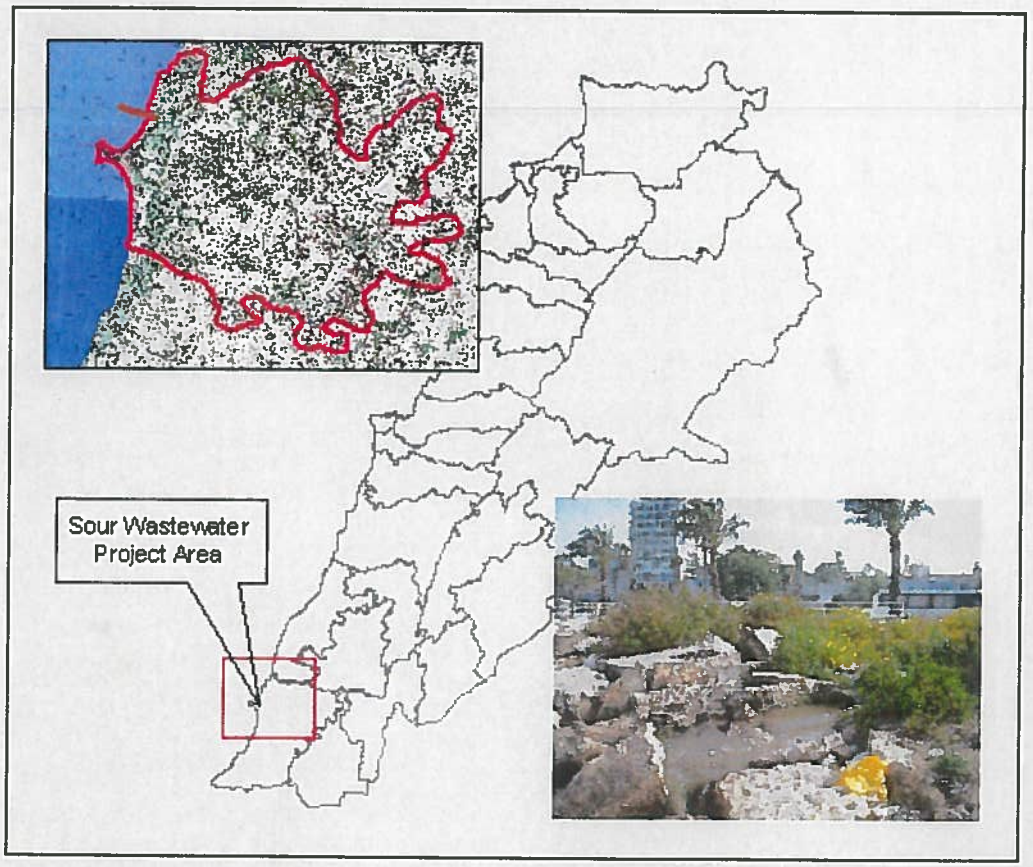
REPUBLIC OF LEBANON

COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION

ENVIRONMENTAL IMPACT ASSESSMENT FOR SOUR WASTEWATER PROJECT



ENVIRONMENTAL IMPACT ASSESSMENT REPORT

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EXECUTIVE SUMMARY

Introduction

This report presents an Environmental Impact Assessment (EIA) of the Sour Wastewater Project that will serve for the horizon year 2040, the Sour area including, in addition to the City of Sour, 48 villages and populations agglomerations. The scope of work implemented in the preparation of the EIA report consists of the following:

- Description of the proposed project
- Definition of existing legal and administrative framework
- Definition of baseline environmental conditions
- Identification and analysis of potential environmental impacts
- Analysis of potential alternatives
- Development of an environmental mitigation plan
- Development of an environmental monitoring plan
- Institutional strengthening for environmental management
- Public participation and consultation activities

Project description

The main components of the project including the 1) Collection Networks and Pumping stations, 2) Wastewater Treatment Plant and 3) Sea Outfall are summarized in the sections below.

