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Ministry of State for Environmental Affairs
Egyptian Environmental Affairs Agency

Alexandria Integrated Coastal Zone Management Project (AICZMP)

Environmental and Social Impact Assessment

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ABREVIATIONS

AFD	French Agency for Development
AICZM	Alexandria Integrated Coastal Zone Management
ALAMIM	Alexandria Lake Mariout Integrated Management
ASDCO	Alexandria Sanitary Drainage Company
B.C.	Before Christ
BOD	Biological Oxygen Demand
BP	Best Practice
CAA	Competent Administrative Authority
CEDARE	The Center for Environment and Development for the Arab Region and Europe
CEO	Chief Executive Officer
cm	Centimetre
COD	Chemical Oxygen Demand
Cr	Chrome
Cu	Copper
CW	Constructed Wetland
CZM	Coastal Zone Management
DO	Dissolved Oxygen
DRI	Drainage Research Institute
EA	Environmental Assessment
EEAA	the Egyptian Environmental Affairs Agency
EGP	Egyptian Pound
EIA	Environmental Impact Assessment
EIB	European Investment Bank
ESMP	Environmental and Social Management Plan
EMU	Environmental Management Unit
EPAP	Egypt Pollution Abatement Project
ESIA	Environmental and Social Impact Assessment
ETP	East Waste Water Treatment Plant
FRP	Fiber Reinforced Polymer
GAFRD	General Authority for Fish Resources Development
GDCZM	General Directory for Coastal Zone Management
GEF	Global Environment Facility
GOE	Government of Egypt
HP	Horse Power
HRT	Hydraulic Retention Time
ICZM	Integrated Coastal Zone Management
IWLEARN	International Waters Learning Exchange and Resource Network
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
Kg	Kilogram

Km	Kilo Meter
Km2	Square kilometre
kW	Kilo Watt
kWh	Kilo Watt hour
M	Meter
M&E	Monitoring and Evaluation
M3	Cubic meter
M3/d	Cubic meters per day
MALR	Ministry of Agriculture and Land Reclamation
MAP	Mediterranean Action Plan
Mg/l	Milligram per liter
mm	Millimetre
MSEA	Ministry of State for Environmental Affairs
MWRI	Ministry of Water Resources and Irrigation
N	Nitrogen
NCICZM	National Committee for Integrated Coastal Zone Management
NGO	Non Governmental Organisation
NH4	Ammonia
Ni	Nickel
NO3	Nitrates
O2	Oxygen
OP	Operation Policy
P	Phosphorous
Pb	Lead
PIT	Project Implementation Team
PM10	Particulate Matter
PMU	Project Management Unit
ppm	Part per million
PRP	Pollution Reduction Project
PRP	Pollution Reduction Project
PSC	Project Steering Committee
PWG	Project Working Group
Qrt	Quarter
RBO	Regional Branch Office
RPF	Resettlement Policy Framework
Sec	Second
SFD	Social Fund for Development
SMAP	Short and Medium term priority environmental Action Program
T	Ton
TSS	Total Suspended Solids
UNEP	United Nations Environment Programme
US$	United States Dollar

WB	The World Bank
WTP	West Waste Water Treatment Plant
WWTP	Waste Water Treatment Plant
Zn	Zinc

CHAPTER 1 BACKGROUND

Introduction

The countries of the Mediterranean Sea basin face a variety of shared environmental problems that are trans-boundary in nature. The coastal areas around the Mediterranean are heavily populated and are undergoing a dramatic process of development.

In 2003 the Mediterranean countries adopted the Strategic Action Program for the Conservation of Mediterranean Marine and Coastal Biological Diversity that identifies priority actions and targets to protect fragile ecosystems and reduce damage to natural habitats.

Degradation of water quality due to land-based pollution is a major problem in the Mediterranean coastal areas. The Strategic Action Plan for the Mediterranean[1] has identified several “hot spots and sensitive areas” on the northern coast of Egypt, which for several decades have been experiencing a continuous increase in population, development, and environmental degradation. Two of these “hot spots” are located in Alexandria, namely El-Mex Bay and Abu-Qir Bay

The Government of Egypt, represented by the Egyptian Environmental Affairs Agency (EEAA) is currently preparing the Alexandria Integrated Coastal Zone Management Project (AICZM) which has the following main objectives:

a. to supply a strategic framework and immediate small- scale investments to reduce the load of land- based sources of pollution entering the Mediterranean Sea in the hot spots" of El Mex Bay and Lake Mariout; and
b. to protect/restore globally significant coastal heritage and ecosystem processes by supporting the Government of Egypt's efforts to develop and implement a National Coastal Zone Management Plan.

This proposed project is developed with assistance from the World Bank (through a grant from the Global Environment Facility (GEF)), which continues to provide support to the Government of Egypt for improving its environmental management capabilities and to demonstrate the value added of an integrated and participatory approach to coastal zone management for sustainable development. The project is partially blended with the ongoing Second Egypt Pollution Abatement Project (EPAP II) implemented by the Egyptian Environmental Affairs Agency (EEAA), with the aim of reducing industrial pollution in two hot spots in Egypt, namely Alexandria (primarily Lake Mariout) and Greater Cairo. The proposed project builds upon the successful collaboration both in terms of policy work and project investments (EPAP I and EPAP II) over the past several years, based on a comprehensive approach linking technical, environmental, social and economic considerations.

Purpose of the Report

The Alexandria Coastal Zone Management project is expected to have important positive environmental impacts with the objective of contributing to a reduction in the load of land-based sources of pollution entering the Mediterranean Sea, especially from Lake Mariout, through the hot

[1] The Mediterranean countries have also worked together to set priorities related to these transboundary problems and have jointly agreed on what interventions are needed to address such priorities through two Strategic Action Programs (SAPs): (a) The Strategic Action Program to Address Pollution from Land-Based Activities (SAP MED); and (b) The Strategic Action Program for the Conservation of Mediterranean Marine and Coastal Biological Diversity (SAP BIO). The two Strategic Action Programs are aimed at: (i) reducing land-based sources of marine pollution (SAP-MED) and (ii) protecting the biodiversity and living resources of the Mediterranean, as well as their habitats (SAP-BIO).

spots of El-Mex Bay and Alexandria. Accordingly, the project is classified as an environmental Category B according to both EEAA guidelines and the World Bank's Operation Policy on Environmental Assessment (OP 4.01), requiring Environmental Screening Form (B) or partial assessment prior to construction activities respectively.

The project activities will not cause conversion or degradation of natural habitats and there will not be a need for any mitigation measures as anticipated project activities will not lead to adverse impacts towards natural habitats. On the contrary, project activities are expected to result in an improvement in biodiversity conservation in the lake ecosystem. However, scope of assessment of natural habitats will be covered as part of the environmental assessment process discussed in this report.

The main purpose of this ESIA is to investigate potential impacts of the proposed main intervention projects on both the environment as well as the community living around near Lake Mariout.

Rationale of the Proposed Project

The city of Alexandria lies on the southern Mediterranean cost with a population of about 4 million inhabitants. It occupies an area of about 300 square km, with an increasing demand for new land for development, including planned development of vacant land around Lake Mariout.

Lake Mariout is now considered a major source of pollution to the Mediterranean Sea through El Mex Bay... It is one of the major sources of conveyance of land based pollution to the El-Mex Bay. The Lake has no direct connection to the sea and its surface is maintained at 2.8 m below mean sea level by pumping water from the lake to the Mediterranean Sea at El-Mex Bay. The Lake Mariout receives polluted water from three major sources on a daily basis:

- Industrial effluents: Various industries discharge directly their effluents into the Lake or El Mex Bay. The pollutants brought by the industries include high Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) and heavy metals.

- Domestic effluents: Two wastewater treatment plants discharge their primary treated effluents into the Lake Mariout. The total discharge of primary treated sewage is about 916,000m3/day. The East Waste Water Treatment Plant (ETP) releases effluents into Dayer-El-Matar drain which then empties into the Lake. Additionally, Lake Mariout receives effluent that is discharged directly from the West Waste Water Treatment Plant (WTP).

- Drainage water from agriculture: The Lake receives an important part of agricultural drainage water coming from secondary drains and agricultural activities upstream, bringing pesticides, nutrients (phosphate, nitrogen compounds, sulphate, etc) along with organic matter from animal farming and domestic wastewater of nearby villages.

As a consequence of the environmental degradation, sewage and industrial wastewater, in addition to the inflow of nutrient-rich agricultural drainage water, Lake Mariout has changed from being the most productive fisheries resource of the four major Egyptian brackish water lakes, to the least productive in a couple of decades.

The proposed project will use a *two pronged approach* to sustainable coastal zone management including the use of institutional strengthening measures and pollution reduction interventions. The project will also pilot innovative and low-cost technologies for pollution reduction originating from agricultural drainage water and rural domestic wastewater, partially responsible for the severe eutrophication problem in the Lake basins. The project will complement other on-going projects,

each addressing a different source of pollution. The other set of interventions include the EPAPII sub-projects on industrial pollution and the Government upgrade of the East and West Waste Water Treatment Plants for domestic pollution as part of the Alexandria City Development Strategy. The project will thus treat more diffuse non-point sources of pollution originating from rural and agricultural areas while the other interventions target point source pollution.

Given the scale of the environmental degradation in Alexandria, the project in itself may only contribute marginally to the reduction of pollution ultimately entering the Mediterranean Sea. However, its main advantage and value added reside in its catalytic function to trigger consensus building, awareness raising and institutional strengthening on sustainable coastal management using pilot investment interventions as a platform to bring all stakeholders closer on the issue[2]. The project will address the continued fragmented approach to coastal zone management in and around Alexandria area and the lack of consensus around the future of the lake by consulting a wide range of stakeholders with conflicting interests and supporting the mainstreaming of coastal zone management principles into land use or urban planning in Alexandria.

Scope of the ESIA

The proposed project is composed of 3 components. These are:

- Component (1), Institutional Capacity and Monitoring (US$ 1.982 million)
- Component (2): Pollution Reduction (US$ 4.625 million)
- Component (3): Project Management and Monitoring and Evaluation (US$ 0.543 million).

Since components (1) and (3) do not include any construction works or physical activities that may result in direct environmental impacts, the study will focus on component (2) with its planned interventions. However, a brief description of both components (1) and (2) will be presented,.

A pre-feasibility study for Component (2) was conducted and it included the main proposed physical interventions for dealing with the remediation of the main basin which represent the main scope of this Environmental and Social Impact Assessment. The proposed interventions are in the form of an integrated package that is composed of the following applications:

- Engineered wetland for Lake Mariout
- In-stream wetland
- In-stream biofilm
- Aeration system

This study aims to develop an Environmental impact Assessment for the main intervention, Integrated Package, with the objective of mitigation of any potential negative environmental or social impacts and preparing an Environmental and Social Management Plan (ESMP).

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[2] EEAA, MWRI, MALR and Alexandria Governorate…etc

CHAPTER 2 POLICY, LEGAL AND REGULATORY FRAMEWORK

Introduction

The Integrated Environmental and Social Assessment for the project must meet a number of policy and legal requirements associated with the environment, social issues and resettlement. The World Bank safeguard policies and the Egyptian Environmental Protection Law No. 4/1994 (amended by Law 9/2009), Law No. 48/1982 concerning the protection of River Nile, canals and drains, and detailed requirements for conducting EA as defined in Law 4/1994 have been complied with during the course of project preparation and will also be complied with during project implementation.

National Policy and Legal Mandates

Responsibilities for environmental protection in Egypt are dispersed among a number of Ministries and Governorates and can be classified in the following three categories: (a) the national environmental organization represented by the MSEA, the Egyptian Environmental Affairs Agency (EEAA) and its eight Regional Branch Offices (RBOs) which are charged with overall monitoring and regulatory coordination; (b) institutions with specific operational functions which are performed by environment units in line ministries, and by Environmental Management Units (EMUs) in the Governorates; and (c) institutions with environment support role (mostly universities and research institutes). One of the functions of the EEAA Alexandria RBO is to monitor wastes from inland Nile fleets and coastal waters.

Water quality legislation in Egypt is governed by two main Laws: Law No. 48/1982 for protection of the river Nile and waterways from pollution; and Law 4/1994 on Environmental Protection. The Law No. 48/1982 regulates the discharge of wastewater into the River Nile and other waterways whereas the Law No. 4 of 1994 on the protection of the environment constitutes the main legislative body in the field of environment to formulate the general policy and prepare the necessary plans for the protection and promotion of the environment. The Law No. 4 of 1994 provides for the use of environmental management mechanisms, which include command and control measures such as the setting of appropriate standards, the application of the polluter pays principle (through the implementation of penalties and fines) and the use of environmental impact assessments (EIAs).

Although EEAA is responsible for the environment countrywide, Law 4/1994 retained most of the enforcing authority for inland waters with the Ministry of Water Resources and Irrigation (MWRI) and the Ministry of Interior. As EEAA is responsible for inspections regarding compliance with environmental and occupational health and safety regulations, it has to manage water quality in coordination with the MWRI and the Ministry of Health and Population.
On a more local level, MWRI is responsible for controlling the water level in the lake Mariout through a balancing of the El-Mex pumping station with the influents to the lake. On the other hand, the General Authority for Fish Resources Development (GAFRD), under the Ministry of Agriculture and Land Reclamation (MALR), is responsible for the management of fish resources in the lake including aquaculture.

The Government of Egypt's program and policy on environmental management is based on:

- A strong commitment towards controlling industrial discharges, and stricter monitoring of all that may influence the quality of drinking water.
- Air pollution abatement and consistent monitoring of air pollution levels in large cities.

- Environmental impact assessment studies for all projects, and prohibition of any project that may negatively impact the environment, especially near tourism development areas and coastal zones.
- Rapid implementation and monitoring of programs, environmental laws, regulations and international environmental protection protocols and conventions.
- A program for the management of national marine coastal zones as part of the Second National Environmental Action Plan developed in 2002 and covering the period 2002-2017.
- The preparation of a national strategy on sustainable development by the National Committee on Sustainable Development established in 2006.
- The preparation of a solid waste management master plan in 2007 that estimated the cost of upgrading the current solid waste management systems, and proposed a detailed governorate-by-governorate assessment.

Concerning Coastal Zone Management in Egypt, Law No. 4/1994 for the environment (as amended by Law 9/2009) includes articles defining the coastal zones (art. 39) and the Integrated Coastal Zone Management (art. 40 & 48). Integrated management of coastal areas has been defined as “a process by which all concerned authorities participate in coordinating their work in order to preserve the environment of the coastal areas.” The amended law also assigns to the Minister of State for Environment, a coordinating role with the relevant agencies/stakeholders to achieve the water protection and integrated coastal zone management objectives. Specifically, the EEAA was given the authority to "participate with the concerned agencies and ministries in the preparation of a National Integrated Coastal Zone Management Plan for the Mediterranean Sea and Red Sea coasts". The executive regulations of the amended law are expected to establish a Governorate level Coastal Zone Management (CZM) Committee. The Alexandria CZM Committee is projected to be in place before project implementation.

With this mandate, the EEAA through its General Department for Coastal Zone Management has initiated the coordination of the Integrated Coastal Zone Management (ICZM) planning, in which the first step was to establish the National Committee for Integrated Coastal Zone Management (NCICZM). A Ministerial Decree establishing the NCICZM was issued in 1994 with subsequent amendments. The function of the Committee is not only to draw up a consistent policy and strategy for future development, but also to resolve conflicts between different users. The National Committee includes top rank representatives of all concerned ministries, NGOs and major stakeholders.

On a local level, in conformity with Law no. 124 of 1983, the General Authority for Fish Resources Development established the Lake Mariout Development Committee. The tasks of the Committee are to plan, supervise and implement development programs for the Lake and to make field visits to the Lake to detect any violation. Due to its limited mandate, membership and representation, its role has been limited to regulate fish catch, develop fish production and protect the interests of the fishermen community. It includes members from Universities, NGOs, research centers, Alexandria governorate local council, General Organization for Sanitary Drainage, EEAA and fishermen association.

World Bank Requirements

World Bank requirements for ESIA’s are laid down in the Operational Policy for Environmental Assessment (OP 4.01). Further guidelines are presented in the Environmental Assessment

Sourcebook (1991) and updates thereof. Other relevant standards that would potentially be applicable are shown in the following table.

Table 1: World Bank Safeguard Operational Policies and their applicability to AICZM

No.	Policy	Policy triggered	Justification
1	OP 4.01 Environmental Assessment	Yes	The project is classified as an environmental Category B requiring partial assessment All environmental and social impacts of AICZM are adequately examined AICZM will have significant positive impact on the Lake Mariout and Mex Bay AICZM is not likely to have significant negative environmental impacts on its area of influence
2	OP 4.12: Involuntary Resettlement	No	Resettlement is not expected from any of the project activities. No land take is anticipated and no potential restriction of access to socio-economic resources is foreseen from Component (2), as no fishing is practiced in Qalaa drain nor in the area designated for the in-Lake wetland since it is most polluted and avoided by fishermen. Impact from Component (1) is also nonexistent, as the implementation of the plan itself is beyond the scope/duration of the project. Furthermore, a set of checks and balances is built into project design, including: (i) representation of civil societies organization in the National Committee on Coastal Zone Management, as well as in the Project Steering Committee; and the plan to hold public consultation workshops during the preparation of the coastal zone management plan.
3	OP 4.11: Cultural Property	No	None of the interventions will affect any known archaeological sites.
4	OP 4.20: Indigenous People	No	No indigenous people are present in project areas
5	OP 4.09: Pest Management	No	AICZM will not affect pest management by any way

No.	Policy	Policy triggered	Justification
6	OP 4.04: Natural Habitats	No	The project activities will not cause conversion or degradation of natural habitats. There will not be a need for any mitigation measures as anticipated project activities will not lead to adverse impacts towards natural habitats. On the contrary, project activities are expected to result in an improvement in biodiversity conservation in the lake ecosystem. As the project is expected to have a positive impact with regards to natural habitats, the policy is triggered. However, scope of assessment of natural habitats will be covered as part of the environmental assessment process.
7	OP 4.36: Forestry	No	No forest areas exist
8	OP 4.37: Safety of Dams	No	AICZM does not involve construction of dams, and not depending on any dams
9	OP 7.50: Projects on International Waterways	No	This is applicable to water bodies that form a boundary between two states or any other water body that is a part of these boundary water bodies. OP 7.50 is not applicable to this project.
10	OP 7.60: Projects in Disputed Areas	No	This policy introduces specific requirements for loans in areas disputed by more than one country. This is not applicable to the AICZM.

EEAA Requirements

The EEAA sets guidelines for Environmental Impact Assessments, reviews EIA for different activities and recommends approval / refusal of the proposed projects as part of the licensing procedures for any new activity or development. An EIA is required as part of the licensing procedures for any new project or expansion of existing activities. The EEAA classifies projects into three categories:

- Category A projects likely to have minor environmental impact. The developer applies to the CAA before construction works are initiated with an Environmental Screening Form "A".
- Category B projects that may result in significant environmental impact. The developer applies to the CAA before construction works are initiated with an Environmental Screening Form "B".
- Category C projects requiring complete EIA due to their potential impacts.

The Environmental law No.4 of 1994 (amended by Law 9/2009) and its Executive Regulations No. 338 of 1995 (currently being amended) provides that the new projects as well as the expansion of existing facilities shall assess the environmental impact statement before issuing them.

The competent administrative bodies or the donor's permission send a copy of the environmental impact assessment report to EEAA for an opinion and put proposals to be implemented during the project establishment.

EEAA must report to the competent administrative authority or the donor of the license in this assessment during a maximum period of 30 days from the date of receipt of report, it is considered that not to respond is approval of the assessment.

Relevant legislation to the project activities

There are many laws, regulations and decisions related to the project either during the construction phase or during the operation, the relevant international laws has also been revised depending on models for environmental impact assessment of EEAA.

National Environmental legislation

- Environmental law No. 4 of 1994 that amended by Law No. 9 of 2009
- The Executive Regulations stated by Prime Minister Decree No. 338 of 1995, and amended by decree No.1741/2005
- Law 102 of 1983 States the requirements for management of natural protectorates
- Law 124 of 1983 about the marine life
- Law 48 of 1982 for the protection of the Nile River and its tributaries and groundwater pollution
- Law 93 of 1962, amended by the Minister of Housing Decree 44/2000; sets limits for reuse of treated wastewater in agricultural purposes and Sets limits for effluent discharges to the public sewer.
- Law 57 of 1978, Minister of Housing Decree No.206/1979 Concerning eliminating ponds and pits.
- Law 12 of 2003 for the protection of workers and occupational safety and health of workers amending Act 137 for the year 1981 and its implementing decisions.
- Decision of the Head of State in the protection of the air pollution from the Ministry of Health No. 864 of 1969
- Guideline to basics and procedures of environmental impact assessment issued by the EEAA in the second edition in January 2009 and contains a model for the evaluation of environmental projects
- Environmental impact assessment guidelines for urban development projects issued by EEAA in January 2005

Institutional framework and Management Arrangements

Partnership Arrangements

The project will be implemented as part of the GEF-World Bank-UNEP Strategic Partnership for the Mediterranean Sea Large Marine Ecosystem (LME), which will support capital investments, economic instruments, implementation of policy reforms, and strengthening of public institutions and public participation. This Partnership will be accomplished through two complimentary components: the Regional Technical Assistance project or Regional Component, implemented by UNEP and executed by the Mediterranean Action Plan (MAP), its regional centers, and various partners (FAO, GWP, UNESCO, UNIDO, WWF), and the investment Fund managed by the World Bank. The project will cooperate with the UNEP Regional Component of the Partnership to enhance awareness and replication, given that the Director of the CZM Department in EEAA is the focal point for the PAP/RAC-MAP in Egypt.

Several donors are active in supporting environmental projects in Egypt. In fact, EPAP II project, with which this proposed project is partially blended, is a multi-donor project with contribution from the European Investment Bank (EIB), the Japan Bank for International Cooperation (JBIC, currently JICA), the French Agency for Development (AFD), with technical assistance provided, in part, by the Government of Finland. The Bank's team is in constant contact with the donors active in the sector to ensure that there is a common understanding and agreement as to the measures that are needed to improve the coordination related to coastal zone management. In addition, the Bank has established a close relationship with the Center for Environment and Development for the Arab Region and Europe (CEDARE) as the project builds on the Alexandria Lake Mariout Integrated Management project (ALAMIM) funded under the EU SMAP III (Short and Medium term priority environmental Action Program). The ALAMIM project is implemented by CEDARE and aims to promote the integrated development of the Lake Mariout and its activities.

Institutional and implementation arrangements

The ***EEAA*** is the agency responsible for overall project implementation. Together with the Governorate of Alexandria, the EEAA will also lead the coordination work with other implementing agencies, including the MWRI and the MALR. The institutional arrangements have been designed to ensure a multi-sector and participatory approach to sustainable Coastal Zone Management and to build on the technical expertise and comparative advantage of the different agencies. Synergies and cross-fertilization with the EPAP II PMU staff at EEAA will be ensured.

A number of steps have been included in project design to address potential conflicts from project interventions. These measures include the participation of the Lake Mariout Development Committee in the Project Steering Committee and the assignment of a social specialist and an environmental specialist in the EEAA PMU to review and monitor the social and environmental safeguards. The management (and assets) of the investment component will be transferred from the EEAA to the relevant agency/ministry after project completion to ensure long-term sustainability. To that effect, an inter-agency agreement was prepared and will have to be signed between EEAA and each of the relevant implementing agencies as a condition of effectiveness.

The proposed implementation arrangements are as follows:

A ***Project Management Unit*** (PMU) for the proposed project will be put in place. In order to build on the significant expertise gained in EEAA from the implementation of the EPAPI and EPAPII, the Director of the PMU for EPAP II in EEAA will serve as the PMU Director for the proposed project. However, given that the EPAPII is still under implementation, the PMU will be reinforced by hiring three new staff: (i) a technical manager: (ii) a financial manager; and (iii) a procurement specialist. This will ensure that the GEF project PMU can continue to oversee the project implementation, even after the EPAP II closure date in 2012. In order to draw on the experience accumulated by EEAA in the area of sustainable coastal zones management, the project will be technically anchored in the General Department for Coastal Zone Management in EEAA. The head of the General Department will ultimately be responsible for the technical aspects related to CZM and in particular for the preparation of the Alexandria CZM plan. The technical staff in the PMU will also include staff from the Alexandria EEAA RBO who will have a significant role in overseeing the monitoring of the water quality in the El-Mex bay as well as progress related to the project interventions. In order to reflect the interests of all stakeholders in the proposed interventions, the PMU will contract and pay out of the project funds (i) a Social specialist, (ii) a M&E specialist and (iii) a Communication specialist on a part-time or task basis. The PMU will have the overall technical and fiduciary responsibility of the project. The PMU will be responsible for the preparation of tender documents, receiving and evaluating bids, managing contracts, supervising works and consultants, and prepare progress reports.

Project Working Groups (PWG) will be formed in each implementing agencies (MWRI and MALR). The PMU will work with a relevant agency to coordinate the implementation of the project's interventions, the MWRI for the in-stream biofilm and in-stream aerators, and the Ministry of Agriculture and Land Reclamation for in-lake wetland and reed removal (Component 2 of the project). These working groups will include technical specialists from the relevant Ministries in order to ensure ownership during project implementation and sustainability of the interventions upon project completion. The implementing agencies will ultimately be responsible for the preparation of the technical specifications of the bidding documentation together with the PMU Procurement specialist as well as the evaluation, contracting, construction supervision and reporting tasks. The technical specialists from the implementing agencies will be financed and appointed by the relevant Ministries.
The management of the investment infrastructure will be transferred from EEAA to the relevant agency/ministry after project completion. Close coordination with the Governorate of Alexandria is essential as the Governorate will facilitate the provision of information and data related to the fulfilment of the project outputs and provide feedback on the annual work plans and progress reports.

A ***Project Steering Committee*** (PSC) will be established to provide oversight and direction to the project including the Annual Work Plans. The PSC will include representatives of all agencies involved in implementation directly or which have a legal stake in project outcomes or implementation including EEAA; the Governorate of Alexandria; the MWRI: the MALR; a member of the Lake Mariout Development Committee which represents the interest of the fishermen community; and a member from the civil society organizations. The PMU Director, the representative of the Alexandria RBO and the PMU CZM Technical Manager will represent EEAA in the PSC. The Committee will be chaired by the CEO of EEAA. The PSC will meet quarterly to review progress and propose any remedial actions if necessary.

The ***National Committee for Integrated Coastal Zone Management*** will provide scientific advice and inputs into the preparation of the Alexandria Coastal Zone Management Plan serving as a scientific and advisory body in particular for Component (1) during the preparation stage. The Committee will approve and adopt the final version of the Alexandria ICZM Plan upon receipt of a draft by the PSC. The Committee may also provide scientific and advisory inputs on any aspects of the project components if requested by the PSC.

The Operations Manual and the Inter-Agency Agreement between the EEAA and the relevant agencies spell out the implementation arrangements and roles and responsibilities of each agency.

International and regional environmental legislation

The Egyptian Government has ratified multilateral environmental agreements on biodiversity and natural resources, oceans and seas, hazardous materials and chemicals, atmosphere and air pollution, and health and workers safety. The following list provides the multilateral agreements relevant to the project activities:

- The convention for the protection of the Mediterranean Sea against pollution(Barcelona) and its amendments and protocol regarding pollution from land-based sources which lists the substances of which discharge is prohibited, and the factors which should be taken into account in order to eliminate pollution from these substances. It also lists substances for which discharge is subject to authorization by the competent national authorities. This authorization must take particular account of the characteristics and composition of the waste, the characteristics of the elements in the waste in terms of harmfulness, the characteristics of the place where the waste is discharged and the marine environment it is

entering, the techniques available to manage the waste, as well as possible damage to marine ecosystems and its effect on sea water usage.

- Convention on Wetlands of International Importance Especially as Water Fowl Habitat (RAMSAR 1971)
- Convention Relative to the Preservation of Fauna and Flora in their Natural State
- International Plant Protection Convention
- African Convention on the Conservation of Nature and Natural Resources
- Protocol to Amend the Convention on Wetlands of International Importance Especially as Water Fowl Habitat
- Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn 1983)
- Convention on Biological Diversity (1992)
- Convention Concerning the Protection of the World Cultural and Natural Heritage
- Protocol Concerning Mediterranean Specially Protected Areas
- Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean
- United Nations Convention on the Law of the Sea
- Agreement Relating to the Implementation of Part XI of the United Nations Conventions on the Law of the Sea of 10 December 1982
- Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters (Paris, 1974)
- Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972
- Convention Concerning Prevention and Control of Occupational Hazards Caused by Carcinogenic Substances and Agents
- Protocol on the Prevention of Pollution of the Mediterranean Sea by Trans boundary movements of Hazardous Wastes and their Disposal
- Basel Convention on the Control of Trans boundary movements of Hazardous Wastes and Their Disposal
- Amendment to the Basel Convention on the Control of Trans boundary movements of Hazardous Wastes and Their Disposal
- Bamako Convention on the Ban of the Import into Africa and the Control of Trans boundary Movement and Management of Hazardous Wastes within Africa
- Stockholm Convention on Persistent Organic Pollutants (POPs)

CHAPTER 3 PROJECT DESCRIPTION

Introduction

As mentioned earlier, the proposed project will complement other on-going projects, each addressing a different source of pollution. The other set of interventions include the EPAPII sub-projects on industrial pollution and the Government upgrade of the East and West Waste Water Treatment Plants for domestic pollution. The proposed project will therefore focus on treating non-point sources of pollution originating mainly from rural and agricultural areas while the other interventions target point source pollution as shown in the figure below.

