# 8- ENVIRONMENTAL IMPACT ASSESSMENT

## 8-1 PREFACE

The presented Environmental Assessment Study has been elaborated within the frame of local, national and international guidelines and follows the terms of references defined for this project and the requirements of the 'Operational Directive 4.01: Environmental Assessment' stated by The World Bank in October 1991.

The table of contents meets with the requirements of the Water and Wastewater Sector Implementation Unit (SIU), Ministry of Hydraulics and Electric Resources (MHER), and Council for Development and Reconstruction (CDR), Beirut.

## 8-2 EXECUTIVE SUMMARY

The facts and findings for 'Water and Wastewater Study for Jbeil Caza' Environmental Assessment Study indicate an urgent need for the improvement of wastewater management within the project area.

The project area is bound by Nahr el Madfoun on the north and by Nahr Ibrahim on the south. The area lies at about 35 km to the north of Beirut, and is one of the less densely populated regions of Mount Lebanon, with an estimated present population of about 115,000.

The coastal region of Jbeil district underwent moderate environmental pollution due to the absence of adequate wastewater discharge infrastructure, helped by low population densities. This applies especially for the terrestrial areas. The rock formation is Karstic and the wastewater of the entire region (mountainous areas included) are discharged into ditches, natural holes or boreholes. Penetrating the Karstic rocks with different retention times, these wastewaters finally reach and pollute the sources lying at lower altitudes.

The degradation of the marine littoral zones rests at a comparatively low level, due to the scarcity of short outfalls discharging on the shores. This situation, if not checked at an early stage, may develop in the near future to conditions encountered in the more densely populated coastal areas of Lebanon.

In the context of policy, legal and administrative framework, the national legislative authorities of Lebanon, due to the restricted development potentials during the past three decades, had only little opportunity to update the necessary environmental framework according to the present demands. This situation has been undergoing rapid change in the present decade.

In April 1993 the Lebanese government created the Ministry of Environment (MOE) with the basic tasks of setting out the general policy for matters related to the Environment. During the last few years, MOE achieved a great deal of progress towards the ratification of environmental law. Parallel to this, the Ministry of Hydraulic and Electric Resources (MHER) has already laid out the foundation for the establishment of Regional Water and Sanitation Companies (RWSC), whose main function would be to provide reliable water and sanitation services within the territories assigned to each.

The proposed improvement of the wastewater disposal system represents the best possible solution for the area, aiming at the minimization of negative impacts on nature and man at the same time.

The sewerage system foresees several mountain collectors that convey the flow from scattered communities in the mountains overlooking Jbeil City and the seacoast, mostly by gravity, resorting to pumping in certain locations to overcome ridges or high ground. This flow arrives to the coastal strip, or flows directly into the French Protocol Zone, surrounding the city of Jbeil, whose sewerage system and sewage treatment plant are subject of a different study. Flows from communities in the higher mountains reaches of the district or form secluded watersheds where flows cannot be brought down to the coastal strip economically, are provided with local treatment plants.

Several alternatives have been developed and evaluated. The topography of the study area is a rather steep mountainous terrain sloping generally towards the seashore. Unfortunately, the valleys and wadis are not all connected by roads and highways to the coastal strip. Sometimes, despite the presence of roads that connect the communities with the coastal strip, the rolling terrain does not provide suitable routes for gravity sewers. Hence, it was necessary in such cases, for economical reasons, to provide local treatment plants.

These local treatment plants shall be mainly of three types: oxidation ditch, extended aeration, or waste stabilization lagoons, pending further studies in later stages.

The study area is not considered as an agricultural area, existing agricultural practice being limited mainly to green house culture of vegetables, usually eaten raw. Hence, it is not advisable to irrigate these crops with treated wastewater. However, reuse of treated wastewater may be incorporated into the project, pending more specified studies, and may be considered for a restricted use in watering of crops and grove trees, industrial application, landscaping and other similar uses.

Tender documents for construction shall include clear clauses for possible realignment or relocation of facilities where historical and cultural monuments are discovered. Monitoring and site inspection by a qualified archeologist during construction will be required. In fact, the general conditions of the tender documents adopted by the Lebanese government impose very strict regulations regarding preservation of historical and cultural monuments.

The project, as a whole, is not expected to have any considerable negative impact on the environment. The sewerage scheme would involve short duration negative impacts resulting from construction nuisances, road crossings of major highways, passage of sewer lines through congested downtown areas, and possible odor control problems within pumping stations and treatment facilities.

Noise and odor from pumping stations, pretreatment works and secondary treatment plants shall be controlled. Noise levels in areas adjacent to pumping stations will be restricted, although it should be mentioned that most of the proposed locations for these stations are at reasonable distances from inhabited areas.

The positive impacts of the project include:

- Eliminate discharge of sewerage in the sensitive Karstic layers which is contaminating the natural springs and the water table progressively.

- Elimination of the pollution of the seashore, which is, considered a highly prized touristic attraction, particularly in the coastal areas of Jbeil City and Aamchit.
- Elimination of health risk to the population both from potable water and marine environment.
- Enhancing the socioeconomic conditions of the people by improving touristic projects, especially since the general income of the population of Jbeil is on the low side.

In relation to the expected low negative impact caused by the implementation of the proposed systems, detailed mitigation plans with high complexity are considered not necessary. These are almost restricted to:

- Restoration of surrounding landscaping and containment of land slides where construction occurs.
- Minimum disruption of traffic by passing the major coastal collectors along the old coastal road.
- Crossing of major highway and sensitive down town areas to be done by micro-tunneling techniques, wherever necessary.
- Noise levels for machines in pumping stations and treatment site shall be kept to acceptable standards.
- Dumping of heavy metals and toxic materials will be subject to national regulations and MED-POL limits and shall be controlled at source.

Reflection of these low-level negative impacts, and the previous positive impacts on a "no project" situation immediately highlights the overall positive impact of the project.

The training programs concerning basic environmental issues, set up for the staff needed for the management and the operation of the proposed systems are of utmost importance to ensure a cost effective and environmentally safe operation. The main items should therefore concentrate on basic chemical analysis in the laboratory and in the field as well as on basic engineering principles of wastewater collection and treatment.

In addition to these programs, monitoring plans are considered to be an integral, essential framework for the implementation of the proposed schemes. Such plans may include periodical leak detection of sewer pipes, periodical effluent analysis of the wastewater treatment plants and daily quality monitoring of the water sources feeding the water supply systems.

# 8-3 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

## *8-3-1 National And International Regulations And Guidelines*

It is mainly due to the critical national situation during the last three decades that Lebanon in fact had no possibility to establish a sound and effective national environmental legislation framework as it has been developing in the other Mediterranean countries for years. This does not only apply to water and wastewater quality standards but also to legislative tools for the protection and sustainable use of natural resources.

However, following the end of the years of strife, the Lebanese government has embarked on the rehabilitation and expansion of the nation's infrastructure to overcome the deficiencies resulting from the wartime disruption. Parallel to this, Lebanon has actively started to upgrade its prevailing environmental regulations and laws, and has participated in the regional conferences that addressed environmental problems. Lebanon is a signatory to the convention and protocols produced through the Mediterranean Action Plan (MAP), and has agreed to support a continuing research and monitoring program known as MED-POL II. Under this program, guidelines have been produced that govern the design of marine outfalls which discharge wastewater into the Mediterranean. Signatories to the MAP convention have established criteria, whereby coastal communities with more than 100,000 population should establish sewage treatment plants, but no time scale has been set. Demographic studies in Jbeil district, however, indicate that the present population contributing to the proposed coastal treatment plant in the French Protocol Zone (FPZ) do not approach the above mentioned limit. Future growths in population, on the other hand, may exceed the said limit, and the MAP convention criteria will govern. Hence, it is imperative that the proposed study take such aspects into consideration.

In addition, Lebanon has taken part in other action plans set up for the Mediterranean region and has to be defined among other Mediterranean countries as target region for various environmental protection and development programs (UNDP, UNEP, METAP, WHO) of which only a number of publications have been revised representatively for this study.

In April 1993, the Lebanese government created the Ministry of Environment (MOE), whose basic task is to set out the general policy that governs matters related to the Environment, and to present the necessary implementation framework, in coordination with other governmental authorities. MOE has proceeded with its tasks, and has started to draft appropriate environmental regulations, and to present the framework necessary for implementation, in coordination with other government authorities. In 1997, MOE has prepared for adoption a project for environmental law.

Also, the Ministry of Hydraulic and Electric Resources (MHER) has started a program for the reform of the water and wastewater sector. This involves the establishment of five autonomous Regional Water and Sanitation Companies (RWSC). The main function of these entities is to provide water and sanitation services to cities, towns and smaller communities within its jurisdiction. Jbeil district falls within the proposed central company covering the Mohafaza of Mount Lebanon.

According to this plan, matters related to tariffs, levels of service and the allocation of water resources will be regulated through a central department of MHER, and the environmental impact of the RWSC activities will be regulated by the Ministry of Environment (MOE).

In this framework, the environmental assessment study refers to international guidelines and standards concerning the evaluation of the present environmental status of the project area as well as the definition of effluent requirements for wastewater treatment plants and in the discussion of negative impacts. In this respect, MOE in its resolution No. 53/1 dated 1/12/1996, has established standards and discharge limits to protect the environment from pollution.

### *8-3-2 Principle Guidelines For Wastewater Management in Coastal Watersheds*

The threat of biological degradation that coastal littoral zones are faced with is similar to nearly every coastal stretch on each continent of the world. Subsequently, guidelines, standards and programs to decrease coastal degradation in order to protect the natural resource potential of these zones are nowadays clearly definable and proved to be applicable for most of the existing climates.

Although protection of the littoral zone of Jbeil district would be a subject for discussion in the study that is being conducted by the French Protocol Consultancy, never the less, the present study endeavored to address the issue through conveyance of all flows arriving at, or issuing form the coastal strip via coastal collectors to connect either with the (FPZ) system, or with the Kesrouan sewerage scheme.

The principle guidelines governing wastewater management in coastal watersheds include:

- The sound and intensive evaluation of possible wastewater disposal methods prior to planning and construction of wastewater systems, including inland treatment plants and sea outfalls, to achieve more cost effective solutions, e.g., infiltration or reuse of sewage effluent in agriculture.

- The clear and rational definition of adequate treatment techniques including degree of treatment required, such as primary, secondary and tertiary, for the elimination of certain chemical pollutants and nutrients, based on the obtained data pool (effluent standards).

- The site selection of treatment plant sites and subsequent points of effluent discharges, including choice of sea outfall location, based on scientific analysis programs and data interpretation, including chemical, physical, biological and, in the case of sea outfall, oceanographic studies. In the case of inland treatment plants, sufficient data has to be accumulated to allow rational investigation of possibilities of recycling and eventual infiltration into the karstic ground water formations.