Wastewater Network and Pumping Stations

Wastewater networks consists of main collection trunks that serve a group of 49 population agglomerates that forms a catchment area of the same hydrogeology and hydrology formations. The project area extends from Bourghliye to Ras El Ain at the coastal line and to Rashkananey and Chehour inland; it also includes the city of Sour and its suburbs. The networks consists of various lines having different lengths, however, the cumulative length of the all the lines are calculated to be 139 km. As the project area is characterized by hilly terrain, about 17 pumping stations were required to alternate the obstacle emerging from difference in elevation and ensure a smooth flow velocity of transported sewers.

Wastewater Treatment Plant

The wastewater treatment plant in Sour area is proposed to reach secondary treatment level using biological treatment. For domestic wastewater, the major objective of biological treatment is to reduce the carbonaceous BOD (Biochemical Oxygen Demand), coagulate "non-settleable" colloidal solids, and stabilize organic matter.

Sour WWTP components:

1. Pretreatment system:
   - Inlet chamber for gases removal and large objects removal.
   - Coarse screening (50 mm).
   - Pumping station to the fine screening and degritting, degreasing zone, MCC for pretreatment.
2. Screening and degritting, degreasing system:
   - Fine screening (8mm).
   - Longitudinal grit and grease removal.
3. Buffer tank for overflow load system.
4. Primary settling system:
   - Distribution chamber from degritting, degreasing area to the primary settlers
   - 4 concrete primary settlers
   - Primary sludge pumping
5. Biological treatment system:
   - Flow distribution to biological tanks.
   - 2 biological treatment assimilation tanks with 2 biological treatment contact tanks in stage 1, and 3 by 3 in stage 2, 4 by 4 in stage 3.
   - SAS pumping station to final clarifiers
6. Flow distribution tank and recirculation pumping station
7. Clarifier system:
   - 4 clarifiers (2 in stage 1; for the later stages one clarifier is to be added per stage)
8. UV disinfection system
9. Irrigation pumping station
10. Air production system:
    - 4 air blowers to produce process air to the biological treatment area
11. Sludge treatment system:
    - 2 primary sludge thickening units for primary sludge coming from primary settlers.
    - Gravity belt thickeners for biological sludge.

- Sludge storage area from biological treatment.
- Mixing tank for primary sludge and biological sludge.
- 2 primary digester in case of stage I, and a place of two additional digesters for the implementation of stage II.
- Centrifugal dewatering sludge.
- 2 secondary digesters for sludge.
- Biogas storage tank: stores the biogas from digesters to supply the engine biogas or to heat the inlet of digester

12. Odor treatment system: it consists of biological odor removal system (ALIZAIR).

Sea Outfall

The design of the outfall is based on an average dry weather flow of 540l/s and a peak flow of 930l/s. It comprises the following sections:

1- Marine section: a bore sea outfall pipeline of nominal diameter 800 mm and length of 1355 mm plus a diffuser (800 mm x 500mm) section of 145 m length. The pipeline will be laid in trench in the sea bed to a depth reaching up to 13 m.
2- Land section: a low pressure pipeline of nominal diameter of 800 mm and length of 585 m, from the wastewater plant to the sea shore.

Legal and administrative framework

Several ministries and government bodies are responsible for wastewater management related activities in Lebanon including the:

- Ministry of Energy and Water (MoEW)
- Regional Water and Wastewater Establishments
- Ministry of Environment (MoE)
- Ministry of Interior and Municipal Affairs (MoIMA) – Municipalities
- Council for Development and Reconstruction (CDR)
- Ministry of Public Health (MoPH)

The project will involve primarily the CDR, South Lebanon Water and Wastewater Establishment and the MoEW. Upon completion of the design and construction phase (Design-Build Contract) of the Wastewater Treatment Plant and Sea Outfall (about 2 years), the Contractor will be responsible for plant operation and maintenance for a period

of five years, with the option to extend this period up to 25 years by mutual agreement between the contractor and CDR.

While Lebanon has a large body of sector-specific environmental laws and regulations, some dating back to the 1930's, generally speaking, these laws and regulations require updating and integration within a well-articulated environmental policy framework. The Lebanese EIA draft decree provides a list of project types that require an EIA. Included in this list are projects that involve the construction of wastewater treatment plants similar to the proposed Sour WWTP. The decree outlines the elements to be examined in an EIA report, which are consistent with the scope of work described above. In addition, the MoE has introduced national quality standards for air, water, and soil in the context of Decision No. 52/1 dated July 1996. Recently Decision No.8/1 dated March 2001 included standards for the discharge of wastewater to the sea, to surface water and to sewerage systems. Both decisions are applicable in the context of the proposed Sour Wastewater Project.