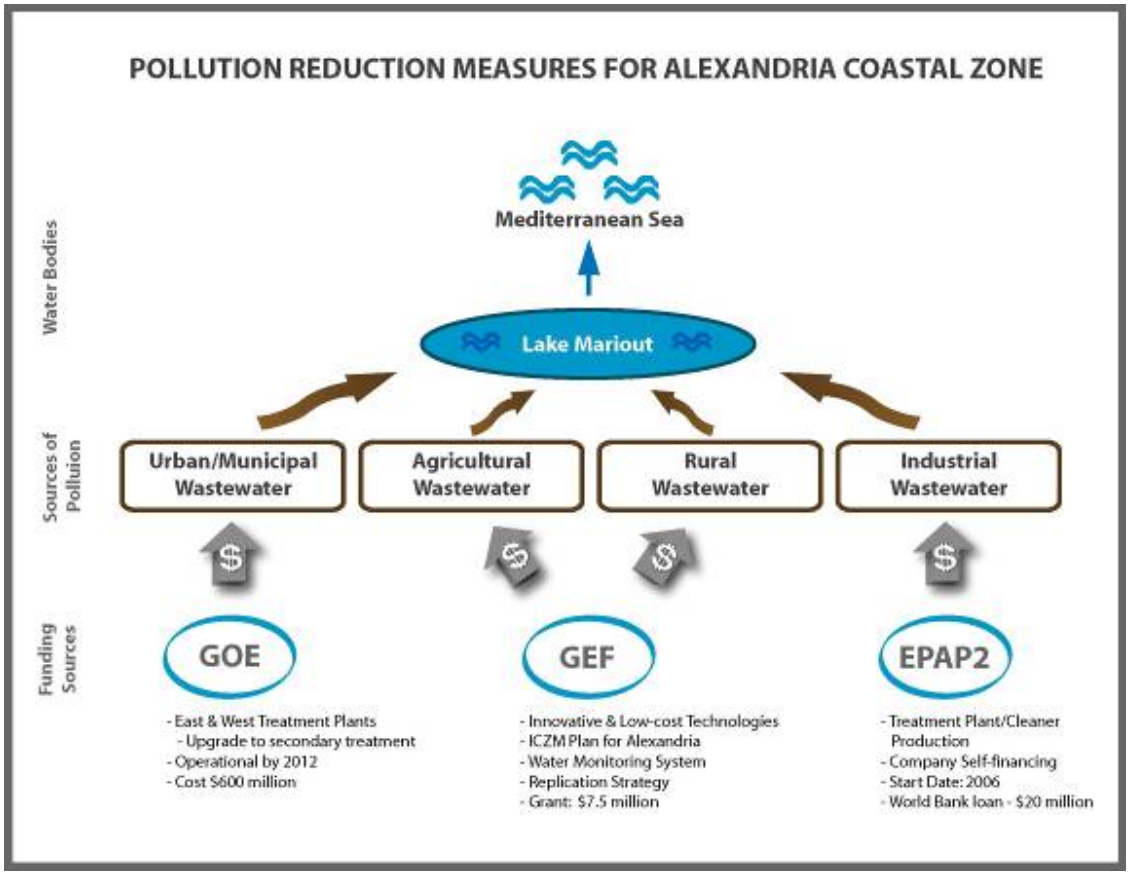


Figure 1: Complementarities of the proposed project with other on-going activities

Project Objectives

The Alexandria Coastal Zone Management project is expected to have important and positive environmental impacts with an objective of contributing to a reduction in the load of land-based sources of pollution entering the Mediterranean Sea, especially from Lake Mariout, through the hot spots of El-Mex Bay and Alexandria. The project will develop a master plan for the management of coastal zones of Alexandria including Lake Mariout, and through the implementation of innovative pilot-level low-cost investments in pollution reduction. Accordingly, it is not expected that significant impacts would be generated through the implementation of the project.

The main objective of the project is to improve the institutional mechanisms for sustainable coastal zone management in Alexandria in particular to reduce land-based pollution to the Mediterranean Sea.

The proposed key outcome indicators of success are:

- The ICZM plan is officially adopted and the institutional mechanisms for implementation are successfully implemented;
- The pollution load entering the Mediterranean Sea through Lake Mariout is reduced by at least 5%.

Project components

Component (1): Planning, Institutional Capacity and Monitoring

This component is intended to help increase the institutional capacity of the relevant agencies involved in the management of Lake Mariout, in particular, and the coastal zone in Alexandria, in general. These agencies include all those responsible for the direct implementation of the project, i.e the EEAA, the Governorate of Alexandria, the MWRI, the MALR and the Lake Mariout Development Committee. The integrated management of this vital resource is contingent upon:

(i) Identifying the roles and responsibilities of the various stakeholders, through compiling available studies, assessing the needs and capabilities of each of these stakeholders, through focus group surveys and building consensus amongst those stakeholders, through stakeholder consultation workshops.

(ii) Developing a management plan for the Lake that takes into account the interests of the various groups in an integrated manner, and studying the impact of various scenarios through a water quality and hydraulic modelling of the lake and the various possible activities.

(iii) Raising the capacity of the various stakeholders toward the optimal management of the Lake, through training workshops and ICZM study tour for a representative group (a six-day study tour for 10 participants).

(iv) Ensuring the sustainability of the developed ACZM Plan through providing the main players (EEAA, Alexandria RBO, and Alexandria Governorate) with the tools required to achieve this goal, in terms of maps, GIS capabilities, computers and printers/plotters, water quality monitoring equipment, and water quality management and data analysis software.

The expected outcome is an increased capacity by the various relevant entities to manage the coastal zones in and around Alexandria in an integrated, participatory and sustainable manner, including planning, consensus building, and monitoring. The outputs for this component will include:

(i) a master plan for the management of the coastal zones of Alexandria including Lake Mariout (the “Alexandria Coastal Zone Management (ACZM) Plan”), and

(ii) the development of a water quality monitoring network to assess impact of project interventions including a modeling activity for El-Mex bay, which can be used to estimate the overall project impact on the Mediterranean..

The recommendations of the ACZM Plan will be reflected in the future land use plan for the city of Alexandria. The Project Management Unit will prepare drafts of the ACZM Plan which will be reviewed by the Project Steering Committee. The final draft will be approved by the National

Committee on ICZM and a Ministerial decree will be issued to officially adopt it. This component will finance:

a) consultancy services including public consultation workshops and master plan dissemination and
b) procurement of goods (computers, printers, water monitoring equipment, etc.).

This component will be implemented by the EEAA in close collaboration with the Governorate of Alexandria.

The overall objectives of the ACZM Plan to be developed under this component shall be guided by the on-going activities in Egypt related to coastal zone management as well as the principles of the Barcelona Convention Protocol on Integrated Coastal Zone Management for the riparian Mediterranean countries to which Egypt is committed. Under Article 5 of the Barcelona Convention, the objectives of integrated coastal zone management are to:

(a) facilitate, through the rational planning of activities, the sustainable development of coastal zones by ensuring that the environment and landscapes are taken into comment in harmony with economic, social and cultural development;

(b) preserve coastal zones for the benefit of current and future generations;

(c) ensure the sustainable use of natural resources, particularly with regard to water use;

(d) ensure preservation of the integrity of coastal ecosystems, landscapes and geomorphology;

(e) prevent and/or reduce the effects of natural hazards and in particular of climate change, which can be induced by natural or human activities;

(f) achieve coherence between public and private initiatives and between al decisions by the public authorities, at the national, regional and local levels, which affect the use of the coastal zone.

It may be difficult at this early stage to foresee with great detail what the ACZM Plan would entail, especially in the face of the complex institutional and administrative landscape related to lake management in Egypt. Nonetheless, deriving from international experiences in the development of similar plans, a CZM plan would typically include sections covering the following key areas:

(i) the legislative framework and the overall regional and national contexts within which the plan is developed,

(ii) an overview of the overall coastal zone management program in the area,

(iii) definition of the coastal zone boundary and a description of key activities influencing the development of the coastal zone,

(iv) institutional measures, guidelines and standards that govern the decision making related to development in the coastal zone (this could be divided into several sub-sections covering the relevant issues, such as water quality, marine ecology, wetlands, aquaculture, archaeology, data management, public awareness & dissemination…etc),

(v) description of the implementation arrangements including the assignment of roles and responsibilities for the implementation and monitoring of a set of short, medium, and long term measures, and

(vi) an overview of the key agencies and stakeholders involved and their relevance to the implementation of the plan.

Component (2): Pollution Reduction.

The expected outcome is a reduction in the land-based source of pollution entering the Lake Mariout and subsequently the Mediterranean Sea through pilot pollution reduction measures. This will entail the implementation of a package of pollution reduction measures, to be implemented on **a pilot basis**, to reduce the pollution load entering the Lake Mariout, especially the nutrients (Nitrogen and Phosphorous), as well as the oxygen depleting substances, such as the biological oxygen demand (BOD) and the chemical oxygen demand (COD). This will, in turn, reduce the pollution load entering into the Mediterranean from the Lake water through El-Mex pumping station.

It should be emphasized that the proposed project is complimentary to other on-going projects, each addressing a different source of pollution (e.g. East & West Sewerage Treatment Plants; Innovative and low costs technologies under the ICZM Plan for Alexandria; and EPAP II project.

The interventions considered to achieve the desired results fall under four major groups, namely:

1. Increasing DO level in the Qalaa Drain (the agricultural drain is mostly responsible for the BOD, COD, and nutrient load to Lake Mariout) through installation of a set of aerators in the Qalaa drains aeration.
2. Use of in-stream Bio-film for pollutant treatment in Qalaa Drain
3. a small scale engineered in-lake wetland located at the outfall of the Qalaa drain over 30 feddans[3] as minimum area required for this application
4. reed removal in the lake to improve water circulation and self-cleaning capacity of the Lake.

This package is expected to bring a reduction of approximately 15 % of the COD load currently reaching the El Mex Bay. The proposed package, when added to the implementation of the upgrading projects of Alexandria WWTPs could make this reduction reach 50% of the current load. The presence of the biofilm is likely to avail nitrogen in the form usable by the duckweeds, and will afford to clear reeds in selected channels in the basin (selected based on hydrodynamic modelling). The reduction of load resulting from the upgrading of the East Wastewater Treatment Plant could make the final effluent from the Qalaa drain of reasonable quality (less than 50 mg/l), and a higher conversion of NH4 to NOs.

At least a similar improvement is expected in terms of BOD reduction. Since the base information concerning the nutrients reaching the bay is not consistent, it was not possible to estimate the percentage reduction of nutrients reaching the bay. It should be noted that this level of reduction of COD/BOD in the effluent to El-Mex Bay and the partial recovery of the Lake's ecosystem, brings Egypt substantially closer to achieving its regional commitments concerning discharges to the Mediterranean.

Further discussion of the applied technologies under this component will follow.

Planned Interventions under Component 2

In this section, the proposed interventions under component 2 are described. It has to be noted that further studies will be conducted to refine these interventions however given the pre-feasibility studies conducted earlier, it has been concluded that the proposed interventions should be adequate to achieve the desired outputs within the overall project objectives if implemented in an **integrated package approach.**

The proposed package is composed of 4-intervention applications:

1. In-Lake Wetland

[3] [3] 1 feddan = 4200 square meters

2. In-Stream Biofilm
3. In-Stream aeration
4. Reeds removal

This integrated package represents a total approach to the pollution carried by the Qalaa drain including COD/BOD and nutrients, as well as the larger scope of improving the basin's sediments.

The package of interventions is designed to use the nutrients conveyed by the Qalaa drain and valorise them in a marketable product (1.25 ton/day NH4-N, and 2.29 ton/day NO3-N). Though nutritive salts will not be eliminated fully, with the change in conditions, they will benefit of phytoplankton rather than hydrophytes, helping the lake to recover its ecosystem, and gradually improve the assimilative capacity of the lake.

The expected reduction in COD load of the interventions in the Qalaa stream would be of 50%, out of a base load of 98 tons/day. Based on a total load of 315 tons/day received by the basin, the total load will decrease to 266 tons/day, and the expected reduction represents approximately 15% of the total load. The COD load reaching the Mex bay through the pumping station will be of 189 tons/day. This will represent a reduction of 15 % of the COD load currently reaching the bay (224 tons/day).

The reduction in COD/BOD load and the diversion of nutrients from the lake, together with the improved water circulation in the lake resulting from reed removal will have a positive impact on the Lake's Biodiversity. It will permit endemic biota to begin to occupy its niche within the Lake's ecosystem.

In addition, this will improve the assimilative capacity of the lake by at least 25 % in a short term basis (or 36% as opposed to the current 29%) As the situation improves, this improvement could reach more than 50 %. The Lake's assimilative capacity could thus reach 43%. in the near future. An average increase of the self-cleaning capacity to 40% will mean that the effluents to the bay through the Mex pumping station will be of 160 tons per day or almost 70% of the load currently reaching the bay.

The following is a description of each intervention independently.

Intervention 1: In-Lake Wetland

Theory:

Natural processes have always cleansed water as it flowed through rivers, lakes, streams, and wetlands. Enhanced lagoon systems actively promote natural aquatic processes. They have the capability to convert waste nutrients into benign and easily harvested forms. They can provide efficient, consistent and economical wastewater treatment with the added potential for resource recovery. The availability of low-cost land allow a more extensive, low-energy treatment processes can be, especially for final treatment of effluent, and provide a cost-effective alternative to capital intensive treatment plants.

Engineered wetlands are now used to improve the quality of point and non-point sources of water pollution, including storm water runoff, domestic wastewater, agricultural wastewater, and coal mine drainage. For some wastewaters, engineered wetlands could provide a stand-alone treatment. For others, they are one component in a sequence of treatment processes. In such case, similar to the case in hand, engineered wetlands follow primary or secondary domestic sewage effluent.

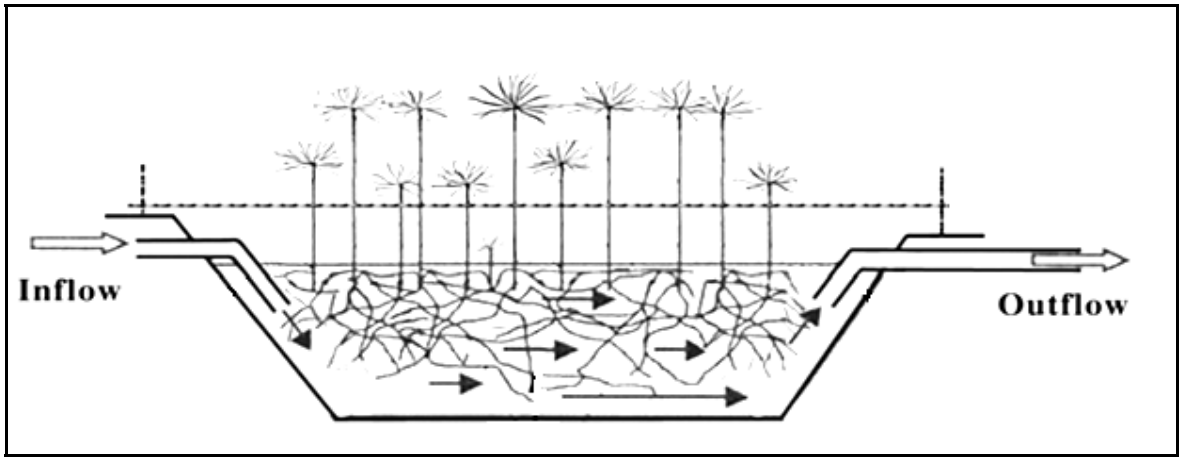


Figure 2: Schematic of a substrate-free CW with horizontal surface flow

The incorporation of aquaculture into wastewater treatment to reclaim nutrients and release clean effluent has proved successful in many parts of the world. Purification levels have reached those attained by the best alternative treatment methods.

Selected Location for the In-Lake Wetland:
The Main Basin (originally 6000 feddan) has the lowest water quality indices as shown in the Tables below. It has the lowest dissolved oxygen (1.3 mg/l), the highest Sulphides content (5.93 mg/l). It has been dissected by roads, canals and land reclamation. This situation decreased the basin surface area, impacted the water circulation and created stagnation in many locations.

Table 2: Water quality indices of the various basins of Lake Mariout (Helmy, 2005).

Site	pH	Salinity mg/l	Turbidity TU	COD mg/l	DO mg/l	N03-N ppm	N02-N ppm	Sulphides mg/l
Main	7.5	292	0.76	51.11	1.3	12.55	0.07	5.93
Northwest	7.9	713	0.35	180.2	4.2	22.67	0.28	3.2
Fishery	7.9	833	0.35	45.83	5	27.1	1.68	3.6
Southwest	7.5	820	0.25	295.8	4.9	0.25	1.2	1.2

The Main Basin also receives three major sources of pollution. The Alexandria West Wastewater Treatment Plants (WWTP, an overloaded primary treatment plant) discharges its effluent in the Northern part of the lake. From the South it receives effluent from the Omoum Drain (Agriculture Drain) that continues almost uninterrupted till the Mex Pump Station. In the Southern Eastern side, comes the Qalaa drain (agriculture drain) that receives the effluent of Alexandria East Wastewater Treatment Plant (EWTP, an overloaded primary treatment plant), see Figure 3.

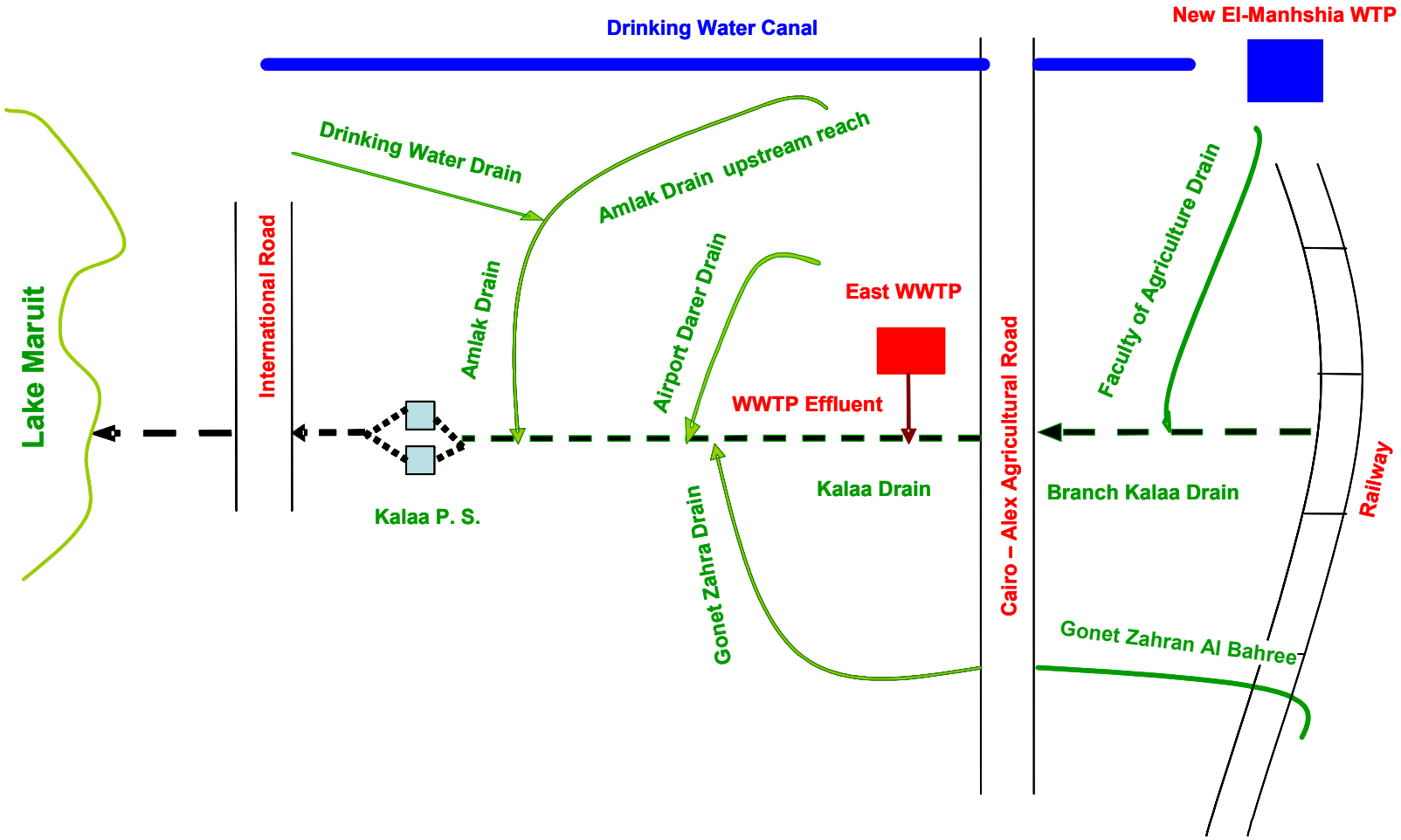


Figure 3: Sketch of Qalaa Drain System

The north-western side of the main basin, where the Mex Pump Station is located, is in much better shape because of the better water quality of influents reaching it, Omoum Drain and seepage from Nubaria Canal and because of a higher water circulation, as opposed to the eastern part suffering from stagnation.

The Southern-Eastern part of the main basin suffers from high load of BOD, COD, TSS and nutrients. Although the discharge at this point ranges from 900,000to 1,300,000m^3/day depending on the source of data, stagnation in addition to pollutants gave the chance to hydrophytes to invade this part of the lake, which magnify stagnation.

Based on the previously mentioned facts, the most suitable location for the engineering wetland has been selected to be the East-Southern part of the lake at the outfall of El-Qalaa drain (Figure 4). This aims to neutralize the negative impact of pollutants entering the lake, to utilize the high nutrients input and increase the dissolved oxygen, directly and indirectly, and improve the water quality entering the other parts of the lake.

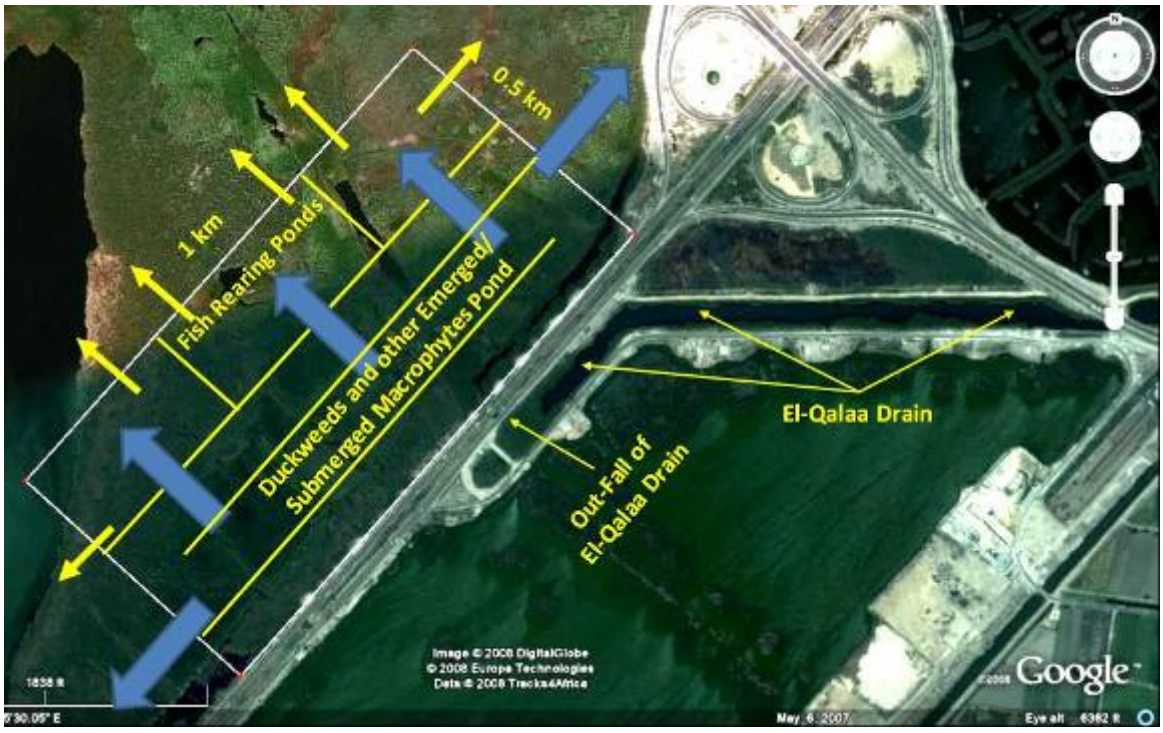


Figure 4: Preliminary Layout of the Proposed In-Lake Engineering Wetland

Conceptual Design:
An area of approximately 30 feddans has been chosen for the proposed wetland construction. The area will be facing the Qalaa Drain out-fall, and will be cleared from vegetation (reeds), excavated to depths of 2 m and surrounded by earthen/rock walls to isolate this part from the lake. The excavated material will be used for Dikes formation. Bucket dredgers, or similar devices, will be used for such operations[4].

[4] Although the humic state of the sediments should not allow this use, it is assumed that the sediments are not in this state for the 0.8 to 1.0 m depth of excavation needed in this context.

This area will be then subdivided into a number of Plug-Flow units where duckweeds will be transplanted. It was suggested to include duckweed in the treatment system to play the role of macrophytes

The out flow from the plug-flow units will be diverted to feed fish ponds stocked with tilapias and silver carp. Other aquatic reeds and fish species can be tested in order to optimize the removal capacity of this engineered wetland.

The outer surrounding walls of the area allocated to duckweed transplantation will be built with non bounded stones and maintain a height below the maximum permissible level of the lake indicated by the Ministry of Water Resources and Irrigation. A stainless-steel or plastic netting fence shall be used to cover the remaining height to 50 cm above the maximum lake level. Such precautions to insure that no retardation, due to the effect of vegetation growth, of the water flow coming out from the Qalaa Drain and the water level is within the safe limits set-out by the Ministry of Water Resources and Irrigation for Lake Mariout.

The walls surrounding the fish ponds (Figure 5) will be earthen and most of its material will be from the dredging of the area allocated to the Engineered Wetland to maintain the 2 m water depth.

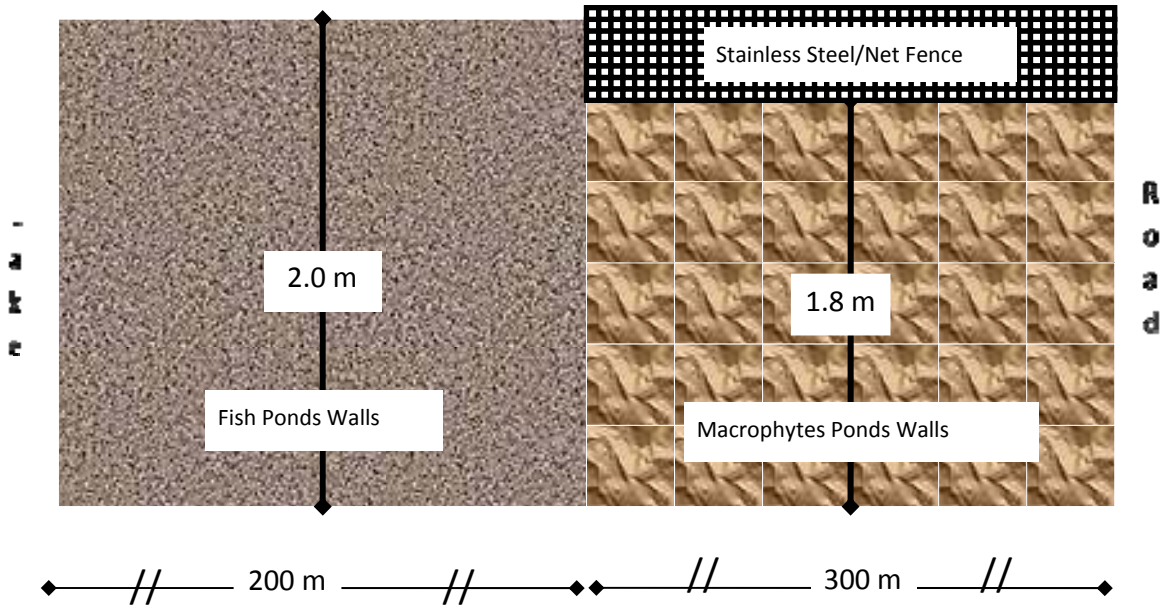


Figure 5: Surrounding Walls

Benefits of using Duckweeds

Duckweed ponds can be qualified as secondary or tertiary treatment. It is reported that removal rates can rise up to 75% and 80% for suspended solids and BOD respectively, while it also may ensure effective precipitation (and thus removal) of heavy metals when preceded by sedimentation to remove suspended solids (up to 65–70%) and a large part of the organic matter (30–45% of BOD), which is comparable to the current case. Removal efficiencies of over 90 % for BOD, over 74 % for nutrients and 99.78 % for faecal coliforms were reported in other country experience from having a duckweed covered sewage lagoon (Figure 6).

