thermal energy and its utilization in the gasification process enhances the efficiency rate of the Unit to approximately 89%, contributing to the saving of energy resources, the protection of environment and the reduction of operational costs.

2.2 Second Upgrade Terminal Station LNG – Addition of a 3rd LNG Tank

2.2.1 Existing LNG Terminal

Currently, the LNG is stored in two tanks with total capacity 130,000 cubic meters and is regasified in the gasification installations of the Terminal, supplying the National Natural Gas Transmission System.

In October 2007, DESFA completed one of the most important investments in the energy infrastructure of Greece, upgrading the LNG Terminal at Revithoussa in the 1st Upgrade Phase and increasing both its receiving and regasification capacities. The Terminal can now accept larger LNG ships and efficiently receive double gas quantities in the same period. The continuous gasification capacity of the Terminal is tripled to 1,000 cubic meters LNG per hour from 271 cubic meters before the upgrade, thus tripling the LNG processing capacity of the Terminal and increasing the supply capacity to the National Transmission System

In an international environment where energy is emerging as a key factor for growth of economy and quality of life, DESFA reinforces one of the main energy assets of Greece in order to meet the present and future energy needs of the country. In terms of the 2nd Upgrade Phase of the LNG Terminal at Revithoussa, DESFA has completed the feasibility study for the construction of the third LNG storage tank and the increase in the gasification capacity. The third tank will have storage capacity of 95,000 cubic meters LNG and will raise the total storage capacity of the Terminal to 225,000 cubic meters LNG from 130,000 cubic meters LNG today. The gasification capacity will be raised to 1,400 cubic meters LNG from 1,000 cubic meters LNG today. The terminal station, after the second upgrade could receive ships with capacity up to 260.000 m^3..

2.2.2 Technical Description

The second upgrade Terminal Station LNG Revithoussa includes the addition of a third tank with net capacity 95000 m^3 and with "double shell" (full containment) and partly underground as exactly the two existing tanks.

Upgrading the LNG Terminal Station by adding a 3rd Tank in Revithoussa Island aims to the increasing of the capacity of the terminal station. Specifically, the 3rd tank will contribute so that the terminal station can meet the demand of natural gas in case of its supply interruption for a long time.

Regarding the structure of the 3rd Tank, it consists of two containers, the exterior and interior, both designed with sufficient quality to withstand the stored LNG, separately.

The same philosophy with the existing tanks is followed, namely, the inner shell consists of special steel containing 9% nickel, suitable for cryogenic facilities. The outer shell is a special cryogenic concrete and is capable to retain the cryogenic liquid as well as the amount of gases come from possible failure of the inner shell. In addition, the outer shell consists of a concrete dome roof tank and is designed to combine two functions. The one is to maintain the thermal

insulation of the inner container in normal operation of the tank and the other is to get all of the liquid contents of the inner container and LNG steam, in case of a possible failure of the inner tank. The main features of internal and external tank are presented below:

Table 2-1 External Tank Characteristics.

Feature	Size
Diameter	81.5 m
Wall thickness	750mm
BedplateThickness	1000mm
Bedplate Diameter	82.1m
Roof Thickness	450mm
Total height (from the bottom of the bedplate until to the upper part of the roof)	37.26m
Height from the top of the bedplate up to the top of the roof	28.487m
Inside Height from the top of the Bedplate to the upper part of the perimeter beam	27.08m

Table 2-2 Internal Tank Characteristics.

Feature	Size
Nominal Diameter	78 m
Height from the base to mounted roof	24.405m
Shell thickness (max)	18mm
Bottom Thickness	6mm
Suspended ceiling Thickness	5mm

Table 2-3 Insulation Systems

Feature	Size
Thickness of insulation shell	1000mm
Bottom Insulation thickness	500mm
Suspended ceiling Insulation thickness	600mm

Table 2-4 Tank foundation system

Feature	Size
Raft Thickness	2000mm
Seismic Isolation Height	1800mm

Table 2-5 Capacities

Feature	Size
Geometric capacity	115787m^3
Gross capacity	103773m^3
Pumpable Volume	100203m^3
Working capacity	95204m^3
Pumping Rate	3000m^3/h
Rate of Loading	12500m^3/h

Table 2-6: Level

Feature	Size
Maximum level	22733mm
High high high level Switch (IIILS)	22680mm

High high level switch (IILS)	22460mm
High level switch (ILS)	21800mm
Switch Low (LLS)	1800mm
Low low level Switch (LLLS)	1000mm
Low low low level Switch (LLLLS)	750mm

Table 2-7: Pressure

Feature	Size
Operating Pressure	260mbar
Design Pressure	290mbar
Hydrostatic Test Pressure	363mbar

Double shell tanks (full containment), usually have not collection basin. Nevertheless, in Revithoussa, where the tanks are buried, there are collecting channels which lead LNG in opened catchment basin in case of leakage. This tank has been designed to reduce both the evaporation surface and the rate of evaporation of the collected LNG. This is achieved by coating the free surface of the collected LNG with high expansion foam.

Table 2-8 New equipment within the scope of the LNG Terminal Station Second Upgrade.

Equip. No.	Equipment	Type	Capacity in operation (per equipment)	Design conditions		Material	Remarks
				Pressure (bar)	Temp. °C		
Tanks							
P3201 C	LNG Tank	Partially underground. Full load.	Net: 95000m^3 Total: 112500 m^3	0,29	(-170) ÷ (+65)		Roof: Reinforced Concrete. Walls: Concreteα Internal: 9% nickel with alum Susp Deck
Pumps							
J-3201 I/J/K	Low pressure LNG tank pumps (P-3201C)	Immersed Vertical Engine	200m³/h at 239m height difference	15	(-196) ÷ (+35)	Alalloy +SS	Within tanks' pomonas. Consumption 85kW, approx. each one

Notes:
1. When the gasification rate is 1000m3 / h, then two pumps shall be in operation. Three pumps may be required when the peak gasification rate is 1250m^3 / h.
2. In case of Terminal's future gasification rate increase, a fourth pomona will be installed in the tank for the addition of a pump.

2.2.3 Construction

The construction of the project includes two main parts: the earth-works and construction of the third LNG tank.

a. EARTH-WORK

At the southeastern end of the island one well, with ~82m diameter and 25.00m depth will be drilled, and it will be placed 129m away from the eastern tank. The estimated earthwork volume is 129.000m³.The new LNG storage tank will be constructed in this well. Following this construction philosophy, the one half part of the tank will be buried in the ground and the other half will be out of it, reaching the same level as the existing. The part of the tank that will not be buried will be filled with well's excavated materials at a volume of ~30.000m³, so that the landscape impact be minimized. After this procedure, the assimilation of the third tank to existing installations will be achieved. As a result the intervention in the social environment is relatively small and the safety level is high. The embankment's slope is 4: 3 (H: V), similar to existing slope.

These works will be carried out with appropriate mechanical equipment and without any use of explosives for security reasons. The solid wastes, which will be generated (~ 100.000m³), will be disposed at specified locations, according the instructions of competent authorities as well as the Environmental Terms.

b. CRYOGENIC FACILITIES AND UTILITIES CONSTRUCTION

A perimeter road of third tank will be constructed for safety reasons. Piperacks, low pressure LNG pumps, trench collection in case of LNG leakages and catchment basins, will also be constructed. The surface around the LNG processing facilities will have such an inclination as to be drained (through a catchment ditch) to the catchment basin. The catchment ditch will be placed next to the main piperacks and will follow their path. The ground beneath the piperacks will also have an inclination so the catchments ditch to be drained. The whole ditches system design is based on the scenario that an LNG spill takes place from the line with the largest flow during any of the normal operating procedures (LNG unloading, LNG transportation etc.). The ditches system is designed with such gradient so the LNG spill is drained with the greatest possible speed, to the catchment basin. The water rain and firefighting water will drain also at the same catchment basin through the ditches system.

The existing catchment basin has a rectangular shape and a minimum capacity of 225 m³. The basin walls are constructed of cryogenic-type concrete and are coated with perlite slabs, in order the vapor production rate of the LNG (because of heat exchange with the walls), to be minimized. Concrete wall with 1m height, has been constructed around the basin as a continuation of the basin walls, in order the vapor to be retained (Vapor fence). The retention basin is consisting of a water drainage system in order to provide to the spilled LNG with free space. The drain valves are connected to the LNG spilled probes in order to prevent the systems function in case LNG is detected in the collection ditches. The basin has to be able to hold spilled LNG equal to 1.5 min releasing from the larger tubing.

Despite that the new third tank is covered by the above existing retention leakages basin, the constructing of an additional drainage basin has been predicted. The details about the size and location of the new basin will be considered in the detailed design phase of the new tank.

2.2.4 Operation

2.2.4.1 LNG Terminal Main Processes

Main Processes that take place within the existing main LNG Plant Units are the following:

I. **LNG Storage** (from ships)

II. **Boil-Off Re-Condensation** (meaning, condensation of LNG-produced undesirable vapour phase within storage facilities – a safety item. This vapour phase is produced through heat losses of LNG Storage Tanks and is consisting of flue gases (boil-off), 0.075% of the gross capacity of the tank per day by calculating pure methane).

III. **LNG Pumping and Gasification**

IV. **Gasified LNG infusion to National Natural Gas Transmission System (NGTS) of Greece**

Maximum LNG unloading rate to LNG Terminal is specified / set up to 7,250 m^3/hr.

Main Equipment included within aforementioned LNG Terminal is shortly described as follows:

- **LNG Storage (through Storage Tanks suitable for LNG Service)**

The LNG shall be stored in two existing tanks, with net capacity 65.000m^3 each one, as well the new (future) tank with net capacity of 95.000 m^3.

- **Low Pressure LNG Pumps**

For each existing storage tank P-3201A and P-3201B there are four quenched pumps installed. For the new tank P-3201C – and for the same reason – four (4) new quenched pumps will be foreseen / installed. These LNG low pressure pumps will recirculate LNG in the discharge line, in order to be kept in cold conditions, and will provide the required LNG amount to the gasification system.

- **Cryogenic LNG Compressors**

Three (3) two-stage cryogenic and reciprocating compressors (tagged V 3101 A/B/C – two in duty / one stand-by) are installed in LNG Plant. The compressors send waste / boil-off gas either to recondenser or to the combustion gasifiers.

- **Recondenser**

A recondenser, tagged O-3102, is installed within the LNG Terminal Station, in order to re-liquefy the produced into tanks waste / boil-off gases and to mix them with low pressure LNG. The recondenser feeds the high pressure pumps. The recondenser is designed to completely cover the maximum amount of waste gases which are compressed by the two (out of three) compressors when operating at 100% of their capacity. The addition of the third LNG Storage tank has no impact on recondenser, needing no revamping at all.

- **High Pressure LNG Pumps**

There are six feed high pressure pumps, tagged J-3101 A/B (low-supply), J-3102 A/B (medium-supply) and J-3103 A/B (high-supply).

- **Gasifiers**

There are seven (7) gasifiers installed within LNG Terminal, in order to gasify LNG. Three of them are seawater gasifiers (tagged M-3101A / B / C) and four of them (tagged M-3102A / B / C / D) operate utilizing NG combustion. The seawater gasifiers are preferred for the LNG gasification because their function is more environmental friendly compared to the NG combustion gasifiers.

- **Fuel Gas System**

The fuel gas system is divided into two (2) sections: low pressure and high pressure. The low-pressure system is fed with gas, taken from the compressors and - if required - from the gas fueling system (send-out gas system). The high pressure gas system is exclusively fed from the gas fueling system (send-out gas system). The high pressure fuel gas consumers are both internal combustion engines of Combined Heat & Power (CHP) unit which is installed in the terminal station.

- **Flare system**

The flare system can manage the Roll-over scenario in the new tank P-3201C, provided this new tank is designed for the worst case scenario. Thus the addition of this third LNG Storage tank does not create additional environmental impact because of the Roll - over phenomenon.

- **Compressed Air System**

The compressed air system meets the needs of both instrument air and plant air. The compressed air is produced by three air compressors.

When the third LNG Storage tank is added, no modification of compressed air system is required.

- **Nitrogen system**

There are two (2) liquid nitrogen tanks, with 30 m^3 storage capacity each one, fed by trucks.

- **System Drinking Water and Water Plant**

The drinking water and plant water supply networks are already connected to Public Water Supply System, through submarine pipeline and land pipeline. There are two (2) potable water storage tanks, with a capacity of 8 m^3 and 2 m^3, respectively. Adding a third LNG Storage tank does not require additional consumption of drinking water.

The plant water supply network covers:

- The utilities stations
- The replacement of water in the cooling water system
- The consumption of water in the sodium sulphite system.
- The replacement of water in gasifiers utilizing NG combustion.

The additional consumption, which is required by the addition of the third tank, is oversubscribed.

- **Seawater System**

The seawater is used as the main plant firefighting requirements medium and as heating medium for seawater gasifiers. The addition of the third tank has no impact on the seawater system.

- **Cooling Water System**

The cooling water system is a "closed" network, which is supplied with filling water by the plant water system. The cooling water consumers are the compressed air compressors and the air instruments dryer as well as the waste gases compressors.

Third LNG Storage tank addition is not expected to increase the consumption of cooling water in the terminal station.

- **Firefighting Water System**

Since the fire lake scenario on the roof of an LNG tank is no longer considered as an engineering firefighting study scenario, according to the new European code EN 1473, the addition of the third tank does not change the firefighting water system.

- **Diesel Fuel System**

The diesel fuel system is designed to meet the needs of diesel machines (diesel-powered firefighting water pumps and power generator in case of emergency). The addition of the third tank is not expected to increase fuel diesel consumption.

- **Retention Containers (K.O. drums)**

  - Pier Retention containers (O-3101)
  - Retention container waste gases suction of compressor (O-3103)

- Low pressure fuel gas Retention container (O-3104)
- Flare Retention Container (O-3105)

The addition of the third LNG Storage tank does affect operation of aforementioned containers.

2.2.4.2 Safety Precautions, Regulations and Environmental Protection Items

The LNG Storage Terminal has been designed to minimize solid, liquid and air (Volatile Organic Compounds - VOC) emissions to the environment. In any case, EU and Greek Legislation certain Safety & Environmental Protection Requirements, Regulations and Specifications are strictly followed.

Certain Safety & Environmental Protection Measures already specified, designed, foreseen or already in operation are briefly described as follows:

1) Sulphur-free Fuel (NG) utilization. Low-Sulphur Diesel is only utilized for firefighting stand-by pumps and Diesel Generators.

2) Complete Combustion Safety Flare utilization of adequate capacity (up to 127,400 kg/h), to eliminate unburned HC (hydrocarbons) emissions to the Environment.

3) Human and Sanitary Activities WWTP (Waste Water Treatment Plant) installation and operation.

4) Oily-phase wastes collection to barrels. Safe removal to safe disposal areas designed and in operation for relevant environmental protection activities.

5) Provisions to be taken for safe collection and disposal of common solid garbage.

6) Safety regulations and measures already followed for Noise Reduction.

Total sources of Air, Liquid and Solid Waste pollution from the LNG Terminal Station (both for existing as well as for new facilities) are in details described through Greek Legislation Ministerial Decision No. 181794 / 05-04-2013 of Greek Ministry of Environment, Energy and Climate Change (subject to EU Directive No. 2010/75/EU (IED)), paragraphs A.7 to A.10.

2.2.4.3 Wastes Management

- **Waste Gases**

Under Normal Operation there is no continuous emission of waste gases, though:

- Installed and Operated Flare System utilizes only small amounts of NG (max. 250Nm³/hr), necessary to maintain flare system pilot flame.

- Installed seawater gasifiers are sufficient / adequate to cover normal NGTS requirements. NG Combustion gasifiers shall operate only in case of peak requirements
- CHP Unit – using internal combustion engines and Fuel NG

All individual LNG Terminal Facilities are potential HC leakage points, specially localized on certain types of equipment, like valves, pumps, compressors etc. The leakage rate for each equipment separately is a function of its design, its age, maintenance etc. Considering LNG Terminal Stations, the main leaked HC is Methane, with small other emissions of heavier alkanes taken into account, additionally.

- **Wastewater (Liquid-Phase Wastes)**

Liquid Wastes are expected to be produced during Terminal normal operation (paragraphs A.7 & A.9 of aforementioned Greek Legislation). No additional wastewater is expected after installation and operation of the third LNG Storage Tank.

- **Solid Waste**

Solid Waste is mainly produced during Construction Phase of subject Project (see aforementioned Legislation paragraph A.8 – New Facilities). No additional solid waste during installation and normal operation of the third LNG Storage Tank is expected.

2.2.4.4 Water Consumption

Water consumption has been already covered on the relevant section for the LNG Terminal Main Processes (see section 2.2.4.1).

Relevant Systems are Drinking Water System (M-4100), Firefighting Water System (M-4200), Seawater System (U-4300), Cooling Water System (M-4400) and Plant Water System.

Addition of the third LNG Storage Tank does not affect these systems.