Description of the environment

Baseline data and field and marine surveys conducted for the project area include a description of the physical, biological, and socio-economic environment (Table I). These were collected, synthesized, and analyzed in the context of Sour Wastewater Project.

Table I. Description of the environment

Component	*Description*
Physical environment	Climate and meteorology Surface water Groundwater Geology and soil Tides, waves and currents Bathymetry Seawater salinity Seawater temperature Seawater quality Topography Ambient air quality Ambient noise levels
Biological environment	Marine biodiversity Terrestrial biodiversity
Socio-economic environment	

Assessment of Environmental Impacts

The environmental impact analysis showed that environmental impacts will occur during both the construction and operation phases of the project particularly with respect to seawater quality, air quality, dust and noise emissions, visual intrusion, waste generation, safety concerns, and socio-economic impacts. During the operation phase, the analysis showed that the proposed project will result in positive impacts related to the potential increase in job opportunities for locals, enhancing seawater quality along Sour coastline, reducing environmental stress to the marine environment, as well as enhancing public health. On the other hand, several adverse aspects that are associated with the project require the adoption of proper environmental management plans to ensure the sustainability of the project and its expected benefits. Table II provides a qualitative summary of the significance of potential environmental impacts that are associated with both the construction and operation phases.

Table II. Summary of impact analysis

Impact	*Construction*	*Operation*	*Comment*
Air quality	0/-	0/-/--	depending on sludge management option
Traffic	-	-/++	depending on the attracted traffic volume with respect to the capacity of the constructed roads
Noise	-	-	
Odors	0/-	-/--	depending on sludge management option
Seawater quality	-	-/+++	
Marine biodiversity	-	-/+++	
Terrestrial biodiversity	0	++	
Resource use (water and energy)	-	--/0/+	
Groundwater and soil quality	-	-/++	
Solid wastes and sludge generation	-	--	
Health and safety	-	-/+++	
Landscape and visual intrusions	0/-	0	
Socio-economics	-/+++	-/+++	

+++	High positive impact	- - -	High negative impact
++	Moderate positive impact	- -	Moderate negative impact
+	Low positive impact	-	Low negative impact
0	Neutral impact		

Analysis of Alternatives

The analysis of alternatives describes the project implementation as compared to the "do nothing" scenario, assesses the suitability of the selected site, and compares alternative treatment and disinfection technologies.

In the "Do Nothing" scenario, wastewater will continue to be discharged into the environment with no prior treatment. This will increase the possibility of seawater, groundwater and surface water pollution, soil contamination, odor generation, in addition to potential adverse health impacts caused by the breeding of mosquitoes and vectors of diseases. Table III presents a comparative evaluation of constructing the plant versus the "do nothing" scenario.

Table III. Comparative evaluation with the 'do nothing scenario'

Impact	*Construction*	*Operation*	*"Do nothing" scenario*
Air quality	0/-	0/-/--	0
Traffic	-	-	**0**
Noise	-	-	**0**
Odors	0/-	-/--	- -
Seawater quality	-	-/+++	- - -
Marine biodiversity	-	-/+++	- - -
Groundwater and soil quality	-	-/0	-
Solid wastes and sludge generation	-	--	**0**
Health and safety	-	-/+++	- - -
Landscape and visual intrusions	0/-	0	- -
Socio-economics	-/+++	-/+++	- -

+++	*High positive impact*	- - -	High negative impact
++	*Moderate positive impact*	- -	Moderate negative impact
+	*Low positive impact*		
0	*Neutral impact*	-	Low negative impact

A comparative matrix for assessing biological processes is presented in Table IV. While the activated sludge system (score = 74) is a most favorable technology for biological stabilization of domestic wastewater, using the adopted criteria and weighing system, its score is comparable with that of the trickling filters, UASB, and RBCs (score = 73, 70, and 66, respectively). As such, based on this analysis, any of these four technologies is environmentally acceptable. A more detailed comparison is recommended once the specific design of the treatment options is determined. The two least favorable technologies were the aerated lagoon and the stabilization pond (scores = 57 and 59, respectively), owing to their large area requirements and lower removal efficiency.