- The set up of monitoring programs for the supervision of cost effective and environmentally safe operation of the total systems of the scheme.

### *8-3-3 Effluent Standards for Wastewater Discharge to Land and Sea.*

Of the principle guidelines listed above, arrival at an adequate treatment technique proves to be the most complex principle. Coupled to the first guideline, the choice becomes widespread and diversified, particularly when reuse is projected on the overall view. And what still complicates the scene more is the financial factor that plays a crucial role in the overall picture.

However, in the present study, littoral zones and final disposal of effluents from those zones are beyond its scope of works, to be handled by the French Protocol Consultancy. This study will, therefore, be more concerned with surface and ground waters problems, rather than seawater protection.

Consequences of improper sewerage practices within the area are already manifesting themselves. And when treatment is implemented, an additional problem will impose itself, namely, that of sludge treatment and disposal.

No national or local codes of practice are yet available, and the study will have to depend on regional or international guidelines for guidance in this stringent subject.

## 8-4 PROJECT DESCRIPTION

### *8-4-1 Introduction*

The project covers a series of discrete and independent components, covering the sewerage systems for the whole of Jbeil district. The project area covers part of the coastal strip, extending from Nahr Ibrahim until the outskirts of Halat, which initiates the beginning of the French Protocol Consultancy Area. The latter covers the area from Halat to Aamchit, including the city of Jbeil and the hills and slopes surrounding it. After Aamchit, the project area is resumed, and extends along the coast till Wadi El Madfoun. The project area extends eastward from the coastal strip and the boundaries of the FPZ to the eastern boundaries of the district at the top of the mountains, reaching an elevation of around 1100m. However, the areas above Aaqoura and Laqlouq are mostly arid and uninhabited, with almost no roads or other utilities reaching them.

### *8-4-2 Sewerage System for the Coastal Strip and Surrounding Slopes*

Sewerage collection facilities are almost non existent in the district. Even in the coastal areas and the city of Jbeil itself, the inhabitants still rely on primitive on-site facilities for sewage disposal.

The coastal area and surrounding slopes extend from Nahr Ibrahim to Madfoun valley, and includes the FPZ, which covers the main and most densely populated parts of the district. The general topography of this area lends itself readily to gravity flow down the slopes of the adjacent hills and low mountains until arriving at the coastal area. There, main collectors, running by gravity and under pressure convey flows to either the FPZ or to Kesrouan. The flow through the latter collector discharges into the main collector of Kesrouan Caza to the Kesrouan pretreatment plant and sea outfall at Tabarja.

The general topography of the land along the coastal strip, and the division of the project area into several zones either by the present TOR (FPZ) or the previous studies (Kesrouan), limits the choice of alternatives along the coastal strip. However, for the mountain collectors, various alternatives were considered upstream from the FPZ, with particular care being taken to possible future developments within the area.

Further investigation will be carried out to locate the most suitable routing for the coastal collector, and the railway track may be chosen in order to achieve the following objectives:

1) Avoid the coastal roads, which can be reserved to other utilities.
2) Minimize on expropriation.
3) Maneuver around the mountainous ridges.

4) Take advantage of the flat layout of the railway or their mild slopes thus avoiding dips in the ground and consequent pumping/lifting stations.
5) Avoid the main highway.
6) Minimize the undesirable environmental impacts during construction.

### 8-4-3 *Sewerage for the Mountainous Area*

Several alternatives for the sewerage schemes were considered, combining gravity lines, pumping stations, pressure lines and local treatment plants. Description of the alternatives is provided in section 2.

### 8-4-4 *Treatment Plants*

In the context of sewage treatment, several alternatives were investigated. Although waste stabilization lagoons can be considered the most economical for the region, oxidation ditches and extended aeration plants were selected as more suitable processes for Jbeil Caza due to the rugged nature of the areas surrounding the mountain communities, and the relative absence of large flat areas suitable for the location of the lagoons

At a later stage of the study, more consideration shall be given to the possible reuse of effluent for irrigation. If feasible, this consideration will necessitate, most probably, resort to the use of maturation ponds to obtain an effluent that is acceptable for irrigation purposes with respect to natural die out of fecal coliform.

### 8-4-5 *Implementation of the Scheme*

The immediate requirement is to stop pollution of ground water aquifers within the area, which are the sources of drinking water for Jbeil district itself, and neighboring areas. Thus, all sewage disposal to the ground water through deep wells and leaking septic tanks shall be stopped. Direct discharge of sewer lines on the shoreline should be terminated, and sewage be collected and diverted to the proposed treatment works and sea outfall at the coast, or to the smaller local treatment plants in the inland areas. Accordingly, the first phase works will consist of the following:

1) Installation of the proposed central treatment plant, to be designed by the French Protocol Consultancy, to properly dispose of the sewage, and to prevent seashore pollution.
2) Construction of the sewage collectors.
3) Construction of local sewerage schemes for smaller communities or those that connect to larger schemes, and which are presently contributing to the pollution of ground water aquifers.
4) Construction of the smaller local treatment plants shall be achieved consecutively to serve the schemes mentioned in (3.) above.

## 8-5 BASELINE DATA

### *8-5-1 Ecological Characteristics of the Project Area*

#### *8-5-1-1 General*

The landscape of the project area is dominated by a high mountain ridge that ovesees a narrow coastal strip. The local climate is partly triggered by this mountain ridge, and the two main seasons, a short winter and a long, dry summer are overlain by humid periods, which locally occur in the coastal regions.

#### *8-5-1-2 Geomorphology and Geology*

The rock formations within the project area originate from the Jurassic period and their composition is mainly calcareous. They are heavily weathered and intersected by numerous fissures and cracks. The sedimentary origin of the rocks and their calcareous composition are typical features for the characteristics of the mountainous landscape.

#### *8-5-1-3 Ecology*

Most of the regions, areas and sites within Jbeil district have almost conclusively kept their original, natural characteristics, except for parts of the coastal strip, particularly from Aamchit to Nahr Ibrahim, where construction activities have affected the original status of the area, and resulted in mild pollution of the sea coast. These activities have restricted any development of natural habitats and plant associations, which are under severe human influence in this strip due to the intense use of agro-chemicals, particularly in green houses.

#### *8-5-1-4 Hydrology*

Many smaller and bigger rivers that penetrate the strata of the rocks and form a large number of caves and submerged watercourses characterize the highly permeable karstic formations of the mountainous regions. These waters emerge again in lower areas and thus a few freshwater sources are scattered across the project area. These sources have different average yields, which range from 18,000 m3/d (Afqa) to 100 m3/d (Ain el Ghara). Most of these sources are exploited for the water supply of the area.

The area under study extends along the seashore and on the hills and mountains lying to the east, up to 1850 m altitude. The prevailing climate is of the Mediterranean type, characterized by two distinct seasons, a wet winter and a long dry summer. The average annual rate of rainfall is about 900 mm/year on the coast, and about 1300 mm/year on the mountains. The recorded temperatures show a rather hot tendency, with a yearly average varying between 9.7 and 21.3°C for altitudes not higher than 650m.

Two important valleys limit the region, namely Nahr Ibrahim to the south, and El Madfoun to the North. Other valleys and watercourses penetrate the district, but most of them dry up during the summer.

The rocks within the area are constituted, on the surface, of hard permeable and carbonated rocks, corroded, with developed karstics all over the surface, with some sinkholes and an infinite number of very large faults. This karstification renders the surface very permeable and extremely vulnerable to pollution.

The main sources within the district and their average flows are provided in Section 3 of this report.

### *8-5-1-5 Conditions of Pollution*

According to recent investigations, it seems that Nahr Ibrahim, the main water course in the Jbeil district is characterized by extensive pollution. At the time of sampling, however the flow was substantial. It is understood that the river has significant flows at most times of the year, and hence, no serious deterioration in water quality between the upstream and downstream sampling locations was noted, regardless of the fact that the river receives, in addition to industrial wastes, domestic sewage and stormwater runoff. Recent investigations indicate that most of the pollution observed in the natural springs within the district (Afqa, El Moukhada, Ain el Jaouze, Ain el Ghara, Ain Qatra, and Saraaita) is due to superficial reasons, resulting mainly from insufficient protective measures at the mouths of these springs.

### *8-5-1-6 Sources of Pollution*

Although the present status of pollution in the district is not drastic, but, if the present trends are not checked, then pollution will spread out in a manner similar to other more developed districts, such as Metn and Kesrouan. Probable sources of such spreading pollution could be attributed to several distinct sources such as:

- wide spread use of improperly built septic tanks, located mainly along the high level fissures of the Karstic formations;
- the use of incomplete sewerage systems that discharge into valleys without treatment, the discharge eventually finding its way into either a body of surface water (Nahr Ibrahim) or the underground water through fissures or sink holes;
- the open bottom wells that convey the sewage from a single or several buildings directly into a Karstic void, which makes the well constantly permeable, and draining off. Such works, if not terminated, would accelerate the pollution and the rapid transfer of the sewage to the underground water, particularly when the well reaches the ground water itself.

The solid waste problem on the other hand emphasizes itself in the area. Whereas Jbeil and a few other municipalities have their solid wastes collected and disposed of by the privately owned "Sukleen", other communities, such as Bejje, Aalmat, Qartaba, Jaj and Aaqoura dispose of their solid wastes indiscriminately in the open air. Their location on a mainly Karstic terrain makes their acidic and highly organic leachate extremely pollutant to the underground water and this will constitute an imminent risk due to fermented solid wastes if a solution is not found and implemented promptly.

Industrial and agricultural discharges constitute another potent source of pollution. In Jbeil, there are several industrial estates, which include large and diversified factories of small and medium size, including food processing, olive oil presses, pesticides factories, marble and granite saw-mills, steel processing, wood industries, carton and paper recycling and cables and wires production.. None of these industries addresses its wastewater or solid waste problems properly, and sewage is systematically disposed off into the rivers (Nahr Ibrahim) or into primitive septic tanks, whereas solid wastes are haphazardly dumped in the open air.

Petrol stations impose another category of institutionalized pollution. Car wash effluent, discarded motor oil and other similar mineral wastes are discharged into channels, and streams or directly into the nature, polluting the environment and finally arriving to ground water and rivers.

Hospital wastes constitute another source of dangerous pollutants in the district. Their effluent is discharged into makeshift permeable septic tanks with no treatment whatsoever.

As to agricultural products, surplus fertilizers and pesticides are washed down from farms and fruit and olive tree gardens into the ground water, and will tend to increase nitrate and phosphate content of these waters, with subsequent undesirable effects, whether in nature or in treatment plants.