Figure 6: Lemnaceae is a family of flowering plants (also known as the duckweed family)

Duckweed treatment systems can either be, designed and operated as plug-flow, or batch systems. The plug-flow (continuous flow through) design is more suitable treatment option for larger wastewater flows originating from communities and urban areas such as in the case presented in this report, as it ensures an improved and more continuous distribution of the nutrients (Figure 7). It also enhances the contact surface between wastewater and floating plants, thereby, minimizing short-circuiting. Moreover, a narrow, channel-like design allows easier access to the water surface for operation and maintenance work.

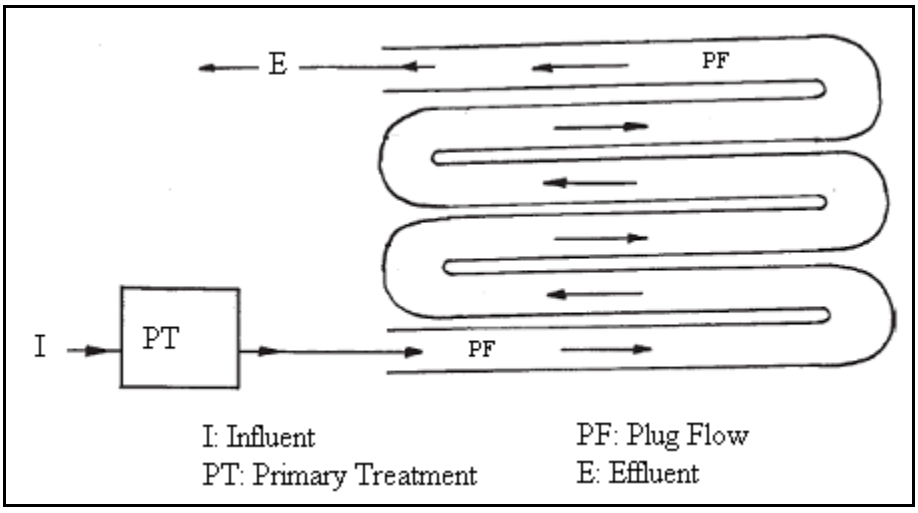


Figure 7: Ideal Plug-Flow Systems for Combined Duckweed-based Wastewater Treatment and Protein Production.

Since *Lemnaceae* (duckweeds) are very sensitive to water current, a floating bamboo or plastic containment grid system is recommended to prevent the plants from drifting to the shore by the action of wind and water current.

Reduction of Pollutants of Concern:
Engineered Wetlands, especially those based on Duckweed, have a great potential for renovating effluent from a wide variety of sources including municipal sewage treatment

plants, intensive livestock industries (including aquaculture), abattoirs and food processing plants. The system could effectively address all pollutants of concern. However, the actual reduction depends on a system design that facilitates the correct combination of organic loading rate, water depth and hydraulic retention time.

Pathogen removal is of utmost importance in case of effluent reuse as well as for duckweed use as a fodder crop. Duckweed ponds perform well due to the intense duckweed cover preventing sunlight penetration in the water column. The inclusion of tertiary maturation is recommended in case pathogen reduction has not yet reached World Health Organization guidelines. To ensure acceptable pathogen removal and treatment efficiency, comparatively long retention times in the range of 20 to 25 days are postulated for duckweed (plug-flow) systems. However, although in the current case Qalaa drain is mostly anaerobic and allow the survival of pathogens, these are not expected to require such long HRT since the closest discharge of municipal sewage is at least 7 km upstream of the drain outfall to the Basin

Time Frame for Implementation

The major issues that should precede implementation is the dissolution of the very high uncertainties resulting from the lack of reliable data on the water quality and circulation patterns within Lake Mariout. To ensure the proper design of any intervention, such data should be available to designers. Construction and making the system fully operational may take one year subject to budget availability. Table 3 presents the tentative time frame envisaged for the In-Lake Engineering Wetland option.

Sustainability

The rapidly growing and small floating aquatic plants of the botanical family of *Lemnaceae* are capable of accumulating nutrients and minerals from wastewater. The latter are finally removed from the system as the plants are harvested from the pond surface. Because of their comparatively high productivity and nutritional value, particularly their high content of valuable protein, they provide an excellent feed supplement for animals such as fish or poultry.

A uniform income should thus be generated which should contribute to the sustainability of the proposed system. The generated income has the potential to cover total financial costs, and will cover the operation cost. Integrating other production units, e.g. fish farming, will generate additional income.

Duckweed holds the potential to create a financial incentive for controlled wastewater collection in both rural and urban areas and, therefore, improve sanitary conditions. This increases the potential for replication of the project.

When duckweed biomass is used for animal production, the generation of income and nutritional improvement appear as possible side-benefits from the wastewater treatment process. Thus, the full potential of duckweed aquaculture lies in its combined use in the fields of sanitation, food production and income generation.

Table 3: Tentative time frame for the construction schedule for the In-Lake Wetland

Task Name	Duration Days	Year 1												Year 2											
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Field Investigation Stage*																									
Lake water and sediment quality Assessment	36																								
Qalaa Drain water quality assessment	24																								
Water circulation model and Ecological survey	240																								
Survey works	15																								
Design of in-lake Wetland system	45																								
Participatory Approach Stage*																									
Local Governorate	15																								
Stakeholder awareness	30																								
Pre-construction group meetings	15																								
Wetland Construction Phase																									
Dikes	180																								
Earth works for drain outfall	60																								
Gates general	60																								
Weir and screen	30																								
Reeds transplanting	20																								
floating plants placing	20																								
Floating frames system	7																								
Steel works for screen and weir	14																								
Pine timber blocks (0.2*0.2*3m)	15																								
Fixed water level ruler system	7																								

*Intermitted activities covering all the period specified by the activity.

Intervention 2: In-stream Biofilm

Theory:

The in-stream biofilm approach is considered to remove or reduce the organic pollutants by adapting the severely polluted segments of the drains to act as large plug-flow anaerobic/aerobic biofilm reactors in which bacterial culture will be intensified. This is to be achieved by hanging submerged plastic packing media in a staggered manner at three-dimensions in a chosen segment of the drain. This will form small channels of water allowing for good contact between pollutants and biomass attached to the packing media. The packing media will be hanged in the segment of the drain by a mesh of wires fixed at both sides of the drain. The bacterial growth on the biofilm occurs naturally based on the conditions of the medium in which the biofilm is applied (aerobic, anaerobic, or anoxic), and could be accelerated by inoculation.

Selected Location

Certain aspects and parameters are considered when choosing a restricted location of Al Qalaa Drain and need to be verified /updated before the actual implementation of the project. These aspects are illustrated below:

- The selected segment of the drain is preferred to be lined where the lining makes no aggressions on the drains. Lining of the drains allows also for proper implementation of the proposed approach (application of packing media in many segments of the drain)
- The cross-section of the drain segment should be uniform along the selected reach. This would cause the velocity to be uniform along the reach.
- The selected reach is preferred where the drain is not surrounded by a residential area. This decreases the chances for aggression of solid waste discharges, and improves accessibility to the drain banks required for construction and maintenance, as well as performance monitoring.
- Possibilities of more industrial wastewater to be discharged to the drain, e.g. through the ETP, containing toxic chemicals, not treatable through the ETP process, might inhibit the biological process. It is therefore preferable to apply the biofilm at a distance from the ETP to allow chemicals, if any, to be fixed in the drain's bottom sediments.

Accordingly, a specific location for applying the in-stream biofilm approach has been selected and it lies at the height of Qalaa Pumping station (Location "A" shown in Figure 8). The drain in this location is conveyed to two branches, and each branch is of about 400 m length.

Figure 8: Location for Biofilm Application in Qalaa Drain

Conceptual Design:
The main hydraulic characteristics and water quality parameters of Al Qalaa Drain that are considered during the conceptual design of the In Stream Biofilm treatment system are illustrated below. Table 4 presents the hydraulic characteristics of El Qalaa Drain in terms of flow, velocity, cross-section parameters as per MWRI's records related to the Qalaa drain upstream the pumping station[5].

Table 4: The Hydraulic Characteristics of Al Qalaa Drain

Parameter	Values
Flow (m^3/d) • SOGREAH – N° 1740798/ FCN – May 2008 • El Qalaa Pump station data Sep 2008 (MWRI)	 915,790 1,296,000
Bed width (m)	6
Bed level - above sea level (m)	-8.10
water level - above sea level (m)	-6.20
Water depth (m)	1.90
Bank width (m)	8.00

[5] It is assumed that the drain conserves the same characteristics, at the height of the pumping station. However, this assumption will need to be confirmed during the feasibility stage.

Bank level - above sea level (m)	-1.50
Side slope (3:2)	1.50
Bank width at bank level (m)	25.80
Water width at surface (m)	11.7
Water cross-section area (m^2)	16.815
Available cross-section area for the packing media (0.50 m above bed level) (m^2)	13.44
Average velocity (m/sec) • SOGREAH – N° 1740798/ FCN – May 2008 • MWRI	 0.63 0.89

The main constraints that are considered prior for the proposed design of the in-stream biofilm approach for Al Qalaa drain are summarized as follows:

1. The short length of the drain segment available for applying the approach (400m *2), with minimal preparatory investments, since the other possible location will need larger preparatory investments;
2. Dynamic flow variation (916,000 – 1,300,000 m^3/d).
3. Possibilities of reduction in pollutants concentration due to expected improved performance of the WWTP discharging to the drain (upgrading of the WWTP to be secondary treatment). This will in general improve the conditions of the drain, but will decrease the treatment efficiency of the proposed scheme. This is consequently reflected in % reduction of total load and a higher cost per unit of pollution reduced.

Packing media: One meter length of corrugated collecting pipes for drainage water (used for sub-drains, 3 inch PVC is selected to be the packing media for the case of Al Qalaa Drain. The packing media will be packed in steel-bars box-frame/FRP (fiber reinforced polymers) units of dimensions 0.5*1.0*1.0 m. Two steel cables will be fixed in the side slopes of the drain to hang the units. These cables will be used in hanging the units containing the carrier material and it will represent one section of interventions of in-stream biofilm.

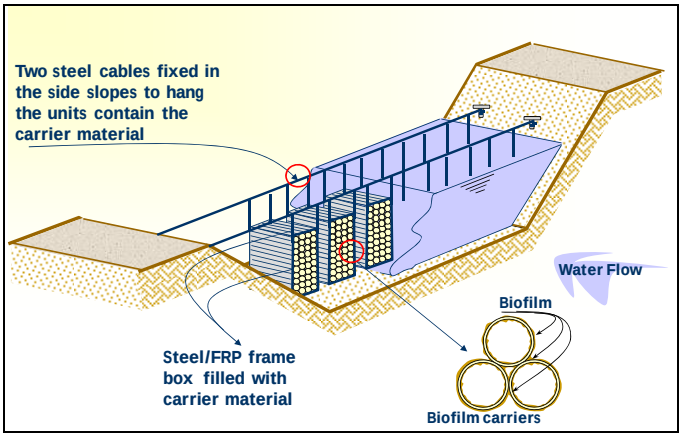


Figure 9: Schematic diagram illustrating the implementation of one section of the proposed Instream Biofilm System at Al Qalaa Drain

The in-stream biofilm system is designed to be applied in 500 sections along the selected segment of Al Qalaa Drain. Figure 10 Illustrates the general arrangement of these sections). The implementation of these 500 sections may well be carried out using occupancy ratio of 75% or 50%. In these cases, the units of the pipes will be designed according to the dimensions of the drain cross section to have 75 or 50 % occupancy of the cross section.

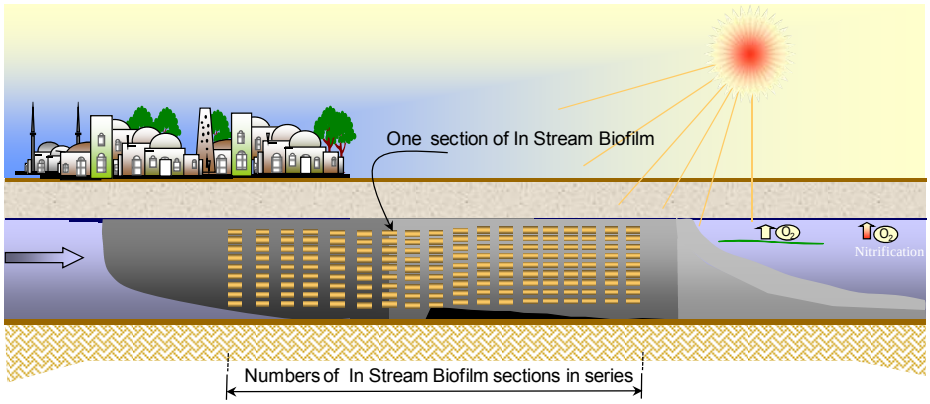


Figure 10: The proposed implementation of different sections of in stream Biofilm system along Al Qalaa drain

The proposed occupancy ratios are easier in construction and maintenance and they have less hydraulic resistance and losses. The main disadvantage of such scenarios is that they require an increased length of segments of the pipes to be used.

.A very careful hydraulic assessment of the drain is required before the actual implementation of this intervention.

Reduction of Pollutants of Concern

The pollution reduction of this proposed in-stream biofilm system will depend mainly on the oxygen condition created in the drain after the interventions. The system has the possibility to work dynamically /simultaneously under aerobic and anaerobic conditions, although at different efficiencies. High removal efficiency is expected under aerobic conditions (DO > 1 -1.5 mg/l) however under anaerobic condition reduction would still be expected, but at a much lower level. Practically, and given the flexibility that the system provides, the performance of the system will fall within the range specified by the extreme (aerobic-anaerobic) conditions presented in the Table below.

These calculations are based on the data available on current load of the Qalaa Drain. With the expected improvement resulting from the upgrading of the WWTP, the removal rates and thus the efficiency are expected to decrease. The magnitude of decrease can, however, hardly be estimated, given the lack of data on the current material balance of the drain.

Table 5: The expected reduction of pollution at both aerobic & anaerobic conditions

Item	(75%) Occupancy	(50%) Occupancy
Anaerobic condition		
Removal rate for each section (Kg COD/day)	1.9 - 11	1.3 – 7.3
Total removal rate for 500 sections (T COD/day)	0.95 – 5.5	0.65 – 3.7
Total removal rate for 500 sections (T /year)	347-2000	237-1350
Removal efficiency* (%)	1 - 6	0.7 - 4
Aerobic condition		
Removal rate for each section (Kg COD/day)	86 - 150	57 - 100
Total removal rate for 500 sections (T COD/day)	43 - 75	29 - 50
Total removal rate for 500 sections ('000 T/year)	15.7- 27.4	10.6- 18.25
Removal efficiency* (%)	44 - 77	29 - 51

* Removal efficiencies are calculated based on the Pollutants Loads (t/d) provided by (SOGREAH – N° 1740798/ FCN – May 2008).

Time Frame for Implementation

The in-stream biofilm intervention can be implemented according to the following procedure:

- Survey works
- Drain water quality assessment (Detailed assessment of water quality parameters)
- Hydraulic characterization of the location/s of application including velocity, flow and detailed cross section description (bed, side slopes, water depth, berm level, etc.)
- Allocating sampling units to assess the kinetics of the approach under both aerobic and anaerobic conditions
- In-stream Biofilm Construction
- Monitoring and Evaluation that includes ;
  - Water quality parameters (TSS, COD, BOD, NH_4, P, DO, pH)
  - Hydraulic parameter (water level and total heading up due to the backing media, clogging, etc.)
  - Biofilm characteristics (TSS, VSS, biomass activity test)

Table 6 illustrates the time frame for implementing the in-stream Biofilm approach according to the procedures mentioned previously.

Table 6: Timeframe for implementation of In-Stream Biofilm Approach

Task Name	Duration Day	Qrt 1	Qrt 2	Qrt 3	Qrt 4	Qrt 5
Field Investigation Stage						
Survey works	30					
Drain water quality Assessment	60					
Hydraulic characterization of the location/s of application	60					
Allocating sampling units to assess the kinetics of the approach under both aerobic and anaerobic conditions	90					
Design of in-stream biofilm	60					
Public Awareness Stage						
Local Governorate awareness	30					
Stakeholder awareness	30					
Pre-construction group meetings	30					
In-stream Biofilm Construction						
Site preparation (Enhancing drain profile)	90					
Fence construction	90					
Manufacturing of packing media in unit sections	90					
Manufacturing of screen and other supporting materials (cables , etc)	90					
Installation of packing media in phases (100 section in each phase)	90					
Monitoring and Evaluation	180					

Sustainability

The system is flexible and can cope with variations in operation conditions (system could self adjust from aerobic to anaerobic and even to anoxic conditions and vice versa according to changing contextual conditions). The system flexibility is extended to cope with any variations in the performance of both the eastern and western WWTPs. In case of plant performance is improved and accordingly the pollution load is decreased in the drain then biofilm species could be shifted from one type to another according to upcoming variation in water quality. The system could work anaerobically in case of high organic loads while in case of improving the plant performance the system could work then as tertiary treatment either for ammonia oxidation or even to perform de-nitrification process.

Intervention 3: In Stream Electric powered Aeration

Theory

This application is utilized to increase the DO which will improve the drain conditions and thus self purification. It also helps in the consumption of COD/BOD as well as the conversion of NH4 to NO3.

Location

The chosen location for this application is responding to a number of factors. The primary objective being to raise the DO in the drain, the reaches of the drain with the lowest DO level are expected to have the highest assimilation efficiency. Moreover, because the equipment is costly and requires electric power, it needs to be located in a secured site close to a source of power. Two locations seem to fulfill these criteria, the ETP and the Qalaa pump station (Location "A" of Figure 8). Finally, if aeration is coupled with the biofilm application, it needs to be located right in its upstream. Accordingly, Location "A" has been chosen.

Technical Description

Aerators utilized for wastewater treatment are readily available on the market. The one selected be energy efficient in a way that converts the least amount of energy into the maximum amount of aeration and mixing. The aerator selected should also be of a simple design, to insure low cost of maintenance. In order to insure a high assimilation of oxygen, all aeration will takes place below the water surface and optimal bubble hang time. A compact and mobile, and accordingly self-contained, will be used to allow the needed flexibility for location adjustment, if needed.

Figure 11: Typical Float Mounted Aerato

The unit proposed is mounted on a stainless steel floating platform and has a stainless steel shaft and a large sub-surface propeller, as shown in the figure above. It is assumed that the unit would be of 50 HP (37.5 kW).

The specifications of the selected system ensure a transfer of 1 kg O2/kWh. The selected size of 50 HP thus transfers 37 kg of O2/hour or 888 per day. The actual intake depends on a number of factors including the base level of DO and the size of bubbles and their hang time. The location and shaft angle will be selected to maximize intake. However, if a mildly conservative rate of transfer of 50% is used, this will result in an intake of 444 kg O2/ aerator.

Reduction of Pollutants of Concern
The daily flow of Qalaa Drain is between 900,000 and 1,200,000 m3/d depending on the source. Sources agree that the DO level is +/- 0.5 ppm. A single aerator[6] could substantially improve this level by about 0.3 to 0.5 ppm.

Time Frame for Implementation
Survey of proper locations, stream velocity, DO concentration and accessibility as well as concept refinement should take place during the feasibility stage. All design and shop drawings should be ready for producing the modules within 2 months. The manufacturing time will depend on the number of modules, which will be installed along the stream, but is preliminarily estimated to be of 4 months.

Parts assembly and fitting should be tested before installation at the site. Module testing for proper balancing and rotation shall be carried out to insure proper rotation before implementation. Installation time would also be sensitive to the number of modules to be installed. However, according to the above it could start as early as 6 months after the start of the implementation phase.

Intervention 4: Reed Removal

Reed removal will potentially improve water circulation in the basin, thus both improving its aeration and entraining some of the deteriorated sediments. The second order effect of both direct impacts will be to improve the basin's self cleaning capacity to a rate higher than the current 29% and 56% for COD and BOD respectively. Although, it is impossible to predict the improvement at a reasonable accuracy given the current level of data concerning current circulation patterns and the lack of a modeling tool for the basin, any alternative recommended will be expected to better perform if coupled with an in-lake reed removal component. It is therefore considered a base intervention.

[6] For actual design, smaller strategically positioned aerators will be considered.

Figure 12: Area of Intervention for Reed Removal

Phasing of Implementation of the Proposed Package

Within the proposed package described above it is proposed to start implementation with one set of 500 sections of biofilm and accompanying aerators, in Location A, monitor its performance, and take the following steps accordingly. Although, it is expected that not less than 500 sections will be needed, it is recommended to implement this set in phases of 100 sections to allow for needed mid-way adjustments.

It is also proposed to construct a small pilot in-lake wetland. The area is proposed to be limited to a few feddans. This will play two roles. First, monitoring of its influent, its effluent and its production rate will generate important information to direct the following investments.

Moreover, since Duckweed is newly introduced to Egypt, therefore it could represent a demonstration for a subsequent up-scaling. Starting with a small pilot, will also be useful in addressing resolve the potential institutional conflict in the lake, which could be easier to manage after an initial success of duckweed production and marketing.

After one year of operation, i.e. two years within the project implementation phase, the above system should have reached steady state. Based on the monitoring of performance, potential additional treatment investments could be:

- An extension in biofilm/aerators modules; and/or
- Additional aeration.

Component (3): Project Management and Monitoring and Evaluation.

The expected outcome is the completion of a M&E system and the documentation of the project results for the purpose of up-scaling and replication. The outputs of this component include

1. a project monitoring system with measurable indicators; and
2. documentation of project's progress and results, dissemination of lessons learned from the project and adoption of a replication strategy.

This component entails supporting the Project Management Unit (PMU) currently associated with the EPAP II to carry out the various activities related to the project implementation. The Monitoring function under component 3 applies to all project interventions including evaluation and reporting whereas the Monitoring function in component 1 is only intended to monitor the water quality of Lake Mariout and the Mediterranean Sea.

In addition, the monitoring equipments are different for each component and require a different set of skills for their operation. This component includes hiring of local and/or international consultants to:

(a) support the PMU, especially as related to technical, financial management and procurement, on a part-time basis,
(b) assist the PMU in the development and implementation of the necessary monitoring and evaluation framework, including data analysis and reporting as related to pollution loads to Lake Mariout and to El-Mex bay, and
(c) assist the PMU to develop the necessary information dissemination strategy to follow-up on the project's progress and to disseminate lessons learned.

The vehicle for the latter is likely to be national workshops, as well as the participation in the GEF's International Waters Learning Exchange and Resource Network (IWLEARN) programs.

CHAPTER 4 : DESCRIPTION OF THE ENVIRONMENT

Lake Mariout Background

Lake Mariout has been subject to major modifications, most of which are either direct human interventions or indirectly result from such interventions. Human activities have put the lake to a wide variety of uses some of which are benign, including fishing. However, these uses are not always consistent as the Lake has also been used for discharging of primary treated sewage and industrial wastes. The lake environment was continuously subjected to quality degradation due to human pressure as well as land reclamation reducing the area of the Lake. In 1801, the original area was probably in excess of 700 km2 (Figure 13).

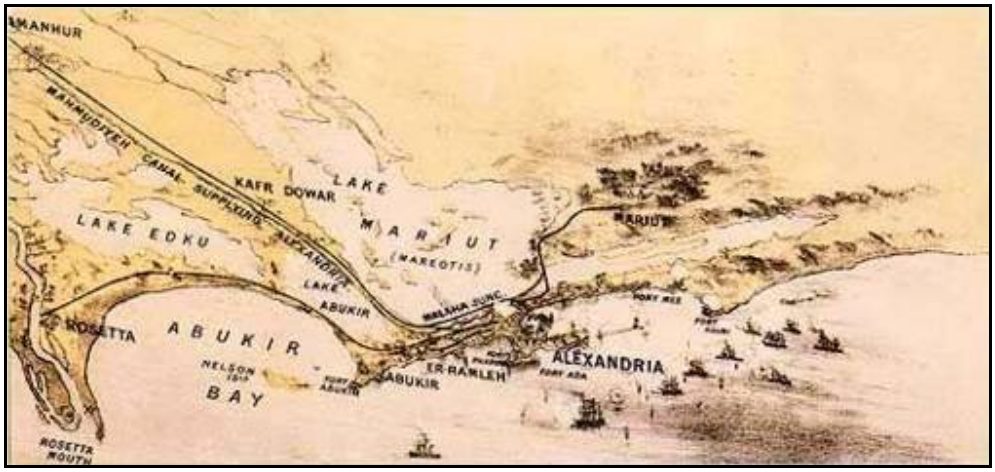
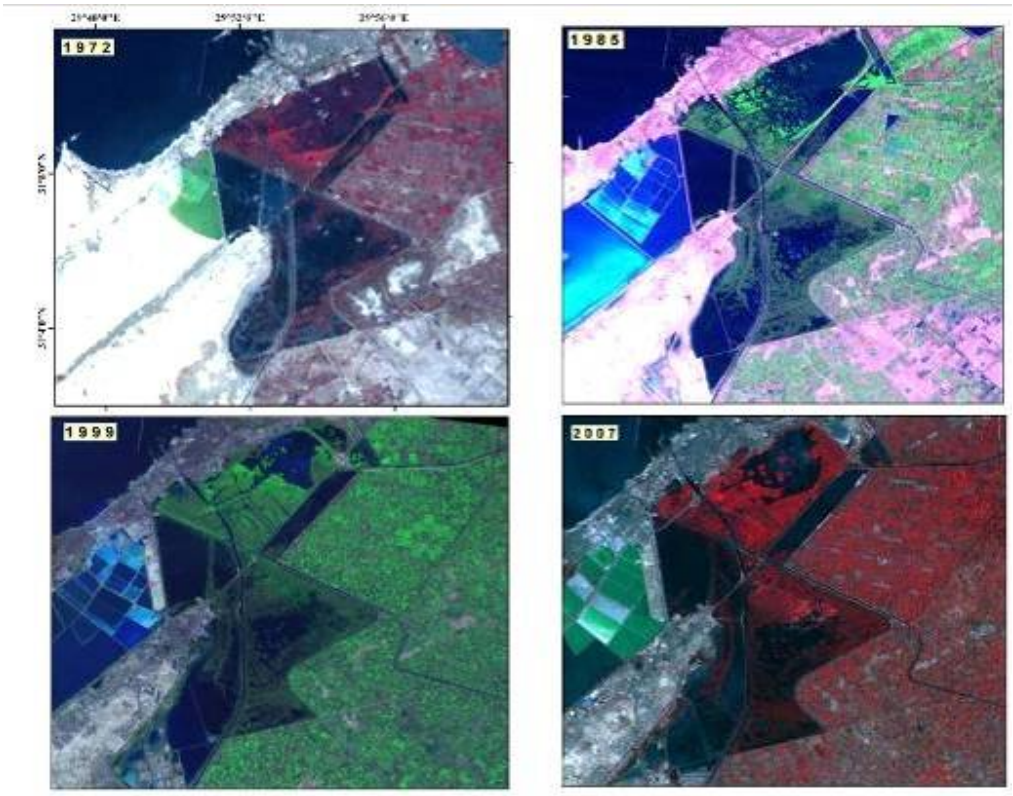


Figure 13: An early map, published in 1882 clearly showing Lake Mariut

Because of railway and road construction isolating parts of the lake, the cessation of annual Nile flood after building the Aswan High Dam, and land reclamation which started early in the 20th Century before it became a state policy in its second half, the area of the lake is now less than 65 km2.

Figure 14 represents the evolution of Lake Mariout since 1972 till 2007.