2.2.4.5 Energy Consumption

As also referred to paragraph A.4 – New Facilities of aforementioned Greek Legislation, the addition of the third LNG Storage Tank will cause an increase in Terminal electricity consumption of about 10% (lighting, pumps, ESD System).

2.2.4.6 Maintenance

LNG Terminal preventive maintenance program has been established on the basis of the terminal equipment installed, in collaboration with certain equipment vendors and their relative regulations / instructions. Maintenance is executed on different levels and at specified

time limits / intervals, according to maintenance subject and program, while keeping records on the necessary data of it.

To serve maintenance programs requirements, following equipment has been provided:

- Appropriate Special Positive Isolation Systems (isolation valves, double-block-and bleed valves and arrangements, blinds and spectacle blinds etc.)
- By-pass lines for achieving smooth operation of the facilities during maintenance
- Special Connections for:
  - Cleaning
  - Washout
  - Aeration
  - Drainage / Sewage
  - Neutralization / Hibernation

All these elements are sealed and locked and handled only by authorized employees DESFA.

2.3 Second Upgrade Terminal Station LNG – Upgrading the Port Facilities

2.3.1 Existing Port Facilities

The LNG is transported, in ships with a capacity up to 130.000m^3, and it is unloaded from them once they moored at Revithoussa' s jetty..

The jetty is placed at the southern part of the island, so as to ensure the safe approach and mooring of ships. Moreover, this position contributes to their quick release in case of emergency and it also provides a protection from the prevailing wind (North- Northwest winds).

The transfer of LNG from ships to Revithousa's storage tanks is served via ship's pumps, after their connection with the unloading system.

The total unloading system consists of 3 unloading arms (2 with capacity 1.750m^3 LNG/hour and 1 with capacity3.750 m^3LNG/hour) and 1 vapor recovery loading arm.

Each arm is connected with the tanks through independent pipes that carry return valves so as to avoid cumulative leakage from the supply of the three arms in to the sea.

Figure 2-1 View of Revithousa's jetty and unloading arms

Source: (RINA, D'APPOLONIA, EXERGIA, 2013)

2.3.2 Technical Description of the New Port Facilities

The present paragraph examines the upgrade of port facilities of the Terminal Station LNG, which main purpose is to serve three (3) categories of ships that will carry Liquefied Natural Gas (LNG) and they have capacity 180.000m^3, 220.000m^3 and 260,000 m^3. The following works will take place:

- Sea bottom Clearance from accumulated sediments and stones, in front of the platform wharf, in order to be restored to its original depth, namely 13.42m deeper than the minimum water level of the sea (LLWL), thus achieving the minimum safety distance range of the ship keel from the sea bottom.
- Replacement of existing Buffers / Fenders with new ones, capable of absorbing the planning energy, when the large capacity ships are moored (220.000 m³ & 260.000m³) under adverse weather conditions.
- Supply and installation of two additional Mooring Hooks (one on each side), in order to ensure safe mooring under adverse conditions, when the above mentioned LNG carriers are approaching.
- Armoring of the retaining structures for the two new mooring hooks installation and stabilization of the existing ones, where is required.
- Certification of the operation and effectiveness of all existing cables, with the appropriate checks, as well as of the existing cables and bases automatic hooks, where they are founded.

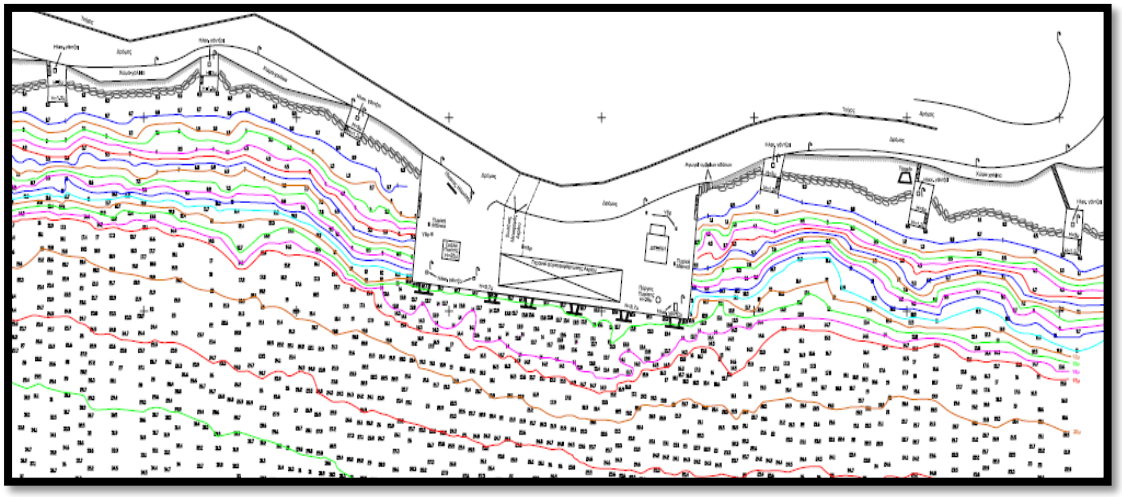
2.3.3 Construction

As mentioned in the previous paragraph some basic steps for the construction of the new port's facilities have to be taken. These steps are described below:

- Sea bottom Clearance

Hellenic Navy Hydrographic Service, after bathymetric survey, has spotted an area of small depth in front of Revithousa's jetty bottom, specifically in the eastern part of the LNG platform. According to the findings of this survey, DESFA performed a site survey for the visual and morphological assessment of this bathymetric anomaly.

Figure 2-2 Bathymetric mapping of the Hellenic Navy Hydrographic Service



Source: (ΔΕΣΦΑ, 2014)

Along the sea bottom in front of the LNG platform, material accumulation was spotted in certain areas. These areas overcome the desired design level and that is why the required depth for ships approach is reduced.

This elevation consists of aggregates, mainly rip-rap materials. It is estimated that these aggregates were accumulated during the initial construction of the LNG Terminal. Existing aggregates characterized as concentrated. Removal of these materials only with manual methods is considered to be very difficult.

The critical depth in front of the platform, based on the construction plans is -13.42 m, measured from the Lowest Low Water Level.

This depth, according to the above mentioned bathymetric survey, was measured -12.77m, due to the accumulation of sedimentary material and stones (rip-rap and some natural rock materials). Small raises of these materials are observed, sporadically, in several spots along the LNG platform.

Based on the above, ships with maximum draft of 12.4m would be able to be accommodated conditionally that the aggregates will be removed and the maximum sea bottom depth, in front of the jetty will be cleaned so that it is restored to its initial depth of 13.42m.

As mentioned above, the removal of aggregates is not possible to be achieved exclusively with manual methods. The bottom cleaning process will be supported by specialized equipment, which will be installed at the project site

All bottom cleaning works will be restricted out of the buffers line, not to risk disturbance of the jetty wall.

Figure 2-3 View of aggregates accumulated in the bottom of the platform

Source: (ΔΕΣΦΑ, 2014)

- Replacement of existing Buffers/ Fenders

The calculations which they have been performed show that existing buffers are marginally sufficient for safe energy absorption of a Qmax ship class mooring, namely the class of 266.000m³.

The safest scenario is the replacement of the existing six (6) fenders with other qualified and of the same dimensions and height tire, in order to secure a single mooring line. This way the buffers will be able to withstand the maximum design load of the ship during normal operations and also be able to withstand loads generated by non-routine events, such as mishandling or accident that may occur in the future.

In this case, the safety factor for a ship of 260.000 m³ LNG capacity is considered marginally low due to the following:

- The age of the existing bufferswhich may cause various problems affecting their efficiency.
- The fact that the two external buffers have to absorb the increasing mooring energy with an angular approach up to 10°
- Of shiploads that require additional safety factors.

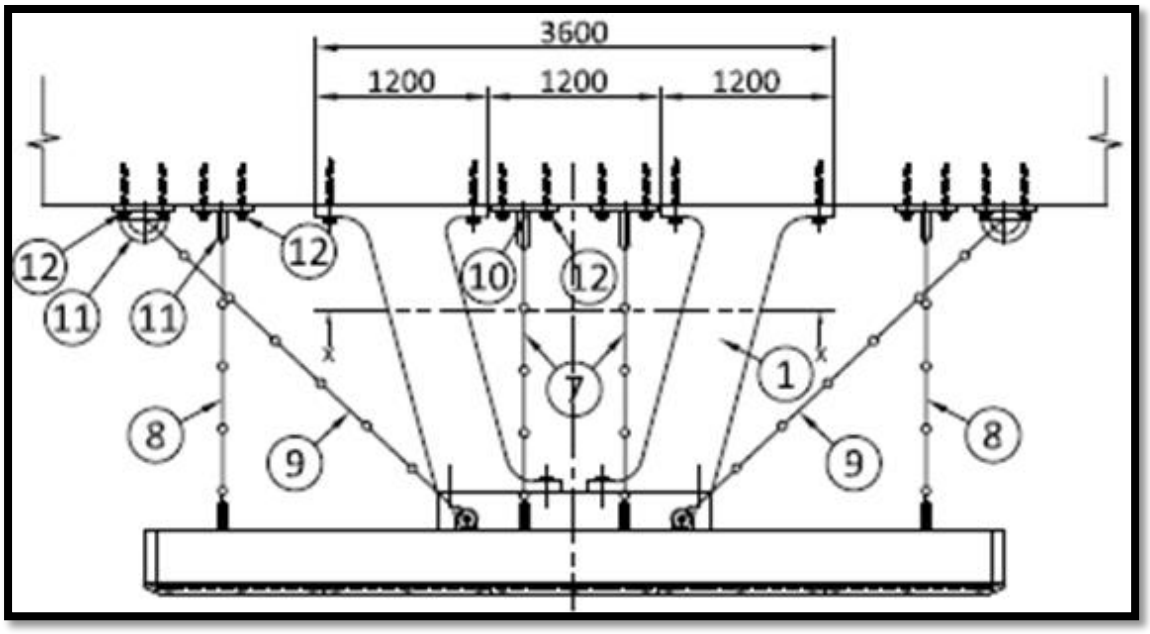
For the new buffers which shall be installed, the following factors are taken into consideration:

- The configuration of the pier, which results in the buffers' dependence as a whole, as in this case, and not as individual elements.
- The Mooring frequency
- The approaching speed to the jetty to be low
- The vulnerability of the structure that supports the buffers
- The range of ships (Qmax, Q flex)
- Type of cargo

- New Mooring Hooks

The position of ship's mooring is very important for the safe unloading of the ship. In the case of the Terminal Station in Revithoussa Island, the lines of the bow and stern of the ship in some cases do not help ensuring the safe mooring of the ship. For ships with capacity 180.000m^3 and 220.000m^3, the existing mooring hooks are sufficient to secure their berth. For ships of 260.000m^3, two new mooring points should be placed in a distance of 35m from the last eastern and western point respectively. With the bindings addition, the requirements for safe mooring and anchoring of ship class of 220.000 m³ - 260.000 m³ are met.

Figure 2-4 Section of Proposed Buffers



Source: (ΔΕΣΦΑ, 2014)

- Armor Retaining Structures

To restore and strengthen the armoring along the coastal road, the construction of retaining structures with the appropriate classified boulders is scheduled. The significant wave height in the open from Revithoussa area is 2.2m and 2.6m for normal and extreme conditions, respectively, from the critical S-SW direction.

The current armor, consisting of natural boulders of varying gradient, as well the embankments along the road will be purged along of the western and the eastern part, where necessary and as determined by the plans of project. The works will be performed up till -2.50 m (MSL) along the interventions. The excavation slope is foreseen 2:3, and locally near the anchoring bollards base, 1:1 (vertical: horizontal). The extent of the proposed work is designed so as not to endanger the stability of the overlying road and the anchoring bollards bases. The extent of the works will be assessed on site by the supervising engineer, if it is necessary. The partial implementation of these works is suggested to prevent any unwanted damages during a possible storm.

The natural boulders that will be lifted - fished could be reused in other locations, which have to be protected. The armoring of the created by the embankments slopes along the coastal road will consist of a main and a secondary armoring and shall be founded on the created sea bottom at -2.50 m (MSL). The main (external) armoring with total thickness of about 2.20 m and slope gradient 2:3 (vertical: horizontal), will consist of a double layer of natural boulders 2500 - 4500 kg. The secondary armoring (substrate), with total thickness of about 1.00 m, will be founded on the slopes (created or existing ones, depending on each case); it will be created

with a double layer of natural boulders of 250-500kg with the same gradient as that of the main armoring. The feet of the main armoring is to be manufactured at a minimum distance of approximately 1.50 m from the slope of the natural bottom. The crest of the main armor is formed at a level +4,50 m (MSL) and the width is approximately 3.30 m, allowing the placement in the crest of at least three boulders.

Along the project, where the crest of the main armor is formed below the crest level of the existing slopes, a rip rap will be constructed 50 to 100 kg will be casted, for further protection of the embankments slopes fine materials, in case of armoring's overcoming. Rip rap's gradient will follow the excavation slope or the existing slopes and its crest will reach the road's level, in the western section. Along the eastern part, where the armoring's slopes crest is lower than the existing slopes, rip rap shall extend to a maximum height of about 1.50 m above the main armoring's crest and follow the inclination of the existing slopes.

Before the construction of the project's secondary armoring, at the created embankments slopes and bottom, a polyester geotextile will be lined, such as Geolon PET 200S or equivalent, in order to prevent leakage of fine materials through the formed gaps between the secondary and primary armoring. The geotextile is designed to be of sufficient length, in order to ensure anchoring around at least one natural boulder at the foot of the slope.

In the section between the eastern edge of the pier and the first anchorage base to the east, concrete is proposed to fill the gaps between the natural boulders from the contour of +1.0 m (MSL) to the contour of about -0.50 m (MSL), forming a buffer zone of 3.5 m and a length of about 15 m, following the slope of the natural bottom.

Figure 2-5 Western Part - Inadequate armoring along the western part with varying gradient of materials

Source: (ΔΕΣΦΑ, 2014)

2.3.4 Operation

After the construction phase, the LNG will be transported, as already mentioned, in ships with larger capacity (260.000m The LNG will be unloaded once the ships are moored at Revithousa's jetty.

If the Sea bottom Clearance is completed successfully as described above, ships with a maximum draft of 12.50m will be able to reach Revithousa's jetty, ie 92% of the existing LNG carriers, namely 320 out of 348, will be able to moor at Revithousa's LNG Terminal.

Revithousa's LNG carriers characteristics according to their draft are tabulated below (Table 2-9).

Table 2-9 Revithousa's LNG carriers characteristics.

Capacity of LNG Carriers (m^3)	Number and Percentage out of the Total LNG Carriers that will be able to reach the LNG Terminal
Less than or equal to 90,000 m3	1 ship of 22 existing ships. Percentage 4.5%
120,000m3 to 149,999 m3	14 ships, of 213 existing ships. Percentage 6.6%
150,000 m3 to 180,000 m3	14 ships of existing 30 ships. Percentage 20%
200,000 $m^3$to 220,000 m^3	10 ships of existing 30 ships. Percentage 33.3%
Larger than 260,000 m^3	4 ships of existing 13 ships. Percentage 30.8%

The transfer of LNG from ships to Revithousa's storage tanks will still be served via ship's pumps, after their connection with the unloading system.

2.4 Second Upgrade Terminal Station LNG - Installation of an ORV gasifier

2.4.1 Existing Regasification System

The LNG terminal station is used for the storage of transportable LNG and for its regasification in order to be inserted into the network. The station is connected to the main network via two subsea pipelines with 24" diameter each one and 510 m length and 620 m respectively. The insertion to the network is performed at a temperature of 3°C at least and a pressure between 26 and 64 barg.

At the moment, the system for the LNG gasification consists of three (3) gasifiers type ORV (Open Rack Vaporizer) and four (4) gasifiers type SCV (Submerged Combustion Vaporizer).

2.4.2 Technical Description

The aim of the project is to increase the Constant Maximum Gasification Rate (Sustained Maximum Send out Rate - SMSR) of gas to 1.400 m³/h, by installing one (1) additional ORV, with all the required ancillary facilities (seawater, pumping and piping systems).

All construction areas are located at Revithoussa Island. The civil works and the installation works of new equipment will take place in the southern part of the island.

The following tasks will be carried out:

- Installation of new ORV gasifier and civil work for the channel and the seawater discharge pipeline adaptation.
- Replacement of the high pressure pump (HP),
- Replacement of seawater pumps,
- Install new seawater filters
- Upgrading of seawater chlorination unit
- Installation of a new pipeline (24 ") forwarding natural gas to the system, covering the increased capacity of station (up to 1.400 m3/h SMSR).

Specifically, the area of the new ORV is located few meter southern than the existing ORVs and western of the existing sea water return channel. The installation works of the sea water pumps and HP pump require dismantling of existing equipment and the subsequent installation of the new in the same area of the terminal station.