### *8-5-1-7 Pollution Transfer*

Surface pollution, in general, is easy to detect and control. Pollution traveling below ground, however, is not that easy to discover and rectify. The Karstic configuration of the Jbeil district renders the pollution problem more complex. To clarify this problem, it is necessary to understand the structure of the hydrological karstic system. The feeding zone is essentially formed by the outcropping on the surface of permeable carbonated rocks, which are connected to the subsoil. Feeding is accomplished by rainfall or snow coming into contact with these rocks, and flowing through them to the lower channels through what is called the infiltration zone. In the upper part of this zone, and at a depth of about 20m, there is a possibility to find an epikarstic zone, which consists of a layer of corroded rocks with fissures filled up with clay, thereby, the infiltration process is obstructed, and a temporary water table can be formed during rainy weather.

Further down, the Sunken Karst Zone can be found, whose fissures and voids are saturated with water traveling at variable velocities, accompanied sometimes by turbulence. These conduits collect in one or more drains that finally arrive into one axial collector that directs the flow towards the outlet of the system.

Pollution arriving at the feeding zone of the Karstic system, finds its way into the epikarstic zone or the infiltration zone, and may be retained there temporarily. But with the first heavy rains of the year, a flushing effect is produced and the stocked wastewater is directed towards the springs and wells.

Open bottom wells in fact constitute a short cut to this system, accelerating the phenomena, and providing easy access for fecal pollution to reach water sources that are allocated, in their majority, for the supply of potable water to the inhabitants.

Although the present low density population in the district of Jbeil does not produce sufficient pollution, particularly in the higher reaches of the area, to trigger the above scenarios, however, future growth may produce the undesirable effect.

#### *8-5-1-8 Sensitive Areas*

The sensitive terrestrial area in terms of habitats and biogenesis, which should be put under protection de facto, are virtually non existent due to the continuos and historic exploitation of the districts forest resources. The only remains of the famous Cedars of Lebanon in the area are to be found only in the Jaj forest, with a number of trees estimated at about 400.

However, under hygienic aspects, the slightly polluted fresh water sources exploited for water supply gain very high importance. Thus the catchment area of the sources may be defined as sensitive in terms of human hygiene.

### *8-5-2 Social Characteristics Of The Project Area*

#### *8-5-2-1 Population*

The only two regular censuses in Lebanon took place in 1922 and 1932, during the French mandate. Due to sectarian reasons, no census was undertaken ever since. However, Population figures were published by the Directorate General of Census during the years 1961 and 1964. At the end of 1961, the number of officially registered Lebanese was 2,151,884, and at the end of 1964 it rose to 2,367,141 indicating an average compound rate of increase of 3.23 %.

This figure is presumed to be too high for the current situation, particularly in the case of Jbeil which, at present can not support high rates of growth due to its weak economic structure and poor infrastructure conditions.

Recent studies by Khatib & Alami (K&A) for the Ministry of Environment (MOE), indicate a probable future rate of increase of 2.0% to 2.2%, but their population estimates are believed to be on the low side.. Consequently, for the purposes of this report, ACE figures obtained from the field survey, coupled with the data obtained from the Jbeil Water Authority, and from the Jbeil Electricity Company and Electricité du Liban, were used as basis for the population projections shown in Table 2-7.

The distribution of population within the District of Jbeil reflects the general pattern typical of Lebanese areas. The major cities and large communities are located mainly along the sea coast, such as Jbeil city, Aamchit, Blat and Halat, and some are scattered in the mountain, such as Aalmat, Aaqoura and Qartaba.

Most of the communities located high in the mountains are actually situated within the watersheds of the springs that are used as sources of potable water for the district itself.

### *8-5-2-2 Industries*

In Jbeil district, there are two industrial estates approved by decrees, namely, Nahr Ibrahim, and Hosrayel, and a third one which is being processed at Aamchit. In addition, and according to the field survey, there are 96 other industries scattered within other communities of the area. Several of the industries available within these estates do not produce industrial effluents, but for those that produce such wastes, there is no available treatment or disposal method, and the effluents are discharged into the vicinity in its raw state or in septic tanks, with subsequent pollution of the immediate environment.

### *8-5-2-3 Touristic Industry*

The touristic industry is concentrated at present along the seacoast of Jbeil district in addition to other dispersed locations in the mountains, with Aannaya representing the major example of the latter type. According to the field survey conducted by ACE during the study, the total number of hotel beds within the project area is minimal. There are a few summer resorts scattered along and the seacoast, particularly the coast of Aamchit. Again, the sewage produced by these hotels and resorts does not receive any approved treatment prior to discharge.

The project area also includes several restaurants and nightclub establishments, situated mainly in Jbeil city, Fidar, Halat and Aannaya. As in the case of hotels, the sewage produced by these establishments is not treated properly prior to discharge into the surrounding land or water bodies.

#### *8-5-2-4 Petrol Stations*

A further source of wastewater within the project area is due to petrol stations, of which there are about 52 with a total estimated water consumption of about 270 m3 per day.

#### *8-5-2-5 Schools and Educational establishments*

The total number of students registered in the area covered by the survey was found to be about 5740, resulting in a total estimated water consumption of about 150m3 per day, assuming that the number of boarding students out of 5740 is about 470 (approximately 8%).

#### *8-5-2-6 Hospitals*

The number of public medical centers in the project area is about 18. No hospitals are available within the project area, as most of such establishments are located around Jbeil City (FPZ).

#### *8-5-2-7 Land Use*

Land use within the Jbeil District follows a pattern typical of the developed areas within Lebanon. The agricultural land of the coastal strip is beginning to be severely infringed on, being replaced by urban development. Figure 8-1 was prepared by the United Nations Food and Agricultural Organization (FAO), Agricultural Department, in 1990. The map indicates that the district of Jbeil was not heavily urbanized during 1990, built up areas being concentrated around Jbeil city. The situation is now slightly different, with urbanized areas extending around Jbeil city, towards Blat and other surrounding hills, and in Halat, Nahr Ibrahim, Aamchit, Qartaba and Aaqoura. This trend will definitely gain momentum in the future, particularly along the sea cost, as the touristic industry enjoys more favorable conditions. Table 8-1 includes a detailed description of the above findings, in addition to other useful data.

### *8-5-3 Pollution Characteristics Of The Project Area*

#### *8-5-3-1 Definition of Pollution Sources*

Severe pollution of the land project area derives from discharged, untreated wastewater and from solid wastes dumped wherever the landscape allows it. Especially during the rainy seasons, the danger of pollutants washed into the Karstic underground, made of highly permeable rock formations, contributes to a high risk potential. This phenomena has not reached danger limits within Jbeil district yet, due to the low population densities. However, the detrimental effects of these practices will increase in gravity as urbanization spreads within the district, particularly along the coastal strip.

The second large pollution source is wastewater (municipal and industrial) discharged into the sublittoral areas of the Jbeil sea coast, particularly within bays, from the touristic resorts located along their charming beaches.

### *8-5-3-2 Definition of Polluted Areas*

Recent investigations have indicated that up till now, no part of the district can be considered as polluted to a grave degree. Nahr Ibrahim, with a large discharge, is still able to dilute the pollutants its waters receive along its course, whether domestic or industrial. Other areas do not show significant risks of pollution from nearby habitats or communities. This indicates very clearly that it is the right time for the implementation of sewerage schemes within the district.

# LAND COVER LEGEND
## *LEGENDE DE LA CARTE D'OCCUPATION DU SOL*

### URBAN AREAS
*ZONES URBAINES*

- **1** Urban areas (built up)
  *Zones urbaines (habitées)*
- **1a** Urban areas (non-built up, e.g. industrial areas, airports, quarries, etc.)
  *Zones urbaines (non habitées - zones industrielles, aéroports, carrières, etc.)*

### ANNUAL CROPS
*CULTURES ANNUELLES*

- **2** Horticulture
  *Horticulture*
- **3** Field crops and fallow land (irrigated and unirrigated)
  *Champs agricoles (irrigués et non irrigués) et jachères*

### TREES AND PERENNIAL CROPS
*VERGERS ET CULTURES PERENNES*

- **4a** Olives
  *Olives*
- **4b** Vineyards
  *Vignes*
- **4c** Deciduous fruit-trees
  *Arbres fruitiers à feuillage caduc*
- **4d** Citrus or bananas
  *Citrus ou bananes*

### GRASSLAND (UNIMPROVED LAND)
*PATURAGES (TERRES NON AMELIOREES)*

- **5a** Grassland and forbs from open to closed, or abandoned fields or old fallows in agricultural areas
  *Pâturages et zones herbacées (couvert ouvert à fermé) ou bien, dans zones agricoles, champs abandonnés ou jachères anciennes*
- **5b** Sparse grassland and forbs in mountains or desertic areas
  *Pâturages et zones herbacées à faible couvert dans zones de montagnes ou désertiques*

### FOREST AND OTHER WOODED AREAS
*FORET ET AUTRES ZONES BOISEES*

- **6a** Forest Coniferous
  *Forêt de conifères*
- **6b** Broadleaf forest (deciduous and evergreen)
  *Forêt à large feuille (caduque et persistante)*
- **6c** Scrubland and other types of degenerate forest
  *Zones arbustives ou de forêt dégénérées*

### UNPRODUCTIVE LAND
*TERRES IMPRODUCTIVES*

- **7a** Barren rocks
  *Roches nues*
- **7b** Highly dissected and eroded land
  *Terres fortement érodées*
- **7c** Beaches
  *Plages*

### WATER BODIES
*PLANS D'EAU*

- **8** Swamp vegetation
  *Végétation de zones marécageuses*
- **9** Water bodies
  *Plans d'eau*