Source: National Authority for Remote Sensing and Space Science, personal communication

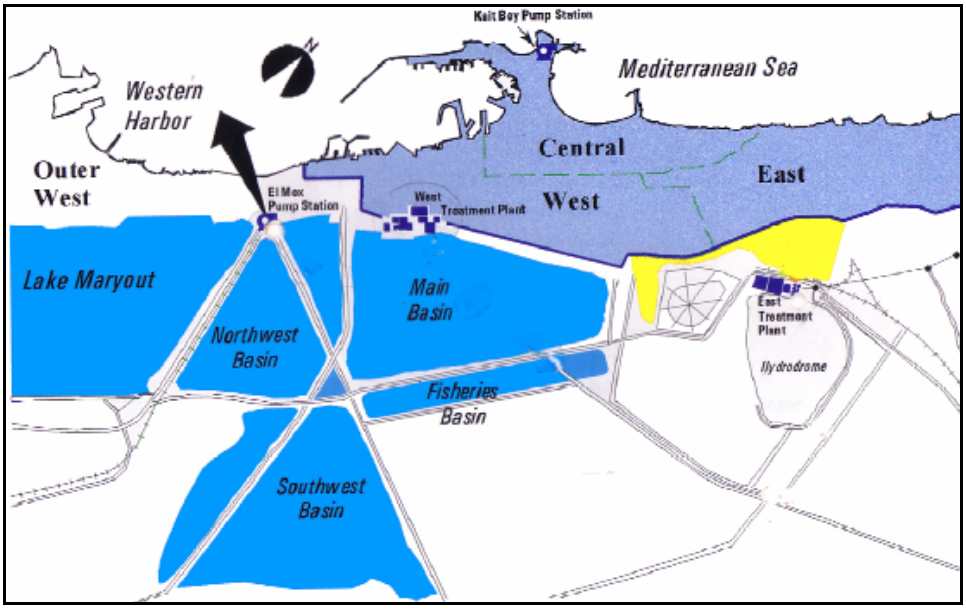
Figure 14: Surface Area of Lake Mariut 1972 – 2007

The direct result of the dynamic and continuous change of the Lake configuration is that the relevance of historical data as inputs to potential interventions is questionable. Accordingly, the following section attempts to collate the most recent data available to provide a reliable, although by nature approximate, basis for this report.

Current System Configuration and Status of the Lake

Lake Mariout is an intermediate stage of discharge of multiple land based sources to the El-Mex Bay. Water level in the lake is managed by pumping the water to the sea, as there is no strait connecting the lake to the Mediterranean. The fact that domestic sewage, industrial, and agricultural waste are discharged continuously to the lake makes this pumping station essential to maintain water level at 1.88 – 2.0 m below sea level.[7]

[7] An important result of the existence of the pumping station as a regulator of water level is that the change of influents to the lake is possible without creating undesired imbalances affecting the surrounding activities



* Source: Comprehensive Strategic Development Plan for Lake Mariout Zone

Figure 15: The Basins of Lake Mariout

As Shown in Figure 15, the lake currently consists of five basins:

1. The main basin (21 km2) with an average depth of 1.2 meters;
2. The northwest basin (10.5 km2) with an average depth of 1.25 meters;
3. The fishery basin (4.2 km2) with an average depth of 1.35 meters;
4. The southwest basin (21 km2) with an average depth of 0.5 meters; and
5. The west basin (8.4 km2) with an average depth of 0.6 meters.

The water quality of the different basins of has been analyzed by the Lake Mariout Rehabilitation Component of the Comprehensive Development Plan for Lake Mariout. The water quality of the basins was reported as follows:

Lake Mariout Water Quality

The concentration of dissolved oxygen in all the basins is less the 5 mg/l, which is not in compliance with the limits set by the Law 48/1982 for non fresh water bodies. However, the lowest DO value was recorded in the Main Basin.

Total heavy metals concentration in the water of the Main Basin is also considerably high reaching over 12 mg/l as compared to 1 ppm for the law limit. Iron is the dominant metal in water with a concentration of 10.2 mg/l. Other heavy metals concentrations in water mainly Ni, Cu, Zn, Cr, Pb are relatively moderate.

Table 7: Average Water Quality in Lake Mariout

Sampling site / Parameters	Limits	Main	Northwest	South	Fisheries	West & Southwest
pH	7-8.5	7.47	7.88	7.8	7.87	7.5
DO	>5	1.3	4.2	3.3	4.95	4.9
Turbidity	50 TU	0.76	0.35	0.1	0.35	0.25

* Source: Comprehensive Strategic Development Plan for Lake Mariout Zone

The sediment quality was also analyzed by the Lake Mariout Rehabilitation Component. Heavy metals analyses showed the highest concentrations of manganese, iron, zinc and copper in the Main Basin.

It is clear from the above the Main Basin is the most polluted basin of the Lake. It is also physically apparent in that water reeds cover about 75% of the basin area. Moreover, the basin sediments are a constant source of contamination to the basin's water. Due to the accumulation of contaminants, poor oxygenation, stagnation and fermentation of biological materials, the basin's sediments are permanently in a colloidal state. This impairs the sediment capability to assimilate pollutants and neutralize their impact on the surrounding ecosystem. The sediments rather seep their historical pollution load to the water, based on the solubility of each compound, rendering the water body above the sediment always saturated with pollutants.

Influents to the Main Basin

The Main Basin is fed from different water sources. These include precipitation and seepage of ground water from surrounding fields, resulting from the lower water level controlled by the El-Mex Pumping Station. However, major sources are Alexandria 2 Wastewater treatment plants and 2 major agricultural drains.

Until the eighties most of the domestic sewage and industrial wastewater were discharged directly into the Mediterranean Sea form a number of outfalls along the coast of Alexandria. Pollution of beaches and the inshore waters caused severe impact on Alexandria as a summer holiday city. This made the local authorities decide to divert these discharges, of untreated raw sewage mixed with industrial discharges, into Lake Mariout Main Basin. Major deterioration of the Basin occurred at that time, and Main Basin became highly eutrophic and polluted with various chemicals.

Later, two primary treatment plants were built and started operation in the nineties. The quality of water reaching the Main Basin improved, but the Main Basin Ecosystem did not recover. The current Self Cleaning capacity of the water body has been deduced through a simple mass balance of pollution loads entering the lake and the water quality data available for the El Mex pumping station[8], to be 39 %, 29% and 56% of TSS, COD

[8] Sogreah Consultant, 2008. Baseline Conditions, August 2008. Alexandria Integrated Coastal Zone Management Sub-Program (AICZM) of the Egyptian, Pollution Abatement Project (EPAP II), Global Environmental Facility fund (ID #2602), pp. 37

and BOD respectively. Although it is clear that the deteriorated ecosystem of the lake is not capable to handle the wastewater with all the soluble organics still being discharged into the lake. Self cleaning of the lake has a major role to play in the improvement of the quality of effluent to the El-Mex Bay.

The Main basin receives the primary treated wastewater from the Alexandria West Treatment Plant (WTP), amounting to 400,000. m^3/day. The agricultural drains discharging to the Main Basin of the Lake are the Omoum and Qalaa Drains. The Qalaa drain conveys primary treated effluent of Alexandria East Treatment Plant (ETP), in addition to agricultural drainage and untreated municipal wastewater discharge from rural settlements through a number of secondary and tertiary drains as presented in figure 4 below. The total flow to the Basin from Qalaa Drain falls within the range of 900,000. to 1,250,000. m^3/day depending on the source[9].

On the other hand, the Omoum drain (4,000,000. m^3/day) flow is mainly agricultural drainage water in addition to minor quantities of untreated sewage discharged along the drain. There are numerous surface water connections between the basins and the drains. These connections include large openings, smaller cuts or breaches in the dykes and small box or pipe culverts. The main pollutants in the agricultural drains are organic materials reaching the drains from domestic and industrial sources; nutrients from application of fertilizers and discharge of untreated domestic wastewater; heavy metals as a result of industrial discharges or impurities in fertilizers; salts from the percolating irrigation water enriched through evaporation; and pathogens from disposal of human sanitary waste. The results of analysis of water quality of the main drains, discharging directly or indirectly to the Main Basin, are summarized in table 4 below.

The dissolved oxygen in all the drains is lower than the permissible limits in Law 48/1982, which requires that the dissolved oxygen in non fresh water bodies be at least 5 mg/l. However, Omoum Drain has clearly a much higher level of DO compared to different reaches of Qalaa drains, including secondary drains discharging to it, represented in the table above by El Amlak Drain.

Table 8: Pollution loads of influents to the lake (t/d)

	TDS	TSS	COD	BOD	P	NH4-N	N03-N	Sources
WTP	-	67	117	44	-	-	-	ASDCO
El Qalaa drain	1.413	110	98	73	1,03	1,25	2,29	DRI, 2005/2006
Oumoum drain	15.54	155	84	277	1,71	8,37	3,98	Nagy

The north-western side of the main basin, where the Mex Pump Station is located, is in much better shape because of the better water quality of influents reaching it, Omoum Drain and seepage from Nubaria Canal and because of a higher flow, as opposed to the eastern part suffering from stagnation.

[9] SOGREAH report, MWRI respectively

The Southern-Eastern part of the main basin suffers from high load of BOD, COD and TSS as shown in the following Tables, stagnation though the discharge is at least 900,000 m^3/day and low salinity that gave chance to hydrophytes to invade this part of the lake.

Table 9: Average water quality in Drains Discharging to Main Basin

Sampling site Parameters	Limits	Qalaa outfall	Qalaa drain	Amlak drain (discharging to Qalaa)	Qalaa PS	Omoum drain
pH	7-8.5	7.16	7.34	7.6	7.64	8.18
DO	> 5	0.54	0.43	1.8	0.01	4.5
Turbidity	50 TU	4.1	2.5	0.3	0.2	0.2

Table 10: Pollution concentration of influents to the lake (mg/l)

	Discharges m^3/d	TDS mg/l	TSS mg/l	COD mg/l	BOD mg/l	P mg/l	NH_4-N mg/l	$N0_3$-N mg/l	Source
WWTP	410325		164	284	108				ASDCO
El Qalaa drain	915790	1543	120	107	80	1,13	1,37	2,5	DRI, 2005/ 2006
Oumoum drain	4200000	3700	37	20	66	0,4	2,0	0,9	Nagy

Regional Geology

Studies on the geology and geomorphology of the north-western Mediterranean coastal region of Egypt were reviewed by Helmy (2005). According to these studies, the entire northern region of the Egyptian western desert is covered by sedimentary formations, which range in age from lower Miocene to Holocene.

The Holocene formation is formed of beach deposits, sand dune accumulations, wadi fillings, loamy deposits, lagoonal deposits and limestone crusts. The beach deposits are composed of loose calcareous oolitic sand with some quartz grains and shell fragments.

The sand dune accumulations are in the form of either coastal or inland dunes. The coastal dunes are composed of snow-white, coarse calcareous oolitic sand, while the inland dunes are of reddish colour and finer sand. The wadi fill comprises lime gravel and fine alluvia. The loamy deposits are fine sandy loam intermixed with gravels. Lagoonal deposits are present in the depressions between ridges and are composed of gypsum intermixed with sand and alluvium. The limestone crusts are developed on the exposed limestone surfaces.

The Pleistocene formation is formed of white and pink limestones. The white limestones are in the form of exposed ridges stretching parallel to the coast. They are composed of white calcareous oolitic sandy limestones, yielding Pleistocene microfossils, echinoid spines, calcareous algae and shell fragments. The pink limestones are composed of pinkish white oolitic sand, yielding Pleistocene micro-fauna.
The Pliocene formation is represented by creamy limestones which are marly and sandy in subsurface. They are partly exposed in some localities. The Miocene formation includes two divisions. These are collectively known as the “Marmarica Limestone”. The Lower Miocene type is formed of sandy limestones, shales and marles and is known as the “Moghrs Formation”. The Middle Miocene type is represented by limestones and dolostones with intercalations of clays, sandstones and siltstons.

Limestone Region of the Northwestern Delta
The deltaic coast west of Abu Qir Bay is characterized by a morphologic structure different from that to the east. This part of the coast is formed from successive chains of oolitic limestone; between them are low valleys. The limestone chains themselves appear as ridges about 120 ft. above sea level. The region has five subdivisions:

i) The coastal range is comprised of white sand dunes mainly consisting of limestone particles. There are several ideas on how the dunes were formed. Some people consider them to be coastal dunes formed at a time when the Egyptian coast was completely dry. Others attribute to them a marine origin. The width of the coastal range is about 400 m2.
ii) Wadi Mariout extends to the south of the coastal range at five meters above sea level or less. The wadi is covered by a thick limestone soil (derived from the bordering ranges) sometimes more than five meters deep. There are different theories about how the *wadi* was formed: whether from crustal movements or an old lake.
iii) The Al- Max-Abu Suwayr range falls to the south of Wadi Mariout. It has a width of between 200 and 400 m. and its height is 36 m. The range slopes abruptly

toward Wadi Mariout in the north and toward the Mallahat Mariout Depression in the south. The formation of this range is attributed in part to the influence of the wind. It was originally formed from remnants of sea shells and calcined sand particles fused by rain and evaporation. During the rainy season, rains loaded with diluted carbonic acid dissolve the calcium carbonate so it becomes bicarbonate; in the dry season this settles between the sand particles and solidifies.

iv) Some geologists think that the western tip of the Max-Suwayr range was subjected to limited folding which uplifted the bottom of the Mallahat Mariout. Depression and separated from it the far western sector. Evidence of this is the gypsum formations (called Wadi Al-Gibs, i.e., gypsum) which are mounds of saline deposits six meters above sea level. These forms to the period between 12,000 and 10,000 B.C., when sea level was lower and aridity prevailed. The depression of Mallahat Mariout lies between the central and southern ranges. It was previously an extension of Lake Mariout.

v) The range of Gabal Mariout (also called Al-Batn and Al-Qarn) forms the southern boundary of the depression; it is 35 m above sea level, and in the northeast reaches 51 m. although it is only 30 m height in the north- west. The width of the range is between 300 and 400 m to the south of the range, the raised plains of Mariout extend as far as the Miocene plateau.

Sandford and Arkell have summarized their opinions concerning these ranges: “The remarkable ridges of lime sand oolitic limestone west of Alexandria, separated by parallel valleys, afford a perplexing geological problem, but on the whole there is much to support the view that they were formed by wind action along a receding shore line; a new dune area is forming between the ridge nearest the sea and the present storm beach”.

It is possible that the shape of Lake Mariout (broad in the east with an arm extending to the west) is attributable to its location at the convergence of deltaic formations with the region of oolitic limestone chains. The influence of the delta is apparent in the eastern lake which is broad and shallow, while the western part is clearly influenced by the morphology of the western coast.

Sand Dunes and the Northern Coast of the Delta

Sand dunes are the main geomorphic feature in the greatest part of the deltaic coast east of Abu Qir Bay. Most of the sand dunes along the coast are low and narrow. They do not exceed a few meters above sea level, and their widths range between 500 and 1500 m three parallel lines of dunes stretch from the sea towards the interior. The outer line is about 50 m wide and consists of sand and silt mixed with some marine formations brought by seawater during high tide.

Lake Mariout

Lake Mariout is different from the other Northern lakes in that it is a closed lake. It is also in a unique region characterized by the presence of limestone barriers. The lake is impounded between one of those barriers and the delta.

It is important to distinguish between Lake Mariout and the Mariout Depression. The lake does not occupy the whole depression; it covers only 23,690 feddans, or about 12.7% of the depression. The lake is broadest in the middle. It has no bays or bogs. A western arm of the lake extends to the southwest, along a hollow between the El-Mex-Abu Suwayr range in the north and Mariout ranges. The width of this 35 km long arm is from two to five kilometres. It is known as the of Mallahat Mariout depression. This arm is now cut off from the rest of the lake by the railway line built in 1858, and has become a group of shallow lagoons. The water level of these lagoons is high in winter and low in the summer, at which time a layer of white salt is left behind. The western end of Mariout is no longer covered by water; some halophytic shrubs and grasses grow in it.

The central section of the western arm is nearly always dry, but covered with layers of salt. The lower eastern end is always covered with salt water. There are no islands in Lake Mariout because it is far from the old deltaic branches and because the lake has shrunk to occupy only the lowest section of its basin. Some time in the past, there were eight islands in the lake. Now they are part of the surrounding land surface. The most famous lands were Al-Sharan, Tall Al-Ghazal, Tall Al-Gabarti, and Tall al-Hanash3. Mallahat Mariout has three islands at present.

Lake Mariout was fed by the Canopic branch, as was Lake Edku to the east of it, but in the 12th century that branch filled with silt and the connection of the lake with the Nile was cut. Thereafter Lake Mariout formed a number of insignificant stagnant pools whose level was related only to local winter rains. The lake gradually became a salt lake because of increased evaporation and because of sea inundation twice in the early 19th century (first in 1801, then in 1807).

The lake since 1892 has been fed by drainage canals. In order to keep the lake at a level of -3 m., excess water is pumped into the sea by El-Mex Pumping Station, created for this purpose. It can be said that today's is partly a Lake Mariout creation of Nile drainage.

Air Quality

The nearest air quality monitoring station to the project area is El Mex monitoring station. The station used automatic monitoring equipment for flu gases (sulphur dioxide, nitrogen dioxide, particulate matter less than 10 micron "PM10" and particulate matter as black smoke). The following table shows the published results of the this station.

Table 11: Air quality in El Max area

Month		**SO2**	**NO2**	**BS**	**PM10**
Permissible limits	Day µg/m^3	150	150	150	150
	Year µg/m3	60	-	60	70
Average daily – January 2006		30	73	67	-

Average daily – February 2006	38	40	160	-
Average yearly – 2005	**26.3**	**31.7**	**30.8**	**56.9**

Source: EIMP annual reports for 2005 and monthly reports for January and February 2006

EIMP recorded two days of exceeding the limits for sulphur dioxide in El Max area during the year of 2005. An increased concentration of BS was recorded in February.

In other older studies in the area (Said, 2003) hydrogen sulfide (H2S) levels were recorded around the lake. It varied according to the location as well as the sampling day (Table 12). H2S emissions may have resulted mainly from Qalaa drain just about the southern entrance of the city of Alexandria.

Table 12: H_2S concentration recorded at different location surrounding the source of flux area of Lake Maryout during August 2003. (from Said, 2003)

4 August 2003			14 August 2003			20 August 2003		
Location		Con.	Location		Con.	Location		Con.
Long.	Lat.	(ppm)	Long.	Lat.	(ppm)	Long.	Lat.	(ppm)
778810	3450494	2.02	778795	3450488	0.12	779217	3452170	0.30
778558	3450214	2.37	778517	3450166	0.34	778810	3450494	2.16
778958	3450214	0.55	778922	3450461	0.43	778558	3450214	1.14
778928	3450492	1.15	779150	3450617	1.61	776033	3447094	0.42
778503	3451925	0.97	779681	3450634	0.99	774059	3445092	0.69
773770	3449551	1.18	778821	3450469	1.44	772370	3445824	1.08
773740	3449769	1.17	778506	3451923	2.97	778928	3450492	2.91
			774699	3450417	0.42	778503	3451925	1.98
			773780	3449579	0.45			
			773770	3449551	0.68			
			773740	3449769	1.14			
			779214	3452174	0.39			

A more recent report of Shalaby (2004), it recorded levels of metals in suspended particulate matter (aerosols) at Abis (among areas studied) in air samples collected at different sites downwind from the old municipal solid waste dump site. The results obtained are shown in Table 13.

In a different report (Shalaby and Saleh, 2004), dioxins and furans were determined in air and soil samples at Abbis area adjacent to the lake where the main solid waste dumpsite of the city of Alexandria was located. Results in Table 14 show that dioxin was

found in air samples while both of them were found in the soil samples. The study also included determination of those pollutants in the growing plants. The uncontrolled fires, as a result of self-ignition were attributed to the emissions of those pollutants.

Table 13: Mean values of heavy metals (µg/m3) in aerosols at Abis area (from Shalaby, 2004)

Distances and direction from Dumpsite	Cd	Cu	Ni	Cr	Zn
Adjacent to dumpsite	1.35 ± 0.10	3.17 ± 0.10	2.85 ± 0.20	3.05 ± 0.27	2.40 ± 0.18
200m SE	1.2 ± 0.08	2.50 ± 0.08	2.25 ± 0.09	1.95 ± 0.20	2.75 ± 0.17
500m SE	0.40 ± 0.07	0.85 ± 0.01	0.63 ± 0.02	0.85 ± 0.12	2.2 ± 0.19
200m S	0.50 ± 0.07	1.65 ± 0.04	1.25 ± 0.09	1.35 ± 0.08	2.3 ± 0.10
300m S	0.20 ± 0.03	0.35 ± 0.01	0.31 ± 0.01	0.35 ± 0.02	2.1 ± 0.11

Table 14: Dioxins and Furans in air and soil in Abbis area (from Shalaby and Saleh, 2004)

Substance	Sampling	Mean	Minimum	Maximum
TCDD	Air (µg/m^3)	$0.91x10^{-3}$	$0.05x10^{-3}$	$2.50x10^{-3}$
	Soil (µg/gm)	$5.22x10^{-6}$	$0.00x10^{-6}$	$12.25x10^{-6}$
TCDF	Air (µg/m^3)	nd	nd	nd
	Soil (µg/gm)	$0.64x10^{-6}$	$0.00x10^{-6}$	$2.50x10^{-6}$

nd= not detected
TCDD: 2,3,7,8-tetrachlorodibenzo-p-dioxin
TCDF: 2,3,7,8-tetrachlorodibenzo-furan

Climate

The climate in Alexandria is influenced by the Mediterranean Sea. The city has a warm dry climate with steady breezes from the sea that keep temperatures moderate in summer. The prevailing wind direction is from the north and northwest.

Temperature

The following table shows the monthly temperatures around the year:

Table 15: Monthly temperatures in Alexandria

Month	Temperature (°C)		
	Maximum	Minimum	Average
January	19	9.5	14
February	19.5	10	15
March	21.5	11.5	17.5
April	24	14	19
May	26.5	16.5	21.5
June	29.5	21	25.5
July	30	22.5	26.5
August	30.5	23	27
September	30	21.5	26
October	27.5	18	23
November	25	15.5	20.5
December	20.5	11.5	16
Annual	25.5	17.5	21

Winds

The following table shows the monthly wind speed and the direction of prevailing wind:

Table 4-3: Monthly wind speed and direction in Alexandria

Month	Wind	
	Direction	Speed (km/hr)
January	South west	14.5
February	West	14.5
March	West north west	14.5

April	North west	14.5
May	North north west	13
June	North west	13
July	North west	14.5
August	North west	14.5
September	North north west	13
October	North	11
November	North	11
December	South west	14.5
Annual	North west	13

Cloud cover and Sunshine

The variation of cloud in winter gives a maximum in the early morning because of the existence of low sheet type Stratus cloud. This cloud normally dissolves after sunrise. There is a second maximum in the afternoon because of the development of Cumulus cloud. In summer the maximum cloud cover occurs in the afternoon, while in the evening the sky is nearly clear.

The amount of solar energy received per unit area is now generally recognized at the background for quantitative analysis of most of the micro-climatic phenomena of the lower atmosphere. There is no difference in sunshine duration from place to place along the coast, or from year to year. Cloudiness is greater near the coast than inland. Strong radiation prevails from March till the end of September, with a peak in June-July. November, December and January are relatively cloudy.

Relative Humidity and Rainfall

The monthly mean of relative humidity in 2005 is given in Table 16. The lower values are recorded in autumn, due to the hot waves, which invade the area during this season. The rainfall ranges from 180 to 250 mm/year, with most of the precipitation occurring in January (about 120 mm). The maximum daily rainfall in the area is 10-12 mm.

Wind Speed

Prevailing wind speed is shown in Table 16. The prevailing wind speed ranged between 2-4 m/s all over the year. However, summer had a higher wind speed than the other three seasons. The analysis of monthly wind roses has indicated that the prevailing wind direction is northerly to north-westerly direction.

Table 16: Meteorological Information in the Study Area during 2002.

	Meteorological Parameters					
Month	Temp. (°C)	R.H. (%)	W.S. (m/s)	Precipitation mm.	Visibility km	Sea Level Pr. hPa
Jan.	13.4	69.7	3.1	84.8	10.0	1016
Feb.	13.1	66.6	3.4	86.0	10.0	1015
Mar.	15.7	64.4	2.9	0.8	8.9	1016
Apr.	17.7	65.5	3.5	0.9	10.2	1014
May.	21.2	66.9	3.7	0.8	9.6	1013
Jun.	23.8	66.7	3.8	0.00	10.3	1011
Jul.	26.3	68.4	3.8	0.00	10.8	1008
Aug.	26.9	76.5	4.0	0.00	10.9	1009
Sept.	25.5	65.5	3.8	0.00	10.3	1012
Oct.	22.3	62.5	3.6	0.00	10.6	1015
Nov.	17.6	66.2	2.8	4.00	9.9	1017
Dec.	14.8	74.6	2.3	68.40	8.8	1017

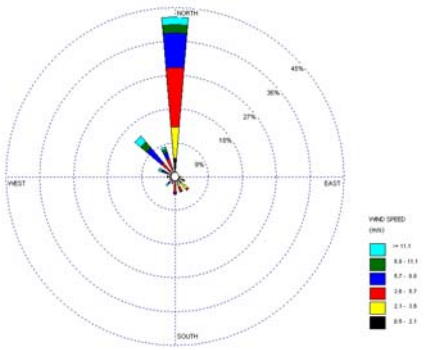
Source: http://www.underground.com/history/airport/HEAX/...../DailyHistory.html

Seasonal and Yearly Average Wind Roses at Alexandria:

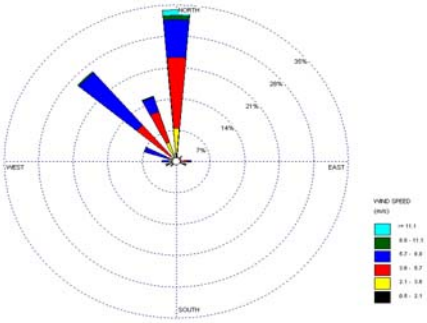
The prevailing wind of Alexandria comes from Northwest. The metrological data collected from IGSR station shows that the highest frequency wind was 33 % along the year 2002 blown from the North-Northwest direction. The least of wind was in the direction north, northeast being 0.92%.

The data collected from IGSR station is plotted as wind roses and these are shown in Figure 16. Wind roses of the four seasons (autumn, spring, summer and winter, respectively) reveal different speeds for the different directions. The strongest windblown is in summer as average, when the wind comes from the most directions with high speed. The strong wind is in summer from the north to north west. While the weakest wind in the year is in spring and autumn. This creates a nice weather in summer because it decreases the moisture content of the air and reduces the risk of condensation, thus, the air temperature is decreased. The wind of this season comes from Northwest only. In spring, the Khamasin wind blows carrying sand and dust, its rate is 13% of the spring wind. The calm weather is 5.5% of the year 2002.

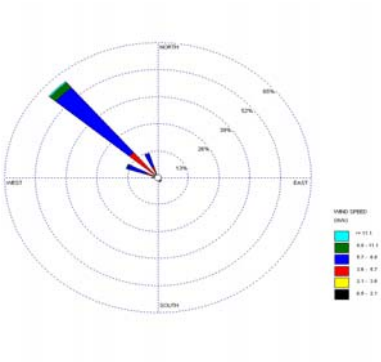
The prevailing wind affects the houses by losing the heat and reducing the humidity and rain penetration. Raising ground temperature, reducing humidity and transport sand and dust recognizes the effect of Khamasin wind.



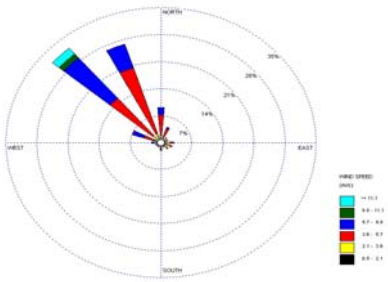
Winter Season



Spring Season



Summer Season



Autumn Season

Figure 16: Yearly prevailing Wind rose

Flora

The vegetation associated with Mariout Lake comprises communities of both aquatic and terrestrial habitats (Tadros and Atta, 1958a). In the aquatic habitat Phragmites australis grows luxuriantly and densely in the shallow water (30-50 cm depth). Inwards, in deeper water, an almost pure population of Eichhornia crassipes is present, and in still deeper parts there are submerged communities of Potamogeton pectinatus associated with Ceratophyllum demersum and Lemna gibba.

Towards the shore of the lake, the soil is saline and halophytic vegetation prevails. The vegetation of this terrestrial habitat can be distinguished into distinct zones. In the submerged soil is a community dominated by Scirpus tuberosus associated with S. litoralis and Typha domingensis. T. domingensis dominates a zone close to that of Phragmites australis and passes gradually into a S. tuberosus community which merges, as the level of the ground increases so that it become less liable to flooding, into a community dominated by either Salicornia herbacea or by Juncus rigidus. S. herbacea

gradually diminishes and is replaced by Salicornia fruticosa which passes gradually to a typical Salicornia fruticosa-Limoniastrum monopetalum zone. The Juncus rigidus community, on the other hand, is replaced by a community codominated by Salicornia fruticosa-Suaeda salsa which passes gradually to a typical S. fruticosa-Limoniastrum monopetalum type. In both situations the ground becomes very dry and saline and a Halocnemum strobilaceum community replaces that of Salicornia-Limoniastrum. On the elevated border of the dry saline beds of the western extension of Lake Mariout is a community dominated by Salsola tetrandra associated with Atriplex halimus, Frankenia revoluta, Limoniastrum monopetalum, Limonium pruinosum and Sphenopus divaricatus.