Upgrading of the return (discharging) seawater system is a civil engineering work for adaption of the existing system (~ 10.000 m^3/h), in order to be able to drain the increased future flow (~ 15.000 m^3 / h). This work refers to:

- Cleaning works of the existing seawater channel
- Replacement of underwater return (discharge) pipeline with new one of increased diameter (44'')

2.4.3 Construction

During construction, the following aspects should be taken into account in order to ensure the maximum level of Health, Safety and Environment (HSE) protection:

- Emissions in the atmosphere during the use of construction's and installation's equipment, during decommissioning and during the relevant terrestrial and marine traffic.
- Emissions of particulate matter into the air during demolition and excavation.
- Noise emissions due to construction's equipment as well as due to installation and decommissioning
- Generation of solid and liquid wastes
- Increase of terrestrial and marine traffic.

2.4.3.1 Possible interaction with environmental aspects during construction

Possible interaction with environmental aspects during construction is basic information for the Impact Assessment section as well as for the relevant mitigation measures. Particularly, the following activities are assessed to cause impacts to the natural and social environment:

- Usage of chemicals, raw materials and fuel. The materials that will be required during construction include steel, wood, pipes, water, gravel or concrete. The necessary supplies will be transported by truck and then by boat.
- Water Use. During construction, water required for construction needs (concrete mixing and watering to combat dust suspension) and other uses (construction personnel).
- Liquid Wastes. During construction, rainfall will be controlled to minimize the risk of erosion or sedimentation and prevent water pollution. Regarding sewage some increase is expected taking into account the presence of construction personnel.
- Civil works (earthworks). Earthworks that are expected to take place during construction arise to 1340m³. If the excavated material is not proper to be used for backfilling purposes, it should be disposed to a proper site, based on national legislation. It is estimated that approximately 1060m³ will be used as backfilling material.
- Wastes production. During the works regarding civil engineering and demolition/ decommissioning of existing facilities or equipment, production of wastes is expected. All wastes shall be managed in accordance with the requirements of national legislation and where possible recycling and reuse will be adopted

- Noise production. During construction, noise emissions associated with the operation of construction equipment and machinery, are expected.
- Marine and terrestrial traffic. During construction, the transportation of raw materials, new equipment, construction equipment and personnel, as well as waste disposal will be carried out by a boat that will connect Revithoussa Island and the mainland. The use of a barge is necessary for the work of replacing the return (discharge) seawater pipeline. Terrestrial traffic will be essentially related to the supply of raw materials and waste disposal. Regarding the latter, based on a preliminary assessment (considering usage of 3 trucks with a capacity of 20 m^3, performing 2 loading/ unloading, on a daily basis), disposal of the total amount of available soil and concrete waste (1.380 m^3) will take about 12 days.

Figure 2-6 Indication of the installation areas of new equipment.

Source: (RINA, D'APPOLONIA, EXERGIA, 2013)

2.4.4 Operation

The terminal station will continue to operate 24 hours per day, 365 days per year, excluding planned shutting-downs, after the new installations as the main purpose is the satisfaction of peak consumption and the provision of an alternative supply source of National Natural Gas System in case of temporary interruption from the usual sources supply.

2.4.4.1 Possible interaction with environmental aspects during operation

Possible interaction with environmental aspects during operation is also basic information for the Impact Assessment section as well as for the relevant mitigation measures. As presented in the previous paragraph, the same activities are studied for the operation phase. Particularly, the following activities are assessed to cause impacts to the natural and social environment:

- Usage of chemicals, raw materials and fuel. During operation of the LNG Terminal, the following are used, for the needs of the ORV:
  - Nitrogen (supplied in liquid form by truck): the work of the 2nd expansion does not require continuous consumption.
  - Sodium hypochlorite: it is produced in the island by the existing chlorination unit that shall be upgraded in order to increase the design capacity of 35 kg/h of chlorine equivalent to 50 kg/h. Two electrolytic cells will be added similar to the four existing ones.
  - Sodium sulphite: an increase in the required amount of sodium sulphite (about 25,9 kg/h) is expected. Sodium sulphite is transferred to the island in suitable containers. Until now, there has been no need to use it.
- Water Use. During operation of the LNG Terminal, water uses, for the needs of the ORV, include the following:
  - Drinking water (supplied via pipeline from the mainland): no additional consumption is foreseen.
  - Installation Water (taken directly from the drinking water network): estimated total increase in consumption of about 0,3 m^3/h.
  - Seawater (fed via pumps, and is used in the ORVs and the electrolytic chlorination unit). An increase of seawater pumped quantity of the order of 5.800 m^3/h is foreseen, to increase the gasification rate. No expansion of the pumping area is foreseen for the upgraded chlorination plant.
- Liquid Wastes. During the operating phase the liquid wastes are associated with the use of sea water in the gasification process (ORVs) during which chlorination (through seawater) is required and subsequent addition of sodium sulfite, if necessary (through the drinking water network). Due to the installation of a new ORV and the corresponding upgrade of the electrolytic chlorination unit, the increase of the flow rate is 5.800 m^3/h, resulting in a total return (discharge) flow of sea water of about 15.000 m^3/h. By the installation of the new ORV no additional quantities of municipal wastewater due to staff presence (collected in sewage treatment system), of cooling water (no additional needs are foreseen) or of rainwater are assessed.
- Wastes production. During the operational phase due to the theoretical increase in the consumption of sodium sulfite for the future operation, an increase in waste generation is expected to occur with respect to sodium sulfite (as powder) containers that the LNG Terminal is supplied. No other differentiation in terms of wastes' production and management is foreseen by the installation of the new ORV (SCV

water, other chemicals, oily water). It should be noted that sodium sulfite had not to be used up till today.

- Air pollutants emissions. During normal operation of the LNG Terminal, occasional air emissions result from the flare system, the SCV gasifiers and the CHP generator unit. During peak operation, when the SCVs are used, corresponding air emissions due to the combustion of natural gas, take place. Given that no additional fuel consumption is expected by the operation of the new ORV, there will be no changes in the emission of air pollutants due to increased regasification.
- Noise production. No modification of the noise produced is expected.

2.5 Schedule

Construction schedule, for all three projects, is provided in the following figure (Figure 2-7). Each of the thick red lines represents a year, separated in 12 months (thin red lines). The hatched areas of the bars illustrate completed, pre-construction activities, whilst the green areas ongoing or future activities.

Section 04 – EPC includes the schedule for all three pillars necessary for construction of a project:

- Engineering, including Detail Engineering, prior to construction works commencement, and Field Engineering, if modifications are required during the construction.
- Procurement of materials necessary for the construction of the projects
- Construction works and activities, including earthworks, foundations, erection of structures, replacement of equipment etc.

These activities take place simultaneously, more or less. Most of the time, these are not successive but overlapping. For example, excavation and earthworks, which is a source of dust suspension and heavy landscape nuisance factor, could take place whilst the necessary materials for the erection of the 3rd LNG tanks are procured and transported to the construction site. At the same time, detail engineering of the ORV upgrade or the contractual agreements for the sea bottom clearance could take place. Another comprehensive example refers to the earthworks implementation; based on international practice and extensive experience of similar projects, earthworks for the 3rd LNG Tank is estimated to last for approximately 7-8 months, for the sea bottom clearance about 3-4 months, and for the replacement of the return (discharge) sea water pipeline associated with the new ORV about 3,5 month. Some of the earthwork activities may happen simultaneously but it is certain that they will not last for the entire EPC construction period (the green section of the bar corresponding to the EPC section of Figure 2-7)

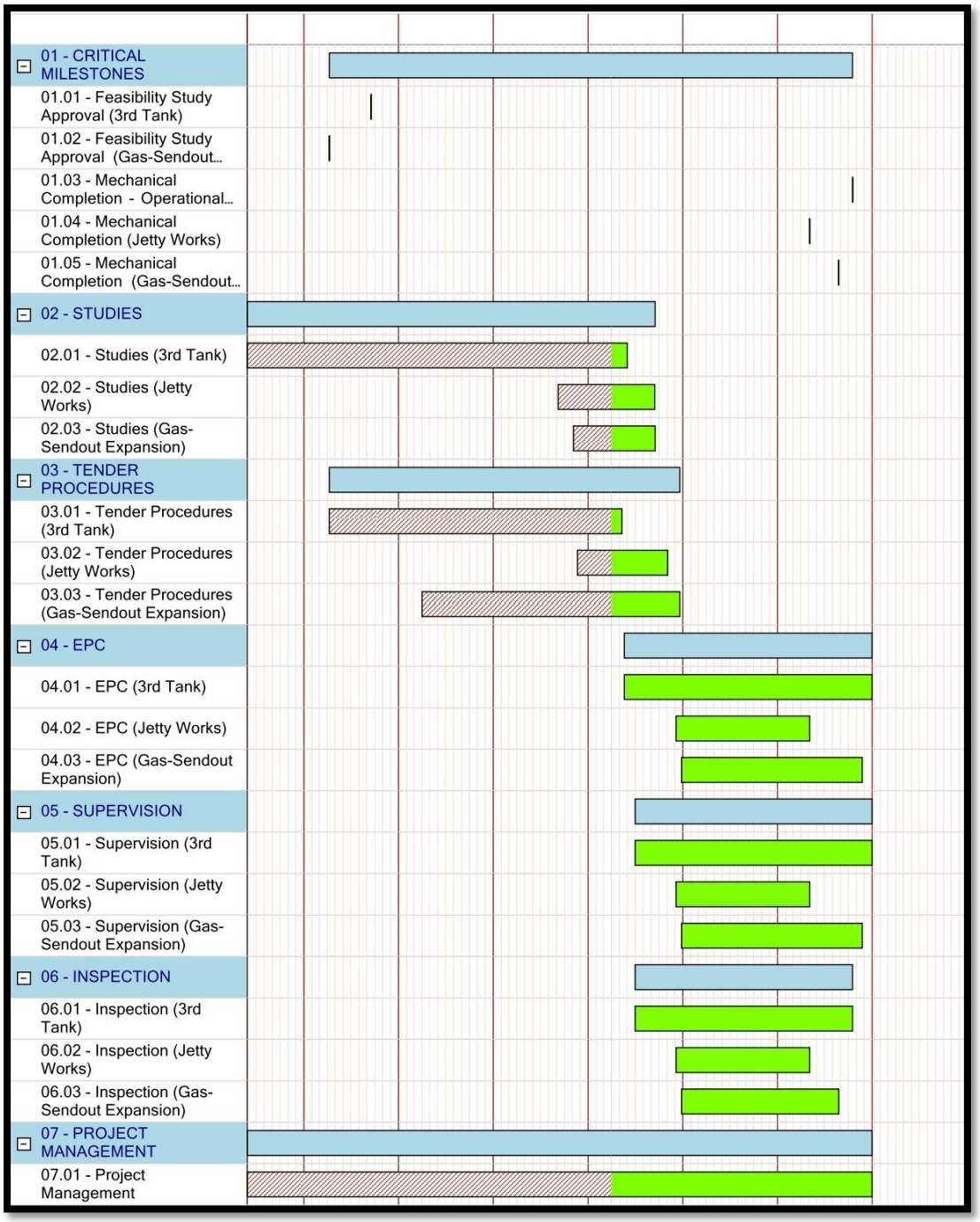
Following the previously described reasoning, the EPC, ie including construction, timeline for the three investigated projects is:

- For the 3rd LNG Tank: approx. 2.5 years
- For the Jetty Facilities: approx. 1.5 year
- For the cryogenic facilities : approx. 2 years

It is noted that all three projects have been designed in order to fit as best as possible to the existing LNG Terminal facilities. Such big infrastructure projects, are usually designed for an operational lifetime of 25-30 years. Of course, this lifetime differs depending on the upgrading projects, economic sustainability and other factors, not within the scope of the present study.

Decommissioning of the facilities is also not included in the scope of the present study. When and if decommissioning of Revithousa's LNG Terminal is decided a separate study presenting project description, potential environmental impacts and mitigation measures shall be prepared and submitted to the competent authorities.

Figure 2-7 Construction Schedule for all three projects.



Provided by DESFA

3 Identification of Potentially Impacted Environmental Parameters

3.1 Introduction

Each of the identified potentially impacted environmental parameters is presented in such as a way as one could easily understand the potential cumulative impacts of all three projects to the specific parameter. The environmental parameters are distinguished in three classes:

1. Abiotic Natural Environment, including air quality, water resources, etc.;
2. Biotic Natural Environment, including biodiversity and protected areas; and
3. Socioeconomic Environment, including economic activities, pollution sources, cultural heritage, etc.

Each parameter is given a section distinguished in the following paragraphs:

1. Summary of baseline conditions
2. Presentation of potential impacts, during construction and operation, identified by each one of the three project's ESIA
3. Presentation of the mitigation measures, during construction and operation, identified by each one of the three project's ESIA; and
4. Assessment of the cumulative effect of the combined construction and operation of each one of the three projects.

The chapter concludes presenting in an overview matrix of the impacts of each project, the potential (unmitigated) cumulative impact of all projects, the residual cumulative impact after the implementation of the mitigation measures per environmental parameter.

3.2 Methodology

The first step was to collect available data from the approved ESIAs of the three projects. Based on these and on national legislation, the study area was defined as 1km around the proposed projects. Nevertheless, the investigated area may be bigger than 1km, in order to address the cumulative effect.

The proposed projects are classified as A1 Class projects; this is the highest classification for projects and activities, requiring Environmental Impact Assessment, based on national legislation.

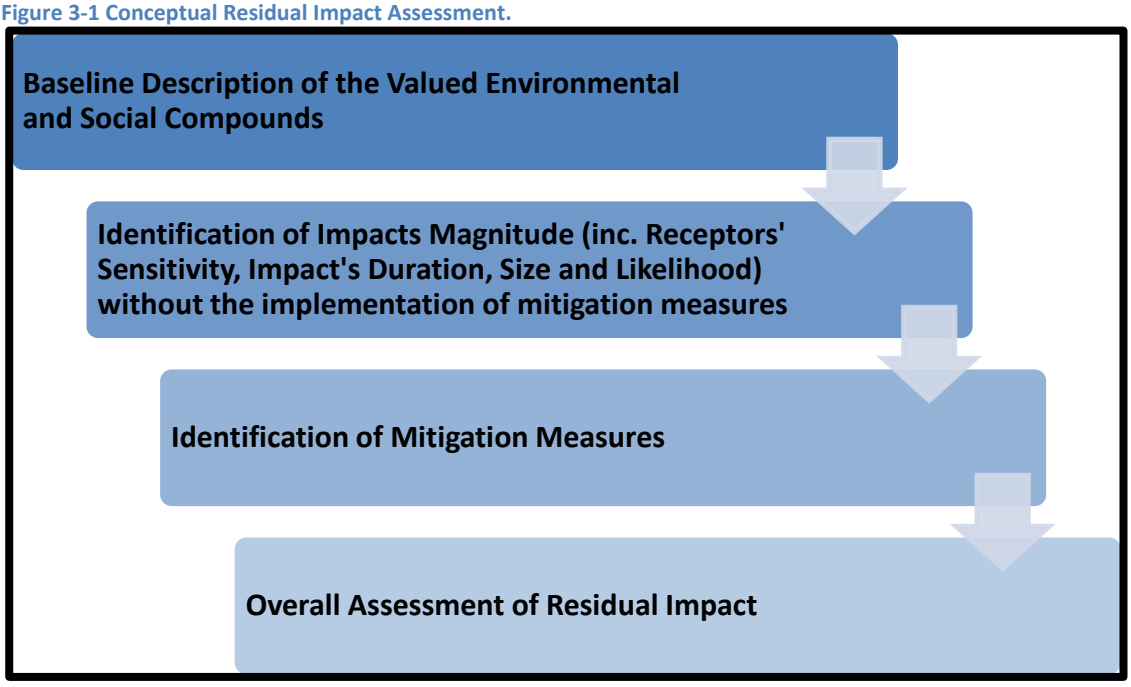
The first step for the identification of the cumulative impacts is the description of the mechanism that each project may has a potential impact to a specific VESC. Based on the identified mechanism, an assessment of potential impacts on the specific resources is presented. This assessment is based on the available literature, mainly the approved ESIAs, and on experts' judgment. In order to understand the previously mentioned mechanisms a short description of the construction and operation of all three projects is presented in the relevant section (see Section 2).

Based on the IFC's guidelines on Cumulative Impacts Assessment (International Finance Corporation, 2013) in order to prepare a comprehensive CIA the Valued Environmental and Social Components (VESCs) needs to be identified. As such, the present document presents such VESCs based on the environmental and social context of the study area and on experts' opinion and judgment. The team prepared the present report was engaged in the preparation of several other projects in the area and thus has an extensive knowledge of the environmental and social baseline conditions of the broader area.

For each of the VESCs a short summary of the baseline description presented in the engaged projects ESIAs is presented. Further details are presented in the corresponding ESIAs. For each of these VESCs the impacts identified in the approved ESIAs are presented complemented by a concluding discussion on the cumulative effect of each separate project on the VESCs. Although the cumulative effects or impacts could be positive ones, based on Liebig's Law[1], only the negative impacts are presented. The assessment of these negative impacts is focused on the cumulative impacts as defined in the previous section.