- Mixed units
  *Unités mixtes*

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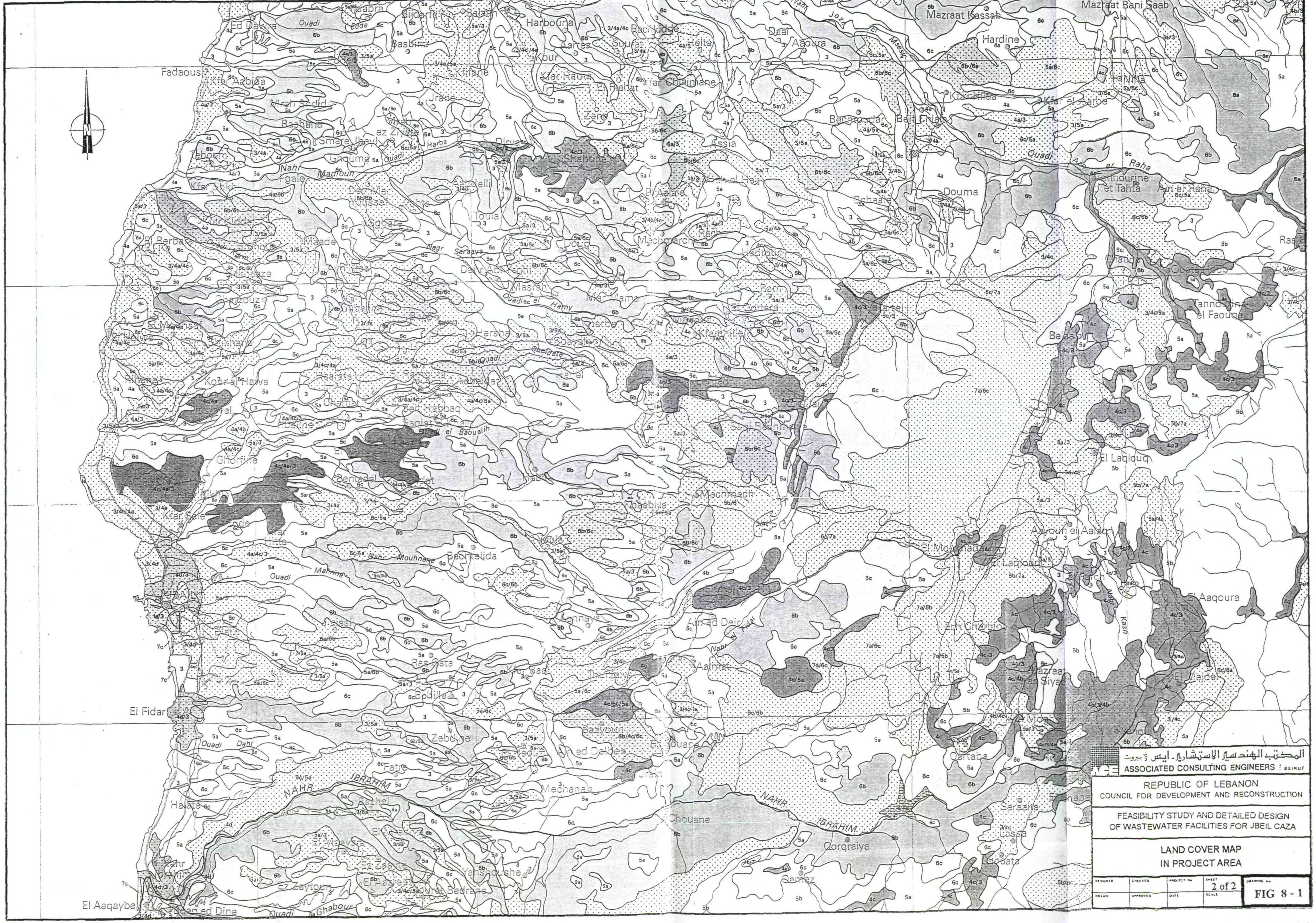
المكتب الهندسي الاستشاري - ايس بيروت
ASSOCIATED CONSULTING ENGINEERS BEIRUT

REPUBLIC OF LEBANON
COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION

FEASIBILITY STUDY AND DETAILED DESIGN
OF WASTEWATER FACILITIES FOR JBEIL CAZA

LAND COVER MAP
IN PROJECT AREA

| DESIGNED | CHECKED | PROJECT No | SHEET | DRAWING No |
|---|---|---|---|---|
| DRAWN | APPROVED | DATE | SCALE | |
| | | | 1 of 2 | FIG 8 - 1 |



Mazraat Bani Saab
Mazraat Kassab
Hardine
Harbouna
Aaqoura
Helta
Ed Dawra
Sijdarit
Basbina
Fadaous
Kfar Aabida
Kfar Hatta
Kfar Chelmane
Zarea
Assia
Bechtoudar
Beit Chlala
Douma
Bchaale
Tannourine et Tahta
Ain er Raha
Chatine
Tannourine el Faouqa
Smar Jbail
Ghouma
Abdelli
Harba
Zebdine
El Barbara
Toula
Machmach
El Laqlouq
El Aaqoura
Afqa
Mazraat es Siyad
Qartaba
Lassa
Chouane
Qorqraiya
Fatqa
Yanouh
Mechane
Kfar Sale
Bechtlida
Ras Osta
Bouidie
El Fidar
Halate
El Aaqaybe
Ez Zaytoun
Nahr Ibrahim
Ghabour
ASSOCIATED CONSULTING ENGINEERS BEIRUT
المكتب الهندسي الاستشاري - ايس ش م ل بيروت
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FEASIBILITY STUDY AND DETAILED DESIGN
OF WASTEWATER FACILITIES FOR JBEIL CAZA
LAND COVER MAP
IN PROJECT AREA
2 of 2
FIG 8 - 1

## *Table 8-1 Surveyed Data*

| Village/Town | Population | | Number of Housing Units | | Schools | | Hotels | | Hospitals | | Restaurants | | Police Stations | Others | Petrol Stations | Animal Farms | | Factories |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max. | Min. | Existing | Under Construction | No. | Pupils | No. | Beds | No. | Beds | No. | Seats | | | | Poultry / Cows / Sheeps | | |
| Aabeidat | 700 | n.a | 150 | 10 | none | n.a | none | n.a | none | n.a | 1 | n.a | none | 3 | 1 | P & C | 2 | none |
| Aalmat | 1500 | n.a | 300 | 5 | 1 | n.a | none | n.a | 1 | n.a | none | n.a | none | 1 | none | none | n.a | none |
| Aamchit | 16000 | 15000 | 3700 | 250 | 7 | n.a | none | n.a | 1 | n.a | 3 | n.a | 1 | 42 | 7 | none | n.a | 5 |
| Aannaya | 450 | n.a | 150 | 0 | none | n.a | none | n.a | none | n.a | 10 | n.a | none | 3 | none | none | n.a | none |
| Adonis | 400 | n.a | 100 | 0 | 1 | n.a | none | n.a | none | n.a | none | n.a | none | 5 | none | P | 1 | none |
| Afqa | 1500 | 150 | 100 | 6 | 1 | 30 | none | n.a | none | n.a | 1 | 100 | none | 2 | none | none | n.a | none |
| Ain El Ghouaibe | 500 | 25 | 50 | 15 | none | n.a | none | n.a | none | n.a | none | n.a | none | 1 | none | P | 1 | none |
| Ain Kfaa | 400 | 400 | 75 | 5 | none | n.a | none | n.a | none | n.a | none | n.a | none | 2 | 1 | P | 1 | none |
| Barbara | 500 | 500 | 130 | 120 | 1 | 15 | none | n.a | none | n.a | none | n.a | none | 2 | none | none | n.a | 2 |
| Barij | 355 | 10 | 81 | 15 | none | n.a | 1 | n.a | none | n.a | 4 | n.a | none | 5 | 1 | none | n.a | 1 |
| Bchelli | 400 | n.a | 120 | 0 | 1 | n.a | none | n.a | 1 | n.a | 3 | n.a | none | 2 | 1 | none | n.a | 3 |
| Bechdaidat | 300 | n.a | 40 | 5 | none | n.a | none | n.a | none | n.a | none | n.a | none | 5 | none | none | n.a | 1 |
| Bechtelida | 2800 | n.a | 120 | 30 | none | n.a | none | n.a | none | n.a | none | n.a | none | 4 | none | P | 4 | none |
| Beit Habbaq | 300 | n.a | 50 | 12 | 1 | 1700 | none | n.a | 1 | n.a | 1 | n.a | none | 2 | none | P | 1 | 2 |
| Bejje | 2000 | 500 | 300 | 10 | 1 | n.a | none | n.a | 1 | n.a | none | n.a | none | 9 | none | P | 1 | none |
| Bentaael | 700 | n.a | 80 | 10 | none | n.a | none | n.a | none | n.a | none | n.a | none | 6 | none | none | n.a | none |
| Chamat | 550 | n.a | 80 | 0 | none | n.a | none | n.a | none | n.a | none | n.a | none | 2 | 2 | P | 2 | 1 |
| Chikhane | 350 | 300 | 70 | 5 | none | n.a | none | n.a | none | n.a | none | n.a | none | none | none | none | n.a | 2 |
| Edde | 1000 | n.a | 195 | 5 | none | n.a | none | n.a | none | n.a | none | n.a | none | 10 | 1 | P | n.a | 12 |
| Ehmej | 6000 | n.a | 750 | 150 | 2 | 425 | none | n.a | none | n.a | 5 | n.a | none | 11 | 2 | n.a | 3 | 1 |
| Farhet | 320 | 150 | 50 | 0 | none | n.a | none | n.a | none | n.a | none | n.a | none | 2 | none | C | 1 | 1 |
| Fatre | 800 | n.a | 150 | 30 | none | n.a | none | n.a | 1 | n.a | 2 | n.a | none | 4 | 2 | none | n.a | 1 |
| Fghal | 700 | 600 | 100 | 15 | none | n.a | none | n.a | none | n.a | none | n.a | none | 4 | none | none | n.a | none |
| Fidar | 600 | n.a | 20 | 0 | none | n.a | none | n.a | none | n.a | none | n.a | none | 2 | none | P | 3 | none |
| Ghalboun | 1100 | n.a | 125 | 15 | 1 | n.a | 1 | n.a | 1 | n.a | 2 | n.a | none | 5 | none | P | 3 | 2 |