In the less saline stands of this community Pituranthos tortuosus, Thymelaea hirsuta, Trigonella maritime and other non-halophytic species may grow. This community has also certain affinities with the non-halophytic communities. The Salsola tetrandra zone gradually gives way to a community whose principal constituents are Limoniastrum monopetalum and Lycium europaeum. Associate species include Asphodelus microcarpus, Bassia muricata, Carthamus glaucus, Cutandia dichotoma, Echinops spinosissimus, Filago spathulata, Helianthemum lippii, Ifloga spicata, Launaea nudicaulis, Noaea mucronata, Picris radicata, Plantag albicans, Reaumuria hirtella, Salvia lanigera and Suaeda pruinosa.

Recent studies showed that the water quality and the biodiversity in the lake has been considerably deteriorated due to the discharged of domestic (partially treated or untreated) and industrial waste directly and indirectly to the lake. This has resulted in severe eutrophication to the lake, especially the main basin. Even if secondary treatment is applied, none of the treatment scenarios are expected to significantly alter the nutrients or metal concentration entering the lake from sources other than sewage, the large amounts of raw wastewater from squatters along the contributing drains, the excessive concentration of metals currently in the industrial wastes accompanied with wastewater, and the relatively low removal rates for metals and nutrients achieved by primary or even secondary treatment of any of the wastewater management scenarios are not expected to be changed significantly from the existing situation with respect to water and sediment or eutrophication

Solid and hazardous waste management in Alexandria

Solid waste

Solid waste activities in the Alexandria Governorate are managed by the French Operator Onyx, contracted by the Governorate. The scope of work includes:

- Daily collection of domestic waste from households, markets, shops and roads to be transported to the municipal landfill.
- Removal of construction debris up to 1 ton/location
- Clean up of streets and roads
- Provision of and regular emptying of waste bins in pubic roads
- General housekeeping for beaches, gardens, squares, and other public areas
- Collection and treatment of medical wastes

- Collection of industrial solid wastes
- Rehabilitation, operation and maintenance of compost plants
- Construction, operation and maintenance of the municipal landfill
- Clean up and treatment of the three old dumpsites (Abis, Zayateen and Amreya).

The contract excludes the clean-up of unused lands outside the urban area and waterways. It also excludes the collection and treatment of aqueous and hazardous wastes.

The new municipal landfill is located in El Hammam area, about 40 km. west of Alexandria city. Two composting plants are operating in Alexandria, i.e. the Montaza and Abis Composting Plants. The main composition of municipal solid waste is plastic, paper/cardboard, glass, ferrous metals, bones, rags, aluminium and organic material.

The American Chamber of Commerce has conducted a study on solid waste management in Egypt in 2000. The amount of municipal solid waste generated in Alexandria in the year 1997 is about 4,761 tons per day. This amount breaks down to about 3,648 t/d from urban areas and 1,113 t/d from rural areas.

Hazardous waste

The Nasreya Hazardous Waste Treatment Centre located south of Borg El Arab road is the only hazardous waste treatment and disposal facility in Alexandria. The centre started operations in 2005 and occupies a surface area of 37 feddans. The capacity of the landfill was designed based on the existing demand of the Alexandria Governorate. The centre consists of the following facilities:

- Hazardous waste landfill for inorganic waste
- Physical-chemical treatment
- Storage facility for organic waste.

The wastes typically received at the landfill are:

- Filter cakes from galvanic processes
- Insoluble metal salts like hydroxides, sulphides, sulphates, carbonates and phosphates
- Inorganic wastes from ceramic industry containing harmful heavy metals
- Ash from power stations
- Inert oxides
- Metallurgical slag
- Foundry sand
- Asbestos waste
- Dry solid heavy metal waste
- Contaminated soil, mainly inorganic contaminants
- Empty dry packages contaminated with any of the above material

The landfill does not accept cyanides mercury, explosives, radioactive waste, flammable, oxidizing, reactive, organic waste, domestic or hospital waste.

The solidification-stabilisation process is used when the solubility of certain components (e.g. heavy metals) exceeds the landfill criteria.

Inorganic hazardous waste in liquid or sludge form is processed in the physical-chemical treatment plant.

Socio-economic conditions

The project aims to improve the water quality of the Lake Mariout, which will ultimately result in improving fish production. This section describes the existing socio-economic conditions of fishermen communities in the area.

Population next to Lake Mariout

According to a previous study conducted in the area neighbouring the Lake, three main social groups are identified, namely: fishermen, poorer communities and scattered land divisions.

The fishermen community as a whole forms the poorest and most disadvantaged group in the target area. The fishermen communities are mainly located in inaccessible areas from land, as the infrastructure is limited or non-existent. The problems in reaching these communities with services and interventions have developmental, economic and social impacts. Fishing cannot be carried out throughout the year, and in the idle periods they lack alternative employment opportunities. Their socioeconomic development is limited.

In Egypt fishing activities are carried out almost entirely by males. Women are only concerned with helping the fishermen in preparations for their trips and in helping them to handle the caught of the fish. In rare cases, women are involved in small scale fish trading or retailing. In Lake Mariout, further degradation of water quality and fish production is significantly affecting people's livelihoods. Fishermen rely both on the fishery and vegetation to support their living, as fishing is the main source of income for the majority of fishermen. Vegetation is used for feeding livestock, making fuel for cooking, and as thatching for living quarters. The fishing community in Lake Mariout is comprised of approximately 6,000 fishermen and consists of a regulated hierarchical structure.

This hierarchical structure consists of a head fisherman for the entire Lake and a head fisherman for each of the four basins. Each fisherman and/or family has fishing rights assigned specified areas and are not free to fish anywhere in the lake. Estimates say that the number of fishermen utilizing the main basin exceeds 1,500. Most fishermen live in an area called "Maawa El Sayadeen" (Fishermen shelter).

In a study carried out by SFD shows that 61.85% of the population is aged between 15 - 55 years. This is considered as the typical range for employment. It is evident that the unemployment rate among those eligible for work is high. The more fortunate residents who are working have very low income and are only involved in small/trivial marginal vocations (hand crafts, support staff in local governmental agencies, carpentry, and labour for nearby factories.

Other demographical characteristics were also specified, namely:

- High illiteracy rates (especially that of females).
- Poor health services and high mortality rates.
- High crime rates Tendency to marry young and have large families, as stated before.

Some poorer communities such as Naga' El Arab with a total population of 17,608 inhabitants, are directly exposed to Lake Mariout. The area started to be inhabited in the early fifties, when they filled parts of the Lake and kept expanding by building informal shelters and buildings. Most of them used to fish in the Lake and manufacture/maintain fishing boats.

Fishermen Community

The fishermen community around Lake Mariout is mainly occupied in fishing, with small percentages of the population working as manual workers and others being employed in seasonal jobs. This was confirmed by a socio economic study that was conducted recently (WADI, EU project 2006-2008), on households in the area of Abbis and especially in Bab El Abid settlement and which place fishing at 59.2% followed by some informal jobs (19.7%) within the area. Interviews revealed that not all fishermen have permanent residence around the lake, but that some reside in Gheit-El-Enab, Qabbary and Metras and that the majority live in scattered, unplanned villages. Research into their ancestry showed that they are of various geographical origins and not only from Alexandria as might be assumed. In terms of the length of residence period in the area, a survey indicated that 63.7% of the inhabitants lived in the area for more than 21 years, followed by 26% who have resided in the area from 10 to 20 years, while only 10.4% have lived there for less than 10 years.

Generations that followed the earlier migrants to the lake inherited the fishing profession and handed it down one generation after the other. The skills of the fishermen community are therefore limited to fishing and other trades around the small scale fishing industry (repairing boats, fishing nets etc.). Few, if any other skills are present among the population, a fact that is confirmed by their inability to change profession even during times when fish catch decreases sharply, substantially affecting their income.

A study showed that more than half (54 %) of the sample are from 22 to 40 years old, while 26.7% are from 41 to 60 years old and the rest of the population are from 18 to 21 years old (5.2%) and over 61 years old (14.1%). The sample had a mean age of 40.26 years ±15.45. Nearly two thirds of the samples (61.5%) were females and the rest were males.

The fishermen community suffers from high levels of socio economic stress. The population lives in unsuitable housing, with more than one family often sharing rooms together, and are unable to secure better housing due to the low return that they gain from fishing. Their low income, which results in part from the low fish catch and increasing pressure on the lake, is further compounded by pollution, spread of reeds and water plants and decreasing water levels

The impact of decreasing income on the socio economic situation of fishermen communities include the delay of marriage age and the lowering of living standards. The age of marriage, which used to be in the twenties for both men and women when fish catch was more abundant, has risen to 30-35 years. Older fishermen recall that their income in the past was more profitable than the salaries they would gain in steady employment in the jobs open to individuals with their skills. Yet today, many of these same fishermen now want their children to get an education and abandon the fishing profession.

Despite this, school drop out rates areas among these communities continues to be high as young men search for employment in menial jobs and the cost of education for others, and girls in particular, is prohibitive. Like other poor communities therefore, the fishermen around the lake find themselves in a cycle of poverty, where the low level of education among the community prevents them from obtaining higher paid jobs that require the ability to read and write, and where economic pressure forces families to take their children out of school thereby not allowing them to complete their education. Therefore, while a review of the educational status of the population reveals that illiteracy is prevalent among the population at 91.1% and that only 5.9% could read and write, unless action is taken to encourage education in among the population in the area, current drop out rates are unlikely to improve the educational status of the fishermen communities around Lake Mariout in the near future.

Fish catch in the lake has continued to decline over the past three decades. Fish caught on the lake is sold in two wholesale-markets daily; the first starts at 6 am and the second at 8 am. Wholesale merchants buy the lots and distribute them all over the country in ice boxes. Fishermen are aware of the development of the lake throughout the past five decades and that parts of the lake were filled in the fifties to reclaim agricultural land. At that time the government donated 5 feddans, a home and some farm animals to each fisherman as compensation for their losses. This was particularly true for those who lost their homes after the construction of the "hydrodrome".

From the fishermens' point of view, low fish catch is compounded by the Fishing Law, passed in 1926. The law, which allows for government interference in their fishing activities, regulates and sets limits on fishing gear, the size of net openings etc. While the law is meant to conserve and increase fish in the lakes, rivers and seas, the continuing decline in fish catch per fisherman renders inhabitants of the area skeptical about its efficiency.

A major issue that fishermen are negatively affected by is obtaining fishing permits and licensing their boats. In 2000, the Fisheries Department canceled permits for 1300 fisherman for various reasons. Their union claims that there are now only 1200 registered fisherman and there are 4000 outstanding applications. The authorities however deny giving any more permits to control the fishing in the area since the fishing quota has been over-exceeded. This situation has led to the spread of unlawful fishing activities that subject the fisherman to a fine of EGP 500 in addition to confiscating fishing gear. A further major complaint that fishermen suffer from is the overcharging that fishermen chiefs (Shiekhs) demand in exchange for getting them fishing permits.

In terms of housing conditions, the total number of houses in the area is estimated to be 1,236 while the total population is estimated at 6,792 persons. Streets in the area surrounding Lake Mariout are irregular and narrow. Since they are unpaved, they are muddy, full of refuse and animal excreta from the animals raised by the community and also have wastewater collection as well as sewage overflow. All houses are made of bricks, closely packed together, and consist of one or two floors at the most. The conditions of housing in the Lake Mariout area are very poor. Houses with cement floors constitute 71.4% of the total, those paved 19.1% and those with dirt floors 9.5 %. Housing is characterized by overcrowding where the crowding index for 64.3% of houses ranged from 2-4 person/room and 35.7% have 5 and more person/room, with mean value of 4.28±2.17 person/room. The majority (95.2%) of houses were inadequately ventilated with windows area representing less than 15 % of the total room area. In terms of facilities in homes and food hygiene, the majority of the sample (92.86%) did not have a separate place to prepare food and all cooking activities took place in the living room which is sometimes used also as a bedroom. About 33.3% use gas stoves, while only 4.8% have refrigerators. The majority of the sample (85.7%) had private bathroom, while 11.9% use shared bathrooms.

The impact of housing conditions on the population's health is clear: about 25% of the inhabitants of houses composed of one room had scabies, followed by 10.9% of those composed of two rooms; while 20% of the sample living in houses composed of three rooms suffered from Teniea and more than one third (37.6%) of inhabitants living in houses with two rooms suffered from lice, compared to none of those who lived in three rooms.

It was observed that almost all houses included in the sample had electrical connections but the lighting of the houses was inadequate for 90.4 % of the sample. The houses of the area are also lacking in natural lighting due to the narrow streets and buildings which are stacked close to each other. Regarding water supply in the area, the main sources of water used by the inhabitants in Lake Mariout area are public taps (47.63%). Half (50 %) of the families store water in clean covered containers and only 4.8% store it in uncovered containers.

The main type of sewage system in the area is the latrine (88.1%), while sewers were found only in 11.9% of the houses in the sample. Disposal is done by dumping into the lake (92.8%) while 4.8% is dumped into the public sewage and 2.4% is dumped in the open ducts in the streets. These practices lead to cross-contamination of water supplies through leaking drainage pipes or direct contamination of water sources by untreated sewage overflow from latrines, cesspools or septic tanks.

There is no solid waste management system in the area, and waste is collected in open baskets and dumped into the lake (90.5%). A small percentage of the families (9.5%) dump their refuse in the street. Improper refuse collection and disposal arrangements attract insects, particularly flies of which the house fly and blowfly are the most common, and mosquitoes. It was reported by the dwellers that there were also many rodents and animals including dogs, and cats. Many insects and small animals have an important effect on hygiene and public health because of their ability to transmit diseases. Several species of mosquitoes are known transmitters of encephalitis, malaria, filariasis, dengue fever and yellow fever.

A study[10] on the socio economic and health status of residents around the lake analysed how lake pollutants affect the health of the inhabitants of Lake Mariout area. The study revealed that residents are affected by high levels of pollution from the lake's water, air pollutants and the food they consume. The amount of discharged organic matter in the lake is about 23,000 to 30,000 m3/day. The lake is also highly polluted by nitrite, phosphate and silica as well as heavy metals such as cadmium, nickel, cooper, lead and chromium which come from the waste that factories in the area dump into it. Fish, which is the basic food of the population in the Lake Mariout area, and the most affordable for these limited income communities, is therefore contaminated with heavy metals, putting the health of fishermen communities severely at risk. Several of health disorders are related to consumption of contaminated fish which was estimated to have frequency of 2.97±2.5 times/week and 77.7% of the sample used to eat fish more than once/week.

The lake inhabitants have a past history of bronchial asthma (6.7%), hypertension for 5.9% and 3.7% suffered from bronchitis. There are numerous factors involved in bronchial asthma such as the poor ventilation, overcrowding, and poor hygiene. In addition, the dwellers of the area are exposed to air pollution through their inhalation of hydrogen sulfide, generated from the decomposition of organic matters discharged to the lake combined with the low oxygen level that is a characteristic of the main basin in the locations near to the sanitary wastewater outfalls. Hydrogen sulfide produces shortness of breath as it irritates the respiratory tract and lead to different type of respiratory disorders.

Finally, parasitic diseases, which find a haven in the organic waste and the high level of water plants, are common in Lake Mariout. Their effect on the health status of the inhabitants of Lake Mariout area is clear, as they suffer from parasitic infections including: A. lumbricoid, Schistosoa mansoni, E. histolytica, Glambia and T. trichura, as well as lower infection of Schistosoma haematobium, E. vermicularis and Trichostrongylus in addition to toxoplasmosis. The parasitic snails of the S. hematubium and S. mansoni have been detected in the lake, the latter have a high prevalence among the fishermen of Lake Mariout. The dwellers of the lake Mariout area are therefore exposed to pollutants directly by inhalation or indirectly through consuming contaminated fish and their life around the lake also makes them vulnerable to a number of parasitic infections. Further, Lake Mariout inhabitants are also liable to schistosomal infection due to their work as fishermen.

Most dwellers of the area (76.2%) depend on folk remedies rather than contacting health centers or asking for professional medical advice. Herbal treatments and infusions are dominant (63.6%) and 23.8% of the dwellers use the boiled afta grass in treating stomachache, renal colic, and cough, while boiled green mint was used by 6.2% for the same complains. 14.4% of the population use non-herbal folk remedy such as honey and nigella oil for cough, inhaled "neshowk" powder for headache, boiled herbs for dyspnea, application of wool bandage and boiled oiler paper for joint pain, application of

[10] *Amel Ibrahim Ahmed. 1997, "A Study on the Relationship between some Environmental Factors and the Health Conditions of the Inhabitants of Lake Mariut Area", M.Sc. Thesis, Environmental Studies Dept., IGSR, Alexandria University*

local kohle for eye redness and finally using of palabiaa as suppositories in treating of piles.

Around 69.6% of the individuals living in area were able to identify the different types and causes of environmental problems in terms of low cleansing level, water pollution of the lake, poor sewage treatment system, and presence of insects. But 30.4% of them were not aware of their poor environment and perceive it as normal circumstances. On the other hand 74.1% of them did not relate health problems with environmental pollutants and while 65.9% of the dwellers approved that the construction of a proper sewage system will solve the environmental problem of the area, 1.5% wanted to leave the area and 6.7% thought that there is nothing that could be done to improve the health and environmental situation.

Fishermen perceptions of causes for the Lake deterioration are mainly due to low water level (35%), sewage disposal (35%) and both previous causes (25%). The majority of the interviewed persons determined that the government is responsible for the deterioration of the lake (58%) and with far lower percentages, they blamed the fisheries authority, residents of the area and industries as secondary causes for Lake problems.

The following are specific recommendations the fishermen suggested for the development of the lake area:

- Removing reeds and aquatic plants and opening channels in heavily vegetated areas,
- Stopping all filling activities,
- Ensuring that families are given fair compensation in case of their resettlement due to highway construction projects,
- Issuing fishing permits only to those fishermen who have been resident in the area for a long time,
- Providing health care centers in accessible areas, and
- Providing the community with soft loans for improving their fishing equipment.

Fisheries and Aquatic Resources

By comparison, Lake Mariout is one of four freshwater/brackish water lakes in the Nile Delta near the shore of the Mediterranean Sea. The relative areas, in hectares (ha), and fish production, in metric tons (t), for Lake Mariout and the other four lakes, as reported by GAFRD, are as follows:

Table 17: Comparison between Lake Mariout and other northern lakes in Egypt

Lake	Maryut	Edku	Brullus	Manzalah
Landings (t)	3,500	8,209	59,200	59,600
Area (ha)	6,800	7,100	48,000	80,500
Production (t/ha)	0.5	1.1	1.2	0.7

Both Lake Mariout and Lake Manzalah are adjacent to large urban populations, whereas Lakes Edku and Burullus are adjacent to lower-density agricultural communities and are consequently less affected by domestic and industrial pollution and subject to somewhat less intensive fishing pressure. The production on the more urbanized lakes (Mariout and Manzalah) is on the order of half of the production of the other lakes.

Several types of fishing gear are used for Lake Mariout commercial fishing activities, depending on the target species. In the Main Basin, where the water is turbid, the trammel net is the type of gear most widely used, and tilapia is the main target species. In the Fisheries Basin, where the water is clearer, both trammel nets and submerged traps are used. In the Northwest and Southwest basins, the most common gear type consists of very elaborate barrier traps made of dried phragmites stems, with removable traps placed at intervals along the barrier. Trammel nets are normally used for tilapia at the edge of patches of vegetation, to catch fish that have strayed away from the grassy stands where they feed and obtain shelter. Catfish are caught with baited long-lines or larger wire mesh traps in all basins. One of the major problems of such practices is the widespread of reeds (phragmites) making the available area for fishing even less. The fishing authorities are making efforts to convince the fishermen to use wire cages instead.

A program to increase the minimum net mesh size might be favourably received. Given the rigid, hierarchically organized social structure of the fishery, it seems plausible that a gradual stepwise introduction of fisheries management regulations might work to help the fishery recover. Ultimately, a policy to reduce the level of fishing effort will be necessary to improve the lives of the fishermen and their families that remain in the sector. That can only be achieved through a massive program of refraining, along with financial subsidies to ease the adjustment of the thousands of people who must inevitably leave the fisheries sector over the next period.

The deteriorating status of the Lake has resulted in diminishing fish catch as shown in Table 18, negatively impacting the living conditions for the inhabitants around the Lake and diversion of fishermen to menial jobs.

Table 18: Annual fish catch from Lake Mariout

Year	Production (Ton)	Year	Production (Ton)
1986	8,800	1996	3,976
1987	8,100	1997	4,489
1988	7,770	1998	4,521
1989	3,500	1999	5,235
1990	1,900	2000	6,378
1991	2,200	2001	6,200
19,92	3,500	2002	5,303
1993	3,990	2003	4,861
1994	3,516	2004	5,100
1995	3,466		

Source: General Authority for Fish Resources Development Statistics (2004)

Silting of the lake bottom and the proliferation of *Phragmites* and other water reeds are two processes continuously decreasing the volume of fish rearing habitat. Wastewater discharge into the lake since 1988 substantially decreased the fishery by creating areas where water quality does not support commercially important species of fish, if at all.

Most of the brackish and less tolerant high-valued fish such as *Mugil cephalus, Labeo niloticus*, *Bagrus bajad, Lates niloticus*, and *Barbus bynni*, decreased or completely disappeared from the lake. On the other hand, *Tilapia spp.* Flourished and has come to represent about 90 % of the total yield in recent years. Also *Clarius gariepinus* production increased from 900 tons in 1996 to 2,341 tons in 2000. The predominance of Tilapia and increase of *Clarius gariepinus* production in Lake Mariout is due to their high tolerance to marginal environmental conditions, in terms of oxygen concentrations, high nutrient loading, and variation in salinity.

Another significant factor contributing to the depressed status of the fishery is excessive fishing pressure throughout most of the lake. This seems to result, at least partially, from the decreased yield unable to meet the needs of small-scale commercial fishing which remains an important economic activity on the lake.

One of the methods through which the fishermen had tried to adapt to the changing conditions is fishing with cages. Fishermen make these cages from reeds and hence spread the rhizomes of the plant over relatively large areas. Accordingly, this practice unintentionally created an additional problem as it helps reed proliferation.

CHAPTER 5 POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS

General

This section presents an analysis of the potential positive and negative impacts of the proposed project activities. In evaluating the potential impacts of the project, the checklists provided in the Environmental Assessment Sourcebook of the World Bank (Technical Paper Number 140, Volume II: Sectoral Guidelines, 1991) were used. The following sections list the main impacts identified.

Anticipated Positive Impacts

The Global benefits expected from the project include:

- reducing trans-boundary pollution from Lake Mariout to the Mediterranean Sea. The reduction of nutrients (nitrogen, phosphorous) and oxygen demanding substances (COD, BOD) at El Mex bay represents global benefits in terms of an improved water quality flowing into the international waters of the Mediterranean Sea.
- improving Lake Mariout's biodiversity. Once important for its high value fish species (e.g. *Mugil cephalus, Labeo niloticus, Bagrus bajad*), the water quality has drastically deteriorated during the last two decades. Currently, the lake is dominated by less valuable fish (*Tilapia*) and about 60 percent of its surface is covered by weeds and aquatic plants[11]. The reduction of COD, BOD, and nutrient loads from the lake and the improved water circulation resulting from reed removal are expected to improve the lake's biodiversity, helping endemic biota to begin to re-occupy its niche within the lake's ecosystem.

Local benefits include:

- Potential sales of duckweeds. In addition to removing nutrients from water, duckweeds have also economic use as feed for fish, chicken, and ducks (Landolt and Kandeler, 1987), or organic manure (Culley et al., 1981). World Bank (2009) estimates that duckweeds generate a total protein yield of 20 t/feddan per year and their lowest price on the market is US$735/t. On a total pilot area of 30 feddans, the potential sales value of duckweeds would be about US$441,000 per year.

- Improved air quality**.** The package is expected to improve water quality in Qalaa drain and Lake Mariout, which might lead to improved air quality by reducing the noxious smell in the vicinity of the lake. The lack of information does not allow the estimation of this benefit. It should be noted however that most air pollution is due to emissions of traffic and industry, rather than the lake itself. Thus, even in lack of estimates, we can assume that the benefit of improving air quality due to the GEF interventions is small.

[11] Based on discussions with the Fisheries Department of the Ministry of Agriculture, the Fishermen Association and the Fishermen Syndicate.

- Increase in fish production. It is assumed that sufficient improvements in water quality through the reduction of COD, BOD, nutrient load, and heavy metals would increase both the fish catch and its quality for consumption. It is assumed that the interventions increase the fish catch by 1 percent annually compared to the baseline scenario, the present value of the additional fish catch would be US$480,000; a 5 percent increase would generate US$680,000, and 10 percent increase would generate US$1.4 million.

The following is discussion on each of the project's component's expected impacts.

Component (1): Planning, Institutional Capacity and Monitoring

Although this component has no direct impact on the environment, yet its indirect positive impacts are obvious. Strengthening the management and institutional capacity of the relevant agencies that are responsible for managing Lake Mariout will ensure that improvement programs for the Lake will be properly implemented and continuously monitored. This will be achieved through various capacity building programs as well as procurement of necessary hardware and software that will allow the entities responsible for the management of the coastal zones in and around Alexandria to be able to better coordinate and integrate their activities in a way that should result in improvement of the overall environmental.

The expected outputs of this component which are the master plan for management of the coastal zones of Alexandria and the establishment of the water quality monitoring network for the Lake Mariout are key elements of the sustainability of any environmental improvement program as well as a safeguarding measure that prevents unsustainable practices to take place within or around the coastal zones of Alexandria.

Component (2): Pollution Reduction

This component with its proposed intervention will result in improving the water quality of Lake Mariout. Although it is determined that the interventions under this component will be implemented as demonstration or pilot projects, the pre-feasibility studies expect some improvement in the Lake water quality.

This improvement will affect positively the aquatic environment of Lake Mariout with an anticipated increase in the fish yield which in-turn will improve the livelihood of the fishermen community utilizing the Lake as their main economic resource

The expected positive impacts of Component 2 can be summarized as follows:

- improvement of Lake Mariout water quality by reducing at least 5% of the pollution levels
- The fish yield is expected to increase due to the improvement of water quality
- Application of low-cost technologies as pilot projects provides a chance for scaling-up the project in the future to achieve more significant water quality improvement

- The interventions can be demonstrated as an appropriate model for replication in other polluted lakes in Egypt
- Reed removal will allow fishermen to have better access to fishing grounds and will remove a major source of problems in the Lake

Component (3): Project Management, Monitoring and Evaluation

The completion of the comprehensive monitoring and evaluation scheme for the project ensures the timely delivery of the entire project's activities. This will have an indirect positive environmental impact due to the assurance of the smooth implementation of the project and monitoring the progress of each of the project intervention programs.

Anticipated Negative Impacts

The following environmental receptors are the ones relevant to the project activities and they will be used to assess the environmental impacts of the different activities on each of them.

- Air
- Soil
- Water Bodies
- Aquatic Ecosystem
- Terrestrial Ecosystem
- Noise

The assessment of negative impacts is based on a quantitative assessment ranging from 1-4 where "4" is high impact and "1" is neutral or negligible impacts. The assessment will be conducted against the following attributes:

- *Reversibility of the impact:* irreversible being more significant.
- *Direct or indirect impacts:* direct impacts being more significant.
- *Geographical zone of impact:* regional impacts being more significant than local impacts
- *Duration of the impact:* permanent impact being more significant than short term
- *Probability of Occurrence:* The higher the likeliness of occurrence the more significant the impact is
- *Severity of the impact:* More severe impacts (such as loss of habitats) are more significant.
- *Cumulative nature of the impact:* The cumulative impacts are more severe than single effect impacts

The decision for impact evaluation is based on the following rules:

- If any of the attributes is ranked "High", the overall impact is significant
- For an impact to score as "Neutral" or no impact, all attributes has to be ranked as "Neutral"
- For the rest of rules, an impact is evaluated based on the dominant ranking.
- In case of a tie, the higher rank prevails (e.g. if the number of attributes ranked as "Low" equals the number of attributes ranked as "Moderate", the overall impact is considered of "Moderate" significance.

Analysis of Impacts

Impacts during Construction

Both components (1) and (3) have no physical interventions and there are no anticipated negative impacts associated with them.

Component (2) is mainly an environmental improvement intervention that aims at reducing pollution levels in Qalaa drain and the Main Basin of Lake Mariout. The technologies used are simple and do not include sophisticated equipment or use of any chemicals or hazardous materials. However, an assessment of some of the impacts that might be associated with the construction and operation of the proposed interventions will ensure achieving the desired goals and minimize the risks of negative results.

Transportation of construction materials and personnel: The main adverse impacts associated with transportation are air pollution and increased noise levels. The impacts are expected to be temporary and will end by the completion of the construction activities. It impacts on air quality and noise levels are ranked as “Low”.

Storage of construction materials: This environmental aspect may result in polluting soils and adversely affecting the terrestrial ecosystem within the storage area. However, since the construction materials used are not including any hazardous materials in addition to the absence of any sensitive habitats in the vicinity, therefore the impacts on soil and terrestrial Ecosystems are considered “Low”.