Cumulative impacts are assessed comparing the baseline conditions with the future, reasonably foreseen, ones during and after implementation of the projects.

Figure 3-1 Conceptual Residual Impact Assessment.



Prepared by ASPROFOS (2014)

[1] Liebig's law of the minimum, often simply called Liebig's law or the law of the minimum, is a principle developed in agricultural science by Carl Sprengel (1828) and later popularized by Justus von Liebig. It states that growth is controlled not by the total amount of resources available, but by the scarcest resource (limiting factor). *Source: http://en.wikipedia.org, retrieved on 23.10.2014*

After the implementation of the mitigation measures, residual impacts are assessed based on the following classification:

- Negligible, when the size (magnitude) of the impact is small and the sensitivity of the receptors is low;
- Not Significant, when the size (magnitude) of the impact is limited and the receptor's sensitivity is low;
- Significant, when the size (magnitude) of the impact and the receptor's sensitivity are local and of certain value; and
- Very Significant, when the size (magnitude) of the impact and the sensitivity of the receptor are regional and of great value.

The above are illustrated in Figure 3-2. Impact's magnitude for the environmental parameters depends mainly on its spatial context (local, regional, national, or international) and dynamics (qualitative or quantitative if possible); for socioeconomic parameters, impact's magnitude depends mainly on the number of receptors (residents, entrepreneurs, etc.) and the type of the parameter (livelihoods, income, leisure, etc.). For example, during construction, noise can cause significant nuisance but for a limited time and in great distance from any sensitive receptor (human or wildlife); taken into consideration the compliance with national legislation – as a mitigation measure – the overall, residual impact of noise during construction is **Negligible**.

Figure 3-2 Matrix for Assessment of Residual Impact's Significance.

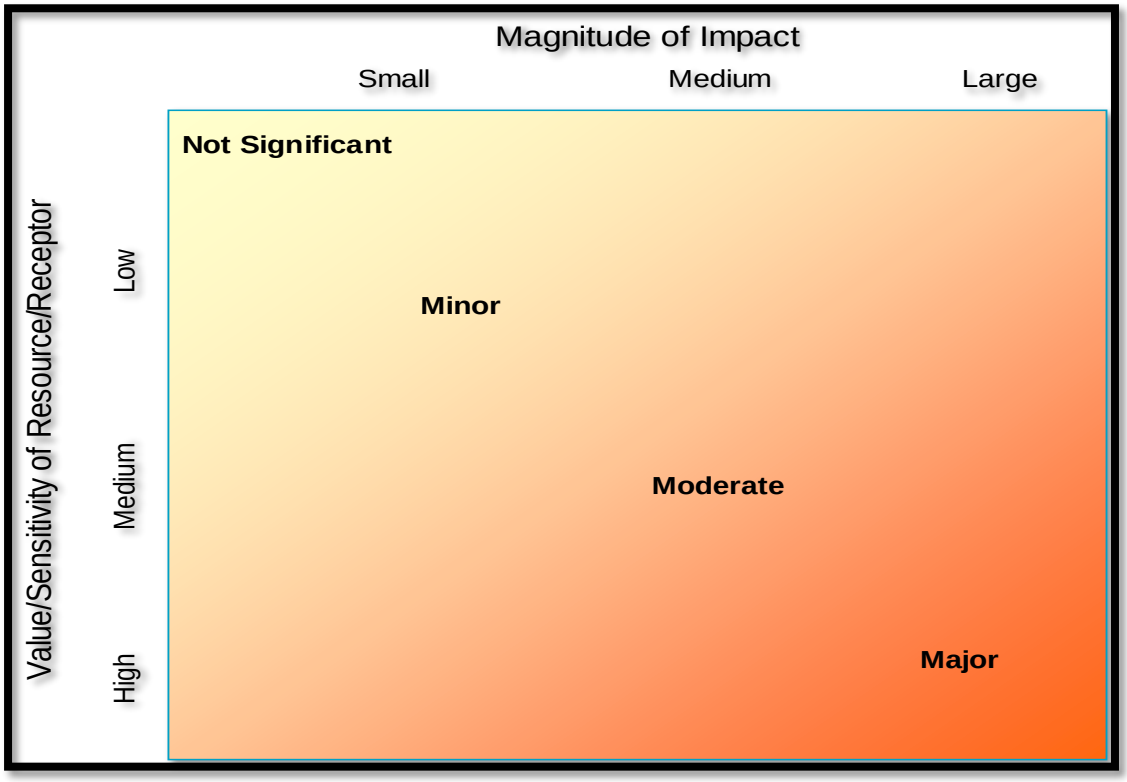


Table 3-1 summarizes the investigated parameters of the present report. These were considered to be the Valued Environmental and Social Components of the study area. It is evident that some parameters are not presented; these include but are not limited to geotechnical and seismological conditions, noise baseline, traffic (onshore and/ or offshore), public health, infrastructure, community capacity, etc. This was opted in order to prepare a comprehensive, easy to read, report focused on parameters that could potentially be affected and valued by environmental and social experts. The excluded parameters are deemed unaffected by the cumulative effect of all three projects or affected in such a small degree not worthy of any further discussion. This and the subjective nature of the experts' judgment that identified the VESCs are highlighted as limitations of the present report.

Table 3-1 Investigated parameters.

Environmental Pillar	***Parameter***
Natural Environment (abiotic)	Air Quality
	Water Resources
	Sea Water Quality
	Soil and Morphological Characteristics
	Landscape
Natural Environment (biotic)	Flora
	Fauna
	Protected Areas
Socioeconomic Environment	Demographics
	Economic Activities
	Land Uses
	Pollution Sources
Cultural Heritage	Designated Archaeological Sites or Monuments and Areas of High Archaeological Potential

Prepared by ASPROFOS (2014)

3.3 Abiotic Environment

3.3.1 Air Quality

- ***Summary of baseline conditions***

Based on the approved ESIAs of the projects, the air quality of the broader area is characterized by the operation of the existing infrastructure on Revithoussa Island. The following tables summarize the air quality based on measurements at the Elefsina Station of MEECC (23° 32' 18''.41 and 38° 03' 04''.86, height 20m), being the closest one to the Island.

Table 3-2 Timeline of average annual values range of SO_2, NO_x και PM_{10}

	POLLUTANT (μg/m³)			
YEAR	**SO_2**	**NO_2**	**NO**	**PM_{10}**
	(hourly)	**(hourly)**	**(hourly)**	**(daily)[(1)]**
2001	15	38	8	-
2002	12	40	21	-
2003	17	40	15	-

YEAR	POLLUTANT (μg/m³)			
	SO_2 (hourly)	NO_2 (hourly)	NO (hourly)	PM_{10} (daily)(1)
2004	13	37	22	-
2005	14	40	14	-
2006	14	38	15	-
2007	9	36	20	-
2008	11	33	15	-
2009	-	35	14	47
2010	3	37	13	48
(1)	Average value resulted by indicative measurements normally distributed within the year.			
Source: Atmospheric Pollution Report 2010.MEECC, Gen. Dir. Of Environment, Dir of Air Pollution and Noise Control (ΕΑΡΘ), Dpt of Air Quality, April 2011.				

Prepared by (ASPROFOS, 2012)

- ***Impacts Assessment***

During Construction

During the construction of the onshore projects (ie construction of the 3rd LNG tank and the installation of the SCV) the same mechanism are applicable regarding pollutants emissions. In short, suspension of dust caused by excavation earthworks, vehicles movements for transportation of materials, equipment and personnel. Based on the approved ESIAs of the two onshore projects, dust emissions to the atmosphere are deemed very small and negligible.

According to a conservative approach adopted in the ESIA of the Jetty facilities improvement, dust emissions from the construction of the jetty facilities are expected to have moderate impacts.

Air pollutants such as NO_X, CO, SO_2, etc. emitted by the equipment and vehicles or ships used for the construction of the projects are also deemed negligible.

Dust suspension, being the most outstanding impact mechanism, is acting accumulatively, meaning that dust from the construction of each project will be added to the dust suspended by the construction of the other two projects constructed at the same time. However, the time frame of the simultaneous construction and consequently dust suspension is deemed limited. No other air pollutants are deemed to be emitted by any of the three projects in such concentrations as to raise alarms or cause impacts. Consequently, the unmitigated cumulative impact of the construction of all three projects is deemed Not Significant.

During Operation

Based on the approved ESIAs only the operation of the 3rd LNG tank could have negative impacts on the air quality of the study area. For that project an air dispersion model performed in 2005 was used to assess the impacts of the overall LNG terminal installations. It was concluded that the operation of the Terminal does not significantly affect the broader area of Attica. The highest concentrations were identified in the area of Elefsina and of Perama, not exceeding 2μg/m³ of NO_2, 4ppb of VOCs and 1μg/m³ for CO. It was concluded that no exceedance of the EU statutory limits regarding air quality would be taken place.

Consequently, the unmitigated cumulative impact of the construction of all three projects is the one of the 3rd LNG tank installation and is deemed Minor.

- ***Mitigation Measures***

During Construction

Generally applicable good engineering practices in the construction sites, including spraying of working areas and access roads with water, and washing of vehicles. More specifically the following good practice measures to minimise dust impacts from construction activities:

- Vehicles will be washed to remove any dusty materials from the body and wheels immediately before leaving a construction area or temporary facilities;
- Vehicles carrying soil or materials from/to the construction sites will be covered to minimise entrainment by the wind;
- Vehicle speed to be limited, especially during the dry season;
- Construction sites will be kept clear of dusty materials or sprayed with grey water to maintain the surface wet.
- Careful driving, resulting to low vehicle emissions;
- Proper maintenance of equipment and vehicles.
- Usage of filters in the exhausts of vehicles
- Exhausts shall not be directed towards the ground
- Use of explosives should be limited as much as possible.
- Compliance with the legislative framework, including but not limited to the following:
  - ✓ MD 37353/2375/07 (HGG 543/B/07),
  - ✓ MD 13736/85 (HGG 304/B/20.5.85)
  - ✓ MD 8243/11113/91 (HGG 138/B/91)
  - ✓ JMD 14122/549/E.103/2011 (HGG 488/B/11)

During Operation

Only by the operation of the 3rd LNG Tank, are impacts assessed by the approved ESIAs. Consequently, the mitigation measures presented there are quoted and applicable.

General mitigation measures for air pollutants control will include:

- Installation of a monitoring system of the forwarded to the flare pollutants or other monitoring system approved by the competent authorities. The monitoring reports will be at the Authorities' disposal at any given time for inspection.
- Annual report of the gases forwarded to the flare and mass balance of Natural Gas in the facilities.
- Proper maintenance and constant monitoring of equipment to minimize any hydrocarbons emission to the atmosphere.
- Co-production technology in the power production units using internal combustion engines and natural gas as fuel.

- ***Residual Cumulative Impacts***

Based on the assumption that all previously mentioned mitigation measures will be implemented and that the Owner shall comply with the Environmental Terms Approval, residual cumulative impacts:

- During construction of the three projects, are deemed **Not Significant**
- During operation of the three projects, are deemed **Not Significant**

3.3.2 Sea Water Quality

- ***Summary of baseline conditions***

Within a few kilometers from the island of Revithoussa there are crude oil unloading stations, petroleum storage areas, a small ship recycling facility, the city of Megara, a number of smaller settlements, scattered farms and a small percentage of wastewater from Psytalia[2] waste water treatment plant.

Marine pollution from these activities is not considered significant, nor is it increased by the activities of the LNG Terminal.

Generally, the Revithousa's area level of pollution is lower than that of neighboring regions.

The limits for disposal of the liquid wastes generated by the LNG Terminal premises disposal to the sea, according to ETA (ref. no. 181794/04.05.2013) are illustrated in the following table (Table 3-3):

Table 3-3 Limits for liquid wastes disposal to the sea.

Pollution parameters	Limit values
pH	6-9
Temperature Difference (DT) between discharged sea water and recipient sea water	7°C(average)
Total residual chlorine	0.4mg/l
Sulphites	1mg/l

[2] Psitalia is the major waste water treatment plant of Athens and Attica Region.

Regarding specific pollutants in the water column, the following are highlighted:

- DO (Dissolved Oxygen)

Based on measurements in the Saronic Gulf, the trend of DO in the sea area of Revithoussa is as follows:

Warm Period: During May, DO concentration is 6,02 ml/l on the surface and 2,7 ml/l on the bottom. Hypoxic conditions are predominant in the deeper layers. In July, the bottom oxygen concentration falls to 0,18 ml/l (anoxic conditions), while in October there is complete anoxia on the bottom (0,00 ml/l) and a surface concentration of 5,28 ml/l. Thermocline's presence is evident before the depth of 20 m:

Cold Season: During November, when homogenizing starts, 5 ml/l DO are observed on the surface and 4,75 ml / l on the bottom. In January, strong concentrations (5,75 ml/l on the surface and 5,38 ml/l on the bottom) are observed, whilst in February complete homogenization of the water column is observed (approx. 6 ml / l at all depths).

- Eutrophication

The following table (Table 3-4) presents, indicatively, the nutrients concentrations for the cold season (February) and warm season (August), regarding eutrophication.

Table 3-4 Concentrations of nutrients (indicative months for cold and warm season)

Depth (m)	DO (ml/l)	$PO4^{-3}$ (mM)	$SiO4^{-2}$ (mM)	NO2- (mM)	NO3- (mM)	$NH4^{+}$ (mM)
February (cold season)						
2	5,85	0,08	2,70	0,09	1,34	0,75
10	5,83	0,06	2,82	0,11	1,61	0,93
20	5,82	0,06	3,29	0,13	0,77	0,78
30	5,78	0,05	3,64	0,14	0,99	0,82
August (warm season)						
2	4,83	0,03	0,38	0,01	0,14	0,94
10	4,57	0,03	0,67	0,02	0,11	0,68
20	0,88	1,08	14,5	0,47	0,64	3,55
25	0,14	3,34	26,6	0,05	0,10	0,74

Source: (RINA, D'APPOLONIA, EXERGIA, 2013)

- Heavy Metals

The study area is relatively clean. During recent measurements the following concentrations of heavy metals were found near the LNG Terminal of Revithoussa Island: 16,00 MnFe, 1,40 nMCu, 0,07 NmCd, 0,10 nMPb (sol.) 0,30 nMPb (particulates).

In sediments near Revithoussa, lead concentrations were measured below 50ppm, indicating that the area is generally cleaner than neighboring ones.

- ***Impacts Assessment***

During Construction

Some impacts on the sea water column should be expected by the deposition of excavated material during the construction phase of the third tank, amounting to about 99.000m^3. During port's construction work, some impacts on the sea water column should be expected due to the sea bottom clearance; the removed materials are calculated approx. 1900m^3 and can be used for armoring of the retaining walls. The removed material can be soil materials of any kind and composition.

During the construction of the new gasifier limited impacts to the water column should be expected by the replacement of the discharging seawater pipeline, of 60 m length.

Generally, transportation and disposal of excavated material will take place at sea depths greater than -50 m, regardless of the transportation distance and at least 6 nautical miles away from the coast.

As for the liquid waste generated during the construction phase from all three projects, it is not expected to cause serious environmental problems in the investigated area. The presence of the construction staff on the sites will produce standard outputs and municipal wastes, for which there is already a treatment unit on the existing facilities.

Liquid wastes disposal limits are tabulated in Table 3-3, based on art. 10, par. 3 of L. 3983/2011 (HGG A' 144).

During construction phase, the unmitigated cumulative impacts from liquid wastes to the surrounding area are considered Not Significant.

During Operation

Wastewater from the LNG Terminal that could potentially affect the quality of sea water can be classified into three categories.

1. Non-oily waste
2. Sanitary waste
3. Oily waste

The most important issue regarding disposal of liquid waste is the thermal pollution that could be caused by the discharge of used cold seawater back to the sea. The uptaken seawater used as a heating medium for the ORV LNG gasifiers will increase from 10.000m^3/h to 15.000m^3/h. For this issue, a cold sea water diffusion model was run, illustrating that the disposal of the used cold seawater back to the sea will not affect the temperature of the marine area nor the

quality of the marine environment where discharged to. More details are provided in section 3.4.1 regarding Flora.

In general, cumulative impacts during the operation of all three projects are mainly incurred by the operation of the ORVs and are deemed Not Significant.

- ***Mitigation Measures***

During Construction

Mitigation measures, during construction phase of the projects, consist in predicting a specific area of maintenance, washing and refueling of equipment and machinery, as dictated by best industry practices. Wastewater accumulated by the washing and cleaning of machines, transportation vehicles, or other equipment may contain chemical components and traces of oil products and, for this reason, will be stored in metal containers which will be present at the worksite.

Discharges to the sea will be avoided as much as possible.

More details are provided in section 3.4.1 regarding Flora.

During Operation

LNG carriers shall comply with existing national and international legislation regarding the protection of the marine environment.