Table IV. Comparative matrix for commonly used biological processes

Parameter	*Weight*	*Technology 1*		*Technology 2*		*Technology 3*		*Technology 4*		*Technology 5*		*Technology 6*	
		Activated Sludge		*Aerated lagoons*		*Trickling filters*		*RBC*		*Stabilization ponds*		*UASB*	
		R	*W*	*R*	*W*	*R*	*W*	*R*	*W*	*R*	*W*	*R*	*W*
Proven technology	2	5	10	3	6	5	10	4	8	3	6	5	10
Area	3	3	9	1	3	3	9	3	9	1	3	3	9
O/M requirements	2	3	6	3	6	2	4	2	4	4	8	3	6
Energy requirements	2	2	4	3	6	3	6	3	6	3	6	4	8
Capital cost	2	4	8	5	10	3	6	3	6	5	10	4	8
O/M costs	2	4	8	5	10	3	6	3	6	5	10	3	6
Removal efficiency	2	4	8	2	4	4	8	3	6	2	4	4	8
Odor generation	3	3	9	2	6	3	9	3	9	2	6	2	6
Public nuisance	3	4	12	2	6	4	12	4	12	2	6	3	9
Total			**74**		**57**		**70**		**66**		**59**		**70**

A similar comparative matrix for assessing the four most commonly used disinfectants with respect to a set of predefined criteria is presented in Table V. Based on this analysis, the two most favorable disinfectants for the treatment of wastewater at Sour WWTP, using the adopted criteria and weighing system, are chlorine and UV disinfection (score = 49). The latter has recently been emerging as a preferable more environmentally friendly technology despite its higher cost due to increased concerns about chlorination by-products and hence it is the favorable technology adopted in the case of Sour WWTP. As for chlorine dioxide disinfection, it is the least favorable, with a score of 43, but is not far from ozone disinfection, with a score of 45.

Table V. Comparison of characteristics of commonly used disinfectants

Parameter	*Weight*	*Score*							
		Chlorine		*Chlorine dioxide*		*Ozone*		*UV radiation*	
		R	*W*	*R*	*W*	*R*	*W*	*R*	*W*
Availability/ cost	3	3	9	2	6	1	3	1	3
Deodorizing ability	1	3	3	3	3	3	3	0	0
Interaction with extraneous material	2	2	4	1	2	2	4	3	6
Corrosiveness	3	1	3	1	3	1	3	3	9
Toxicity to higher forms of life	3	1	3	2	6	2	6	2	6
Penetration	2	3	6	3	6	3	6	2	4
Safety concern	3	1	3	1	3	2	6	3	9
Stability	2	2	4	1	2	1	2	0	0
Toxicity to microorganisms	2	3	6	3	6	3	6	3	6
Toxicity at ambient temperature	2	3	6	3	6	3	6	3	6
Total			**47**		**43**		**45**		**49**

Two alternatives for safe sludge disposal can be considered in the project:

- Disposal in a local landfill
- Use in agricultural activities

The adverse pollutants that may exist in sludge are heavy metals. These may be considered of major concern to the environment when sludge is disposed of in landfills or used in agriculture as soil fertilizers. The raw wastewater collected from the different communities and facilities in the project area is expected to have low concentrations of heavy metals. The industries in the area are not characterized as heavy industries and as such are not expected to discharge wastewater with significant levels of heavy metals.

Environmental mitigation plan

The primary adverse environmental impacts that are associated with the construction and operation phases of Sour Wastewater Project can be minimized by careful planning and staging of construction activities, adopting proper management practices during operation and relying on effective environmental monitoring and training to support management

decisions. Tables VII and VIII summarize proposed elements of the mitigation plan that will be adopted during the construction and operation phases of the project, namely the WWTP and Sea Outfall. Note that the details of the mitigation measures must be made part of the design proper. During both the construction and operation phases, the implementing responsibilities for the mitigation measures include the contractor(s) and consultant(s); the supervising authorities include the CDR, the MoEW, South Lebanon Water Establishment, the MoIM, and the MoE.