Use of heavy machinery: The use of machinery during construction of the in-lake wetland may cause disruption of aquatic and terrestrial ecosystems, pollution of the lake water, degrade air quality and increase noise levels. Since this aspect is limited to the construction period and all the impacts are reversible after completion of construction works, the impacts are expected to be “Low”.

Temporary storage of excavated contaminated sediments: Deepening of the lake will result in big volumes of excavated sediments (sludge) that may be contaminated with different pollutants including heavy metals. The excavated sludge if improperly stored will be considered as hazardous wastes that may result in land contamination which in turn may cause future health risks if these lands are cultivated. The risks associated with this aspect are considered high due to the severity of the impact and the difficulty in reversing it. The impact is ranked “High”.

Disposal of excavated contaminated sediments/sludge: The improper disposal of the contaminated sludge may allow uncontrolled usage of this sludge in agricultural activities, thus causing health risks. The risks associated with this aspect are difficult to reverse and the severity is significant therefore the impact is ranked “High”.

Temporary storage of contaminated reeds: The removed reeds from the lake will need to be temporarily stored before deciding on their final destination. Some parts of the reeds may have accumulated pollutants, including heavy metals, over the past years. The storage of the removed reeds on clean soils may result in land contamination and disruption of terrestrial ecosystems. The overall impact is ranked “Low”.

Disposal of contaminated reeds: As explained earlier, reeds might be contaminated with several pollutants. Improper disposal of contaminated reeds whether by burning, dumping or uncontrolled recycling will have moderate negative impacts on air, soil and terrestrial ecosystems. The overall impact is ranked “Moderate”.

Introduction of alien aquatic plant species: Duckweeds are proposed to be introduced as part of the engineered in-lake wetland to take part in the pollution reduction in the lake. The duckweed is not naturally occurring in the lake and is considered alien to the lake aquatic ecosystem which might be disrupted. Since duckweed is a common aquatic plant species and it will be introduced in small sections of the lake, it is not expected that there will be significant negative impacts on the aquatic ecosystem of the lake. However, due to some concerns regarding this plant whether it exists on the national level or not, the overall impact is ranked “Moderate”.

Impacts during Operation

Maintenance of the in-stream biofilm: The PVC pipes used as part of the in-stream biofilm intervention as well as the associated parts will need periodical maintenance and cleaning. The parts that will be removed or cleaned will contain pollutants that are accumulated from the treatment process. If cleaning or disposal of the contaminated parts takes place improperly on soils or water bodies, this will result in soil contamination and pollution of water bodies. Since these parts will accumulate pollutants and need special care during maintenance or final disposal, the overall impact is ranked as “Moderate”.

Removal of duckweeds: The duckweeds will need to be removed periodically as part of the maintenance of the natural treatment system. Duckweeds will contain pollutants that are absorbed and bio-accumulated by the plants. Storage and disposal of the duckweeds after removal will have negative impacts on air (if burnt), soil and terrestrial ecosystem. It is also possible to reuse the duckweeds as animal fodder, however, if they are contaminated with pollutants that may result in serious health risks. The overall impact is ranked as “High”

Use of electrically driven aerators: The chosen aerators to be installed will utilize electrical energy. Electricity generation in Egypt is mostly dependent on combustion of fossil fuels that results in air pollution. Since the impacts of this environmental aspect are in-direct and minimal, the overall impact is considered “Low”.

Table 19: Overall Environmental Impact Assessment Matrix

Activity	Environmental Aspects	Environmental Receptors Affected							
		Air	Soil	Water Bodies	Aquatic Ecosystem	Terrestrial Ecosystem	Noise	Health & Safety	Overall Impact
Impacts during Construction									
Installation of In-Stream Biofilm	Transportation of materials and personnel	L	N	N	N	N	L	L	**L**
	Storage of construction material on drain sides	N	L	N	N	L	N	N	**L**
Dredging	Use of heavy machinery	L	N	N	N	N	L	L	**L**
	Temporary storage of excavated contaminated sediments	N	H	N	N	M	N	M	**H**
	Disposal of excavated contaminated sediments/sludge	N	H	N	N	H	N	M	**H**
	Degradation of water quality	N	N	L	L	N	N	L	**L**
	Disruption of aquatic ecosystems	N	N	N	M	N	N	N	**M**
Removal of Reeds	Use of heavy machinery	L	N	N	N	N	L	L	**L**
	Disruption of aquatic ecosystems	N	N	N	M	N	N	N	**M**
	Temporary storage of contaminated reeds	N	L	N	M	L	N	N	**L**
	Disposal of contaminated reeds	M	M	N	N	M	N	M	**M**
Construction of In-Lake wetland	Introduction of alien aquatic plant species	N	N	N	M	N	N	N	**M**
Impacts during Operation									
Maintenance of the in-stream biofilm	Cleaning and disposal of biofilm parts	N	L	L	N	N	N	N	L
Maintenance of In-Lake wetland	Removal, recycle or disposal of duckweeds	L	L	N	L	L	N	H	H
Use of electrically driven aerators	Consumption of fossil-based energy	L	N	N	N	N	N	N	L

N: Neutral or Negligible
L: Low
M: Moderate
H: High

Socio-economic impacts

The proposed project with its 3 components aims at improving the lake management schemes as well as reducing the environmental pollution in the lake.

Impacts on fishermen community

Although the expected pollution reduction in the lake is not expected to be higher than 5%, yet this small improvement will result, on the long run, in increasing the fish yield and decreasing the health risks associated with fishermen activities in the lake.

It is anticipated that due to the improvement in the lake water quality, fishermen can sell their catches at higher price because of the possibility to have higher market value fish.

The project has also included in its structure the recruitment of a social development expert who is mandated to provide guidance to the project to implement activities that will involve the fishermen in the project during its different stages with the vision of ensuring buy-in and contributing to the improvement of the fishermen's socio-economic activities.

During operation, it is not expected to interrupt or prohibit any fishing activities close to the planned in-lake wetland due to the fact that fishermen are not currently accessing the main basin for fishing due to the dense vegetation covering that basin. Besides, the proposed location for the in-lake wetland is at the most polluted spot in the main basin at the effluent of Qalaa Drain, where no fishing takes place. As for Qalaa drain, it is not considered as a fishing zone due to the high pollution levels that exist in its waters. These facts have been confirmed during the public consultation where fishermen determined that that the majority of fishing activities currently take place in the fisheries basin. They also determined that the main basin, where the project physical interventions will take place, is not currently used for fishing activities. On the contrary, fishermen requested to initiate the project activities as soon as possible and to expand the area of intervention especially concerning reeds removal to allow them to have access to the main basin.

The drains are not a source of revenue and none of the pollution reduction activities on the drain would result in any land take nor would interfere with any of the economic activities of the residents.

Finally it has been concluded that since the project's physical interventions are taking place inside the Lake and Qalaa drain, no land take will be needed and consequently no resettlement is anticipated.

In terms of the long term possible socio economic impacts of developing the Integrated Coastal Zone Management Plan, the project does include a set of checks and balances to ensure that social impacts, especially on marginalized groups, from the plan implementation is minimized, through the following:

(i) The National Committee on Coastal Zone Management Plan, which provides the ultimate oversight on coastal zone management issues in Egypt, including the

endorsement of the development of the Integrated Coastal Zone Management Plan, includes representatives from nongovernmental organizations

(ii) The Project Steering Committee includes a representative from the Lake Mariout Development Committee, which represents the interests of the local communities, in particular the fishermen community during project implementation; as well as representatives from the civil society.

(iii) Financing for the project's first component will include "public consultation workshops and master plan dissemination", which will ensure that the views and interests of the civil society agencies are well represented.

Other socio-economic impacts

Improving the overall environmental conditions of the lake is expected to encourage investments around the lake which in turn may reflect positively on the surrounding poor communities.

CHAPTER 6 : ANALYSIS OF ALTERNATIVES

In this chapter, a discussion of the project alternatives is presented. Each alternative has been carefully assessed and the justification for selection of preferred alternatives is demonstrated.

1. Project Alternatives

The “no project” option

The “no project” option meant failing to recognize that there is an urgent need to support the GOE in its effort to improve its coastal zone management. A “no project” approach would have meant a continued fragmented approach to coastal zone management in and around Alexandria area, little consideration for biodiversity conservation and ecosystem issues, limited investments specifically targeting more diffuse upstream agricultural drainage water and rural domestic wastewater, reduced capacity to monitor water quality in and around Alexandria on a regular basis, limited participation of local communities and relevant stakeholders and foregoing the skills and information to replicate the piloted technology at a larger scale. This alternative is therefore rejected.

2. Focus of Intervention

The main focus of Alexandria Integrated Coastal Zone Management Project (AICZMP) is to reduce pollutant loads discharged by El-Mex Pumping Station to the bay and hence to the Mediterranean Sea. Several projects have been suggested and the “Pre-Feasibility Analysis for ACZMP Pollution Reduction Measures” studied several alternatives according to technical, financial and organizational factors to achieve this goal.

Based on several criteria it has been decided that the main basin of Lake Mariout is the main contributor to the pollution of El Mex bay. Although the main basin of the lake receives pollutants from several sources and drains, the Qalaa drain is the source that affects the most of this basin. The Qalaa drain has a high concentration of pollution and given the directions of water flow to El-Mex pumping station; it is considered the highest contributor to the whole lake deterioration. Accordingly the proposed interventions focus on the point of discharge of this drain to the lake main basin.

3. Conceptual Intervention Alternatives

Treating only point source (industrial) pollution

One of the technical options for the pollution reduction measures involves building a centralized industrial wastewater treatment plant for a group of tanneries that pollute El Mex Bay. This alternative is discounted because it provides a disincentive both for the group of tanneries to pay for the pollution they are ultimately causing and disincentive for other firms that wish to improve their environmental performance, through borrowing

money from the EPAP II project. Ultimately, the tanneries as well as industries that currently discharge industrial effluents into the lake will have to comply with the Egyptian legislations concerning discharge on water bodies, Until this happens, an immediate action is needed to improve the current status of the lake.

Reusing wastewater for landscaping

The option of diverting part of the primary wastewater from the West Treatment Plant currently being discharged to the basin, through reusing the water for landscaping, has also been considered. Although this would significantly reduce the load of urban domestic waste pollution that enters the Lake, it will not address the removal of nutrients, essentially originating from agricultural drainage water as well as rural wastewater. In addition, there will be a need to pump and store significant quantities of water which is practically complicated and the costs involved with such an operation would be excessive and with questionable financial sustainability.

4. Pollution Reduction Projects Alternatives

Alternative Pollution Reduction Projects (PRPs) take into consideration the on-going efforts which address an important part of the pollution load reaching the main basin. They are therefore mainly addressing the residual flows of agricultural run-off in addition to municipal wastewater including that generated by smaller towns and villages in the area and discharged to the drain, which could be partially treated, poorly treated or not treated at all.

The categories of pollutants to be addressed in the influent steam are BOD/COD as well as nutrients. However, their actual concentrations could vary, based on effectiveness of Municipal Wastewater treatment as well as their normal seasonal variability (both for Wastewater and run-off) and time trends resulting from population increase and the normal time lag before adequate measures are taken to address it. Accordingly, the sensitivity of the PRP to variation in flows, concentrations and loads should therefore be within reasonable bounds.

The land surrounding the water system under consideration is fully occupied either by agricultural fields or by human settlements. It is therefore imperative, in order to reduce as much as possible the impacts on human activities that the PRPs be located within the boundaries of the water bodies composing the system under consideration (the main basin and the drains discharging in it, including their tributaries)
Sustainability is a major concern for the PRPs. This will be reflected in two important additional criteria:

- The PRP should be moving the ecological system to a better equilibrium, i.e. improvements should not be of a temporary nature and are most likely not to be reversed with time; and
- PRPs with high operational costs should, as much as possible, be avoided.

Sustainability could also be reflected in having a clear and stable institutional owner which will be engaged in both the implementation and operation phase of the PRP.

5. Selecting a single intervention versus package intervention

A set of pollution reduction intervention projects is considered and reviewed independently against a multi-criteria analysis technique. The interventions considered fall under three major groups, namely:

1. increase DO level in the Drain through aeration (two approaches were proposed),
2. use of Bio-film for pollutant treatment (which also falls under two major possibility for operation, aerobic and anaerobic) and;
3. applying Engineering Wetland practices (either in-stream or in-lake).

In addition, improving the water circulation in the basin through reed removal is already considered as a base intervention.

As a conclusion of several studies, the following interventions are proposed:

a) In-Stream Biofilm (aerobic/anaerobic)
b) In-Stream Aeration (electric/solar)
c) Constructed Wetland (In-Stream/In-Lake)

The following sections evaluate each single pollution reduction intervention. It is however likely that none of the alternatives considered will independently address the Qalaa pollution load due to the limitations inherent in each application. The need for a package of interventions has been therefore determined. However, in order to outline the recommended package, the proposed interventions are systematically compared in the following sections.

Comparison Criteria

All alternatives generated comply with the location criterion (to be inside the water bodies, due to lack of land to acquire for their implementation), as well as the sustainability of their impact on the ecological system, given continuous operation.

In terms of sensitivity to concentrations, the biofilm, and in-stream wetland are seen to be flexible, while aeration is easily adjustable. On the other hand, the benefits envisaged from the in-lake wetland are highly sensitive to the inflow of availabEGP nutrients.

Concerning reasonable operational costs, all alternatives comply with this criterion, except the electric powered aerators. As it was seen in the relevant section, aeration is imperative and use of renewable energy for aeration is subject to site constraints.

Because of the importance of both aeration, to maximize performance, and the in-lake wetland, for cost recovery reasons, none of the options are excluded based on their non-compliance with the original criteria.

Further comparison between alternatives is performed below according to multiple criteria analysis. Changing the water circulation pattern, to improve self-purification of the basin, is another key input to improve the quality of Lake Mariout which is addressed by the reed removal, already to be taken as a base but not independently sustainable, intervention. Therefore it will not show in the comparison below.

Effectiveness

Elevated level of BOD, COD, TSS, nutritive salts and ammonia are the major threat to the environmental quality of Lake Mariout. Decreasing the pollution load reaching the Main Basin through Qalaa drain is the focus of the potential PRPs. Irrespective of other criteria, the proposed intervention should substantially contribute to the reduction of this pollution load.

The alternatives are compared first according to effectiveness, or the potential to substantially reduce the Qalaa pollution load, and subsequently according to the following criteria.

- Technical Ease of Implementation
- Investment Costs
- Financial Sustainability
- Institutional Clarity
- Potential Suitability as a "Pilot" based on potential for scalability in the same site and/or replicability in other sites.

Alternatives Compared

Based on a detailed study of each independent intervention, the following table presents the effectiveness of each on the main pollution parameters identified.

Table 20: Effectiveness of Different Solutions to Major Threats to the Main Basin Lake Mariout

Hazard/Threat / Impact on	High COD/BOD	High Nutririve Salts	High Ammonia	Average
In-Stream Biofilm (aerobic)	5	3	1	3.0
In-Stream Biofilm (anaerobic)	1	1	1	1.0
In-Stream Wetland	1	1	1	1.0
In-Lake Wetland	3	4	3	3.3
In-Stream Areation (natural)	2	1	1	1.3
In-Stream Areation (electric)	4	1	4	3.0

1=Low 5= High

Biofilm operated in anaerobic conditions cannot address the pollution load carried by the Qalaa drain to the Basin. Moreover, because of site constraints, in-stream aeration based on renewable energy, can only marginally contribute to reducing BOD/COD at the utmost but are not able to contribute enough aeration to oxidize ammonia.

Finally, because of design constraints, the in-stream wetland, although effective in its own context has a limited contribution to the reduction of this pollution load. These two alternatives cannot be relied upon for substantial improvement of the quality of Qalaa drain. However, as they are effective in their own right, and are seen to exhibit good cost effectiveness, they are therefore taken further in the comparison, while the anaerobic biofilm is excluded.

The following table compares between the remaining potential interventions. They are all highly suitable as pilot projects, both in terms of replicability and scalability, except for the naturally driven aeration and the in-stream wetland which do not have the potential of up-scaling in the site. The locations in which they can be applied are limited.

Table 21: Solution Suitability

Impact / Solutions	Technical Ease of Implementation	Financial Sustainability Potential	Institutional Clarity	Suitability as a "Pilot"	
In-Stream Biofilm (aerobic)	3	3	5	5	4.0
In-Stream Aeration (electric)	4	1	5	5	3.75
In-Stream Aeration (natural)	4	3	5	3	3.75
In-Stream Wetland	3	3	5	3	3.5
In-Lake Wetland	3	3	3	5	3.5

1=Low 5= High

Similarly, most of them have their technical issues such as sensitivity to initial conditions, which require high technical inputs in the design stage, and their need for adjustments along their life time according to changing conditions. Aeration options are exceptions to this general characteristic. Although naturally driven aerators are sensitive to the stream flow, its velocity is not expected to decrease. Moreover, the extremely low operation costs of this alternative make adjustments a trivial issue. Adjustments for electric powered aerators are based on simple DO measurements. Together with accumulated experience in relation to their operation, this makes them technically superior to the other alternatives in respect.

The biofilm, in-stream wetland and aeration options are characterized by their institutional clarity. The in-lake wet land, on the other hand, could face initial institutional conflicts for large scale implementation utilizing a large portion of the basin. Moreover, the overlapping responsibility of MWRI and MALR could be manageable if addressed as early as the feasibility stage.

Although, as clarified in Table 22, the in-lake wetland has the highest potential for cost recovery, the size of investment required for its full implementation as a treatment option is prohibitive. Although the biofilm and the in-stream wetland options have a limited

potential for cost recovery, their limited running costs increases its potential for financial sustainability. As expected, the electric powered aeration characterized by high operating costs and the lack of substantial cost recovery options, scores very low on financial sustainability. In terms of financial sustainability, the in-stream wetland and the naturally driven aeration are superior in terms of low capital investments and low O&M costs.

Table 22: Potential Financial Sustainability

Economic Impact / Solutions	Capital Cost	Running Cost	Possibility of Cost Recovery	Average
In-Stream Biofilm (aerobic)	3	4	2	3.0
In-Stream Aeration (electric)	2	1	1	2.0
In-Stream Aeration (natural)	4	4	1	3.0
In-Stream Wetland	4	4	1	3.0
In-Lake Wetland	1	3	5	3.0

1=Low 5= High

Outline of the alternative Packages

It is to be noted that the natural aeration and the in-stream wetland are comparable with other options relative to all criteria except for effectiveness which is mainly related to the context in which they are considered. The main package to be considered will thus be composed of the biofilm with needed, or additional, aeration and the in-lake wetland.

At face value, the In-stream aerobic biofilm seems to be superior to the other options. However, the fact that the drain is currently anaerobic would mean that aeration is needed to provide the adequate aerobic conditions. The higher costs of this package still provide a reasonable cost per ton of COD removed. However, the high running costs of aeration if not coupled with a serious cost recovery component might put the whole investment at risk of reverting to the substantially lower efficiency of operation under anaerobic conditions. The high potential for income generation represented by the duckweed crop should be thus integrated within a larger package. The reliance on oxidation of ammonia and the extensive use of biofilm for de-nitrification might be effective in protecting the basin for the load of nutrients it now receives. However, when seen in the context of an alternative use of these nutrients to generate a steady stream of income, it is a waste of a valuable resource typically characterizing selecting treatment for disposal when a recycling option is available.

By integrating the Bio-Film, the Aeration and the in-lake wetland techniques better results are expected. The synergetic effect of the In-Stream Bio-film and the In-Stream Aeration will give the In-Lake Engineered Wetland a medium water quality permitting the latter to initiate its own ecological cycle that will permit the cultivation of duckweeds that will in its turn absorb the nutritive salts, oxygenate the effluent and share enormously in

the cost recovery and running cost of the other components of the project. The combination of Duckweed production, even without taking fish production into account[12], generates considerable income that will enable continuous operation, management monitoring and improvements. Depending on the actual revenues, it might even be utilized to support replication in other locations suffering from similar problems.

Table 23: Suitability of individual components versus integrated package

Impact / Solutions	Technical Ease of Implementation	Financial Sustainability Potential	Institutional Clarity	Suitability as a "Pilot"	
In-Stream Biofilm (aerobic)	3	3	5	5	4.0
In-Stream Aeration (electric)	4	1	5	5	3.75
Biofilm/aeration	3	1	5	5	3.5
In-Lake Wetland	3	3	3	5	3.5
Integrated Package	3	3	4	5	3.75

1=Low 5= High

As shown in the Table 23, the integrated package reflects the superiority of its constituting components. The necessity to package aeration with the biofilm is considered first, and is seen to decrease the financial sustainability potential of the biofilm if considered alone. This is, however, corrected for the integrated package when the potential of cost recovery from duckweeds is included. Moreover, because of the smaller area required for the wetland in an integrated package, it is expected that the potential conflicts will be more manageable. The actual configuration of recommended package depends on the available investment budget discussed in the next section

Tailoring to Budget Constraints

The budget available for the PRP's is EGP 22.5 Million after deducting costs for studies, and contingencies with the assumption of no government contributions..

Three main components that need to be implemented within this ceiling are:

1. Integrated Biofilm/aerator to consume COD/BOD; and
2. In-lake wetland to consume nutrients, and provide crucial income for cost recovery.
3. Reed removal, to improve water circulation (and thus in-lake aeration and sediment improvement.

Within the given budget constraints, major trade-offs are envisaged between these three components. However, some physical and financial requirements constrain these trade-offs.

a) There is a need to avail nutrients in NO2/NO3 before they reach the in-lake wet land, i.e. ammonia oxidation needs to be almost completed; accordingly
b) The larger part of the COD/BOD in the stream needs to be consumed; and

[12] Fish production could also add to this stream of income. It might, however, be more problematic to direct it to cost recovery as it represents the local community source of livelihood.

c) The only source of revenue potential utilized for cost recovery is related to the marketable products grown in the wetland.

Since the consumption of the COD/BOD relies on the level of performance of the biofilm in aerobic conditions. The uncertainty resulting from the wide range of possible performance represents a major driver of the potential PRP package. Moreover, an in-lake wetland of a big scale cannot be implemented as part of this package.

Different iterations of the budget allocations to different components of the package are described below.

Package 1
Assuming biofilm works with high efficiency (COD removal rate of 75% for one set of 500 sections)

- One set of biofilm and one set of aerators (at the direct down stream of the ETP, or in Location A), EGP 11.35 M
- One set of aerators in subsequent location (A or B respectively) to oxidize ammonia, (as needed since could be oxidized naturally if no high oxygen demand exist), EGP 1.85 M max
- Reed removal to improve water circulation in the basin, LE3.5 M
- Downscaled instream wetland, EGP 5.8 M (or approx 48 feddans)

This package addresses all needed functions at a reasonable level, and ensures substantial cost recovery. The risk involved in selecting this package is related to the uncertainty of the actual efficiency of the biofilm. This risk is, however, partially mitigated by the expected improvement of COD load in Qalaa drain resulting from ETP upgrading. The lack of information about the relative contribution of the ETP to the current load limits the possibility of improvement estimation. The improvement of the ETP effluent might indicate that at least 30% improvement of the Qalaa drain quality could be expected. However, this might also be partially balanced by an increase in effluents from population centers not served by the treatment plant.

Package 2
Assuming biofilm works with minimal efficiency (COD removal rate of 43% for one set of 500 sections), it will need to be replicated to reach an efficiency comparable to that achieved in the high efficiency case. The efficiency of the second set assumes a lower rate of removal resulting from its influent's lower pollution concentration achieved by the first set.

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- Two sets of biofilm with aerators (in both the direct downstream of the ETP and Location A), EGP 22.7

In this least performance case, the budget could be exhausted without including the Reed removal, the potential need for additional aeration, and the in-lake wetland. This package thus cannot achieve the functions it should play in an integrated system. The improvement of the quality of Qalaa influent in terms of oxygen consumption demand is likely to naturally increase the DO level in the basin. However, the continuous flow of

nutrients to the basin and the stagnation characterizing it will provide for its consumption by the dominant rooted vegetation.

Moreover, the lack of cost recovery potential could be detrimental to the sustainability of the intervention.

Within the given budget constraint, the potential for a high COD removal (of 75%) can only be achieved based on the max/max performance of the biofilm/aerators package. It is therefore imperative to rebalance the investments as proposed.

Package 3

In this package, a middle ground is sought. It still assumes that the first set of biofilm operates at the min/min efficiency, and that the additional biofilm sections have a lower efficiency than the first set.

Given the high running costs of operation, especially that of the electric powered aerators (EGP 85,000 per 50HP aerator), the whole system could collapse without a serious cost recovery option. Although this needs to be confirmed at the feasibility study phase, 30 feddans seem to represent the minimum area required for the In-Lake wetland. This area is potentially translated to a yearly sales of EGP 2.4 M, which could cover its running costs as well as those of the package of biofilm/aerators. It will, however, not cover depreciation. This option thus takes this area as an additional constraint.

A marginal reduction of the portion removed of the existing rooted vegetation in the south-eastern corner of the basin from 25 % to 20% is needed to insure a proper balance of the budget allocated for different components, as described below.

1. A budget is allocated for 625 sections of biofilm together with required aerators, EGP 14.2 M
- One additional set of aerators to oxidize ammonia, (as needed since could be oxidized naturally if no high oxygen demand exist), EGP 1.85 M max
- Downscaled reed removal to improve water circulation in the basin, LE2.8M
- A minimum area of in-lake wetland (30 feddans), EGP 3.65

If additional aeration is not needed, the budget reserved for it could be redirected to any of the other components.

This option is expected to approach 50% reduction of COD, with the biofilm's at min/min performance, is likely to avail nitrogen in the form usable by the duckweeds, and will afford to clear reeds in selected channels in the basin (selected based on hydrodynamic modeling).

The reduction of load resulting from the ETP upgrading could make the final effluent from the Qalaa drain of reasonable quality (less than 50mg/l), and a higher conversion of NH4 to NO3 (being currently in the drain of 1.37 and 2.5 mg/l respectively). This should be consumed by the wetland duckweeds, expected to recover yearly recurrent costs.

Selected Package for Intervention

Although Package #1 achieves the required performance, it has the risk that actual performance of the biofilm/aerator packages be at the lower range. Rationally, the need to increase the number of sections is much easier to address than discarding useless, or even harmful13, investments. Accordingly, package #3 is recommended to be studied in the feasibility stage.

[13] The over-performance of the biofilm could reduce nutrients available to the wetland, thus reducing its cost recovery potential.

CHAPTER 7 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

Introduction

The principal purpose of the Environmental and Social Management Plan (ESMP) is to present a set of mitigation, monitoring, and institutional measures to be taken during planning and design, construction, operation and maintenance of the various project components and activities associated with potential negative environmental or social impacts. The objective of these measures is to eliminate adverse environmental and social impacts, offset them, or reduce them to acceptable levels.

Institutional Arrangements

Management Setup

This Project is implemented through the coordinated efforts of four Ministries/Agencies:

- Egyptian Environmental Agency Authority (EEAA),
- Governorate of Alexandria,
- Ministry of Water Resources and Irrigation (MWRI); and
- Ministry of Agriculture and Land Reclamation (MALR).

EEAA is the executing agency ultimately responsible for the overall project implementation, and for leading the coordination activities with the other implementing agencies according to their specific roles and responsibilities.

A ***Project Steering Committee*** (PSC) will be established to provide oversight and direction to the project. Amongst the main responsibilities of the Steering Committee are to:

- Review, discuss and approve the Annual Work Plans prepared by the PMU;
- Review, discuss and approve the investment plans and O&M plans for sub-components (2) related to the pollution reduction measures;
- Review drafts of the Alexandria ICZM plan before submission of a final draft for endorsement to the National Steering Committee on ICZM; and
- Review and discuss implementation progress and propose any remedial actions if necessary.

The ***National Steering Committee for Integrated Coastal Zone Management*** which was reinstated in December 2007 will provide scientific advice and inputs into the preparation of the Alexandria Integrated Coastal Zone Management Plan serving as a scientific and advisory body in particular for Component (1) during the preparation stage. The Committee, however, will approve the final version of the Alexandria ICZM Plan upon receipt of a draft by the PSC. The Committee may also provide scientific and advisory inputs on any other aspects of the project components if requested by the PSC.

Within the project's context, a Project Management Unit (PMU) will be established and staffed with the needed expertise required to manage and operate the project. The relevant positions to the execution of the PMU are listed below:

PMU Director. The PMU Director will be responsible for managing staff and overseeing the day-to-day activities of the PMU in its management of the implementation of the Project. The Director will report directly to the CEO of EEAA, which will facilitate resolution of any internal delays to implementation.

Procurement Specialist. The Procurement Specialist will be responsible for overseeing all aspects of the procurement process for contracts financed by the project. With respect to the procurement of the main component of the Project (component 2), the Procurement Specialist will work closely with the Implementing Agencies and the Project Implementation Teams (PIT) carrying out the engineering designs and bid documents. S/He will be providing support during the contracting phases as well as during construction supervision. The Procurement specialist of the EPAP II PMU will provide support to the Project PMU in order to ensure appropriate procurement and contract management at early stages of the project and to assist in capacity building of the PMU. In addition to the current procurement capacity of the EPAP II PMU, an external consultant with extensive procurement experience will be included as part of an overall technical assistance contract to the PMU.