| Village/Town | Population | | Number of Housing Units | | Schools | | Hotels | | Hospitals | | Restaurants | | Police Stations | Others | Petrol Stations | Animal Farms | | Factories |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max. | Min. | Existing | Under Construction | No. | Pupils | No. | Beds | No. | Beds | No. | Seats | | | | Poultry / Cows / Sheeps | | |
| Gharfine | 250 | 150 | 100 | 20 | none | n.a | none | n.a | none | n.a | none | n.a | none | 4 | 1 | P | 1 | 5 |
| Gharzouz | 500 | 500 | 35 | 0 | none | n.a | none | n.a | none | n.a | none | n.a | none | 2 | none | P | n.a | 3 |
| Habil | 400 | 200 | 45 | 0 | none | n.a | none | n.a | none | n.a | none | n.a | none | 3 | none | none | n.a | none |
| Hadtouna | 500 | 200 | 100 | 0 | 1 | n.a | none | n.a | 1 | n.a | none | n.a | none | 2 | none | none | n.a | 2 |
| Halat | 7000 | 5200 | 450 | 250 | 1 | 300 | 1 | 45 | none | n.a | 6 | 1070 | 1 | 8 | 6 | none | n.a | 8 |
| Haqel | 300 | 200 | 60 | 0 | none | n.a | none | n.a | none | n.a | none | n.a | none | 3 | none | none | n.a | 1 |
| Hbaline | 500 | 350 | 130 | 0 | none | n.a | none | n.a | none | n.a | none | n.a | none | 4 | 2 | P & C | n.a | 3 |
| Hboub | 1000 | n.a | 250 | 100 | 1 | n.a | none | n.a | none | n.a | none | n.a | none | 2 | 1 | none | n.a | 5 |
| Hjoula | 2000 | 500 | 40 | 0 | none | n.a | none | n.a | none | n.a | none | n.a | none | 1 | none | P & C | 2 | none |
| Hosrayel | 1000 | 1000 | 170 | 40 | 1 | closed | none | n.a | none | n.a | none | n.a | none | 2 | 1 | | 3 | 31 |
| Hsarat | 1700 | n.a | 200 | 40 | 1 | 250 | none | n.a | 1 | n.a | none | n.a | none | 2 | none | P | 3 | none |
| Hsoun | 1500 | n.a | 60 | 0 | none | n.a | none | n.a | none | n.a | none | n.a | none | 1 | none | none | n.a | 2 |
| Jaj | 4500 | 1500 | 500 | 16 | 1 | 60 | none | n.a | 2 | n.a | none | n.a | none | 4 | none | none | n.a | 3 |
| Jeddayel | 800 | 800 | 0 | 0 | 1 | 20 | none | n.a | none | n.a | none | n.a | none | 3 | 2 | none | n.a | none |
| Jlaisse | 60 | n.a | 12 | 0 | none | n.a | none | n.a | none | n.a | none | n.a | none | 3 | none | none | n.a | none |
| Kafr | 1000 | n.a | 125 | 0 | none | n.a | none | n.a | none | n.a | none | n.a | none | 3 | none | none | n.a | 1 |
| Kehmez | 1700 | 100 | 130 | 0 | 1 | closed | none | n.a | none | n.a | 3 | 1500 | none | 1 | 2 | none | n.a | none |
| Kfar Mass'houn | 800 | n.a | 70 | 5 | 1 | 120 | none | n.a | none | n.a | none | n.a | none | 3 | 1 | P | 1 | 2 |
| Kfoun | 900 | n.a | 120 | 0 | none | n.a | none | n.a | none | n.a | none | n.a | none | 4 | none | none | n.a | none |
| Kharbe (el) | 300 | n.a | 60 | 0 | none | n.a | none | n.a | none | n.a | none | n.a | none | 2 | 1 | none | n.a | none |
| Kottara | 1500 | 500 | 65 | 10 | none | n.a | none | n.a | none | n.a | 1 | n.a | none | 1 | none | none | n.a | none |
| Lassa | 2000 | 500 | 250 | 20 | 1 | 50 | none | n.a | none | n.a | none | n.a | none | 2 | none | P & C | 2 | none |
| Lehfed | 3000 | 1000 | 350 | 10 | 1 | 30 | none | n.a | 2 | n.a | 2 | n.a | 1 | 7 | 1 | C & S | 3 | 7 |
| Lehfed | 750 | 50 | 160 | 5 | none | n.a | none | n.a | none | n.a | none | n.a | none | 9 | none | none | n.a | none |
| Maad | 500 | 450 | 100 | 7 | 1 | 300 | none | n.a | none | n.a | none | n.a | none | 7 | 1 | P | 4 | 1 |
| Maifouq | 4000 | 1000 | 250 | 15 | 3 | 760 | none | n.a | 1 | n.a | 3 | n.a | none | 4 | 1 | P | 1 | none |
| Mazraat Es Siyad | 5000 | 400 | 120 | 0 | none | n.a | none | n.a | none | n.a | none | n.a | none | 3 | 2 | none | n.a | none |

| Village/Town | Population | | Number of Housing Units | | Schools | | Hotels | | Hospitals | | Restaurants | | Police Stations | Others | Petrol Stations | Animal Farms | | Factories |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max. | Min. | Existing | Under Construction | No. | Pupils | No. | Beds | No. | Beds | No. | Seats | | | | Poultry / Cows / Sheeps | | |
| Mechane | 3000 | 2500 | 200 | 40 | 2 | n.a | none | n.a | 1 | n.a | none | n.a | none | 10 | none | P | 1 | 1 |
| Mechmech | 6500 | 200 | 400 | 15 | 1 | 130 | 2 | n.a | 1 | n.a | 7 | n.a | n.a | 7 | 1 | P & C | 8 | 2 |
| Mghaire | 3000 | 300 | 170 | 15 | 1 | n.a | none | n.a | none | n.a | none | n.a | none | 2 | none | none | n.a | none |
| Mijdil | 3000 | 400 | 140 | 0 | none | n.a | none | n.a | none | n.a | none | n.a | none | 3 | 1 | none | n.a | none |
| Mounsef | 3500 | 3500 | 500 | 60 | 1 | 1100 | none | n.a | none | n.a | 1 | n.a | none | 6 | 1 | none | n.a | 2 |
| Nahr Ibrahim | 13000 | n.a | 2500 | 150 | 1 | 100 | none | n.a | 1 | n.a | 3 | 24 | n.a | n.a | 4 | n.a | n.a | 21 |
| Qartaba | 27000 | 3000 | 850 | 30 | 2 | 250 | 2 | n.a | none | n.a | 2 | 300 | 1 | 12 | 3 | P | 1 | none |
| Ras Osta | 2900 | 200 | 100 | 50 | none | n.a | none | n.a | none | n.a | 5 | n.a | none | 5 | 1 | none | n.a | 1 |
| Sakiyit Al Khayt | 300 | n.a | 25 | 4 | none | n.a | none | n.a | none | n.a | none | n.a | none | 1 | none | P | n.a | none |
| Souane | 800 | n.a | 100 | 0 | none | n.a | none | n.a | 1 | n.a | none | n.a | none | 1 | none | none | n.a | none |
| Tartij | 4500 | 1500 | 400 | 0 | 1 | 100 | none | n.a | 1 | n.a | 3 | n.a | 1 | 3 | 1 | P | 1 | 16 |
| Torzaiya | 800 | 400 | 150 | 10 | none | n.a | none | n.a | none | n.a | none | n.a | 1 | 3 | none | none | n.a | none |
| Yanouh | 3000 | 300 | 300 | 0 | none | n.a | none | n.a | none | n.a | 1 | 50 | none | 3 | none | none | n.a | none |
| Zebdine | 400 | n.a | 75 | 10 | none | n.a | none | n.a | none | n.a | none | n.a | none | 2 | none | P & C | 4 | 2 |
| Totals | 155385 | 44535 | 16948 | 1635 | 41 | | 7 | 45 | 19 | | 69 | | 6 | 282 | 52 | | 58 | 153 |

## 8-6 ENVIRONMENTAL IMPACT

### *8-6-1 Negative Impact*

The expected negative impacts of the project as a whole on human settlements, local population and the land and marine environment are considered to be in a very low range, as compared to other coastal areas in the Mediterranean region. Compared to a "no project situation", these negative impacts seem to be minimal and will not have any serious negative impact on the environment.

#### *8-6-1-1 The Sewerage Scheme*

Due to the scattered distribution of the communities within the project area, and the low density of built up areas, the collector system is proposed to be located within existing rights of way wherever possible in order not to harm any natural land habitats. Where the collectors divert from existing roadways, extreme care shall be exercised so as not to cause any disturbance to the natural environment.

Trunk lines C1 and C2 are proposed along the older Beirut – Tripoli main road and the Beirut - Tripoli highway. However, the Traffic density within the project area is not heavy, and no major disturbance is expected. In addition, this location will minimize expropriation costs.

Where a trunk line passes for a short distance in a busy street, construction procedures are required to minimize sound nuisance by utilization of sound mufflers on machinery, dust control equipment, and restrict traffic disturbance to the minimum. In one or two critical situations, micro tunneling to cross the major highway will be specified.

Extreme care shall be taken in the design of pumping stations to implement noise and odor control measures, to prevent possible nuisance to the nearby communities.

The branch sewers in towns and villages will be shallow due to ample available slopes and will have minimum negative environmental impact on the communities surrounding them.

#### *8-6-1-2 The Treatment Plants*

The location for the central treatment plant as proposed by the French Protocol Consultant on the coast of Aamchit is on an available piece of land located near the steel factory. The study of the impacts and mitigation measures to be taken with respect to this site are believed to be rather complicated, but they do not fall within the scope of this report, and are to be handled by other parties. Special studies have to be conducted by the concerned consultant in this respect to decide upon length, size, and other characteristics of the sea outfall, in addition to a special EIA study for the area.

Local treatment plants shall be designed with extreme care with respect to location, prevailing winds, distance from adjacent communities, and sources of noise and odor, and various measures shall be taken to prevent any negative impacts on the surrounding environment, particularly with respect to nearby streams and underground aquifers.

### *8-6-1-3 Relocation of People*

No relocation of people is foreseen to take place as a result of the implementation of the wastewater project. The proposed sites are not populated at present, and if the required land is reserved or expropriated in the immediate future, no relocation or resettlement of inhabitants is foreseen.

### *8-6-1-4 Residual Negative Impacts*

The only residual negative impacts that may occur within the project area as a result of the proposed scheme would be related to the locations of the pumping stations and sewage treatment plants. These areas will have to be cleared of any trees or other plants, and made level or terraced to receive the different components of the proposed structures. Although such impact could be considered residual, but the surrounding areas and empty spaces within, will be replanted with trees and other plants to provide the pumping station or treatment plant with an aesthetically acceptable appearance.

### *8-6-1-5 Uncertainties in Predictions*

The most vulnerable component from this aspect is probably the uncertainty in the predictions made on the population, water consumption, and sewage contribution, these being the three most important criteria in the design of the sewage system. The only applicable approach to circumvent the effects of these impacts is probably flexibility in design and execution, through construction of the different components in distinct phases. This approach is definitely most applicable in the case of treatment units, but it is not so amicable when dealing with the sewerage scheme. However, since most collectors serve small population figures, the minimum size criteria will govern and this impact is also mitigated

### *8-6-1-6 The "No Project" Alternative*

As discussed above, the scheme involves the construction of several kilometers of lateral sewers, sewer mains, collectors and a number of small to medium treatment plants. The overall plan for the district also involves the construction of one large treatment plant along the sea coast and a long sea outfall.

The overall impact of constructing this scheme is definitely a position one, and when compared with "no project" situation, the positive impact of the project is evident and needs no elaboration. The advantages of constructing the scheme will be discussed in the next section on Positive Impacts.

### *8-6-2 Positive Impacts*

The positive impacts of the water and wastewater projects will be immense and include:

- Terminating the present practice of discharging sewage directly to the land or marine environment will cease to exist.
- The effluents from the industrial areas in Aamchit Hosrayel and Nahr Ibrahim, presently being discharged either on land or into the river (Nahr Ibrahim) will be conveyed to properly constructed treatment plants, and disposed of without causing undue nuisance to the environment.
- Freeing the beaches along the shoreline will be free from any possible contamination at the present and in the future.