Table VII. Proposed mitigation measures during the construction phase

Impact	*Mitigation measures*
Air quality	Water surfaces Use chemicals to treat exposed surfaces Install windbreaks or source enclosures to reduce surface wind speed Pave heavily-used roads Cover the road surface with a new material of lower silt content Maintain roads regularly Maintain good housekeeping practices Properly maintain trucks and on-site equipment Adopt a traffic management plan while avoiding congested routes Ensure quality of diesel fuel used with on-site equipment Turn off all equipment when not in use
Traffic	Study possibility of construction during night hours Disseminate information regarding construction schedule Provide proper planning and development of a traffic control plan Guide motorists through construction zones in a clear and safe manner (adequate warning, signing, delineation and channeling at least 500 m down and up-gradient from the construction site) Develop and communicate preliminary routing schemes where needed Limit the movement of heavy machinery to off-peak hours
Noise	Erect noise barriers along active work sites Install vegetative screens where practical Operate on-site well-maintained mechanical equipment only Shut down equipment that may be intermittent in use between work periods or throttle them down to a minimum Utilize silencers or mufflers on construction equipment Properly maintain construction equipment during construction works Use material stockpiles and other structures to screen noise from on-site construction activities Schedule noisy activities during daytime periods Construct noise barriers along roadside Provide noise enclosures or semi-enclosures Install noise reducing road surfaces (such as quiet pavements) Improve noise insulation of windows
Odors	Install odor control system in the WWTP and Pumping Stations Install physical covers over odor emitting sections of the plant where practical and feasible Fit biotechnological treatment systems (bioscrubbers, biotrickling filters, and biofilters)

Impact	*Mitigation measures*
Seawater quality	Carefully load barges to avoid splashing of material Fit barges used for the transport of dredged materials with tight bottom seals Fill barges to a level which ensures that material does not spill over during loading and transport to the disposal site Adopt good housekeeping measures to reduce the presence of foam, oil, grease or litter in the water Direct surface run-off into storm drains via adequately designed sand/silt removal facilities Provide channels, earth bunds or sand bag barriers on-site to properly direct stormwater to silt removal facilities Discharge rainwater pumped out from trenches or foundation excavations into storm drains via silt removal facilities Cover open stockpiles of construction materials with tarpaulin or similar fabric during rainstorms events Prepare guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals
Marine biodiversity	Prohibit disposal of food, oil, sewerage, or chemical wastes directly into the marine environment If suction hoppers are to be used, avoid ecologically sensitive areas
Groundwater and soil quality	Properly store chemicals on-site Install natural or synthetic liners beneath chemical storage tanks Provide proper surface drainage Minimize on-site water and chemical usage (oil, lubricants and fuel) Limit exposure of the soil to accidental releases of pollutants Use non-toxic and readily biodegradable chemicals
Resource use	Adopt dry cleaning practices prior to water cleaning of working areas and vehicles Use energy-efficient construction equipment Properly operate and maintain equipment Turn off equipment whenever not in use
Waste and sludge generation	Reduce or eliminate over-ordering of construction materials Sort construction and demolition wastes into various categories Re-use/recycle construction and demolition wastes on site whenever feasible Use reusable non-timber formwork and temporary works Make use of any uncontaminated soil on site for landscape works Segregate chemical wastes Store chemical wastes in a separate area that has an impermeable floor, adequate ventilation and a roof Store chemical wastes in corrosion resistant containers Label all chemical wastes containers in English and Arabic Store general refuse generated on-site in enclosed bins or compaction units separate from construction and chemical wastes Draft agreement with the solid waste collector in Sour area Prohibit burning of refuse on construction sites Provide separate, labeled bins for aluminum cans Establish a recording system for the amount of waste generated, recycled and disposed of (including the disposal sites) Train workers on the concepts of site cleanliness and on appropriate waste management procedures