Environment Specialist. The environmental specialist will address the environmental safeguards requirements of the World Bank and of the Egyptian Environmental Affairs Agency. Given the EEAA experience with safeguards, EEAA will not need to secure external consulting support in this area. The environment specialist will be assigned by EEAA on a part-time basis to monitor the implementation of the site specific Environmental and Social Management Plans (ESMP). Specifically, the environmental specialist will monitor the implementation of the environmental mitigation measures, monitoring plan, and institutional/training requirements of the ESMP, and will be responsible for environmental reporting responsibility within the PMU.

Coastal Zone Management Specialist. The head of the GDCZM Unit in EEAA will be in charge of all the CZM aspects in the Project and will oversee and lead the day-to-day work of two other staff members with technical expertise in CZM, including one staff from the Alexandria RBO. The CZM specialist and his technical team will work closely with the other PMU members in particular the M&E specialist and will provide technical inputs into the bidding documents when relevant. Each specialist will be working on a full time basis.

Social Specialist. A Social Specialist will be contracted and paid under the project funds on a part-time basis by EEAA to ensure a participatory approach to M&E and to monitor the implementation of the social mitigation measures as part of the site-specific ESMP and will be responsible for the social reporting within the PMU.

Communications Specialist. A Communications Specialist will be contracted and paid under the project funds on a part-time basis by EEAA to increase public awareness about the project, draft a Communication & Replication Strategy (including a media

strategy & dissemination workshop) and prepare dissemination materials (brochures, website, etc…).

The PMU staff will be financed by the Government, as a project counterpart contribution, and will report to the CEO of EEAA.

Specific Project Arrangements

The following describes more specifically the roles and responsibilities of the different parties in managing the different project components.

Component 1 – **Planning, Institutional Capacity and Monitoring:** This component is under the direct responsibility of the EEAA. The PMU will coordinate the activities of the implementing agencies and other key stakeholders. Specifically, the Director of the PMU for EPAP II in EEAA will serve as the PMU Director for this proposed GEF project. The PMU will have the overall technical and fiduciary responsibility of the project.

The technical aspects of the project will fall under the responsibility of the General Department for Coastal Zone Management in EEAA who will have to work in close tandem with the PMU Director and staff. The head of the GDCZM will be the technical manager in the PMU. The technical staff in the PMU will include staff working in the Coastal Zone Management Unit in EEAA, as well as staff from the Alexandria RBO. The latter will be working on the project while physically located in Alexandria. These technical specialists will be responsible for following up on the consultant's work for Component (1), related to the preparation, review and adoption of the Alexandria ICZM plan.

The PMU will be responsible for acquiring the necessary monitoring equipment, the water quality management and data analysis software as well as the maps and GIS capabilities based on technical specifications. The PMU procurement specialist will work with the consulting firms in charge of purchasing the water monitoring equipment.

Component 2 – Pollution Reduction Measures: This component will be under the responsibility of the EEAA which will coordinate the project activities with the implementing agencies i.e. the MWRI and the MALR according to their mandate and specific responsibilities. The PMU at EEAA will contract a relevant agency to coordinate the implementation of the Component (2), under MWRI for the in-stream bio-film and in-stream aerators, and under the Ministry of Agriculture and Land Reclamation for in-lake wetland and reed removal. To ensure that proper attention is given to project implementation,

Project Working Groups will be established within the two Ministries/agencies. Initially, the Project Working Groups will be responsible for the coordination and review of the consultant's work that will be hired for this component to carry out the final feasibility study and final design and tender documents. The PWGs will be ultimately responsible for preparation of the technical specifications of the bidding documentation together with the PMU Procurement specialist, as well as the evaluation, contracting, construction

supervision and reporting tasks. The PWG will be financed and appointed by the relevant Ministries/agencies and will include technical specialists.

The PWGs will be responsible for the day-to-day implementation of their project and be required to work closely with the EEAA PMU by providing regular reports and documentation.

Component 3 – Project Management and Monitoring and Evaluation: This component will be under the responsibility of EEAA, including the Alexandria EEAA RBO. The *Alexandria EEAA Regional Branch Office (RBO)* will collect water quality data from project interventions.

The monitoring and evaluation function is a critical element of Component 3 which includes the elaboration of a Replication Strategy as part of the M&E Evaluation scheme. To that effect, a ***M&E specialist*** will be contracted and paid under the project funds on a part-time basis by the EEAA. In coordination with the PMU staff involved in Project implementation, the M&E specialist will be responsible for developing a M&E evaluation scheme and for preparing periodic reports (Project progress reports, including reporting progress on general implementation and progress against agreed indicators).

Environmental Management Capacity

The Egyptian Environmental Affairs Agency (EEAA): is the competent authority in Egypt responsible for coordinating and implementing environmental projects and initiatives nation wide. EEAA has a long experience in implementing project with international institutions. The ongoing EPAP II project has strong linkages to the proposed project and will provide management support to the implementation of the ACZMP. EEAA and its RBO's have gained high technical skills and they have strong institutional capacity to coordinate, supervise and implement any of the proposed measure in the ESMP.

The Ministry of Water Resource and Irrigation (MWRI): is the national competent authority responsible for all water management issues including policy making, initiation of water management projects, implementation and supervision of new and/or rehabilitation projects related to fresh water bodies or irrigation canals/drains. MWRI has the advantage of having both the competent technical staff and the laboratories that are equipped with advanced water and soil analysis equipment that can be used in conducting some of the proposed environmental monitoring activities.

In addition, MWRI has executed several projects in cooperation with international organisations, including WB which makes it familiar with the standards of reporting and delivery requirement.

The Ministry of Agriculture and Land Reclamation (MALR): the General Authority for Fish Resources Development (GAFRD) under MALR is the officially responsible body for

managing Lake Mariout. GAFRD has got adequate capacity to carry out some of the proposed mitigation measures determined in the ESMP, however, strong coordination efforts with EEAA and MWRI will be needed. At least one of the proposed Project Working Groups (PWG) should be led by GAFRD to ensure close coordination with different ESMP activities. In addition to the In-Lake Wetland and Reed Removal interventions, GAFRD's role in communicating with the fishermen community is unavoidable.

Relevant capacity building for GAFRD's can be in the form of training on communication strategies, socio-economic aspects of the fishermen community, environmental regulations and management structure in Egypt.

Governorate of Alexandria: given the importance of Lake Mariout to the Alexandria residents, Alexandria Governorate through its EMU, may play an important role in providing media coverage of the project activities and seeking public consensus on the proposed interventions as well as keeping the public well informed. Although the EMU is regularly receiving training from the EEAA RBO in Alexandria, it is necessary to provide training for the EMU staff on environmental monitoring activities and the legal mandates of the EMU under the Egyptian environmental regulations.

Summary of Impacts and Mitigation Measures

Potential negative environmental and social impacts that have been identified and ranked as "High", "Moderate" or "Low" in Chapter 5 of this report are discussed and in order to eliminate or reduce the environmental and social impacts identified due to the project activities, it is recommended to adopt and implement a series of mitigation measures as follows:

1. Minimise disruption of aquatic ecosystems during construction

Impacts during construction are resulting mainly from the dredging activities. Given the colloidal and humus state of the sediments, it may not be possible to use mechanical dredgers. Vacuum dredging, can be used after reed clearance. In all cases, it is important that the use of dredgers is restricted to the area chosen to be deepened. This area should be properly marked for instance by a sort of floating platforms.

2. Properly handle excavated sediments during dredging

Prior to deciding the handling method for the excavated sediments resulting from deepening of areas of the lake and drain, sampling and analysis of specimens of the sediments should take place to determine whether they contain heavy metals or other types of pollutants. Following so, the feasibility study that will be conducted in later stages should quantify the amounts of sediments that will be dredged.

Representative sampling technique should be used. Analysis of the samples should take place in officially accredited laboratories.

Given the limitation of available land surrounding the project area to store and dry the sediments, the most appropriate method is to reuse the dredged material in constructing the walls that will surround the fish roaring area.

The residual quantities of the sediments can be re-used as soil conditioner for landscaping and establishing green areas.

3. Properly handle reeds after removal

The quantities of reeds to be removed needs to be determined. Representative samples of the reeds should be analysed to ensure they are free of pollutants especially heavy metals. The sampling and analysis of the reeds will be undertaken by MALR utilising MWRI's technical expertise and capacity with no expected additional funds needed.

Once confirmed that reeds are free from pollutants, stored and dried, they can be recycled for a useful use (e.g. chopped and sold as animal fodder). This measure can be sponsored by EEAA in cooperation with the Social Fund for Development to assist members from the fishermen community to own and operate shredders through a micro financing scheme. The feasibility study that will be prepared in later stages of the project should determine the economic feasibility of such project and assess available markets for the chopped reeds.

In a similar manner to the reeds handling, the harvested duckweeds can be recycled into a fish fodder after ensuring that they are free from pollutants and heavy metals.

4. Improve livelihood of fishermen community

A comprehensive socio-economic study should be conducted to explore means of contribution of the project to the improvement of the livelihood of the fishermen community. Development of some small scale socio economic projects could be suggested to involve the fishermen in the project activities. The social development specialist contracted by the PMU will be responsible to conduct such study and the PMU will take necessary actions to implement the recommendations.

The following table lists the mitigation measures and the associated institutional and financial arrangements.

Table 24: Mitigation Measures and Associated Institutional and Financial Responsibilities

Environmental/Social Aspect(s)	Environmental/Social Impact(s)	Proposed Mitigation Measure(s)	Responsibility		Timeframe	Cost (US$)
			Implementation	Monitoring		
Transportation of materials and personnel	Air Pollution Health and Safety	Only vehicles which pass the legal environmental tests for exhaust are allowed to have access to the site. Drivers to be provided with Safe Driving Instructions H&S signs and gear should be available on site	Contractor in coordination with MWRI	PMU	Whenever materials or personnel are transported to project site	None Embedded in works contract
Storage of construction material on drain sides	Land contamination	Dedicate specific area for storage of construction material and restrict access to it by installing proper fences	Contractor in coordination with MWRI	PMU	During initial phases of mobilization	Embedded in works contract
Use of heavy machinery in dredging	Noise Disruption of the ecosystem Water pollution	Provide H&S equipment for workers and site visitors Properly mark the areas that will require	Contractor in coordination with MALR	PMU	Continuous during dredging	Embedded in works contract None

Environmental/Social	Environmental/Social	Proposed Mitigation	Responsibility		Timeframe	Cost (US$)
		dredging Restrict access of equipment to the areas where no dredging is required				Embedded in works costs
Temporary storage of excavated contaminated sediments	Land contamination Solid wastes causing health risks	Designate specific area for temporary storage of excavated sediments Conduct a feasibility study for utilizing the sediments.	Contractor in coordination with MALR PMU in coordination with MALR	PMU PMU	Continuous during dredging	Embedded in works costs Included in the final feasibility study of the proposed interventions
Disposal of excavated contaminated sediments/sludge	Solid wastes causing health risks	Sign contract with waste collection contractor to properly dispose of the sediments	Contractor in coordination with MALR	PMU	During temporary storage and before end disposal	Embedded in works costs
storage and disposal of reeds and duckweeds	Solid wastes causing health risks	Conduct Sampling and Analysis for the removed reeds and duckweeds Conduct a feasibility study to find out best way to utilize the harvested reeds and duckweeds.	PMU PMU in coordination with MALR	PMU PMU	Before harvesting of reeds or duckweeds	Included in the final feasibility study of the proposed interventions

Environmental/Social	Environmental/Social	Proposed Mitigation	Responsibility		Timeframe	Cost (US$)
		Designate area for temporary storage of reeds before final disposal	Contractor in coordination with MALR	PMU		Embedded in works contract
Cleaning and disposal of biofilm parts	Solid wastes causing health risks	Sign contract with waste collection company to remove and properly dispose of the un-used materials	MWRI	PMU	During the routine maintenance	To be determined during the feasibility studies.
Aerators consumption of fossil-based energy	Indirect air pollution	Purchase energy efficient aerators	PMU in coordination with MWRI	PMU	During procurement	Embedded in procurement costs
Introduction of alien aquatic plant species	Disruption of ecosystem	A native plant that can provide similar functions as the duckweeds should be researched and utilised	PMU in coordination with MALR	PMU	Before construction of in-lake wetland	Included in the final feasibility study of the proposed interventions
Interaction with fishermen community	Lack of participation threatening the sustainability of the project	Involve fishermen in project activities especially in reeds removal and harvesting of the aquatic plants (duckweeds)	PMU	PMU	During project construction and during harvesting of the aquatic plants	15,000 (from the project budget)
Total Estimated Costs (US$)						**15,000**

Monitoring measures

The following table presents a fully fledged environmental monitoring program that needs to be implemented throughout the project's life time.

Table 25: Continuous Monitoring Program

Parameter	Location (**)	Number of Samples	frequency	Responsible Organization	Costs US$ **
Physical parameters: • Depth • Temperature • Transparency • Salinity • Conductivity • Dissolved oxygen (DO mg/l) • Oxygen saturation (DO%) • pH	• Effluent of west treatment plant • Qalaa Drain outfall • in the course of Nobareya Canal • in the course of El-Omoum drain • at the central part of the main basin. • At the northern corner of the main basin	One sample at each location	monthly	MWRI/ MALR/Alex RBO	None
Bacteriological parameters • Total coliforms • Faecal coliforms • Faecal streptococci	• Effluent of west treatment plant • Qalaa Drain outfall • in the course of Nobareya Canal • in the course of El-Omoum drain • at the central part of the main basin. • At the northern corner of the main basin	One sample at each location	monthly	MWRI/ MALR/Alex RBO	None
Eutrophication Parameters • Nitrate • Nitrite • Ammonia • Total nitrogen • Phosphate • Total phosphorus • Silicates • Total suspended solids • Chlorophyll a • BOD5 • COD • Oil and grease • Heavy metals	• Effluent of west treatment plant • Qalaa Drain outfall • in the course of Nobareya Canal • in the course of El-Omoum drain • at the central part of the main basin. • At the northern corner of the main basin	Representative Samples to be quantified by sampling agency	monthly	MWRI/ MALR/Alex RBO	None
Bottom sediments:	• Qalaa Drain	Representative	Annual	Alex	None

Parameter	Location (**)	Number of Samples	frequency	Responsible Organization	Costs US$ **
• TOC • Heavy metals (Cr, Al, Fe, Cu, Pb, Zn, As, Ni and Hg).	outfall • in the course of Nobareya Canal • in the course of El-Omoum drain • at the central part of the main basin. • At the northern corner of the main basin	Samples to be quantified by sampling agency		RBO/MWRI	
Tissue of Fish (Tilapia) Heavy metals: (Cr, Al, Fe, Cu, Pb, Zn, As, Ni and Hg).	The Main basin Fisheries basin	Representative Samples to be quantified by sampling agency	Half Annual	MALR	None
Excavated Sediments Heavy metals: (Cr, Al, Fe, Cu, Pb, Zn, As, Ni and Hg).	Temporary storage site	Representative Samples to be quantified by sampling agency	Once after the sediments dry out	Alex RBO/MWRI	None
Removed reeds Heavy metals: (Cr, Al, Fe, Cu, Pb, Zn, As, Ni and Hg).	Temporary storage site	Representative Samples to be quantified by sampling agency	Once after the removed reeds dry out	Alex RBO/MALR	None
Duckweeds (or other aquatic plants used in CW) Heavy metals: (Cr, Al, Fe, Cu, Pb, Zn, As, Ni and Hg).	Temporary storage site	Representative Samples to be quantified by sampling agency	After the plants dry out	Alex RBO/MALR	None

(*) The location of sampling could be changed based on the final feasibility study

(**) Component 1 in the project will include procurement of monitoring equipment which will be utilized by the PMU and partner agencies.

Cost estimates and Sources of funds

The sources of funds for the implementation of the ESMP will mainly be from the project's operations budget. The main cost elements associated with the implementation of the ESMP can be categorized as follows:

1. **Manpower**

In order to implement the ESMP, a part-time environmental consultant should be recruited. The duties and responsibilities will include monitoring the implementation of the mitigation measures, recording any environmental violations and most importantly recording and analysing the environmental monitoring data. The periodical environmental reports as stated in the above tables will be included in the periodical project progress report that should be submitted to the donor agencies as agreed upon.

In addition, a social development consultant will be recruited to conduct periodical social studies and enhance the socio-economic aspects of the project.

The cost associated with is element of the ESMP is embedded in the overall project staffing budget.

2. Sampling and Analysis Equipment

Component (1) of the project has allocated funds for procurement of monitoring equipment. Therefore the costs will not show as part of this ESMP. The analysis of the results will be undertaken in MWRI laboratories at minimal administrative costs.

3. Implementation of mitigation measures

Most of these costs will be estimated during the preparation of the final feasibility study of the project. However, any associated costs related to construction will be part of the works contract.

The total estimated cost to implement mitigation measures during construction and operation is $15,000 to be funded from the project's overall budget and specifically from Component 2.

CHAPTER 8 : PUBLIC CONSULTATION AND DISCLOSURE ACTIVITIES

Introduction

The primary purpose of this provision is to protect the interests of affected communities. Therefore, the ESIA process includes consultation and disclosure of information to key stakeholders involved in and/or affected by the AICZMP.

The objectives of consultation and disclosure are to ensure that all stakeholders and interested parties, are fully informed of the proposed project, and have the opportunity to express their views and opinions regarding the potential impacts that might affected their livelihood.

Regulations and Requirements

Consultation with the public has become recently one of the mandatory requirements to projects classified as Category C according to the amended Egyptian Environmental Law (Law 4/1994). Although the proposed project is classified as Category B under the Egyptian environmental classification system which does not require conducting public consultation, EEAA has decided to proceed with this process due to the importance of the subject and the interests of the different stakeholders in the project area , Lake Mariout.

On the other hand, the World Bank requires that affected groups and NGOs must be consulted as part of the environmental assessment of projects as stated in the Bank's Operational Policy (OP) 4.01 Environmental Assessment and other key documents. The World Bank manuals (e.g. Participation Sourcebook, BP4.01 and OP4.01 for Environmental Assessment, OD4.20 for involving NGOs, BP17.50 about disclosure of information are taken into account.

Methodology

The first stage of consultation with the public started by identifying stakeholder groups and affected communities by the proposed project. In the initial phases of the project design, several in-depth meetings and interviews were conducted with key stakeholders such as:

- partner government institutions
- academia and scientific community in Alexandria
- Environmental and developmental NGO's representing different interests in the project area or in Alexandria in general
- Foreign assistance institutions with previous experience in the project area or similar projects

- Fishermen community

During this initial stage, the stakeholders were informed about the project concept and preliminary ideas concerning the project interventions. Inputs from stakeholders were considered throughout the developing the project's main elements and components.

Once the project concept and preliminary approaches have been developed, the draft ESIA was prepared and a call for public attendance to a consultation session was announced and publicised in a widely spread news paper as well as individual invitations which were sent out to key identified stakeholders.

A draft non-technical executive summary was prepared and shared with the stakeholders prior to the consultation session. The summary was available in both Arabic and English languages and were posted on EEAA website to ensure reaching out to as many stakeholders as possible.

The process of conducting the public consultation was led by EEAA and a presentation about the project and its background was prepared and presented in the public consultation session and copies of the Draft ESIA were ready to be sent out to interested participants

Following the public consultation session, the disclosure of the ESIA will be published on the World Bank info-shop for wider distribution.

Consultative Session

On September 30th, 2009, the public consultation session was held at one of Alexandria hotels. Representatives of the civil society, competent governmental authorities as well as technical consults participated effectively in the discussions.

The following figure shows the percentage representation of the different stakeholders in the consultative session.

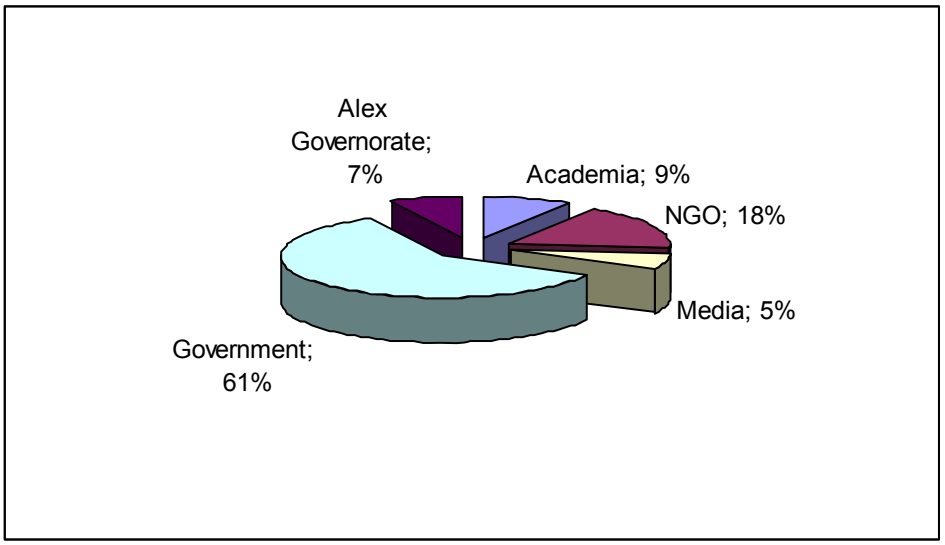

Figure 17: Percentage representation of stakeholders

The main outcomes from the public consultation session demonstrated that there is a very high level of interest in the project area, Lake Mariout, as well as in the proposed interventions and the degree of expected improvement from the project's activities.

All participants have expressed deep concern about the deteriorated environmental conditions of Lake Mariout and the causes of these problems. Several attempts and suggestions concerning improving the situation was proposed and discussed among the participants as well as EEAA team.

The socio-economic conditions of the fishermen community also gained a lot of attention from the attendants, especially from NGO's, who urged the project to involve the fishermen community in implementing the project activities to ensure buy-in as well finding opportunities to improve their livelihoods through small scale projects associated with the proposed interventions.

Due to the fact that there are many institutions involved in utilizing Lake Mariout in different ways, the dominant discussions were concerned about the level of contribution of each institution to the environmental problems in the Lake and the role that each can play to improve the current conditions. The need for coordination and cooperation between the different institutions in managing the lake was stressed upon due to some conflicting activities that need to be coordinated in order to avoid further deterioration of the lake environmental conditions.

A discussion about the environmental and social impacts of each intervention also indicated that the positive impacts are more likely to dominate whereas negative impacts are minimal due to the fact that the interventions aim at improving the environmental conditions and the nature of the project being a demonstration and pilot activity.

The conclusions drawn from this consultation stage can be summarized as shown in the following table:

Table 26: Outcomes of the Public Consultation Session

Key Issue(s)	Comments
Disposal of primary treated wastewater from ETP and WTP into Lake Mariout as a main cause for polluting the Lake and decreasing fish resources	Primary treated wastewater is causing degradation of water quality in the Lake and resulted in increase of the reeds which obstructs fishing activities as well as worsening water circulation hence deteriorating water quality More than EGP 1 Billion are invested to upgrade the ETP and about EGP 2 Billion to upgrade the WTP into secondary treatment with sludge treatment. The secondary treated wastewater will be of better quality which makes disposing it into the Lake and eventually to the Mediterranean Sea to be considered as wasting valuable resources and draining the investments that have been made available. There are different possibilities of using the secondary treated wastewater for irrigating green areas in the newly developed tourism and entertainment areas (such as golf courses, gardens and

Key Issue(s)	Comments
	landscapes) or in irrigating new reclaimed desert lands, or to be used for industrial purposes for a fee which recovers part of the initial investments and generates income to maintain the ETP and WTP. So the option of avoiding disposal of secondary treated wastewater into the Lake is valid and has to be considered. If the water quality in the Lake continues to be polluted from other sources than municipal sewage (mainly agricultural drainage and industrial effluents) then the investments in upgrading the ETP and WTP will be wasted. There is a need for major investments to pump, store and distribute treated wastewater to potential beneficiaries. Feasibility of such alternatives should be carefully studied. Meanwhile, the only alternative is to dispose the treated wastewater into the Lake There are activities that are taking place in the Lake that impacts the ETP and WTP such as the intension of establishing a river passenger or cargo terminal in one of the drains. This may cause flooding in major parts of Alexandria. The contribution of industrial pollution to the Lake is minor (0.5%) compared to the agricultural drainage and municipal sewage drainage.
Lake water balance	The water balance in the Lake is critical. The Ministry of Water Resources and Irrigation is concerned by the incoming flows to the Lake and any activities that may affect the water balance in the Lake. Coordination is needed with both the GAFRD and the wastewater company prior to any actions or projects that may affect the flow of water into the Lake. In case there is increase in the quantity of treated sewage disposed into the lake, the Omoum drain will not be able to accommodate such quantities. El-Mex pump station can not handle extra quantities of incoming flows as it is not possible to expand the station due to existence of fishermen settlements nearby the station. The ground water table level has increased to an alarming level and actions are needed to deal with this threat.
Land-filling of the Lake	The major threat to Lake Mariout is not just pollution, but the rapid urbanisation and formal and informal land-filling the Lake for different purposes such as real estate development or commercial activities. Efforts should be focused on stopping land-filling of the Lake as it has caused significant degradation not only to the environment but mostly to the livelihood of fishermen community.
Source of Pollution of Lake Mariout	ASDCO is currently upgrading the ETP and WTP into secondary treatment and sludge treatment. This will improve significantly the quality of domestic sewage currently disposed into the Lake.

Key Issue(s)	Comments
	MWRI should re-consider the current drainage canals which currently contribute largely to polluting the Lake water. EEAA is working closely with industries to stop or treat their effluents, eventually reaching the Lake, through the EPAP II.
Sediments removal, storage and disposal	Excavated sediments might be contaminated with heavy metals. Sampling and analysis are required to decide best ways to utilize those sediments. A method used in some private sector fisheries in Edko is to clear the wet area from all plants, suck the water out and allow the bottom to be exposed to the sun. This way the sediments will be freed from any contaminants and undesired plant roots or seeds. Documentation of this method and the results are not currently available but the project is welcomed to conduct a field visit. The sediments can be used as soil conditioner for green landscapes. Another alternative is to develop artificial islands inside the Lake using the excavated sediments. Reeds removal will not cause disturbance to the sediments because they are mostly floating. Measures such as using geo-textile curtains can be used to avoid transfer of pollutants to other areas of the lake.
Reeds removal, temporary storage and disposal	Most of the reeds in the lake are not rooted deeply in the lake's bottom; therefore the removal should not require heavy equipment and will not require a lot of time. The proposed project is not designed to remove all the reeds in the Main Basin (4600 feddans) but will be a pilot project that will require only 30 feddans at this stage. More resources will be needed to remove the reeds from the entire Main Basin. Reeds removal will improve the water circulation and hence the water quality will improve Reeds can be temporary stored in the lake by piling each removed feddan of reeds on other reed-covered areas. Studies should be conducted to identify the best way for utilizing the removed reeds. In all cases, open burning of reeds is not allowed, and land-filling should be a last option. The possibility of using the removed reeds as bio fuel should be investigated Sampling and analysis of the reeds should take place prior to recycling to identify if it contains heavy metals
Eco System	It is not currently known whether the proposed aquatic plant to be used

Key Issue(s)	Comments
	in the in-lake wetland (duckweeds) is native or alien to the Egyptian ecological system. If the plant proved to be alien, it is not recommended to introduce such alien species to the Lake ecosystem as the impacts will not be possible to control. Consideration should be given to fish reproduction grounds during reeds removal as some areas might be currently used by fish to lay eggs The improvement in the Lake water quality will allow introduction of more economically valuable fish species that can improve the economic conditions of the fishermen The lake should restore its ecosystem once it is back to its original physical status, i.e. the Lake water should be salty or more brackish than it is now The impact of having the Lake be more of salty nature is negative on the surrounding agricultural lands. Careful studies should be done before suggesting restoration of the lake into its original status due to the de-facto development surrounding the Lake.
Socio-economy	The fishermen community is currently suffering from high illiteracy rates, poor health conditions and deteriorating economical conditions due to: • decrease in the fish resources due to different reasons • rapid increase in land-filling parts of the Lake which has decreased the areas that were used as fishing grounds • increase in the reed covered area in the Lake due to the nutrient-rich effluent, thus restricting fishing in the Main Basin to very limited areas and periods of the year. • Fish might be contaminated and thus decreasing its economical value and posing health risks Fishing activities are currently taking place in the "1000-Feddan" basin and not the Main Basin. The interventions proposed and the area designated for the in-lake wetland is not currently being used by the fishermen as fishing grounds due to the high pollution levels and the density of the reeds. The fishermen are willing and eager to participate in the project activities especially in removing reeds and guarding the proposed in-lake wetland It is recommended to start this proposed project as soon as possible in order to achieve positive results Several studies have been made and there is a need to start implementation

Key Issue(s)	Comments
	Actions should be taken to stop land-filling parts of the Lake The representation of the NGO's and community in the public consultation should increase in the future because they are the ones mostly affected by the different projects Dwellers around the Lake need to be involved in the project activities or to include them in benefiting from the project by raising their awareness, improve their skills and possibly be involved in recycling the harvested reeds and other aquatic plants
Aeration	Aeration is a must to increase dissolved Oxygen in the drains and the Lake waters. However, alternative aeration methods (such as tubular air diffusion) should be considered due to its effectiveness.
In Stream Bio-Film and In-Lake wetlands	Both technologies are well known and they are famous for natural treatment of organic pollutants. The in-lake wetland technology has been implemented successfully in Lake Manzallah and therefore it is expected to have good results in Lake Mariout
Environmental Monitoring	Continuous monitoring of Lake and Sea water quality is needed in order to ensure improvements and to scientifically determine the sources of pollution and the actions needed to be taken.
Coordination and Cooperation	Lake Mariout needs special attention and high level coordination between different Government Authorities such as fisheries, EEAA, ASDCO, NWRI and Alexandria Governorate
Sustainability of the Project	The sustainability of any intervention in the Lake should be considered after the project life time.