Construction of the coastal collectors will immediately stop the discharge of sewage directly on the shoreline along the coastal areas of Jbeil, which constitutes one of the promising touristic attractions north of Beirut. Also, it will serve thousands of swimmers when properly developed a sport that is gaining momentum at present. Otherwise, the level of pollution along the shoreline will rise and may reach serious levels if the coastal collectors are not implemented and the treatment plant not constructed.

Likewise, and when considering the mountain areas, some of the major water sources that supply the district with potable water may become polluted with sewage. The discharge of sewage into the Karstic formation, either by deep sewer wells, or shallow septic tanks, could pollute the underground water and the springs that are feeding the area. This source of pollution will be averted only by the construction of all the secondary sewer lines, the main lines, collectors and proposed treatment plants.

The envisaged overall scheme covers almost all of the communities within the district. A number of the villages and small towns lying within a short distance of the coast line are connected by mountain collectors which are in turn connected to the central treatment plant via the coastal collectors. Final disposal of this sewage is left to be handled by the French Protocol Consultancy. However, higher up communities of villages and towns are provided with local treatment units, of relatively small capacities. The effluents of these plants are not foreseen to cause any adverse impact on the receiving land or bodies of water. Although no proposal is being made at present for the reuse of these effluents, such reuse of treated effluents seems as a very attractive option in the case of Jbeil district, and it may be incorporated into the project pending more detailed studies.

Under certain particular circumstances, where dominant factors governing some sensitive area impose special remedial conditions, such as in the vicinity of sink holes or extensive cracks that lead directly to the ground aquifers, disinfection of the treated effluent or some other type of tertiary treatment will have to be resorted to prior to discharge of sewage on land or valleys.

The health risk may not be so great at present, but implementation of the project will prevent any future deterioration of the overall sanitary foundations within the project area, below acceptable limits.

The touristic potential of Jbeil beaches is expected to reach high levels, thus improving the socioeconomic conditions of the area, as well as the level of local and national income. This can not be sustained without full and adequate sewerage schemes.

### *8-6-3 Long Term Impacts*

1) Sludge resulting from the sewage treatment plants shall be dewatered, dried and disposed off within a suitable land fill, or otherwise used as fertilizer for certain applicable crops, pending further studies.
2) In the present study area, some of the proposed mountain lines flow into the FPZ, which, according to the proposal, discharges into coastal collector C2, which, in its turn, discharges into the central treatment plant. The effluent from this plant will be discharged into the sea via the proposed sea outfall, and will have no adverse impact on the area's ground aquifers. However discharge into seawater will have a long term impact on the sea. Furthermore, reuse of treated wastewater may be incorporated into the overall project, pending more detailed studies. Both of these aspects will have to be handled by the French Protocol Consultancy.

### *8-6-4 Analysis Of Alternatives*

#### *8-6-4-1 Comparison of Alternative Schemes*

Three alternatives have been proposed for the sewerage scheme. These alternatives have already been described in the Interim Report. A short review will be included here for EIA proposes. All of the proposed schemes contain the following common components:

- Collector, C1, located north of the FPZ, collecting part of the sewage produced within the zone, and carrying it south towards the central treatment plant and sea outfall.

- Collector, C2, located south of the FPZ and flowing south into the coastal collector of the Kesrouan Caza, discharging eventually into the treatment plant at Tabarja, Kesrouan.
- The central treatment plant, to be designed by the French Protocol Consultancy.
- Several mountain collectors that link either directly with the FPZ or with either of the two coastal collectors, C1 and C2.

In alternative 1, in addition to the above components, several pumping station and treatment plants were proposed as follows :

1) Line A flows into collector C2 by gravity
2) Lines B, C, D, E, F, F1 and G flow into the FPZ by gravity. Line D1 flows into Line D via pumping station P/S 1.
3) Lines H, H1, I, J, K and K1 flow into collector C1 by gravity.
4) STP 1 serves the single village of Fatre (population < 500) and falls therefore outside the scope of the project in this alternative.
5) STP 2, STP 3, STP 4, STP 5 and STP 6 serve upstream communities, with populations > 500, and all contributing lines flowing by gravity. It is noteworthy to mention that the main collector of STP 3 passes through a winter stream for a length of about 7 km, and hence constitutes an undesirable aspect.
6) STP 7 and STP 8 serve respectively Hjoula and Birqet Hjoula (total population < 500) and Habil (total population < 500) and both, consequently, fall within the category of STP 1, item 4 above.
7) STP 9 serves Haqel and part of Lehfed, with all of their contributing lines flowing by gravity all the way to the treatment plant.
8) STP 10 and STP 11 serve total present populations of about 4000 and 1350 respectively, with all contributing sewers flowing by gravity.
9) STP 12 serves two small communities (Qehmaz and Qarqraiya, with a combined population<500). This plant, therefore, does not fall within the scope of this study, in the context of this alternative.
10) STP 13, STP 14 and STP 15 all serve populations > 500, and all of their contributing sewer lines flow by gravity.
11) STP 16 serves the small community of Laqlouq (pop. < 500) and the important thriving Laqlouq winter sports complex. Estimates for the complex are not available, and it is presumed at this stage that the proposed plant falls outside the scope of the study.

It is clear from this review that with Alternative 1, almost all flows are under gravity (except for line D1), but expropriation is necessary for the routes of several kilometers of sewer liens. Furthermore, local treatment plants are implemented instead of longer gravity sewer lines and additional pressure lines and pumping stations.

In alternative 2, the same configuration of sewers applies as in alternative 1, with the following changes.

1. STP 2 of alternative 1 is replaced by pumping station P/S1 of alternative 2, and the sewage flow from Ain Jrain, Mechane, El-Qass, Adonis and Sinnour is pumped into a sewer line that connects downstream at STP1 which also serves Fatre.

2. STP 4 of alternative 1 is also replaced by pumping station P/S3 of alternative 2, and the sewage flow that was treated in STP4 is now pumped into Line F which flows into the FPZ.

3. STP 5 of alternative 1 is also replaced by pumping station P/S 4 which pumps the flow into the system leading to STP3 which in alternative 1 served Ghebaline, Dahr Saria and part of Maad only

4. STP 7 of alternative 1 which served the small community of Hjoula (<500) is now replaced by a long sewer that arrives finally into P/S 3 of alternative 2, joining the flow from Behdeidat and Bentaael.

5. STP 8, serving the village of Habil only, in alternative 1, is replaced in alternative 2 with P/S 5 which pumps the flow into the sewer serving Aabeidat, finally arriving in STP 3 near Ghebaline.

6. STP 16 of alternative 1 is deleted in alternative 2, and its flow is conveyed via a long sewer line until it arrives in Ehmej, where it joins the flow there that finally arrives in STP 2 below Zebdine.

This alternative emphasizes the use of pumping stations in order to concentrate the flow in a smaller number of sewage treatment plants, thus reducing the per capita cost of treatment, but at the same time increasing the cost of sewage collection through pumping.

The third alternative is a refinement of the first two. It differs from alternative 2 in the following points:

1) The long collector passing through the valley between Kfar Baal and El Hsoun, is deleted, and an additional sewage treatment plant, STP 7, is proposed to serve the villages and towns of Ain Delbe, Es Souane, Bazioun, Farhet, Chloumas, Aannaya, El Aouaynie and Ehmej. The flow from Laqlouq is treated in a separate treatment plant, STP 12, as in alternative 1.

2) The flow from Bentaael, Behdeidat, Dmalsa, Bir Btaria, El Kafr and Kfoun is treated in STP 3, as in alternative 1.

The office of Engineer Elias Feghali is the source of proposed alternative 4, and it endeavors to collect all the flow by gravity, without resorting to pumping. Two main sewage treatment plants are proposed, one at Nahr Ibrahim at the South Western corner of the district, and the other in Beaachta, just to the north of Aamchit along the coast.

Although this proposal was quite helpful in locating the mountain collectors in the other three alternatives, yet its does not conform with the master plan of the area and the ongoing studies, and, in certain instances, it does not comply with the natural topography of the land. It was therefore, not included in the comparison of alternatives.

### *8-6-4-2 Comparative Analysis of Treatment Plants: Types and Sizes*

Several options for treatment processes are applicable to the communities under consideration. The population served vary from less than 200 (1997 population for STP8, alternative 3) to more than 13,000 (2030 population STP7, alternative 3). For such population figures the traditional activated sludge or trickling filters processes are uneconomical, and costs of operation and management of such plants would be unjustifiable. Furthermore, such processes usually produce proportionally larger quantities of sludge, which can not be managed properly and economically with such small-scale plants. These treatment processes may be applicable, however, to the treatment plant of the FPZ, which is outside the scope of this study.

However, the original concept behind the study was to concentrate the discharges from the different communities lying within the project area into the least number possible of treatment plants. This was not readily feasible because the land topography and/or existing road construction did not easily allow it. Consequently, as many as 13 treatment plants were proposed.

The economics of the proposal do not rule out several negative implications linked to the concept of a large number of small treatment plants scattered throughout the project area. Such impacts are:

1) More complexity in the operation and maintenance of these treatment plants as compared to one localized large plant.
2) A number of components would be duplicated several times (equal to the number of plants), e.g., chlorination units, sludge disposal facilities, electrical stations, guard houses and other similar units.
3) Increased number of odor producing locals, dewatering effects and effluent discharge points on adjacent real estates, and other unfavorable effects on the environment such as increased areas cleared of trees to accommodate these plants. Also increased number of access roads with

their generally negative impacts on the environment, in addition to increased lengths of high tension aerial cables and posts, entrenched water supply lines and other utilities necessary to service these plants, which will possibly impose a negative impact on the surrounding environment.

An important aspect to consider is the transport and disposal of sludge linked to the different schemes. With a single plant the management is easier, but with larger schemes, involving activated sludge or trickling filter processes, the production of sludge is higher than, on a unit basis, than that for smaller plants employing such processes as extended aeration, oxidation ditches or stabilization ponds. For communities similar to those under consideration, relative freedom from such a heavy burden as that of sludge disposal is quite effective. From this point of view, stabilization ponds offer the most attractive solution, but due to the ruggedness of the terrain, suitable and large enough sites were very difficult to locate, and this alternative was applied only for the smaller communities with low flows.

### *8-6-5 Mitigation Measures*

In general, the wastewater project for Jbeil, in its overall nature, will not impose any serious negative environmental impact on the area.