Impact	*Mitigation measures*
Health and safety	Restrict access to the construction site by proper fencing Establish buffering areas around the site Provide guards on entrances and exits to the site Install warning signs at the entrance of the site to prohibit public access Provide training to a dedicated staff about the fundamentals of occupational health and safety procedures Provide appropriate personal protective equipment (PPE) Adequate loading and off-loading space Develop an emergency response plan Provide on-site medical facility/first aid Provide appropriate lighting during night-time works Implement speed limits for trucks entering and exiting the site and from the highway Follow CDR guidelines as well as recognized world practices for health and safety Provide fire-fighting equipment such as dry powder extinguishers within the premises of the plant Conduct annual fire-fighting and leak checks training drills for the operating staff Prohibit smoking as well as litter or weed build-up in the area as these may pose fire risks
Landscape and visual intrusions	Enclose site with non-transparent fencing to minimize visual impacts Prohibit vehicles from parking outside the fenced boundary of Sour WWTP Preserve existing vegetation when feasible Select appropriate paint colors for the exterior of the plant to help it blend with the surroundings Select construction materials that will blend with the background Select architectural designs that will blend with the surrounding features of the milieu Incorporate underground utilities (to the extent possible) to house electrical, storage, and operational equipment Comply with the building codes of the area and reduce the construction of elevated structures Open areas adjacent to erected structures of the treatment plant should be grassed and planted with shrubs, trees to provide visual screening Dense planting should include: Eucalyptus Div. Sp (every 10 to 12m), Ficus Nitida (every 2 to 3m), Ficus Elastica (every 2 to 3m), Casuarina Equisetifolia (every 4 to 5m), Leylande (every 1 to 2m) Low density planting should be conducted beyond the planting area for visual enhancement: Nerium Orleander, Dodonea Viscosa, Duranta, Thevetia Specimen trees may include Tamarix, Bamboo, Aurea Select and enforce designs that will maximize the unbarred view of the sea from most areas within the region of influence
Socio-economic	Provide community in the immediate vicinity of Sour WWTP priority in terms of job opportunities Restrict movement of construction machinery outside the site during peak traffic hours

Table VIII. Proposed mitigation measures during the operation phase

Impact	*Mitigation measures*
Air quality	Store the generated biogas (in the case where anaerobic digestion of sludge is adopted) and use as power source within the plant
Traffic	Limit the movement of heavy machinery to off-peak hours and provide prior notification as well as adequate traffic signs on the roads leading to the site at least 500 m down and up-gradient Dewatering of sludge (in the case of landfilling) to a maximum moisture content of 70 percent to minimize transportation requirements
Noise	Install mufflers and noise barriers around the air blowers and pumps Enclose noisy equipment
Seawater quality	Limit emergency discharge to primary treated wastewater Emergency storage should be accounted for in order to temporarily hold sewage overflows in case of operational emergencies Construct an overflow outfall pipe in the case of system surge or shut down (as specified by the bidding document) Restrict necessary shutdown of the plant for operational adjustments to the shortest period possible with minimum flow at the inlet works and following approval by the CDR representative Perform continuous maintenance checks to assure system functionality Schedule repair and equipment replacement operations to coincide with off peak hours Provide appropriate training to a dedicated staff Conduct a rigorous monitoring program on site and at identified receptors Provide backup power source on-site
Odors	Maintain odor control systems Maintain physical covers over odor emitting sections of the plant and pumping stations Maintain chemical odor scrubbing systems and/or biotechnological treatment systems
Marine biodiversity	Ensure that discharges to the marine environment conform with discharge standards
Terrestrial biodiversity	Water the site to maintain the adopted landscaping program and to reduce the impact of dust generated from the operation of the treatment plant that may hamper photosynthesis Prohibit hunting of birds and reptiles by personnel as well as prohibiting the disposal of wastes, hazardous and chemical material in non- allocated areas to avoid spillage and contact with fauna
Resource use (water and energy)	Adopt dry cleaning practices prior to water cleaning of working areas and vehicles Reuse treated wastewater (after secondary treatment) for landscaping within Sour WWTP Devise a plan for the collection and reuse of the generated methane (in case anaerobic digestion is opted for) Install energy efficient equipment, machinery, ventilation, lighting, and pumps
Groundwater quality	Contain spills and develop procedures for emergency clean-up Ensure proper storage of sludge and discharge of wastewater into the overflow outfall Avoiding the application of agrochemicals during on-site landscaping