A system for adding sodium sulphite will be installed at the outlet of gasifier in order to regulate the concentrations of chlorine discharged to the sea. Temperature of the discharged sea water will be also monitored to ensure compliance with the amending ETA with ref. no. 184239/07.09.2014, dictating a maximum temperature difference of 7^{o}C.

More details are provided in section 3.4.1 regarding Flora.

- ***Residual Cumulative Impacts***

Based on the assumption that all previously mentioned mitigation measures will be implemented and that the Owner shall comply with the Environmental Terms Approval, residual cumulative impacts:

- During construction of the three projects, are deemed **Not Significant**
- During operation of the three projects, are deemed **Not Significant**

3.3.3 Soil Characteristics and Morphology

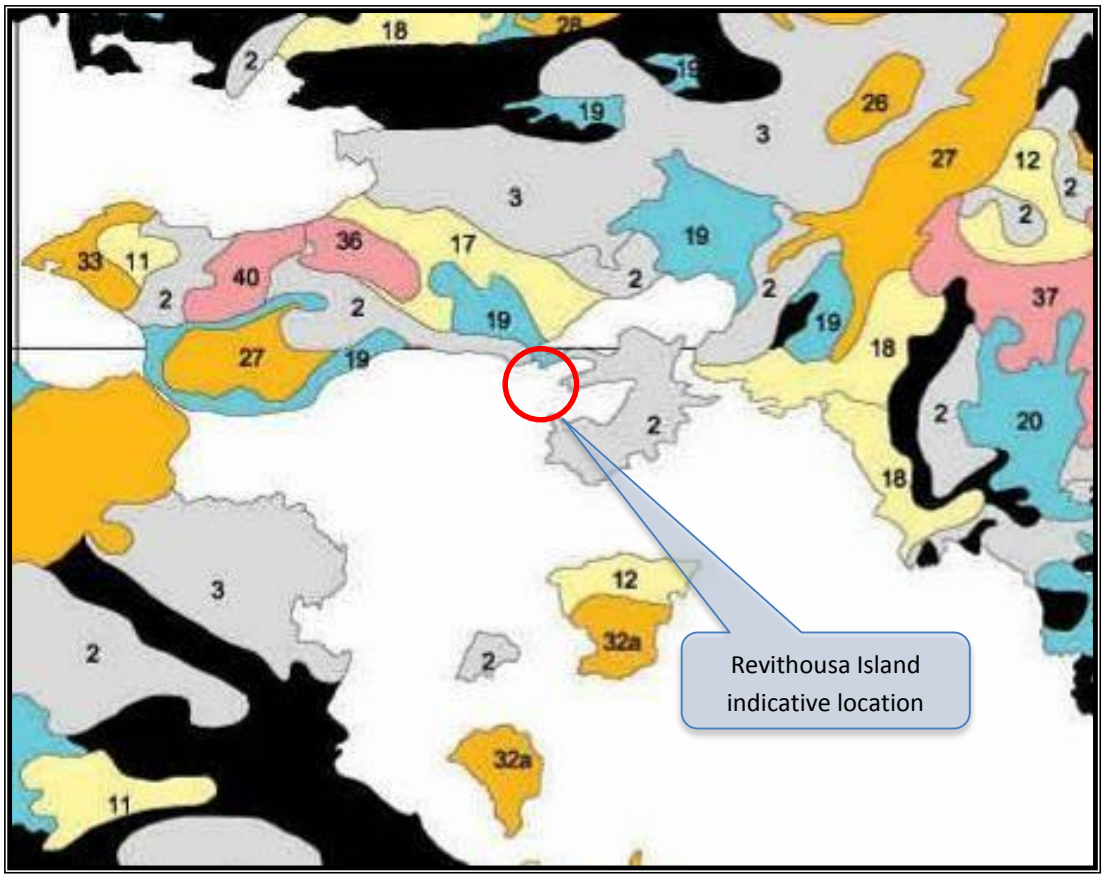
- ***Summary of baseline conditions***

During literature review, no systematic information or study were identified for the specific area. Not even the Soil Associations Map of Greece of the Agricultural University of Athens has included Revithoussa Island. However, Revithoussa is located between the two following associations:

i. Leptosols (#2), Dominant Soil Unit: Calcaric Leptosol, Associated Soil Type Units: Carcaro-leptic Regosol, Calcaro-petric Cambisol, Rock outcrops. Parent material: Limestone. This kind of soils are characterized by the low quality and very high desertification vulnerability, and

ii. Fluvisols (#19), Dominant Soil Unit: Calcaric Fluvisol, Associated Soil Type Units: Haplic Calcisol, Calcaric Cambisol, inclusions of Solonhcak in some cases. Parent material: Holocene alluvium. These kinds of soils are characterized by very high quality and low desertification vulnerability.

Figure 3-3 Soil Associations Map of Greece.



Source: (Γιασόγλου & Κοσμοπούλου, 2004)

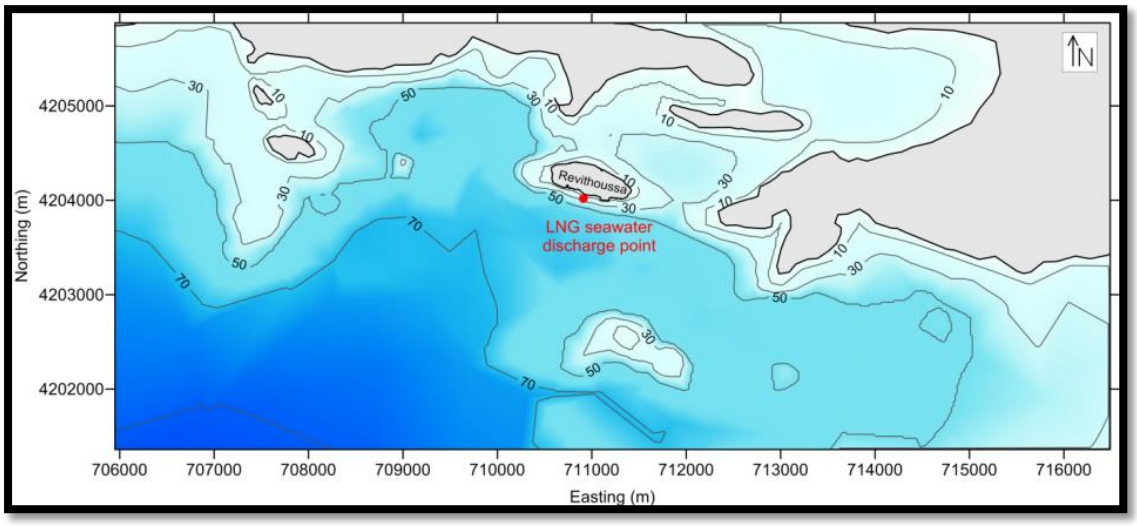
During the site survey on Revithoussa Island (15.07.2011) it was revealed that Revithoussa Island is a longitudinal hilly elevation of NW-SE direction with a mild relief. The LNG Terminal is built entirely on karstified limestone formations with almost complete lack of soil mantle.

There are some locations were a soil mantle of limestone composition is present, whilst there are some other areas covered with topsoil which is added material.

Regarding the sea bottom morphology, in addition to what was presented in section 2.3.3, regarding construction of the Second Upgrade Terminal Station LNG – Upgrading the Port Facilities the following are noted.

In the area north of the island the sea depth increases towards the NE and reaches 30m. The morphology of the bottom between Revithoussa and Makronissos is smooth with small slopes that reach 10°. On the west side a bulge is formed bulge of NS direction, connecting Revithoussa to the Agia Triada peninsula. In the area south of the island there were no specific physiographic abnormalities. The inclination of the bottom is smooth from the coast to the south, but the gradient is higher and reaches 15 degrees on the west side and 19 degrees on the east side of the island's south coast. After the contour of 60 m sea bottom depth is fixed.

Figure 3-4 Bathymetry and morphology of marine area of Revithoussa Island.



Source: (ΔΕΣΦΑ, 2014)

- ***Impacts Assessment***

During Construction

The sources of impacts to soil characteristics and morphology include (i) set-up of temporary facilities (construction sites) (ii) movement of vehicles, equipment and personnel; (iii) production and disposal of solid and liquid wastes; (iv) storage and handling of fuels and chemicals; (v) reanimation of subsurface contamination along the construction sites. Key potential impacts may include:

i. Disturbance and Degradation of soil due to erosion, compaction, removal, modification of morphology.

For the 3rd LNG Tank, earthworks will take place entirely on the N. Revithoussa. There is no topsoil since the planned area is already artificially sealed. The excavated material for the third tank is estimated at 129.000m³. Some of this material will be used for the needs of the project:

Clearance of the sea bottom is going to restore the morphology of the bottom to its former state. The materials to be cleared amount to approx. 1900m³. The materials being removed from the bottom can be any kind of soil materials and composition (eg sediments, sludge, natural boulders of all sizes, rocks, etc) and objects of various weight and composition (eg old chains, iron pieces etc).

The work to replace the return (discharge) seawater pipeline (during the new ORV installation) is expected to have a negligible effect on the morphology of the bottom as it is to replace the existing pipeline and not for re-installation. Furthermore it is expected that upon completion of the replacement works natural reinstatement of local bottom morphology is expected, as it has happened so far in the case of the initial seawater pipeline.

ii. Accidental Pollution of soil by wastes or spills

As previously discussed, aggregates are not considered as solid wastes[3]. However, during the construction phase some solid wastes may be produced. From the construction of any project, small quantities of polythene for the insulation of the welding joints should be expected, as well as empty paint cans and hazardous solvents. Although these wastes could be accidentally discharged locally and the likelihood of such a spill is small, they could have significant impacts, due to their toxicity. Consequently, the unmitigated cumulative impacts are deemed Moderate.

Other potential impacts could be caused by the potential disturbance of subsurface contamination reanimated due to projects' related construction activities or soil occupation/ surface sealing due to the implementation of the projects. However, as discussed in section 3.3.2, there are no data supporting the presence of heavy metals or other contaminants in the area's sea bottom sediments; regarding occupation or sealing of surfaces, this is deemed inconsequential, given that the terrestrial areas are already industrial, sealed surfaces, whilst no additional occupation of the sea bottom is expected to take place.

During Operation

[3] Regarding liquid wastes, discussion is presented in the sea water quality section (section 3.3.2)

No interaction between the projects and the soil characteristics or the morphology is expected. Consequently, no cumulative impacts are assessed.

Discharge of the used, cold sea water, back to the sea is performed, already, in such a way as to avoid impacts to the sea bottom.

- ***Mitigation Measures***

During Construction

Best Available Techniques should be followed during the construction of the projects to minimize/ eliminate impacts to soil characteristics and morphology. Specifically, the following measures will be implemented:

- Works will grow quickly so that the trenches remain open for as minimum as possible.
- Work will stop during periods of extreme weather conditions or will be planned for periods outside such conditions
- All machinery and equipment used in the construction works will be maintained within properly controlled, limited, and approved areas.
- Appointment of responsible for collection of construction sites' garbage to specific receptors, which are in compliance with the relevant statutory requirements and managed accordingly.
- Disposal of solid waste which may release toxic or other pollutants (eg empty containers of fuels, solvents, liquids or teams colours and generally waste impregnated with these substances, tires, etc.), shall in no case take place with the municipal type of waste.
- Employees will use the existing sanitation system or chemical toilets for their personal needs.
- Excavated materials will be disposed at the sea at depths of 50m, as specified by the Port Authority.
- Construction sites will be cleared out upon completion of construction activities
- All waste will be stored at the site, at specific points, until the time of recycling/ reuse, if applicable, or certified disposal. These points shall have solid coating, so as to enable the collection of the overflowing waste or accidental spills.
- Metal and crystal waste shall be forward for recycling
- Solid waste that will be produced will be managed according to the existing Waste Treatment Plan
- For all type of waste produced during the construction works, compliance with JMD 36259/1757/E103/10 (HGG B 1312), as amended by L. 4030/11 (HGG A 249) and in force, is mandatory.

- Discharge of used lubricants and oils to the environment is forbidden. These shall be collected in barrels and be subject for further management according to JMD 71650/3035 (HGG B 655)

During Operation

No interaction between the projects and the soil characteristics or the morphology is expected during operation phase and consequently no mitigation measures are deemed necessary.

- ***Residual Cumulative Impacts***

Based on the assumption that all previously mentioned mitigation measures will be implemented and that the Owner shall comply with the Environmental Terms Approval, residual cumulative impacts:

- During construction of the three projects, are deemed **Minor**
- During operation of the three projects, are deemed **Not Significant**

3.3.4 Landscape

- ***Summary of baseline conditions***

Revithoussa Island has a level morphology and moderate slopes of 35%. There are two hills of approx. 50m altitude. A natural seaway between the island and the peninsula of Agia Triada (to the north) is formulated of depth not greater than 45m.

In the broader area of the project, the following main landscape types are recorded:

- Industrial landscape, in the area of the LNG Terminal and the close proximity to Hellenic Petroleum's tank farm (crude oil storage)
- Marine landscape, around Revithoussa island, including the Makronissos island
- A mosaic of semi natural areas and residential areas, including the airport of Megara. Limited amenity use of Salamina island's beaches is recorded.

Figure 3-5 provides satellite imagery coverage of the broader area of Revithousa's LNG Terminal.

Figure 3-5 Satellite imagery of Revithoussa LNG Terminal broader area.

Prepared by ASPROFOS (2014).

- ***Impacts Assessment***

<u>*During Construction*</u>

The mechanisms that could cause impacts to the landscape of any area, by construction of any project, are more or less similar. These include:

- Land clearance and/ or reclamation for the construction of the 3rd tank, and mainly
- Movement of project vehicles and machinery.

Revithoussa Island, where all projects shall take place, is located at a significant distance from sensitive areas or receptors. The limited number of people using the beaches at the west coast of Salamina Island could be annoyed by the simultaneous construction of all three projects; nevertheless, the construction period for all three projects is limited.

All construction related activities will be located at Revithoussa Island. An increase of vehicles commute is reasonable to be expected but mainly during transporting of materials which is not a daily process. Personnel transport is daily but only at the beginning and end of the

construction shift. Vessels related to the jetty facilities upgrade will be maneuvering, mainly, on the west side of Revithoussa Island; thus limited visual engagement with sensitive receptors is expected.

Consequently, the unmitigated cumulative impact to the landscape, during construction of all three projects is deemed Minor.

During Operation

The mechanisms that could cause impacts to the landscape of the area, by the operation of the upgraded LNG Terminal include:

- Presence of the new facilities
- Manoeuvring, mooring and offloading of LNG carriers.

All additional facilities and upgrades will be incorporated to the existing industrial landscape of Revithoussa Island. No modifications to the nearby landscape types will be affected.

During the ESIA of the 3rd LNG Tank, several viewpoints were visited and photomontages of the operation of the LNG Terminal, with the 3rd tank installed, were prepared. These are presented here in order to demonstrate that any additional impact to the existing industrial landscape of Revithoussa Island is minimal. The modification of the coastline of Revithoussa Island is not expected to be perceivable by any sensitive receptor due to the significant distance from amenity venues.

As previously mentioned, the jetty facilities are located on the western side of Revithoussa Island, concealed for the most part, by the view of the sensitive receptor, ie the beach users of Salamina's Island west coasts. The visual impact by the mooring and maneuvering procedures and unloading sequence of the larger tankers will be limitedly perceived by sensitive receptors. This impact will be limited only during the approach of such a vessel.

The addition of an ORV does not modify the landscape value, since the ORV will be installed on the LNG Terminal.

Consequently, the unmitigated cumulative impact to the landscape, during operation of all three projects is deemed Minor.

Figure 3-6 Photomontage from view point in Agia Triada, of Megara.

Prepared by ASPROFOS (2014). Initial photographic and photomontage by (ASPROFOS, 2012)

Figure 3-7 Photomontage from view point in Iremo Kima beach, of Megara.

Prepared by ASPROFOS (2014). Initial photographic and photomontage by (ASPROFOS, 2012)

Figure 3-8 Photomontage from view point in Xeno beach, of Salamina.

Prepared by ASPROFOS (2014). Initial photographic and photomontage by (ASPROFOS, 2012)

Figure 3-9 Photomontage from view point of Profitis Ilias Church, of Salamina.

Prepared by ASPROFOS (2014). Initial photographic and photomontage by (ASPROFOS, 2012)

- ***Mitigation Measures***

During Construction

Impacts during construction cannot be entirely avoided. In order to minimize the small magnitude of the visual impacts, minimization of construction time is the only applicable mitigation measure; this is included on the best practices of all construction activities. It goes without saying that avoidance of work repetition and minimization of construction time through careful planning and execution of construction works reduces costs and impacts

During Operation

As illustrated in the photomontages, landscape impacts are practically negligible. However, the following measures are applicable not only for the complete incorporation of the 3rd LNG tank in the landscape but also for the overall upgrading of Revithoussa Island landscape. This way the existing visual impact imposed on the social sensitive receptors will be decreased.