- Mitigation measures will be required where natural springs, such as Nabaa Afqa spring, could be polluted by communities located within its water shed. Such possibilities, already addressed in the Identification of Source Protection Works Study by HH & Partners, were found to be of no tangible consequences at present. Already the study had identified several mitigation measures for each source within the area as outlined in section 3.
- However, and for possible future developments within the water sheds of the springs, the construction of the proposed sewerage system will in itself constitute a mitigation measure against possible pollution due to the mentioned new developments.
- The major coastal collectors will end the present practice of discharging sewage directly along the sea shore, thus nullifying the negative impacts of these shoreline outfalls.
- These same collectors will be laid along the wide Beirut-Tripoli highway, or along the old coastal road thus providing minimum interference with present traffic flows.
- If, and wherever a major trunk line passes through a congested area or crosses a main highway, trenchless techniques will be implemented to minimize on traffic interference.
- Most of the lines are located along existing roads or pedestrian tracks in order to minimize on expropriation costs, and to avoid further disturbances to the natural environment.

- Installation of treatment units is considered as a long term mitigation measure. However, such mitigations and other long term mitigations shall be based on the performance of the treatment units as observed through the environmental monitoring plan. Needless to mention that the success of the monitoring plan itself will be a result of the successful implementation of the environmental management and training programs adopted during the final design stage.
- The sites of the treatment plants shall be well landscaped, and surrounded as much as feasible with evergreen trees. Units that are liable to emit obnoxious odors in the vicinity of living quarters shall be so designed as to minimize this effect through adoption of odor control measures. Likewise, the same measures shall be taken for pumping station locations, in addition to provision of noise control equipment.
- When sewage treatment is introduced, a certain quantity of sludge is expected to be produced. If this sludge is not properly disposed off, it will impose a negative impact on the environment. It is, therefor, proposed to dewater and dry the resulting sludge, then convey it to a suitable landfill site at locations to be recommended by the concerned authorities.

### *8-6-6 The Matrix Form*

The negative and positive impacts discusses above, in addition to others have been placed in matrix form in Table 8-2 below.

- **Disposal of excavated material** should be to an approved site to minimize on impacts such as silt runoff sedimentation. Polluted excavated material should be transferred to a land fill site.

⇒ **Mitigation Measures:** provide necessary covering clauses in tender documents.

- **Archaeological sites, historic monuments and historic settlements** are under international protection agreements. Such archaeological sites exist in abundance in the district of Jbeil, and several sites have been dug accidentally during building excavations in several locations, particularly along the coastal strip. All excavations, therefore, have to be handled with extreme care and in such a manner as to protect these cultural properties. As such, the project should have no negative impact on archaeological or historic locations.

⇒ **Mitigation Measures** : Tender documents should contain clear reference to what protection measures are to be taken to avoid damage to historical sites.

- **Dust** is mainly a reversible type of pollution which should disappear when construction is completed

⇒ **Mitigation Measures:** On temporary basis, spraying of water could prevent dust during construction. Tender documents should contain reference to the proposed measures to prevent or reduce this impact.

- During construction, it is anticipated that **odors** will result from breakage of septic tanks prior to connection with the new system, possible diversion of sewage flow, and other similar activities. Impact of these activities can be minimized by proper supervision of construction, and specifying the degree of care that must be practiced by the Contractor.

⇒ **Mitigation Measures:** Tender documents should specify procedures for septic tank elimination and flow diversion and supervision practices.

- **Network Construction.** Nuisance arising from network construction is reversible and short termed, and will be totally reverted once the project is completed. This nuisance is typical of all construction activities and its impact can be minimized by special precautions such as silt screens, spraying of water on site, reinstatement of paving immediately upon completion of work, and disposal of surplus material to an approved site as soon as possible.

⇒ **Mitigation Measures:** Diligent care and responsible supervision during construction

- **Construction of wastewater treatment plants** is always considered as a negative impact on the value of real estate in areas adjacent to the treatment site. However, it has been observed on several locations that development has reached the outskirts of wastewater treatment plants. Complaints of neighbors can be minimized by careful and well planned selection of plant site, and by employing proper operation and maintenance guidelines and practices. The choice of locations of the plants within the project area was all basically dictated by topographical reasons to allow for gravity flow into these plants. In addition, other factors were crucial, including the minimum distance from the nearest household, the direction of the prevailing winds, land costs, access to nearby roads, and possible discharge points for the plants effluents.

⇒ **Mitigation Measures:** Place the treatment plants as far as possible from residential areas, avoid locations where the prevailing winds would carry odors to the nearest households, surround the TP with a barrier of tree wind breakers, allow proper access to the nearest public road, and control quality of effluent not to produce a negative impact on the receiving environment.

- **Visual impacts of construction activities:** Construction has usually a negative impact on the environment. However this is a short term impact which will disappear completely after completion of the works. As for pumping stations and treatment plants, these can be camouflaged behind hedges of adequate landscaping which can help blend the site with the surrounding environment.

⇒ **Mitigation Measures**: Specify adequate landscaping.

- **Cutting of tress:** should be avoided at all costs during the selection of routing, treatment plant sites and all construction activities. If unavoidable, erosion shall be minimized through the use of temporary or permanent soil stabilization procedures. Impact on wilderness and animal life is obvious, but can be reverted by replanting.

⇒ **Mitigation Measures:** temporary measures include silt screens; long term measures include replanting of trees.

- **Operation of Plant:** Positive impact. The proper operation of the plant will result in improvement of water quality. Odors may be a nuisance if the plant is not properly attended to, which will result in complaints from neighbors and possible lowering of land rating.

⇒ **Mitigation Measures:** The possible negative visual impact of the plant can be mitigated by proper landscaping. Other positive impacts include the release of treated effluent into the environment which could be used for agriculture (restricted application) or alternatively result in growth of vegetation and attraction of birds and others. Socio-economic impacts include better health conditions and possible employment for area residents (limited). In general sewage treatment plants can be considered to exert an overall positive impact on the environment. A "no project" situation definitely exerts a negative impact on the environment, its mitigation being the proper construction of the sewage scheme itself.

- **Operation of Lagoons:** This is also a positive impact as it results in the cleaning of water and possible water reuse. However, similarly to other plants, the presence of lagoons may be considered a nuisance if close to a community.

⇒ **Mitigation Measures:** include proper maintenance landscaping and, above all, location in an area where negative impacts can be limited.

- **Operations of Pumping Stations:** negative impacts result from machinery noise, odors and visual impacts. However, it should be noted that odors are not expected in the network in Jbeil because of favorable temperatures and slopes and short residence times in the system.

⇒ **Mitigation Measures:** Care should be taken in the design of these facilities to minimize all of these impacts. Odors can be mitigated through the use of odor control facilities.

- **Operation of Sewerage Network**: presence of a sanitary network is generally considered as a positive impact since its advantages exceed the disadvantages. The main advantage of sewers are reduced pollution and vector proliferation, improved water quality and hygienic conditions.

⇒ **Mitigation Measures:** A positive impact.

- **Discharge of Treated Effluent** is not likely to have adverse environmental impact. Effluents from treatment plants are usually discharged in a local stream or drainage course where winter storm flows exceed the anticipated flows from treatment plants. Therefore, flows from these can not result in, erosion of the stream beds.

⇒ **Mitigation Measures:** Chlorination or tertiary treatment to eliminate pathogens.

- **Septic Tank Elimination** : Is considered a positive impact because of the low standard construction of the existing tanks. Elimination of these will result in improvement of ground water quality.

⇒ **Mitigation Measures:** A positive impact.

- **Disposal of Bio Solids:** The disposal of bio solids in the Caza of Jbeil has yet to be addressed. Disposal of solids is generally a nuisance, unless properly stabilized and applied to agricultural land.

⇒ **Mitigation Measures:** Devise a plan to distribute dried solid sludge on agricultural land.

*Table 8-2 Matrix Form*

| | Construction Phase | | | | | | | | | Operation Phase | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a) Construction Equipment | b) Dust from Construction | c) Encampment / site offices | d) Increased Traffic / Detours | e) Spent lubricants | f) Excavated Material Disposal | g) Network Construction | h) Construction of Plants | i) Cutting of trees | j) Operation of Plant / Oxidation ditch | k) Operation of Plant / lagoons | l) Operation of pumping station | m) Operation of sewage network | n) Discharge of treated effluent | o) Septic tank elimination | p) Disposal of bio solids | No Project Situation |
| Soil Pollution | 2 | | 2 | | 9 | 7 | 5 | 3 | | | | | 1 | 1 | 1 | 1 | 7 |
| Topography | | | | | | 7 | 5 | 7 | | | | | | | | | |
| Physical features | | | | | | 7 | 5 | 7 | | | 5 | | | | | | |
| Surface water quality | 2 | | 4 | | 7 | 5 | 2 | 2 | | 1 | 1 | | 1 | | | 1 | 8 |
| Ground water quality | | | | | 8 | | 2 | | | 1 | 1 | | 1 | | 1 | 1 | 10 |
| Dust | 2 | 7 | | 6 | | 7 | 8 | 7 | | | | | | | | | |
| Odors | | | | | | | 6 | | | 5 | 5 | 7 | 5 | | | 5 | 9 |
| Erosion | 2 | | | 6 | | 7 | | 7 | 8 | | | | | 5 | | | |
| Run off Sedimentation | | | | | | 7 | | | 6 | | | | | | | | |
| Birds / animals | | | | 4 | | | | | 8 | 1 | 1 | | | 2 | | | |
| Land use | | | | | | | | 8 | | 5 | 5 | 7 | 2 | | 4 | 5 | |
| Wilderness | | | 5 | 5 | | | | 8 | 8 | 5 | | | | | | | 6 |
| Forests | | 2 | | | | | | | 8 | | | | | | | | |
| Agriculture | | 5 | | 5 | | | 7 | 7 | | 1 | 3 | | | 2 | | | 6 |
| Visual Impact | | 6 | 6 | 6 | 6 | 7 | 8 | 5 | 8 | 5 | 7 | | 1 | 1 | | | 10 |
| Archeological Sites | 8 | | | | | | 6 | 6 | | | | | | | | | |
| Employment | | | 1 | 7 | | | 2 | 2 | | 3 | 3 | 4 | 3 | | | 4 | 9 |
| Disease / vectors | | | | | | | 8 | | | | | | 2 | 5 | 1 | 5 | 10 |
| Socio-economic / Health | | 7 | | 6 | | | 8 | | | 2 | 2 | | 2 | | 2 | | 10 |
| Nuisance/Comfort | 8 | 4 | 6 | 8 | | | 8 | | | 7 | 7 | | 2 | | | 5 | 10 |

1 is high positive impact / Low negative impact
2 10 is low positive impact / high negative impact
3 5 is neutral impact

### *8-6-7 Environmental Management and Training*

The necessity of environmental management and training for the project area is obvious. In view of the increasing population figures expected during the next two decades, the pollution problems will impose themselves if environmental measures are not implemented towards the improvement of wastewater management. This does not apply to the technical installations and their degree of effectiveness only, but also to the periodical control of the water quality of natural and supplied waters. This control demands not only adequate facilities, such as basic laboratory equipment for rapid professional assessment, but also a staff trained in control and analysis works.