Impact	*Mitigation measures*
Waste and sludge generation	Dispose of screenings, grit sand, debris and residuals removed from the wastewater or generated at the treatment plant at a permitted disposal site Dispose of digested sludge in a permitted landfill or reuse in agricultural lands
Landscape and visual intrusions	Preserve existing vegetation when feasible Maintain landscaped areas in order to prevent the loss of plants and grass by means of uncontrolled growth, diseases, insects, absence of nutrients, extreme climatic conditions and others Remove waste and debris on a weekly basis from the landscaped areas
Socio-economic	Conduct an environmental awareness workshop to introduce the public at large to the benefits of installing and operating a wastewater treatment plant, sea outfall, pumping stations
Health and safety	Restrict access to the wastewater treatment plant by proper fencing Establish a buffering area around the plant Install warning signs at the entrance of the WWTP Provide training to the staff about the fundamentals of occupational health and safety procedures s Provide appropriate Personal Protective Equipment (PPE) Provide appropriate monitoring instruments Conduct regular maintenance of equipment and especially of anaerobic digesters Prevent the stagnation of exposed water volumes to hamper insect and vector breeding Prohibit dirt, dampness, water, oil and other substances within the electrical plant Conduct insulation tests within the electrical plant prior to operation Install warning signs in the proximity of hot pipes, electrical connections and pressure relief valves Lifebelts should be provided in prominent locations adjacent to all open tanks and channels Clear walkways of any debris Fit walkways and tanks where the top wall level is less than 1 m above the finished ground level with handrails and toe boards Safeguarded stands should be provided for maintenance works at scraper bridges and at actuators Portable gas warning devices, lifebelts and securing devices should be provided to workers upon entrance into manholes Position safety showers at all strategic points in the treatment works Provide first aid boxes at key points around the plant Follow CDR guidelines as well as recognized world practice for health and safety Provide Fire-fighting equipment such as dry powder extinguishers within the premises of the plant Conduct annual fire fighting and leak checks training drills for the operating staff Prohibit smoking as well as litter or weed build up in the area as these may pose fire risks

Environmental monitoring plan

Monitoring of air quality, noise levels, seawater quality, groundwater (in case of groundwater pumping), waste management practices, health and safety, landscape, and socio-economics is proposed for all components of Sour Wastewater Project. In addition, performance monitoring of the plant is proposed, in consistency with bidding documents. During construction and operation phases, the implementing responsibilities include the contractor(s) and consultant(s), while the supervising authorities include CDR, MoEW, MoIM, and MoE. Table VIII presents a summary of the monitoring plan.

Table VII. Summary of the proposed monitoring plan

Impact	*Monitoring means*	*Parameters*	*Phase*	*Location*	*Frequency*
Air quality	Sampling	TSP/PM-10	Construction	Fishermen port	Monthly Upon complaints
	Sampling	CO, NO_2, SO_2, Dust, TOC, HCl, HF All parameters listed hereunder CO, NO_2, SO_2, TSP, CH_4	Operation	In the proximity of Sour WWTP (locations TBD)	Monthly Upon complaints Quarterly Quarterly Upon complaints Bi-annual
Noise	Sampling	L_{eq} (dBA)	Construction	at a 500 m radius at the buildings separating the site from the highway	Monthly Upon complaints
	Sampling	L_{eq} (dBA)	Operation		Quarterly Upon complaints
Odors	Olfactory test Sampling	H_2S (ppb)	Operation	Perimeter of the plant	Daily Upon complaints
Seawater quality	Sampling	TSS, DO TSS, DO	Construction	Dredging sites (seawater at 3 depths*) 100, 300, and 500 m along the sediment plume at the dredging site (at 3 depths*)	Monthly Upon complaints Quarterly for QA/QC

Impact	*Monitoring means*	*Parameters*	*Phase*	*Location*	*Frequency*
	Sampling	TSS, DO, Total and Fecal Coliforms		Same as above	Quarterly Upon complaints
		Five selected heavy metals (iron, manganese, lead, cadmium, zinc, mercury, arsenic, selenium) for sediments		Sediment	Bi-annual Quarterly Upon complaints
		pH, temperature, BOD_5, COD, total phosphorous, total nitrogen, TSS, Total and Fecal Coliforms, Intestinal nematodes (Ascaris and Trichuris species and hookworms, only in the case of reuse)	Operation	Final effluent	Daily
		QA/QC tests for all components		Final effluent	Monthly Quarterly
Terrestrial biodiversity	Visual inspection and photographic documentation	General condition of the floral cover	Operation	Landscaped areas within Sour WWTP	Quarterly
Resource use (water and	Metering	Water and energy consumption	Construction	Sour WWTP	Continuous