- Planting of proper species around the 3rd tank in order to improve landscape's aesthetics. This measure could be expanded to include planting of proper species around the 2 existing LNG tanks. In any case, all safety restrictions should be met when locating planting areas. Due to the limited space, the relevant plantation study should be compiled after the completion of the construction works. The following species are suggested:
  - Oleander (*Nerium oleander)*, along the coast of Revithoussa Island. Oleander can increase in height so that the facilities are concealed by low altitude viewpoints.
  - Tree medick *(Medicago arborea)* and other species of the garrigue (phrygana) plant community, along the land reclamation works in order to decrease the visual intrusion of new materials, if any are used.
  - *Pistacia Lentiscus* which shows tolerance to dry environments and salinity

  The above mentioned species are included in the flora species of the area and are well adapted to the local conditions.

- ***Residual Cumulative Impacts***

Based on the assumption that all previously mentioned mitigation measures will be implemented and that the Owner shall comply with the Environmental Terms Approval, residual cumulative impacts:

- During construction of the three projects, are deemed **Not Significant**
- During operation of the three projects, are deemed **Not Significant**

3.4 Biotic Environment

3.4.1 Flora

- ***Summary of baseline conditions***

Regarding the onshore flora, the broader area of Revithoussa Island lays within the Eumediterranean zone of evergreen vegetation (*Quercetalia ilicis*) vegetation alliance, according to the Braun-Blanket classification. Given, that this alliance includes xerophytes and open spaces with garrigue (phrygana) species, the determining factor for vegetation's vertical development are the average minimum temperatures of the coldest month. Most of the plains of this alliance have been surrendered to agricultural use or converted to pastures, with domination of bushes. *Quercetalia ilicis* is divided in two sub-alliances: *Oleo – Ceratonion* and *Quercion ilicis.* Specifically, Revithoussa Island lays within the sub-alliance of *Oleo – Ceratonion*. The climate of this sub-alliance is characterized by 250-550mm of rainfall and a dry season of 4-6 months. *Oleo – Ceratonion* can be further distinguished in two zones: *Oleo – Ceratonietum* and *Oleo – Lentiscetum.* The investigated area lays within the *Oleo – Ceratonietum* which is characterized by degraded natural garrigue (phrygana) areas or cultivated lands.

Due to the existing industrial LNG facilities, almost the entire surface of Revithoussa Island, natural vegetation is very limited, present almost exclusively, on the hills of the island. Plant species identified on the Island are characteristic of the garrigue (prhygana) alliance and include: perennial species such as *Phlomis fruticosa, Genista acanthoclada* and *Sarcopoterium spinosum*, and annual species such as *Dactylis glomerata* and *Anthoxanthum odoratum*. Individuals of *Nerium oleander* are also present. The west coasts of Salamina, at Xeno's settlement area, and the south coasts of Megaia, at Agia Triada and Iremo Kima settlements area, are dominated by abandoned or fallowed agricultural areas, *Pinus halepensis, Tamarix hampeana, Pistacia lentiscus*, and *Olea europea,* either as individuals or in small groups.

Regarding the offshore flora, no marine angiosperms, specifically *Posidonia oceanica, Cymodocea nodosa or Halophila stipulacea* which are protected species, are observed. Algae (seaweeds) on top of the submerged rocks and boulders are present. Indicatively, the following species are recorded: *Cystoseira spp, Digenea simplex* and *Laurencia spp*[4]. There is no extensive, validated literature for the specific area around Revithoussa Island. Limited research for the Elefsina bay (approx. 15km distance) and the Vourkari (aka Vourkadi) bay (approx. 2km distance) is available. The special study of University of Athens (Πανεπιστήμιο Αιγαίου, 2004) for the Vourkari reports that the general ecological conditions of the Vourkari bay are completely disappointed. The main reason is the intense eutrophication.

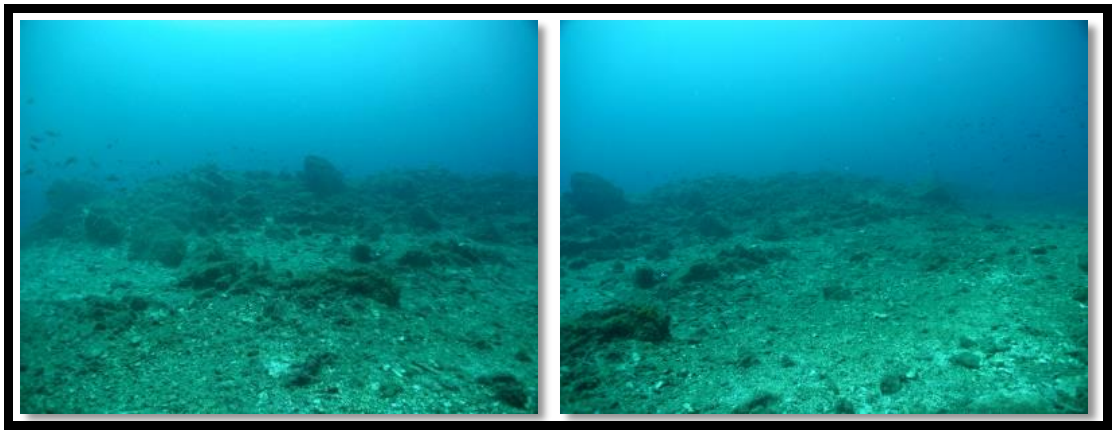
[4] http://www.algaebase.org/

A field survey was performed on 2013 (RINA, D'APPOLONIA, EXERGIA, 2013) commissioned by DESFA studying the two following zones:

- Influence zone south of the Revithoussa Island, which receives the cold discharge of the sea water from the regasification of the LNG. Sea water temperature at this zone was approx. 16°C. The benthic vegetation was dominated by brown algae (mainly *Dictyota*) and red limestone algae (mainly *Corallina).*
- Control zone at the north side of Revithoussa Island. Sea water temperature at this zone was approx. 18°C. the benthic vegetation was the same as the one on the influence zone.

The above data are supported by the study performed by HCMR (Panagiotidis, 2013) commissioned by DESFA and previous studies of HCMR in the broader marine area of Saronikos bay. In addition, within the scope of the monitoring program, various diving expeditions were performed along the jetty of Revithoussa Island.

Picture 3-1 View of the sea bottom 15m, approx., from the jetty.



Source: (ΑΤΛΑΝΤΗΣ ΘΑΛΑΣΣΙΑ ΜΗΧΑΝΙΚΗ, 2009)

- ***Impacts Assessment***

During Construction

The main mechanisms that could cause impacts to the flora biodiversity of the area include (a) movement of vehicles, equipment, and personnel; (b) civil engineer works, such as excavations; (c) sea bottom clearance works. These mechanisms could cause direct species loss – through clearance or indirect species loss – through modification of physicochemical parameters and mainly dust (or sediments) suspension.

Picture 3-2 Marine flora in the influence zone.

Source: (RINA, D'APPOLONIA, EXERGIA, 2013)

Regarding onshore flora, the given the limited or no presence of flora species on the area of the 3rd LNG tank installation, the impacts would be caused by the resettling of dust on the Revithoussa Islands plants. This dust is expected to be caused by the excavation works and the movement of project's related machinery and personnel. The sensitivity of the receiving species is quite low, since the species present on the Island, are well adapted to anthropogenic environments and very common in Greece. Dust transportation is not expected to take place in long distances, thus dust is not expected to reach the continental parts, ie the settlements of Agia Triada or Iremo Kima, to the south, or Xeno, to the east. Impacts from the installation works for the ORV gasifier are identical, for the onshore section. Construction works for the jetty facilities upgrade are not expected to interact with the onshore flora species. Consequently, the unmitigated cumulative impact to the onshore flora species, during construction of all three projects is deemed Not Significant.

Regarding the offshore flora species, no interaction between the 3rd LNG tank installation works and the marine environment is expected. ORV installation includes the replacement of the sea water discharge pipeline, whilst jetty facilities upgrades include clearance of the sea bottom. Both activities shall cause suspension of sediments with the following possible effects: suspension of nutrients; modification of sea water physicochemical parameters, mainly turbidity; and resettling of sediments on top of the marine flora species. Limited suspension of nutrients, not adequate enough as to cause eutrophication conditions, is a positive impact and is not further assessed. Resettling of sediments on top of the marine flora species is similar to dust, for the onshore flora species and what was previously discussed is applicable. Modification of physicochemical could cause indirect mortality, due to decreased

light availability and penetration. However, given that no protected or of high ecological/ conservation value species were recorded, plus the temporary character of the specific modification and the local spatial content of the impact, the unmitigated cumulative impact to the offshore flora species, during construction of all three projects is deemed Minor.

During Operation

The main mechanisms that could cause impacts to the flora biodiversity of the area include (a) marine traffic of LNG carriers and (b) discharge of cold water and residual chlorine from the operation of the ORV. These mechanisms could cause direct species loss – through clearance or indirect species loss – through modification of physicochemical parameters and mainly temperature decrease.

The operation of all three projects does not interact with the environment, in such a way as to have significant impacts to the onshore flora species. Consequently, no cumulative impacts to the onshore flora species need to be assessed.

Regarding the offshore section, the marine traffic of LNG carriers is not expected to cause significant impacts. Mooring is to be performed in dedicated points so direct loss of species will be minimum, if any. No discharge of ballast water shall happen, so no significant risk from alien species genetic pollution exists.

Impacts to marine flora, during operation of the projects, could be caused by the discharge of 5000m³/h sea water, back to the sea, by the operation of the new ORV. The discharged water shall be 4-7°C colder than the recipient environment and the addition of residual chlorine not exceeding 0.4ppm. A sea water dispersion model was undertaken for the ESIA of the ORV (RINA, D'APPOLONIA, EXERGIA, 2013) in order to assess temperature and chlorine dispersion, on various weather scenarios. The main results of this model are presented in the following table (Table 3-5). The model calculated the areas where the temperature (dT) difference between the discharged sea water plume and the sea water itself exceeds -2°C, -1°C and -0.5°C, or where the residual chlorine exceeds 0.2, 0.1 and 0.01 ppm. More details can be found in the project's ESIA.

Table 3-5 Expected temperature difference and residual chlorine concentration in the investigation area.

Scenario	Wind conditions	DIFFERENCE IN TEMPERATURE (dT) (°C)			RESIDUAL CHLORINE (ppm)		
		<-2°C	<-1°C	<-0.5°C	>0.2	>0.1	>0.01
		Area (km²)			Area (km²)		
E_00	Calm	*	*	0.02	*	*	0.12
D_00		*	0.01	0.02	*	0.01	0.15
E_01	Wind Speed: 5.7m/s	*	0.01	0.02	*	0.01	0.12
D_01	Incoming Direction: 180°N	*	0.01	0.03	*	0.01	0.14

Scenario	Wind conditions	DIFFERENCE IN TEMPERATURE (dT) (°C)			RESIDUAL CHLORINE (ppm)		
		<-2°C	<-1°C	<-0.5°C	>0.2	>0.1	>0.01
		Area (km²)			Area (km²)		
E_02	Wind Speed: 6.2m/s	-	*	0.01	-	*	0.08
D_02	Incoming Direction: 315°N	-	*	0.01	-	*	0.11
E_03	Wind Speed: 7.6m/s	*	0.01	0.02	*	0.01	0.07
D_03	Incoming Direction: 180°N	*	0.01	0.03	*	0.01	0.08
E_04	Wind Speed: 10.7m/s	-	*	0.01	-	*	0.06
D_04	Incoming Direction: 315°N	-	*	0.01	-	*	0.08
*: values smaller than 0.01km²							

Source: (RINA, D'APPOLONIA, EXERGIA, 2013)

Temperature differences smaller than 1°C, in a few hundred meters from the discharge point have negligible impact (Peres & Picard, 1964). In addition, based on international experience from industrial sea water cooling systems, the residual chlorine exceeding 0.1ppm at a maximum area of 0.01km² can be also considered negligible. The results of the model support that both conditions are met.

The results of the model are supported by the monitoring program and the baseline conditions that illustrate that the marine flora is not affected by the operation of the existing ORV.. Additional discussion regarding physicochemical parameters of sea water is provided in section 3.3.2 - Sea Water Quality.

Based on the above, and given the lack of sensitive receptors (protected flora species), the small scale of the impact and the homeostasis, ie the adaptation illustrated by the surrounding marine environment to the impacts by the existing facilities, the unmitigated cumulative impact to the offshore flora species, during operation of all three projects is deemed Minor.

- ***Mitigation Measures***

During Construction

Regarding the onshore section, garrigue (phrygana) plants are well adapted to anthropogenic pressures and no mitigation measures are deemed necessary. What is suggested is to proceed with a plantation scheme, subject to safety regulations compliance, with the use of local species that could increase the landscape value, such as *Nerium oleander, Phlomis fruticosa* or *Genista acanthoclada.* Details are presented in the relevant section 3.3.4 - Landscape and the following paragraph regarding mitigation measures during operation.

Regarding the offshore section, there are limited measures in order to minimize impacts, mainly, sediments suspension, by the offshore construction works. Based on the best industry practices, the following measures are applicable:

- Minimization of construction works duration. For this purpose a detail design of all works should be preceded and the best construction practices should be used.
- Compliance with best available techniques prohibits discharge of any type of waste to the sea.
- Selection of the best equipment and technique for sea bottom clearance
- re-use of boulders for armoring the retaining structures. This way local biodiversity will be maintained and natural reinstatement will be facilitated.

During Operation

Regarding the onshore section, as discussed in section 3.3.4 - Landscape replantation, subject to safety restrictions, on the Island is suggested, with the use of local plant species. Specifically, due to the low-value ecological conditions of the island and the presence of native species the plantation of typical flora species of the plant alliance are suggested. These species are well adapted to manmade environments and anthropogenic pressures, and include the following: (i) *Nerium oleander* on the periphery – although a bush species, it can be developed to significant heights, concealing the facilities from sensitive receptors viewpoints; (ii) typical garrigue (or phrygana) species on the slopes, such as *Phlomis fruticosa, Genista acanthoclada, Medicago arborea, Spartium junceum, Pistacia lentiscus, etc* iii) *Pistacia Lentiscus* which shows tolerance to dry environments and salinity.

Regarding the offshore section, in order to minimize impacts from the residual chlorine ending up to the sea, a system of sodium sulfite addition will be implemented. This way the concentrations of the residual chlorine will be regulated and the statutory limits will be met at all times. The temperature monitoring program will continue to run.

- ***Residual Cumulative Impacts***

Based on the assumption that all previously mentioned mitigation measures will be implemented and that the Owner shall comply with the Environmental Terms Approval, residual cumulative impacts:

- During construction of the three projects, are deemed **Not Significant**
- During operation of the three projects, are deemed **Not Significant**

3.4.2 Fauna

- ***Summary of baseline conditions***

Regarding terrestrial fauna species, due to the presence of the LNG Terminal, the fauna biodiversity is limited to small populations of anthropophilic species. Recorded mammals

include rodents such as *Microtus arvalis, Rattus rattus*. Serpentines and amphibians include *Cyrtodactylus kotschyi, Lacerta trilineata, Hemidactylus turcicus* etc.

Regarding avifauna, the area is hosting sea birds, typical of the Greek coasts, such as sea galls (*Larus sp)*, and various Passeriformes, *Hirundo rustica*, *Motacilla alba, Passe hispaniolensis* etc. Although Revithoussa Island is not included in any protected area, it is close to the Vourkari bay (which according to a Presidential Decree is characterized as protected coastal zone) and is also on the migration corridor traversing central Greece. Proximity to the wetland of Vourkari should be noted (see section 3.4.3 - Protected Areas). Of the 104 avifauna species recorded 8 species are characterized as vulnerable: *Ardea purpurea, Burhinus oedicnemus, Chlidonias hybrida, Chlidonias niger, Glareola pratincola, Himantopus himantopus, Larus melanocephalus, Tadorna tadorna* (Πανεπιστήμιο Αιγαίου, 2004).

Regarding the marine fauna species, no specific studies for the area of Revithoussa were identified. As far as the fishfauna is concerned, the typical species inhabiting Elefsina bay, Vourkari bay and Saronikos bay are to be expected. Indicatively the following species are mentioned: *Atherina hepsetus*, *Engraulis encrasicholus*, *Boops boops, Mugil cephalus*, *Scomber japonicus*, *Dicentrarchus labrax*, *Pagellus erythrinus*, *Oblada melanura*, *Mullus surmuletus*, *Boops salpa*, *Diplodus sargus*, *Sardina pilchardus*, *Scorpaena sp*., *Diplodus annularis*, *Spicara smaris.* In general, the zoobenthic community is expected to be characterized by resilient to pollution species such as *Capitella capitata* or *Corbula giba.* Siboura et al (Siboura, Zenetow, Panagiotidis, & Makra, 1995) support that the Saronikos bay is home of 191 species, whilst the broader area of Revithoussa Island (ie Elefsina bay and Megara bay) hosts 18 species. The genetic pollution by 4 alien species is also recorded (Young, Πολυχρονίδης, & Ζενέτου, 2007). Marine biodiversity of Revithoussa Island also includes species of octopus and mollusks.