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ANNEXES

Annex 1: World Bank Safeguard Policy Issues

1. The Alexandria Coastal Zone Management project has an overarching objective to deliver a strategic framework and immediate small-scale investments to contribute towards a reduction in the load of land-based sources of pollution entering the Mediterranean Sea, especially through the hot spots of El-Mex Bay, from Lake Mariout. The proposed project will consist of the following three components, to be implemented within a timeframe of five years: Component (1): Planning and Institutional Capacity: The outputs include (i) a master plan for the management of coastal zones of Alexandria including Lake Mariout, (ii) establishment of a multi-stakeholder Lake Mariout Management Committee to address the sustainability of the pollution reduction measures including cost recovery and any other issues encountered during implementation of the project, and (iii) development of a water quality monitoring network for Lake Mariout. Component (2): Pollution Reduction: The output is the completion of one or more low-cost innovative pollution reduction measures such as engineered wetland or in-stream treatment among others. Component (3): Monitoring and Evaluation: The outputs include (i) water monitoring network with measurable indicators; and (ii) documentation and dissemination of lessons learned from the project.

Environmental Aspects

2. The project is classified as an environmental Category B according to the World Bank's Operation Policy on Environmental Assessment (OP 4.01) and as a result, an environmental and social impact assessment framework (ESIAF) is being developed by an independent third party consultant, according to Terms of Reference approved by the Bank. The ESIAF will include an assessment of potential impacts of the proposed project and the likely significance of such impacts and recommend mitigation measures. The ESIAF will include a generic environmental and social management plan (ESMP) relevant to potential project interventions, which will then be used as a guide for the preparation of site-specific ESMPs that will be a part of the contractor's bidding documents. The generic ESMP will include—for construction and operation—potential environmental and social impacts, mitigation measures, and institutional responsibility for implementing and monitoring the recommended mitigation measures, capacity building and training requirements, and a cost estimate for implementation. Additionally from a Project Preparation Grant, consulting firms hired by EEAA carried out several studies including Monitoring and Baseline Studies; Strategic Environmental Assessment for the project, Pre-Feasibility Studies for Demonstration Projects, Pre-Feasibility Analysis for Pollution Reduction Measures; Lake Mariout and El-Mex Bay Environmental Improvement Master Plan; and Institutional Report. Results and recommendations from these studies will be taken into account in the preparation of the ESIAF, as relevant.

3. Lake Mariout does not have a direct connection to the Mediterranean Sea, but rather through some Bays, one of them being the El-Mex Bay. It receives water from different sources including canals, drains, sea locks, underground water, and also directly from the East and West Treatment Plants. Lake Mariout is one of the major sources of conveyance of land-based pollution to the Mediterranean Sea, through El-Mex Bay. From Lake Mariout, El-Mex Bay receives untreated pollutants—sewage waters, municipal and industrial wastes, agriculture—affecting water quality and sediments. Additionally, the Alexandria tanneries complex with about 40 small private tanneries and one public tannery discharge their waste

effluents to a stormwater line, which discharges directly to El-Mex Bay. It is estimated that the combined waste effluents (characterized by high levels of TSS, COD, BOD, Sulphide and Chromium) from all the tanneries located in this complex and reaching El-Mex Bay has an average flow of about 3200 m3/d. In order to maintain the lake surface below the sea level, water from the polluted lake is pumped to the Mediterranean Sea at El-Mex Bay. The main pollutant loads to El-Mex Bay come from the outflow of El-Mex pumping station and from the tanneries. Water pollution in Lake Mariout is caused by industrial waters, municipal/domestic waters, and agriculture with the following characteristics: industrial waters containing high COD and heavy metals; agricultural effluents containing nutrients and organic matter; and municipal/ domestic effluents containing primary treated effluents discharge from the two wastewater treatment plants. There are two main drains entering the Lake—El-Qalaa and El-Oumoum. El-Qalaa drain receives effluent from the East Treatment Plant, raw wastewater, and irrigation drainage and agriculture runoff. El-Oumoum drain receives agricultural drainage (including pesticides and various nutrients) along with organic matter from animal farming and domestic wastewater. Additionally, Lake Mariout receives effluent that is discharged directly from the West Treatment Plant. Domestic sewage, industrial and agricultural waste are discharged continuously into the Lake, thereby further deteriorating its status and resulting in diminishing and harmful fish (containing heavy metals), impacting the living and socio-economic conditions of the inhabitants around the Lake.

4. The net environmental impact of the project will be positive as it is expected that proposed project interventions will lead towards the restoration and rehabilitation of the lake ecosystem, improve water quality and biodiversity conservation, and improve environmental conditions for inhabitants around the lake. The environmental issues that may require attention would be related to Component 2 of the project dealing with civil works due to pollution reduction interventions. Site-specific environmental and social management plan (ESMP) for each intervention—meant to eliminate adverse environmental and social impacts—will be prepared and included in the bidding documents for contractors.

5. The project is considering various pollution reduction interventions to reduce the pollution load entering the Lake Mariout, especially the nutrients (Nitrogen and Phosphorous), as well as the oxygen depleting substances, such as the biochemical oxygen demand (BOD) and the chemical oxygen demand (COD). This will, in turn, reduce the pollution load of these priority pollutants entering into the Mediterranean from the Lake water through El-Mex pumping station. The proposed project is complimentary to other on-going projects, each addressing a different source of pollution. The pollution reduction measures being considered will be based on clear criteria covering environmental effectiveness to substantially reduction pollution load; technical ease of implementation; investment costs; financial sustainability; institutional clarity; and, suitability as pilot based on potential for scalability in the same site and/or replicability in other sites. The project has identified the following selection of possible interventions for implementation. However the final selection of interventions and locations will be confirmed during implementation.

- In-stream/drain biofilm: considered to remove or reduce organic pollutants by adapting the severely polluted segments of the drains/streams to act as large plug-flow anaerobic/aerobic biofilm reactors in which bacterial culture will be intensified. This option is highly effective in polluted drains (El-Qalaa Drain) and causes a decrease in BOD/COD levels;
- In-stream/drain aeration: considered to increase the level of dissolved oxygen in the El-Qalaa Drain (the agricultural drain most responsible for the BOD, COD, and

nutrient load to Lake Mariout). Two approaches were studied, namely, in-stream aeration through available renewable energy; and in stream electric powered aeration. It should be noted that El-Qalaa drain's annual pollution load to Lake Mariout;
- Reed removal: considered to improve water circulation in the basin, thus both improving aeration and entraining some deteriorated sediments. Removing the weeds would contribute to restoring the ecosystem of the Lake and its self-cleaning capacity and preserving the fish variety and bio-diversity per the PDO. In particular, original species could be re-introduced in the Lake);
- In-lake wetland: considered for its capacity to remove many persistent organic compounds such as nitrogen and phosphorous. Duckweed will be used for their capacity to neutralize the load of BOD, COD, suspended solids, nitrogen and phosphorous, with an adequate retention time, depth and water flow. This option provides efficient, consistent and economical wastewater treatment.

6. It was determined in the preliminary analysis that individual pollution reduction measures would not be sufficient to achieve the optimal targets of pollution reduction. Instead, a "package" of intervention is required, whereby a synergy of these individual measures is ensured for a maximum, all around, performance. Some expected outcomes will be a reduction in BOD/COD load, diversion of nutrients from the lake, improved water circulation in the lake resulting from reed removal, thereby resulting in positive impact on the lake's biodiversity. It will also lead to an improvement in the assimilative capacity of the lake as well as an increase in its self-cleaning capacity.

7. Monitoring indicators will be built into each subproject intervention and will focus on measuring compliance with related standards and permits, including health and safety for construction workers. Special attention will be paid during construction works to chance findings of objects of archaeological or cultural value. As required, works will be suspended immediately if cultural objects are found, and the contractor will inform the relevant authorities before proceeding.

Institutional setup for ESMP implementation

8. The main implementing agency for the project is the Egyptian Environmental Affairs Agency (EEAA). The Project Management Unit (PMU) that was established for EPAP II under EEAA will also serve as the PMU for the proposed project—with the hiring of additional technical staff. A part-time environmental and a part-time social specialist will be hired by the PMU. The environmental specialist will be responsible for oversight of both the Bank and Egyptian environmental safeguards requirements. He/she will also be responsible for monitoring implementation of the site-specific ESMPs, especially of the environmental mitigation measures, monitoring plan, and institutional/training requirements of the ESMP, and will be responsible for environmental reporting within the PMU. The part-time social specialist will ensure a participatory approach to M&E and monitor the implementation of the social mitigation measures as part of the site-specific ESMP and will be responsible for social reporting within the PMU. The Coastal Zone Management Unit in EEAA will act as the Technical Secretariat of the project and will prepare the annual work plans. The work plans will be reviewed by the Alexandria Coastal Zone Management Committee which is expected to be established pending the revisions of Law 4/1994 for the environment (as amended by Law 9 for the year 2009).

9. Although EEAA is responsible for overall project implementation, the PMU at EEAA will contract the relevant agencies to coordinate the implementation of Component 2, dealing with pollution reduction measures (subprojects) with the Ministry of Water Resources and Irrigation (MWRI) for in-stream biofilm and in-stream aerators; and with the Ministry of Agriculture and Land Reclamation (MALR) for in-lake wetland and reed removal. Additionally, project implementation teams (PITs) will be established within the two ministries/agencies to ensure proper implementation. Consequently, the management of the investment component (pollution reduction measures) and equipment will be transferred from EEAA to the relevant agency after project completion (expected in 2015).

Reporting on ESMP

The part-time environmental and social specialists of the PMU will be responsible for environmental and social reporting on implementation of the ESMP. Their inputs will be included in the quarterly reports that the PMU will prepare and submit to the Bank. Additionally, the PMU with input from the M&E specialist will prepare a chapter on implementation of the ESMP as part of their project mid-term report. A draft of this report will be available before the Bank's mid-term review mission.

Disclosure of ESIAF

In accordance with World Bank policy and guidelines, public consultation is being undertaken with key stakeholders and their concerns are taken into account during preparation of the ESIAF. Consultations are also being undertaken with various stakeholders during preparation of the component for developing a master plan on coastal zone management for Alexandria and Lake Mariout. The executive summaries of the ESIAF will be translated into Arabic and disclosed at the World Bank's Infoshop and in-country in easily accessible places to the public, including the websites of EEAA and other government agencies, before project appraisal.

Annex 2: Fisheries in Lake Mariout

Lake Mariout is one of four brackish water lakes in the Nile Delta near the shore of the Mediterranean Sea. The fish of Lake Mariout are essential to the well-being and livelihood of about 7,000 fishers and their families (EEAA, 2009). Figure A9-1 illustrates the trend of fish catch over a 90-year period, based on available statistics. Until the mid-1970s, Lake Mariout was highly productive, contributing no less than 75 percent of the national fish catch. In 1974, fish catch attained its peak level of 17,000t. Since the beginning of 1980s, fish production decreased progressively, mainly due to the discharge of industrial waste and sewage from Alexandria into the lake and, to a less extent, to overfishing. As a result, fish catch dropped to 5,000 t in 2007, or about 70 percent of the mid-1970s level. Nowadays, fish production in Lake Mariout is 0.5 t/ha of lake, which is lower than that in the other brackish lakes in Nile Delta, namely Edku (1.1 t/ha), Burollus (1.2 t/ha), and Manzala (0.7 t/ha).

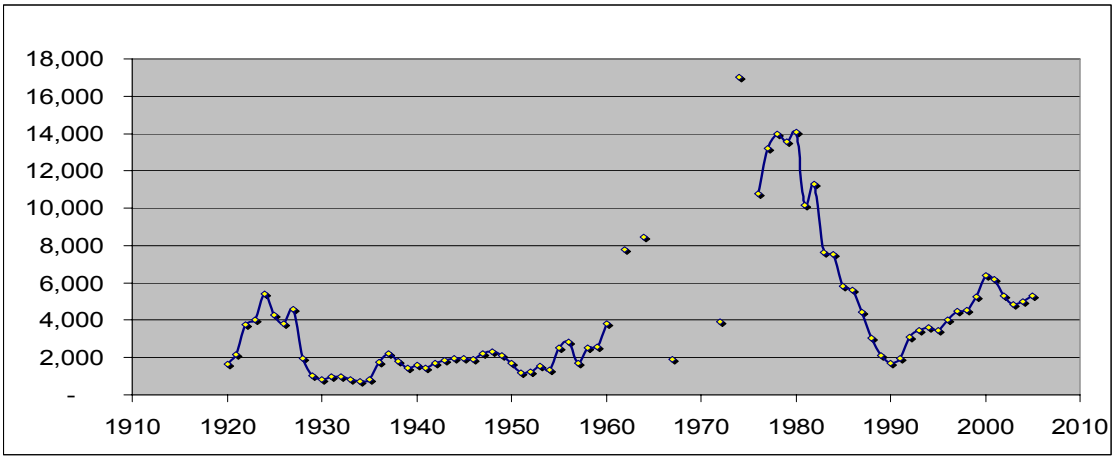


Figure 18: Fish Catch in Lake Mariout

The decrease in fish catch was accompanied by a change in fish composition over time. Most of the brackish high value fish (e.g. *Mugil cephalus, Labeo niloticus, and Bagrus bajad*) almost disappeared from the lake. They were replaced by other less valuable fish such as Tilapia, which now accounts for about 75 percent of the total yield. The dominance of Tilapia and increase of Clarius gariepinus production in Lake Mariout are due to their high tolerance to marginal environmental conditions, in terms of oxygen concentrations, high nutrient loading, and salinity variation.

Consumption of fish from Lake Mariout is considered a health hazard. Amr et al.[14] (2005) found that the levels of heavy metals in fish samples from the Main Basin were higher than those in water samples, and recommended to reduce fish consumption from this

[14] Amr, H.M., El-Tawila, M.M., Ramadan, M.H.M. 2005. Assessment of pollution levels in fish and water of main basin, Lake Mariout. The Journal of the Egyptian Public Health Association (JEPHAss.), Vol. 80, No. 1,2.

basin until heavy metals reach acceptable levels. El-Rayis[15] (2005) also found elevated concentrations of heavy metals in the main basin and concluded that the basin is a dangerous source for health-hazard fish.

[15] El-Rayis, O. 2005. Impact of man's activities on a closed-fishing lake, Lake Mariout in Egypt, as case study. In: Mitigation and Adaptation Strategies for Global Change 10: 145-157

Annex 3: Participants list in public consultation

جلسة الاستماع لمشروع "الإدارة المتكاملة للمناطق الساحلية بالاسكندرية" المقترح تمويله من مرفق البيئة العالمية من خلال البنك الدولى للإنشاء والتعمير

فندق ميركور- الأسكندرية

الأربعاء ٢٠٠٩/٩/٣٠ من الساعة ١٠:٣٠ صباحاً إلى الساعة ٤:٠٠ عصراً

	م	الاسم	الوظيفة	الجهة	المحمول
الجامعات	١	أحمد على أحمد قاسم	أستاذ بكلية الزراعة	جامعة المنوفية	٠١٠٦٦٠١٤١٧
	٢	د/ خالد محمود	استاذ بجامعة المنصورة	جامعة المنصورة	٠١٠٢٦٩٧٧٢٦
	٣	صلاح حسن	أستاذ بجامعة الاسكندرية	جامعة الأسكندرية	٠١٢٣٣٣٣١٨٨
	٤	هناء عوض الله	مدرسة	كلية العلوم	٠١٢٤٠٠٢١٨٢
	٥	د/ صبرى سالم	أستاذ مساعد	مهعد الدراسات العليا والبحوث- جامعة الأسكندرية	٠١٢٦٣٨٣٣٢١
الجمعيات والمنظمات الأهلية	٦	المستشار/عبدالعزيز الجندى	النائب العام السابق ورئيس جمعية أصدقاء البيئة	جمعية أصدقاء البيئة	
	٧	إبراهيم أحمد شهاوى	رئيس جمعية محبى العلم والعلماء	جمعية محبى العلم والعلماء	٠١٨٦٢٠٧٢٩١
	٨	أ/ ماجدة إبراهيم فتحي	رئيس جمعية رعاية اهالي حي العامرية	جمعية رعاية اهالي حي العامرية	٠١٢٢٦٤٩٢٢٥

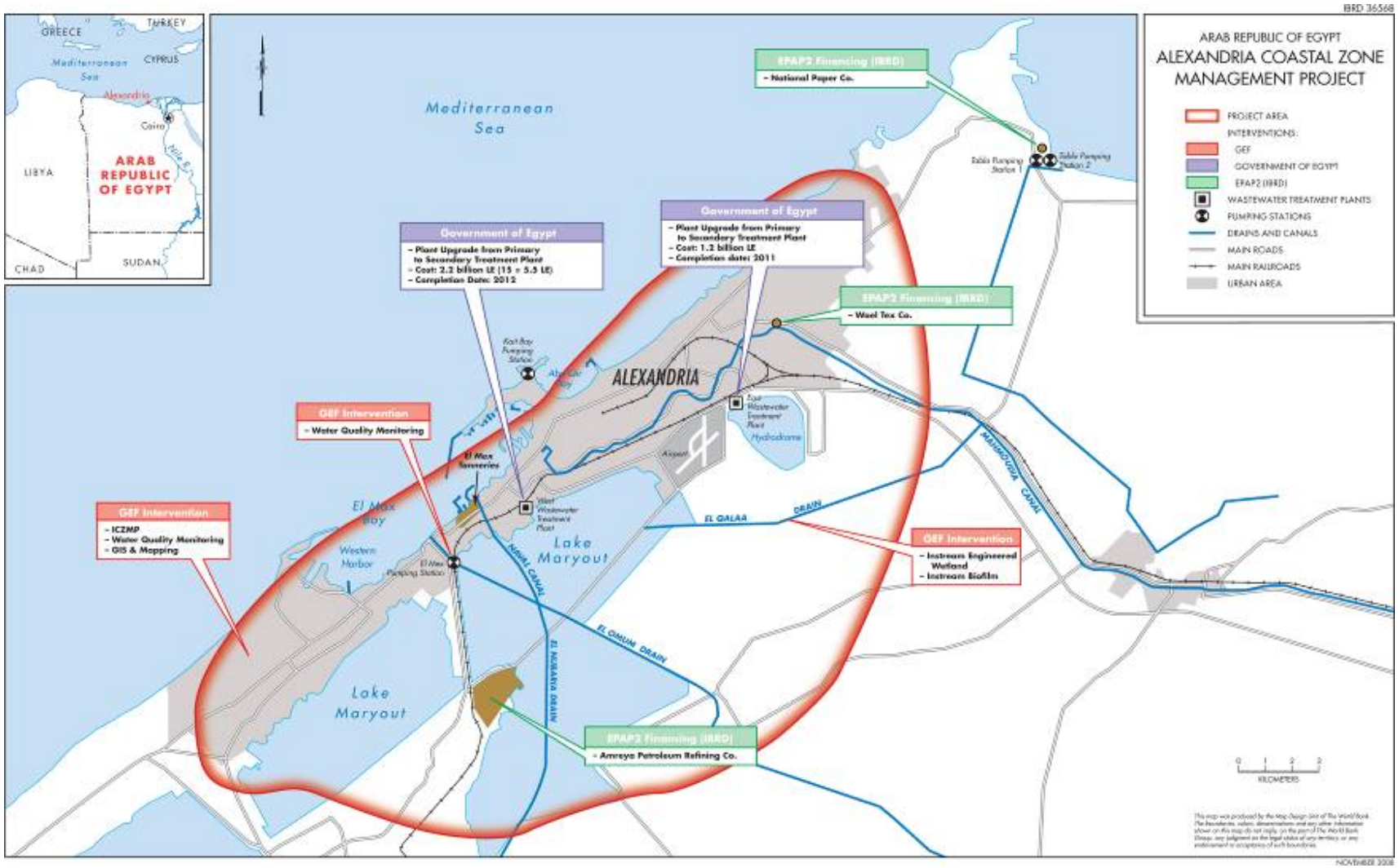
	٩	محمد عبده المغربى	مهندس بحرى	جمعية ثمار مصر	٠١٢٧٥٩٥٦٦٠
	١٠	محمد حسن موسى	أمين صندوق وعضو مجلس إدارة	جمعية ثمار مصر	٠١٢٢٥٠٣٩٣٦
	١١	سامح رضوان عثمان	المستشار الفنى (لجنة الطاقة والبيئة)	جمعية رجال اعمال الاسكندرية	٠١٨٨٨٥٤٤٥
	١٢	نرمين محمد سالم حفنى	محامية	جمعية ثمار مصر للتنمية	٠١٦٨٩٣٦٣٦٣
	١٣	ا. د. سناء سعد محمود	استاذة جامعة	جمعية شهاب العلم للتنمية البشرية	٠١٠٥٣٢٠٦٥٥
	١٤	د/ وفاء المنيسى	استاذة بجامعة الاسكندرية ورئيس منظمة رواد البيئة	منظمة رواد البيئة	٠١٠٥١٣٠٩١٨
	١٥	أسماء حجازى	مسئولة علاقات عامة	منظمة رواد البيئة وحقوق الإنسان	٠١٨١٠٦٧٠٧١
الإعلام	١٦	أحمد سليم سالم	صحفى بأخبار اليوم	جريدة الأخبار	٠١٢٥٣٨١٠٢٣
	١٧	السيد فؤاد السيد على	محرر صحفى	جريدة المال	٠١٠١٨٦٨١١٤
	١٨	أميمة كريم	صحفية	أخبار اليوم	٠١٠٥٣١٩٣٧٦
وزارات وهيئات	١٩	احمد محمد أحمد مرس	رئيس الإدرة المركزية لإقليم صرف غرب الدلتا	وزارة الرى والموارد المائية	٠١٨٨٩٦٩٤٣٩
	٢٠	أشرف السيد اسماعيل	وكيل معهد بحوث الصرف	وزارة الرى والموارد المائية	٠١٢٧٨٣٥٥٨
	٢١	م/ فتحى جويلى	وكيل وزارة الرى بالبحيرة	وزارة الرى والموارد المائية	٠١٠٥١٧٩٣٦٨

٢٢	م/ علاء محمد تاج الدين	مدير عام صرف النوبارية	وزارة الرى والموارد المائية	٠١٦٠٨٠٨٧١٧	
٢٣	م/ علاء الدين عبد الفتاح	مدير عام إقليم الاسكندرية	الهيئة العامة للتخطيط العمرانى	٠١٢٣٩٩٧١٤٨	
٢٤	م / أحمد زكريا أحمد	مدير عام إقليم اسكندرية	الهيئة العامة للتخطيط العمرانى	٠١٧٣٧٧٥٣٢٥	
٢٥	د/ منى صالح الباشا	خبير عمران بيئى	الهيئة العامة للتخطيط العمرانى	٠١٢٧٢١٠٣٠٦	
٢٦	محمد أحمد شعبان	وكيل وزارة	الثروة السمكية	٠١٠٩٥٠٥٧٢٧	
٢٧	رأفت فريد طلبة	رئيس إدارة مركزية	الثروة السمكية	٠١٢٢٨٤٢٥٥٤	
٢٨	أ / أبو بكر الصديق	نائب مدير معهد بحوث الشواطىء	معهد بحوث الشواطىء	٠١٢٤٨٠٤٥١٠	
٢٩	د/ أيمن عبد المنعم الجمل	باحث	معهد بحوث الشواطئ	٠١٠٥٢٩٦٠٢٧	
٣٠	م/ محمد بهجت عبد المنعم	رئيس شركة الصرف الصحى	الصرف الصحى	٠١٢١٣٦١١٣٤	
٣١	م / باسم البحيرى	رئيس منطقة الاسكندرية	الجهاز التنفيذى لمياه الشرب والصرف الصحى	٠١٠٣٤٩٦٥٢٠٠	
٣٢	د/ أحمد حسن مصطفى	مديرعام التدريب والبيئة والجودة	شركة الصرف الصحى بالاسكندرية		
٣٣	جلال الدين كمال أبو الغيط	مدير عام صرف شمال البحيرة	الإدارة العامة لصرف شمال البحيرة	٠١٦٢٢٥١٥٠٦	
٣٤	ا. د. محمود محمد فهمى	وكيل أول بحوث الأراضى	مركز البحوث الزراعية	٠١٢٦٢٣٥٥٥١	

٣٥	م / أحمد عبد الفتاح حسن	مهندس زراعي	استشارات بيئية	٠١٢٦٦٢٤٧٥٤	
٣٦	إيهاب مصطفى الشرقاوى	باحث بيئى	جهاز شئون البيئة	٠١٢٠١٢٨١٢٢	
٣٧	م/ إهاب شعلان	استشارى الشئون البيئية	جهاز شئون البيئة		
٣٨	هدى على السيد	مدير إدارة	جهاز شئون البيئة	٠٣٠٢٤٤٧٧	
٣٩	د/ على ابو سديرة	رئيس قطاع الفروع	جهاز شئون البيئة		
٤٠	د / فاطمة ابو شوك	رئيس قطاع الادارة البيئية	جهاز شئون البيئة		
٤١	م/ ميسون نبيل	المدير التنفيذى للمشروعات الاجنبية لدعم الصناعة	جهاز شئون البيئة	٢٥٢٦١٤٢١	
٤٢	م/ هناء جمعة	وحدة المشروعات التنفيذية	جهاز شئون البيئة	٢٥٢٦١٤٢١	
٤٣	م/ أحمد مدحت	مدير إدارة التحكم بالتلوث الصناعى	جهاز شئون البيئة	٢٥٢٦١٤٢١	
٤٤	م/ ياسر عسكر	مدير إدارة الدعم الفنى والمؤسسى للصناعة	جهاز شئون البيئة	٢٥٢٦١٤٢١	
٤٥	م/ أسماء مصطفى	وحدة الصناعة- قطاع نوعية البيئة	جهاز شئون البيئة	٢٥٢٦١٤٢١	
٤٦	ا/ محمد عبد الله	اخصائى مؤسسى	جهاز شئون البيئة	٢٥٢٦١٤٢١	
٤٧	د/ محمد جميل مصطفى	باحث بيئى	جهاز شئون البيئة	٠١٢٣٥٣٩٨٠٩	

	٤٨	منى جمال الدين	رئيس الإدارة المركزية لفرع الإسكندرية	جهاز شئون البيئة الاسكندرية	٠١٠١٥٥٨٧٧١
	٤٩	م/ هدي مصطفي	مدير نوعية البيئة	جهاز شئون البيئة الأسكندرية	٠١٠١٩٢١٦٤٠
	٥٠	ماجدة عبد الرازق	مفتش بيئي	جهاز شئون البيئة الاسكندرية	٠١٢٣٠٧٨٧٤٩
	٥١	نهى مصطفى محمد	مفتش بيئى	جهاز شئون البيئة الاسكندرية	٠١٠٣٣٥٠١٦٣
	٥٢	رمضان مرشدى حسين	باحث قانونى	فرع ثقافة الأسكندرية	٠١٧٣٠٤٩٤٥٨
محافظة الأسكندرية	٥٣	مصطفى محمد السيد صقر	المدير التنفيذى لجهاز شباب الزراعيين	محافظة الاسكندرية	٠١٠٨١٤٩٥٠٠
	٥٤	هانى حامد محمد	مدير ادارة شئون البيئة	محافظة الأسكندرية	٠١٢٣٣٥٨٣٥٦
	٥٥	مى محمود غلاب	منسق بيئى- إدارة شئون البيئة	محافظة الأسكندرية	٠١٢٤٨٢٢٣٥٩
	٥٦	د/ أيمن سعيد محمود	مفتش بيئى- إدارة شئون البيئة	محافظة الأسكندرية	٠١٠٣٨٢١٨٣٠

Annex 4: Alexandria CZM Map



Annex 5: List of Preparers

Ihab M. Shaalan	Team Leader, EIA Specialist
Fakhry Abdel Khalik	Environmental Scientist
Ayman Khalifa	Water & Sanitation Specialist
Mohamed El-Akrat	Civil Engineer
Ahmed Aboul-Magd	Mechanical Engineer