Impact	*Monitoring means*	*Parameters*	*Phase*	*Location*	*Frequency*
energy)	Sampling Metering	Intestinal nematodes (Ascaris and Trichuris species and hookworms, only in the case of agricultural reuse) Water and energy consumption	Operation	Sour WWTP	Daily Continuous
Groundwater quality	Sampling	TSS, conductivity, salinity, and Fecal Coliforms QA/QC tests for all parameters	Operation	Pumped wells Locate at least two wells at the northern and southern site boundaries	Quarterly (in case of pumping) Bi-annually
Solid waste and sludge	Waste audit	Generation, storage, recycling, transport, and disposal	Construction	Sour WWTP site	Quarterly
	Waste audit Sampling	Generation, storage, recycling, transport, and disposal Quantity and five selected heavy metals (mercury, beryllium, iron, manganese, lead, cadmium, zinc, mercury, arsenic, selenium) Quantity and dry solids content	Operation	Solid wastes stabilized sludge Sludge	Quarterly Monthly Daily

Impact	*Monitoring means*	*Parameters*	*Phase*	*Location*	*Frequency*
Wastewater and plant performance	Sampling Visual inspection	pH, temperature, BOD_5, COD, total phosphorous, total nitrogen, TSS, Total and Fecal Coliform Operation of pumping stations, electrical plants, generators, biological reactors, and incinerator	Operation	Influent Primary treated wastewater Final effluent	Daily Quarterly for QA/QC Continuous
Health and safety	Health and safety surveys	Proper use of PPE, presence of signs, first aid kit, and fire fighting devices	Construction Operation	Sour WWTP site	Continuous
Landscape and visual intrusions	Visual inspection and photographic documentation	Ensure the effective implementation of mitigation measures	Construction Operation	Entire area	Monthly Quarterly
Socio-economics	Field questionnaires Interviews	Population perception Employment records	Construction Operation	Region of Influence	Annual

* 3 depths: 1m below surface, mid- depth and 1m above seabed

Institutional strengthening

In the context of Sour Wastewater Project, institutional strengthening in environmental management falls within several sectors ranging from wastewater treatment, air quality, traffic to solid waste management, water conservation, and protection of marine resources.

Appropriate environmental management dictates that construction and operation be implemented in accordance to the current state of the art and knowledge regarding environmental protection. For this purpose, contractors and consultants who will be involved in the construction and operation of the various components of the proposed project will be required to attend an environmental training course prior to the initiation of project activities. Environmental training sessions will be conducted twice per year for a period of three days during the construction and operation phases. In an effort to strengthen institutional capacity and environmental awareness, training sessions on the proposed project should be opened for individuals from concerned ministries and agencies such as the MoE, CDR, MoEW, MoIMA, MoPH, South Lebanon Water Establishment, concerned NGOs, etc.

The environmental monitoring and management plans should be implemented by an entity independent of contractors and consultants involved in any component or tasks of the project to ensure quality control and quality assurance. Guidelines, specifications, and content for systematic and comprehensive environmental training and awareness programs shall be developed within the final design. Such guidelines will define the contribution of the proposed project to potential institutional strengthening and capacity building in environmental management in the project area in particular and at the country's scale in general.

Public Participation

Public involvement and consultation are important components in any wastewater management project as they aim to increase the general environmental awareness among the public and various concerned stakeholders on the proposed project thus addressing their concerns.

Preliminary meetings were held between representatives of the CDR, the Ministry of the Environment, the Municipalities of Sour City and Aabbasiyeh village and the Consultant (Rafik El-Khoury & Partners). General concepts associated with Sour wastewater Project are being discussed during these meetings. Every effort was exercised to address all concerns in various parts of the EIA Report and will be made part of environmental specifications for Contractors to abide by. In addition, a public consultation meeting was conducted to introduce

the project and the findings of the EIA and to get feedbacks from various stakeholders in the project area.