Large marine mammals or cetaceans are not systematically recorded in the area. However in May 2012[5] a young *Balaenoptera physalus* was recorded NW of AIgina Island, in Saronikos bay, where it stayed for two days. The species is crossing occasionally the Greek seas. Consequently, the record of the species should not be further taken into consideration as baseline conditions. In addition, according to the Greek Red Book of Endangered Species (Λεγάκης & Μαραγκού, 2009) two species of dolphins have been recorded in the broader area: *Delphinus Delphi* and *Tursiops truncatus*

The diving expenditure discussed in section 3.4.1 confirmed that the presence of various invertebrates such as sponges, bryozoans, polychaetes and bivalves in the broader influence zone, as well as fish populations. In fact, the control zone was recorded to have smaller number of fish populations

[5] http://archipelago.gr/episkepsi-pterofalenas-ston-saroniko/, Retrieved on 24.06.2014

Picture 3-3 Overview of marine biodiversity.

Source: (RINA, D'APPOLONIA, EXERGIA, 2013)

Picture 3-4 Marine biodiversity growth in rocky outcrops on the sea bottom.

Source: (Panagiotidis, 2013)

- ***Impacts Assessment***

During Construction

The mechanisms that could cause impacts to the fauna of the area during the construction phase of the projects are the same as the ones presented for the relevant flora section (see section 3.4.1) and could cause:

- Loss of habitat or species as a result of vegetation clearance or nesting sites removal, in the construction area
- Disruption of habitats and ecological corridors of local populations due to the installation of the construction site and the execution of construction works
- Create barriers to the movement of species
- Introduction of alien species

Regarding the onshore section, as mentioned in the baseline description, there are no mammals and reptiles of significant ecological or conservation value. Due to the island nature of the projects area there is no interaction with other terrestrial ecosystems, while the Island hosts no ecosystems of high ecological importance. Possible introduction of alien species is not a concern as it is difficult to transport them to the Island, whilst even if they are transported, most likely the species will be from the mainland of Megara (of Agia Triada where the small port for the communication between mainland and Revithousa is located) with similar ecological functions, services and value. Consequently, the unmitigated cumulative impacts of all three projects construction to terrestrial fauna are deemed Not Significant.

Regarding avifauna, direct loss of habitat, nesting sites and hunting areas are not expected. However, given that Revithoussa is located on the migration corridor of central Greece, some nuisance to the migratory species could be caused. The wetland of Vourkari is at significant distance and indirect impacts could not be imposed as well. Although only 2%, approx., of the species recorded in the area of Vourkari are of high conservation value, the sensitivity of these should be deemed as high, due to the environmental policy of DESFA. A secondary, indirect, positive impact should be also taken into consideration, ie the suspension of nutrients in the sea water. Given that thanks to the gentle currents of the area and the limited time/ spatial frame of the construction works no eutrophication danger exists, the increased nutrients concentration could have positive impacts to the increase of phytoplankton, followed by an increase of zooplankton and therefore of the entire marine food chain. Based on this assumption, impacts on avifauna could be mitigated. Consequently, taken into consideration the distance between Revithoussa Island and Vourkari bay which is approx. 2.5km; the limited spatial and temporal frame of the construction works which are located on and next to Revithoussa Island; and mainly the geographic exclusion of the two areas, the unmitigated cumulative impacts to the avifauna by the construction of all three projects should be assessed as Minor.

Regarding the offshore section the mechanisms are similar to the ones described previously and in the relevant section of flora biodiversity (see section 3.4.1)

The organisms that will probably suffer pressures are benthic organisms that may have developed upon the rocks and other materials that have elevated the bottom of the channel. These organisms will suffer a direct loss of habitat, but in a small area nonetheless. Although these organisms are not included in any special protection list, their sensitivity is deemed high, within the environmental policy of DESFA. It should, however, be noted that since there are no sea grass beds whatever benthic organisms found on the sea bottom are adapted to the local conditions and native to the local waters. Consequently, the unmitigated cumulative impacts of all three projects construction to benthic organisms are generally deemed Minor.

Fishfauna is not expected to be affected directly. Although sediments suspension could cause serious impacts to fishes, the species can easily avoid construction areas, or areas of increased suspended solids. Given that the time frame of the construction works for sea bottom clearance and the installation of the offshore ORV pipeline are limited, it is assessed that fishes will return upon completion of marine works.. The spatial context of the works is also very limited compared to the sea water that will remain unaffected by any construction related activity. Consequently, the unmitigated cumulative impacts of all three projects construction to fishfauna are deemed Minor.

Marine mammals are not assessed to be present in the area of Revithoussa Island. Even if one adopts a conservative approach, assuming that marine mammals may be present in the broader area, the small time frame of the construction works eliminates any impact due to noise emulation by the construction works. Consequently, no unmitigated cumulative impacts by the construction of all three projects are assessed.

During Operation

The mechanisms described previously and in the relevant section of flora biodiversity (see section 3.4.1) are applicable.

As mentioned in section 3.4.1, the operation of all three projects does not interact with the environment, in such a way as to have significant impacts to the onshore fauna species. Consequently, no cumulative impacts to the onshore flora species need to be assessed.

Regarding the offshore section, the discussion presented in the relevant section of marine flora (section 3.4.1) is applicable and shall not be repeated here. The following are highlighted for completeness purposes:

- LNG carriers will moor on dedicated points minimizing impacts to marine species habitats
- The discharge of the cold sea water from the operation of the existing and the new ORV does not constitute reason for impacts to marine species. Temperature difference is not calculated larger than 1°C and residual chlorine larger than 0.1ppm,

in a few hundred meters from the discharge point; these benchmarks are assessed to be acceptable by international literature.

- Temperature differences smaller than 1°C, in a few hundred meters from the discharge point have negligible impact (Peres & Picard, 1964). In addition, based on international experience from industrial sea water cooling systems, the residual chlorine exceeding 0.1ppm at a maximum area of 0.01km² can be also considered negligible. The results of the model support that both conditions are met.
- Based on the existing monitoring program, impacts from the operation of the LNG Terminal do not have a negative impact to marine biodiversity.

- ***Mitigation Measures***

During Construction

Regarding mitigation of impacts to terrestrial fauna, no significant impacts are assessed and no special mitigation measures are required. The measures presented for the corresponding flora species are applicable, given that vegetation reinstatement and/ or enrichment is an enhancement for animals' habitats.

An additional measure to minimize impacts to avifauna is the proper planning of construction works, outside the migration period of birds (April and September)..

Based on the results of the monitoring program, natural reinstatement and re-colonization is deemed satisfactory.

Regarding ichthyofauna and marine mammals and reptiles, no mitigation measures are suggested given that no impacts are assessed.

During Operation

The use of a sodium sulphite addition system, if necessary, at the exit of the gasifier is suggested, in order to regulate the residual chlorine concentrations, ending up to the sea. This way compliance with statutory limits will be achieved. Up till today, there was no need for usage of such a system. The monitoring system shall continue to measure discharged water temperature, ensuring that the maximum temperature difference with sea temperature does not exceeds 7°C.

- ***Residual Cumulative Impacts***

Based on the assumption that all previously mentioned mitigation measures will be implemented and that the Owner shall comply with the Environmental Terms Approval, residual cumulative impacts:

- During construction of the three projects,
  - To terrestrial fauna are deemed **Not Significant**
  - To avifauna are deemed **Minor**
  - To marine benthic organisms are deemed **Minor**
  - To ichthyofauna are deemed **Not Significant**
  - To marine mammals are not expected

- During operation of the three projects,
  - To terrestrial fauna are not expected
  - To avifauna are not expected
  - To marine benthic organisms are deemed **Not Significant**
  - To ichthyofauna are not expected
  - To marine mammals are not expected

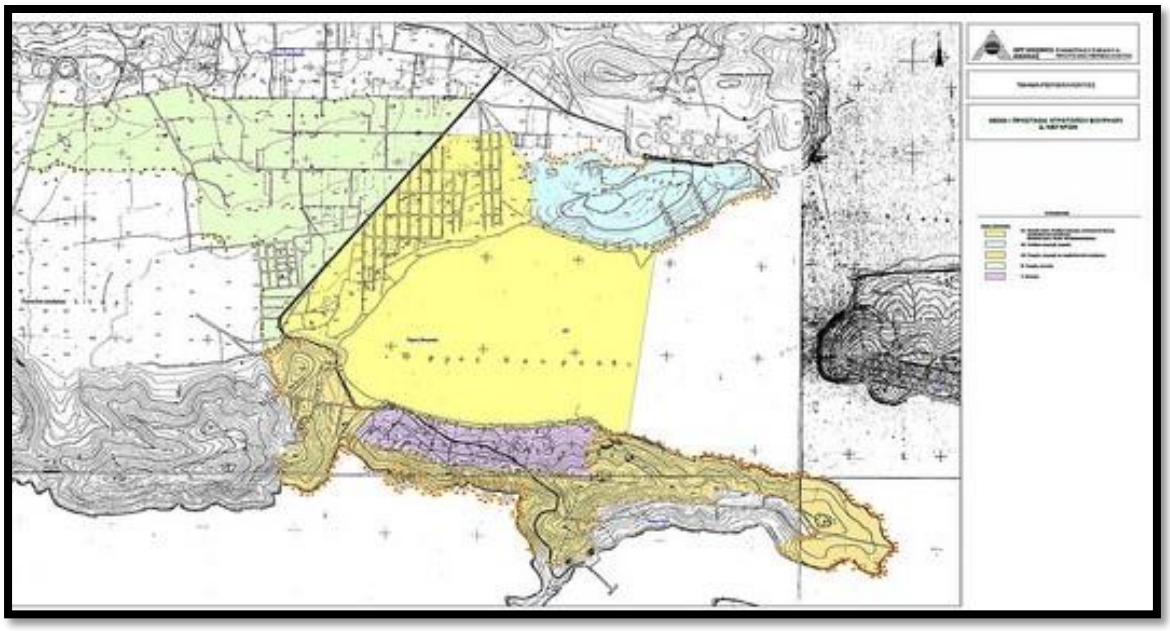
3.4.3 Protected Areas

- ***Summary of baseline conditions***

There are no environmental protected areas within the study area of any of the three projects, ie in a 1km radius. However, as previously mentioned, Vourkari bay, and the corresponding wetland, is at close proximity.

It is stressed out that the approved ESIAs, the ETAs and the special study prepared for the characterization of the area as protected do not assess any impacts from the LNG Terminal at Revithoussa to the protective characteristics of Vourkari wetland (Figure 3-10). However, for completion purposes and within a conservative environmental approach, the Vourkari wetland is shortly described in this section.

Figure 3-10 Zoning of Vourkari wetland protected area.



A study prepared by the Hellenic Ornithological Society (Καστρίτης & Δημαλέξης, 2009) for the Vourkari Wetland reports 127 different species of avifauna present in the area out of which:

- 3 species are characterized as "Near Threatened", according to the IUCN Red List of Threatened Species; specifically the waders (coastal birds) *Limosa limosa, Numenius torquata*, and *Falco vespertinus*. These species are present, mainly, during the migration period. According to the Greek Red List of Threatened Species (Λεγάκης & Μαραγκού, 2009), 11 species are characterized as Threatened and 5 more as Near Threatened.
- 28 species are listed in Annex I of Directive 79/409/EU
- 13 species are listed in SPEC2 and 39 species in SPEC3 of Birdlife International
- 86 species are listed in Annex II and 36 in Annex III of the Bern Convention
- 77 species are listed in Annex II of the Bonn convention

The number of avifauna species is greater during April and September, when the species migration reaches its climax.

Two more protected areas (under L.3937/2011 – HGG A' 60) are protected under the legislation of small island wetlands (wetlands smaller than 8hectares near the coast or on islands). Based on the corresponding Presidential Decree (HGG AAP 229/19.06.2012) two protected areas are located on the west coastline of Salamina Island, at significant distance from the LNG Terminal. These are illustrated in the following table (Table 3-6) and figure (Figure 3-11).

Table 3-6 Small island wetlands in the broader area of Revithoussa Island LNG Terminal.

Code	Name	Municipality/ Island	Category	Type	Area (m^2)	Distance from Revithoussa Island (km)
Y300SAL001	Elos Archaiou Limena (Marsh of Ancient Port)	Salamina	Wetlands System	Coastal	27,8	14.5
Y300SAL002	Aliki Naftikis Vasis (Salt pit of Naval Base)	Salamina	Seasonal salt pit swamp	Coastal	19.4	9.3

Source: (ΔΕΣΦΑ, 2014)

- ***Impacts Assessment***

During Construction

The mechanisms that could affect the protected areas are the ones described in the previous biodiversity sections (sections 3.4.1 and 3.4.2, regarding flora and fauna species, respectively). Due to the significant distance from the two small island wetlands, no impacts are assessed by the construction of any of the three projects. Regarding the Vourkari wetland, no impacts from the construction of any of the three projects are expected, either, based on the following arguments:

- There is a significant geomorphological feature between Revithoussa and Vourkari, the peninsular of Agia Triada., the northern part of which is the limit of the protected wetland. This clearly separates the two areas and isolates the terrestrial features of the Vourkari wetland from any interaction with Revithoussa;
- There is a noteworthy distance between the LNG Terminal and the Vourkari bay;
- The construction period for the three projects is limited.

However, adopting a conservative approach and in order to maximize environmental protection from the construction of all three projects, the discussion presented for the avifauna (section 3.4.2,) is applicable. In short, although the wetland of Vourkari is at significant distance, indirect impacts could be imposed, due to the nuisance caused by the construction logistics. A secondary, indirect, positive impact should be also taken into consideration, ie the suspension of nutrients in the sea water. Given that no eutrophication danger exists, the increased nutrients concentration could have positive impacts to the entire marine food chain. Based on this assumption, impacts on avifauna could be mitigated. Consequently, taken into consideration the distance between Revithoussa Island and Vourkari bay which is approx. 2.5km; the limited spatial and temporal frame of the construction works which are located on and next to Revithoussa Island; and mainly the geographic exclusion of the two areas, the unmitigated cumulative impacts to the avifauna by the construction of all three projects should be assessed as Minor.

Figure 3-11 Small island wetlands and Revithoussa Island.

Prepared by ASPROFOS (2014)

During Operation

As discussed in the previous sections regarding biodiversity (sections 3.4.1 and 3.4.2) no interaction between the protected species of avifauna and the LNG Terminal is identified, consequently no impacts are identified. The same applies for the physicochemical characteristics of the Vourkari wetland which cannot be affected by the operation (nor construction) of all three projects.

- ***Mitigation Measures***

During Construction

The measures presented in the corresponding fauna section (section 3.4.2) are applicable, mainly the proper planning of construction works exerting every possible effort to avoid construction works during April and September when migration pick happens, if deemed necessary.

During Operation

No impacts are assessed and no mitigation measures are deemed necessary.

- ***Residual Cumulative Impacts***

Based on the assumption that all previously mentioned mitigation measures will be implemented and that the Owner shall comply with the Environmental Terms Approval, residual cumulative impacts:

- During construction of all three projects are deemed **Not Significant**
- During operation of all three projects, no residual cumulative impacts are identified.

3.5 Social Environment

Land uses are not expected to have any impact, given that the projects will be implemented on an already industrial area, with no interaction with other land uses. Consequently, no cumulative impacts are expected hence no discussion is deemed necessary.

Regarding cultural heritage, all three projects will be implemented on the Revithoussa Island, which has been already investigated in detail regarding cultural heritage, during the initial implementation of the LNG Terminal. The 2 nd upgrade of the LNG Terminal with the three investigated projects does not interact with new areas that could have unidentified cultural heritage resources. Consequently, no interaction with cultural heritage resources is expected neither during construction nor operation of the three investigated project; hence no cumulative impacts are expected.

A short discussion is presented in the next paragraph regarding economic activities, although it is also assessed that no cumulative impacts exist, given mainly the isolated nature of the construction works and projects operation.

3.5.1 Economic Activities

- ***Summary of baseline conditions***

Revithoussa Island is not inhabited, except for the LNG Terminal staff. According to L. 3852/2011, Revithoussa Island belongs to Municipality of Salamina, whilst the closest municipality is that of Megara. Table 3-7 presents the employment per economic sector whilst Table 3-8 economic development per activity of the two closest municipal entities.

Table 3-7 Employment per economic sector.

Local Administration Organization	Economically Active							Economically Inactive
		Employeed					Unemployeed	
	Total	Total	Primary Sector	Secondary Sector	Tertiary Sector	Other	Total	
Municipality of Megara (Municipal Entity of Megara)	11035	9753	1740	3095	4310	608	1282	12971
Municipality of Salamina (Municipal Entity of Salamina)	8335	7265	363	1609	5037	256	1070	14286

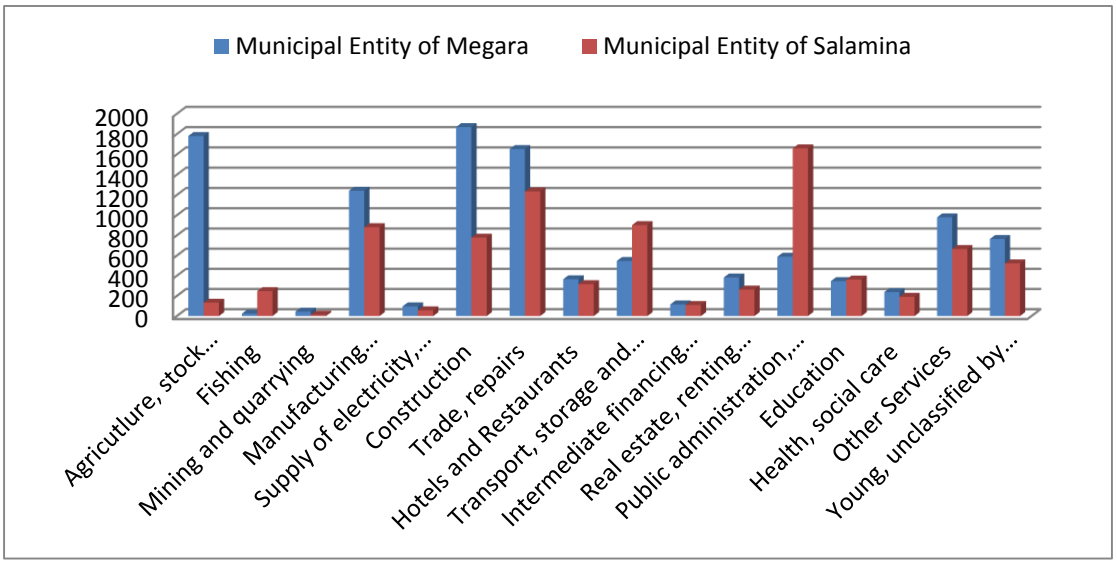
Source: Greek Statistics (census 2011)

Table 3-8 Economic development per activity.

Economic activity	Municipal Entity of Megara		Municipal Entity of Salamina	
	Population	%	Population	%
Agricutlure, stock farming, hunting, forestry	1781	16.14	133	1.60
Fishing	24	0.22	247	2.96
Mining and quarrying	44	0.40	14	0.17
Manufacturing industries	1242	11.26	881	10.57
Supply of electricity, natural gas and water	96	0.87	57	0.68
Construction	1869	16.94	778	9.33
Trade, repairs	1652	14.97	1234	14.81
Hotels and Restaurants	365	3.31	317	3.80
Transport, storage and communications	546	4.95	902	10.82
Intermediate financing organizations	116	1.05	110	1.32
Real estate, renting and business activities	383	3.47	263	3.16
Public administration, defense	589	5.34	1659	19.90
Education	347	3.14	362	4.34
Health, social care	238	2.16	191	2.29
Other Services	979	8.87	665	7.98
Young, unclassified by sector	764	6.92	522	6.26
Total	**11035**	**100**	**8335**	**100**

Based on Greek Statistics (census 2011)

Figure 3-12 Economic activity significance.



Prepared by ASPROFOS (2014)

- ***Impacts Assessment***

During Construction

Negative impacts from the construction of the project could be not incurred on the touristic sector of economy (activity: "Hotels and Restaurants"), because the construction period is very limited and the construction sites away from touristic venues. On the contrary, it is reasonable to expect some construction staff to spend money on the restaurant enterprises of the broader area. Consequently, no cumulative impacts are assessed.

Some negative impacts (similar to the ones described for the biodiversity sections – sections 3.4.1 and 3.4.2) could be caused on aquaculture farms but none fishfarms were identified in the investigation zone. Given the island nature of Revithoussa and the lack of interaction with any other activity of the primary sector, no cumulative impacts are identified on the primary sector either.

Positive impacts may be incurred on the construction, trade and repairs sector, as it is reasonable to expect increase of relevant economic activities due to the construction related needs; however, based on the methodology presented in section 3.2, these are not further assessed.

During Operation

2nd upgrade of LNG Terminal shall have no, macroscopically identified, difference in the operation process, except for the presence of the 3rd LNG Tank and the occasionally berthing of larger LNG carriers. These aspects were discussed in the relevant to the landscape section

(section 3.3.4). Given that no cumulative impacts were assessed as significant, there is no reason to expect negative impacts on the economic activities of the neighboring population. In other words,2 nd upgradeof the LNG Terminal is not expected to modify existing conditions whatsoever, in terms of social understanding.

- ***Mitigation Measures***

During Construction

As discussed in section 3.3.4 (Landscape) impacts during construction cannot be entirely avoided. In order to minimize the small magnitude of the visual impacts, minimization of construction time is the only applicable mitigation measure; this is included on the best practices of all construction activities.

During Operation

No impacts are assessed and consequently no specific mitigation measures are necessary. The ones presented in all previous sections, are also applicable.

- ***Residual Cumulative Impacts***

Based on the above, no residual cumulative impacts are assessed during construction or operation.

3.6 Cumulative Impacts Matrix

Table 3-9 Cumulative Impacts Matrix.

Potentially Impacted Environmental Parameter	Projects' Phase	Projects' Mechanism	Impact from the 3rd LNG Tank	Impact from the ORV installation	Impact from the JettyFacilities Upgrade	Potential (Unmitigated) Cumulative Impact Significance	Significance of Residual Cumulative Impacts	Reasoning
Air Quality	Construction	Dust Suspension Air Pollutants Emission	Negligible Negligible	Negligible Negligible	Minor Negligible	Not Significant Not Significant	Not Significant Not Significant	Only dust is deemed significant. Dust acts accumulatively but for a limited time. All equipment will comply with EU regulations about exhausts' emissions.
	Operation	Air Pollutants Emission	Minor	None	None	Not Significant	Not Significant	Only the 3rd LNG tank interacts with the environment. Model results suggest that no exceedance of statutory limits will happen.
Sea Water Quality	Construction	Sea bottom clearance works, ORV discharge pipeline, and 3rd LNG tank excavation	Minor	Minor	Minor	Minor	Not Significant	Compliance with waste water disposal legislation.
	Operation	Marine traffic of LNG carriers Discharge of cold water and residual chlorine	None None	None Minor	Minor None	Minor Minor	Not Significant Not Significant	Compliance with national and international regulations Temperature differences smaller than 1°C or residual chlorine concentration of 0.1ppm, in a few hundred meters from the discharge point have negligible impact. Model run supports that both conditions

Potentially Impacted Environmental Parameter	Projects' Phase	Projects' Mechanism	Impact from the 3rd LNG Tank	Impact from the ORV installation	Impact from the JettyFacilities Upgrade	Potential (Unmitigated) Cumulative Impact Significance	Significance of Residual Cumulative Impacts	Reasoning
								are met. Establishment of a sodium sulphite system for regulating residual chlorine
Soil characteristics and morphology	Construction	Disturbance and Degradation of soil due to erosion, compaction, removal, modification of morphology	Moderate	Not Significant	Minor	Moderate	Minor	100900m³ of aggregates that shall be disposed in areas identified by the competent authorities.
		Accidental Pollution of soil by wastes or spills	Minor	Minor	Minor	Moderate	Not Significant	Compliance with national and international legislation minimized the potential for any accidental pollution
	Operation	Projects related activities	None	None	None	None	None	No interaction with the specific parameter during operation
Landscape	Construction	Land clearance and/ or reclamation	Minor	Negligible	Minor	Minor	Not Significant	Revithoussa Island is located at a significant distance from sensitive areas or receptors whilst the construction period is limited.
		Movement of project vehicles and machinery	Minor	Minor	Minor	Minor	Not Significant	Increased vehicles commute mainly during transporting of materials that is not a daily process. Personnel transport is daily but only at the beginning and end of the

Potentially Impacted Environmental Parameter	Projects' Phase	Projects' Mechanism	Impact from the 3rd LNG Tank	Impact from the ORV installation	Impact from the JettyFacilities Upgrade	Potential (Unmitigated) Cumulative Impact Significance	Significance of Residual Cumulative Impacts	Reasoning
								construction shift. For the jetty facilities upgrade maneuvering, mostly, on the west side of Revithoussa Island meaning limited visual engagement with sensitive receptors
	Operation	Presence of the new facilities Maneuvering, mooring and offloading of LNG carriers	Minor Minor	None None	Minor Minor	Minor Minor	Not Significant Not Significant	Photomontages demonstrate that any additional impact to the existing industrial landscape of Revithoussa Island is minimum, decreased even more by the mitigation measures, ie planting (subject to safety restrictions) .The jetty facilities are located on the western side of Revithoussa Island, concealed for the most part, by the view of the sensitive receptors. The visual impact by the mooring and maneuvering procedures and unloading sequence of the larger tankers will be limitedly perceived by sensitive receptors. This impact will be limited only during the approach of such a vessel.
Flora (Terrestrial)	Construction	Movement of vehicles, equipment, and personnel Civil engineer works	Minor Minor	Minor Minor	Minor Minor	Minor Minor	Not Significant Not Significant	Dust is the main impact and is expected to be caused by the excavation works and the movement of project's related machinery and personnel. The sensitivity of the receiving species is quite low, since the species present on the Island, are well adapted to anthropogenic environments and very common in Greece. Dust

Potentially Impacted Environmental Parameter	Projects' Phase	Projects' Mechanism	Impact from the 3rd LNG Tank	Impact from the ORV installation	Impact from the JettyFacilities Upgrade	Potential (Unmitigated) Cumulative Impact Significance	Significance of Residual Cumulative Impacts	Reasoning
								transportation is not expected to take place in long distances, thus dust is not expected to reach the continental parts, ie the settlements of Agia Triada or Iremo Kima, to the south, or Xeno, to the east.
	Operation	Projects related activities	None	None	None	None	None	No interaction with terrestrial environment exists.
Flora (Marine)	Construction	Sea bottom clearance works	None	Minor	Minor	Minor	Not Significant	No protected or of high ecological/ conservation value species were recorded. Temporary character of the physicochemical parameters modification. Local spatial content of the impact.
	Operation	Marine traffic of LNG carriers	None	None	Minor	Minor	Not Significant	Mooring is to be performed in dedicated points so direct loss of species will be minimum, if any. No discharge of ballast water shall happen, so no alien species danger exists.
		Discharge of cold water and residual chlorine	None	Minor	None	Minor	Not Significant	Temperature differences smaller than 1°C or residual chlorine concentration of 0.1ppm, in a few hundred meters from the discharge point have negligible impact. Model run supports that both conditions are met. Establishment of a sodium sulphite system for regulating residual chlorine

Potentially Impacted Environmental Parameter	Projects' Phase	Projects' Mechanism	Impact from the 3rd LNG Tank	Impact from the ORV installation	Impact from the JettyFacilities Upgrade	Potential (Unmitigated) Cumulative Impact Significance	Significance of Residual Cumulative Impacts	Reasoning
		Introduction of alien species	None	None	Not Significant	None	None	
Fauna (Terrestrial)	Construction	Civil engineer works and Movement of project vehicles and machinery	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	No interaction with other terrestrial ecosystems. Revithoussa Island hosts no ecosystems of high ecological importance. Possible introduction of alien species is not a concern as it is difficult to transport them to the Island, whilst even if they are transported, most likely the species will be from the mainland of Megara (of Agia Triada where the small port for the communication between mainland and Revithoussa is located) with similar ecological functions, services and value.
	Operation	Projects related activities	None	None	None	None	None	No interaction with terrestrial environment exists.
Fauna (Avifauna)	Construction	Civil engineer works and Movement of project vehicles and machinery	Minor	Minor	Minor	Minor	Minor	Direct loss of habitat, nesting sites and hunting areas are not expected. Some nuisance to the migratory species could be caused. Although the wetland of Vourkari is at significant distance, there are no impacts that could be imposed. Given that no eutrophication danger exists, the increased nutrients concentration could have positive impacts to the entire marine food chain.

Potentially Impacted Environmental Parameter	Projects' Phase	Projects' Mechanism	Impact from the 3rd LNG Tank	Impact from the ORV installation	Impact from the JettyFacilities Upgrade	Potential (Unmitigated) Cumulative Impact Significance	Significance of Residual Cumulative Impacts	Reasoning
	Operation	Projects related activities	None	None	None	None	None	No interaction with terrestrial environment exists.
Fauna (Marine Benthic Organisms)	Construction	Sea bottom clearance works	None	Minor	Minor	Minor to Moderate	Minor	These organisms will might suffer a loss of habitat, but in a small area nonetheless. These organisms are not included in any special protection list; whatever benthic organisms found on the sea bottom are adapted to the local conditions and native to the local waters.
	Operation	Marine traffic of LNG carriers	None	None	Minor	Minor	Not Significant	Mooring is to be performed in dedicated points so direct loss of species will be minimum, if any. No discharge of ballast water shall happen, so no alien species danger exists.
		Discharge of cold water and residual chlorine	None	Minor	None	Minor	Not Significant	Temperature differences smaller than 1°C or residual chlorine concentration of 0.1ppm, in a few hundred meters from the discharge point have negligible impact. Model run supports that both conditions are met.
		Introduction of alien species	None	None	Not Significant	None	None	
Ichthyofauna	Construction	Sea bottom clearance works	None	Not Significant	Not Significant	Minor	Not Significant	Species can easily avoid construction areas, or areas of increased suspended solids. Limited time frame of the construction works for sea bottom

Potentially Impacted Environmental Parameter	Projects' Phase	Projects' Mechanism	Impact from the 3rd LNG Tank	Impact from the ORV installation	Impact from the JettyFacilities Upgrade	Potential (Unmitigated) Cumulative Impact Significance	Significance of Residual Cumulative Impacts	Reasoning
								clearance and the installation of the offshore ORV pipeline. Species are widely common in the broader area of Saronikos, Elefsina and Vourkari bays; thus of low sensitivity. The spatial context of the works is also very limited compared to the sea water that will remain unaffected by any construction related activity.
	Operation	Marine traffic of LNG carriers	None	None	None	None	None	
		Discharge of cold water and residual chlorine	None	Minor	None	Minor	Not Significant	Temperature differences smaller than 1°C or residual chlorine concentration of 0.1ppm, in a few hundred meters from the discharge point have negligible impact. Model run supports that both conditions are met.
		Introduction of alien species	None	None	Not Significant	None	None	
Fauna (marine mammals)	Construction	Projects related activities	None	None	None	None	None	No marine mammals are assessed to be present on a regular basis in the area.
	Operation	Projects related activities	None	None	None	None	None	No marine mammals are assessed to be present on a regular basis in the area.
Protected Areas	Construction	Civil engineer works and	Minor	None	None	Minor	Not Significant	Direct loss of habitat, nesting sites and hunting areas are not expected. Some

Potentially Impacted Environmental Parameter	Projects' Phase	Projects' Mechanism	Impact from the 3rd LNG Tank	Impact from the ORV installation	Impact from the JettyFacilities Upgrade	Potential (Unmitigated) Cumulative Impact Significance	Significance of Residual Cumulative Impacts	Reasoning
(Vourkari wetland)		Movement of project vehicles and machinery						nuisance to the migratory species could be caused.. Given that no eutrophication danger exists, the increased nutrients concentration could have positive impacts to the entire marine food chain.
	Operation	Projects related activities	None	None	None	None	None	No interaction with terrestrial environment exists.
Economic Activity	Construction	Nuisance to touristic sector Nuisance to primary sector	None None	None None	None None	None None	None None	Limited construction period, isolated location. See also landscape and biodiversity sections No fishfarms identified in the area.
	Operation	Projects related activities	None	None	None	None	None	In all, cumulative impacts to all other factors are deemed not significant, consequently, the existing conditions, in terms of social understanding, are not going to be modified.

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4 Conclusions

The present report discussed the potential cumulative impacts by the construction and operation of the three projects related to the 2nd upgrade of the LNG Terminal in Revithoussa Island, ie construction of a 3rd LNG Tank, upgrading of the jetty facilities and installation of a new ORV Gasifier. The report, following the guidelines of IFC, focused on the Valuable Environmental and Social Components that were identified during the ESIAs of the projects under discussion, within a study area of 1km around the LNG Terminal.

During construction, there are some cumulative impacts, prior the implementation of any mitigation measures. Nevertheless, given:

- the isolated nature of the LNG Terminal and consequently of the new projects area,
- the limited construction period,
- the fact that no irreversible impacts are incurred,
- the fact that no sensitive receptors are identified in the study area,
- other factors described in detail in the relevant sectors, and
- the implementation of the mitigation measures

Cumulative impacts, during construction, are not significant, if any at all.

During operation, models elaborated for the ESIAs of each one of the three separate projects that consists the 2nd upgrade of the LNG Terminal, illustrated that no impacts should be assessed. Consequently.

No cumulative impacts, during operation of the upgraded LNG Terminal, are assessed.

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