The basic demands for proper environmental management and training should incorporate:

- Training of engineering and laboratory staff for the water supply and wastewater systems by adequate training personnel (senior engineers, environmentalists from various institutions and universities).
- Training of this staff is considered to be most effective when initiated at the start of the construction works of the wastewater system. As such, the staff will be very familiar with the environmental monitoring requirements of the system when it is placed in operation, as provided in the next section.
- Information exchange through regular meetings between the various institutions, including the staff of the water supply and sewerage systems, concerning such subjects as:

  a) ecological degradation: members of institutions involved in terrestrial and marine biological studies, should convene regularly to discuss and exchange information regarding environmental risks.
  b) health risks associated with marine food: members of governmental and private medical institutions, colleges and universities, should be involved in regular meetings to discuss risks arising from consumption of contaminated marine food.
  c) health risks arising from touristic activities, to be the subject of regular meetings of the environmentally concerned parties in the country, including governmental agencies, to exchange information and statistics on the subject.

The concerned governmental agencies and institutes should maintain close contact with the international agencies involved with the terrestrial and marine environmental programs, particularly those involved with the Mediterranean area, including the UNEP, UNDP and MAP. This will keep the local authorities aware of international and regional standards regarding environmental and hygienic conditions, and will provide them with prompt information pertaining to changes in international regulations, standards and guidelines.

### *8-6-8 Environmental Monitoring Plan*

The basic characteristic of the **environment monitoring plan** for the water supply and the wastewater systems should be directed towards:

- The maintenance of sufficient water quality standards for the water supply systems.
- The maintenance of effluent standards for the wastewater effluents of treatment plants.

In fact, these characteristics will decide upon the probability of raising health within the served populace, and occurrence of biological degradation conditions.

In order to keep the defined and demanded standards, several periodical control activities are considered to be necessary:

- **Control of drinking water quality:** microbiological analysis for toxic pollutants at least twice a week, and general analysis for other pollutants at least twice a month.
- **Control of collected wastewater:** general analysis for toxic pollutants at least twice every month; BOD, TSS/VSS, daily; and temperature, pH and Degradable Organic, continuous/on-line readings.
- **Control of effluent from wastewater treatment facilities:** analysis for the standardized parameters at least twice during one month for chemical analysis and on daily basis for BOD.
- **Control of seawater** at different beach areas of Jbeil district's coastal strip: microbiological analyses for coliforms and fecal coliform bacteria, at least once a week.

The monitoring control, particularly control of sea water, should be intensified during the summer season, when the number of beach comers increases. With respect to other important areas, a standard iteration time of sampling is considered as once a week.

The proposed monitoring scheme is considered to be sufficient for the project area. However, it may turn out that a monitoring plan, with these characteristics, can only be effective when it is carried out in cooperation with various institutions, such as the Lebanese Marine Institute located in Jounieh Kesrouan, and the Ministry of Environment.

In this respect, the proposed structures of both 'Environmental Management and Training' (section 9-7) and the 'Environmental Monitoring plan' are considered mutually interactive, in such a way that neither of them can operate independently without losing effectiveness.

It is proposed to have 5 staff operating at the central treatment plant (FPZ) laboratory, one of them shall be the laboratory head technician, having sufficient experience (above 5 years) in the field of bacteriological and chemical testing. Two skilled technicians and six skilled workmen to assist the technicians in collecting samples from the smaller treatment plants and other possible locations within the project area.

The site laboratory shall depend on a larger, more advanced and better equipped laboratory or a central laboratory, if available, for guidance, follow up, uniformity and standardization purposes. The latter could possibly be the site laboratory at North Beirut Sea outfall in Dora.

The Site Laboratory shall perform part of the tests listed for samples collected from potable water, raw waste treated effluents and sea water, and mainly the frequent ones, such as the continuous / on-line and the daily ones, and any further test that need to be performed promptly, such as bacteriological and BOD test. The rest of the tests shall be performed at a more centralized laboratory.

#### *8-6-8-1 Development of Wastewater Pollution Monitoring Systems*

A wastewater monitoring program must be instituted as a part of the wastewater treatment project in the Caza of Jbeil. Aside from being an important tool for the operation of municipal wastewater treatment plants (WWTP), monitoring programs are needed to assess impacts of treated effluent discharge on the environment and to estimate pollutants loading on receiving bodies.

Based on the structure of the sewerage collection and treatment systems proposed for Jbeil, and the number and size of the plants needed, it is suggested that a central laboratory be used to conduct the environmental sampling and monitoring programs. Such laboratory should ideally be located within the Jbeil Central WWTP located within the FPZ, and proposed by others. Accordingly, a comprehensive monitoring program is proposed in this chapter that will be built around the proposal to collect samples from all district plants in Jbeil Caza for analysis at the Jbeil Central WWTP.

It is therefore essential to provide a complete laboratory in Jbeil as part of the Wastewater Collection and Treatment schemes. However for economic reasons, the number of tests to be conducted in this laboratory shall be limited as indicated previously to minimize capital investment. A number of elaborate tests, e.g. heavy metals contents and coliform counts could be conducted at a regional laboratory, after adequate preparation in Jbeil. In this arrangement, custody of the data collected should remain with the Jbeil Wastewater Authorities, which shall be responsible for reporting and supervising the operation of plants in the Caza.

The organization structure for the monitoring program is as follows:

1) Samples will be collected (composite when required) and transferred promptly to the assigned laboratory.
2) Tests on these samples are conducted promptly, while a portion is stored after adequate preparation for transfer to a regional laboratory for specialized tests (e.g. heavy metals). Until such a laboratory is established, either at the Dora Wastewater Treatment Plant or elsewhere, a third party can conduct the specialized tests.
3) Test results are collected from the different laboratories and stored centrally in the laboratory in Jbeil Caza. Periodic reports on this data will be submitted to the concerned authorities.

This proposed structure presents many advantages from economic and organizational points of view, including:

1) Testing procedures unified for all sites.
2) Smaller initial capital investments and only one central laboratory will be required for Jbeil Caza to conduct daily tests from the district's WWTPs. Elaborate tests that require sophisticated equipment can be conducted at one regional laboratory located within one of Beirut's WWTPs.
3) Centralized archiving and management of the data obtained for the different areas.

The program proposed in this chapter is divided into two parts: discharge measurement and monitoring of environmental impacts on rivers, streams and coastal waters. Because this program will be conducted in the Jbeil Central treatment plant, aspects pertaining to the monitoring of coastal waters, in accordance with METAP have been retained, although these may be addressed by the French Protocol study.

### *8-6-8-2 Discharge Measurement and Wastewater Characteristic Tests*

The object of the measurement of parameters such as flow rate and the physical, chemical and biological characteristics of wastewater is usually to monitor the performance of the facilities and, in the long run, to provide a comprehensive data base that will assist in the management of wastewater facilities. Some of the parameters considered in this program could be monitored automatically on-line, with the necessary instruments being installed as part of plant equipment and instrumentation. The proposed monitoring program, Table 8-3, also identifies tasks and distinguishes between those to be performed in the Jbeil laboratory and others in Beirut.

a) Flow Measurement: Flow intensity is a very important operational parameter, which is also very useful in planning wastewater facilities. All treatment plant designs under this project will employ Parshall Flumes for on-line flow measurement.

b) Wastewater Characteristics: Significant wastewater parameters include:

- Total solids: dissolved, suspended, volatile, etc.
- Biodegradable and non degradable organics: measured by $BOD_5$, COD and other methods.
- Pathogens: Total and Fecal Coliform, using E. Coli as indicator organism.
- Nutrient: nitrogen (nitrate and total) and phosphorus.
- pH.
- Fat, oil and grease (FOG).
- Conductivity.
- Color.
- Alkalinity.
- Heavy metals, especially mercury, cadmium and others.
- Pesticides and other refractory organic.

All of the tests for the measurement of these parameters involve a varying degree of complexity and should be performed by qualified technicians. Number of test procedures have been selected from Standard Methods for each of these tests, and are tabulated in Table 8-4. This selection can be refined at a later stage based on the experience gained in the field, after the approval of the Ministry of Environment.

***Table 8-3 Proposed Monitoring Program for Wastewater***

| Parameter | Raw Sewage Influent | Treated sewage Effluent | Frequency | Method |
|---|---|---|---|---|
| Temperature | Yes | Yes | Continuous | On-line |
| pH | Yes | Yes | Continuous | On-line |
| D.O. | Yes | Yes | Continuous | On-line |
| TSS/VSS | Yes | Yes | Daily | Jbeil lab |
| COD | Yes | Yes | Daily | Jbeil lab |
| $BOD_5$ | Yes | Yes | Daily | Jbeil lab |
| FOG | Yes | Yes | Weekly | Beirut |
| Coliform Count | Yes | Yes | Weekly | Jbeil lab |
| Alkalinity | Yes | Yes | Daily | Jbeil lab |
| Heavy Metals | Optional | Yes | Weekly | Beirut |
| Nutrients ($NH_4$, $PO_4$) | Yes | Yes | Daily | Jbeil lab |

*Table 8-4 Proposed Testing Procedures*

| | Test | Standard Method / Procedure No. |
|---|---|---|
| I | **Total Solids. dissolved, suspended and volatile** | |
| | a) Total residue dried at 103-105 °C | (209A) |
| | b) Total non-filterable residue dried at 103-105 °C | (209,B) |
| | c) Total volatile and fixed residue at 550 °C | (209,E) |
| II | **Salinity** | |
| | a) Electrical Conductivity method | (210A) |
| III | **Heavy Metals** | |
| | a) Preliminary treatment of samples | (302 A-H) |
| | b) Determination of metal content by Atomic Absorption spectrophotometric method. | |
| | Aluminum (Al) | (306-A) |
| | Cadmium (Cd) | (310-A) |
| | Calcium (Ca) | (311-A) |
| | Chromium (Cr) | (312-A) |
| | Iron (Fe) | (315-A) |
| | Lead (Pb) | (316-A) |
| | Magnesium (Mg) | (318-A) |
| | Manganese (Mn) | (319-A) |
| | Mercury (Hg) | (320-A) |
| | Zinc (Zn) | (328-A) |
| IV | **Nitrogen** | |
| | a) Ammonia | (317) |
| | b) Nitrate | (418) |
| | c) Organic Nitrogen | (420) |
| | d) Oxygen (dissolved): by membrane electrode method | (421-f) |
| V | **Phosphorus** | |
| | Calorimetric Method | (424-D) |
| VI | **Grease and oil** | |
| | Extraction Methods | (503-C) |
| VII | **Biochemical Oxygen Demand** | |
| | Using membrane electrode of $O_2$ readout | (507) |
| VIII | **Chemical Oxygen Demand** | |
| | Open / Closed reflux method with Calorimetric readout | (508) |
| IX | **Microbiology Examination** | |
| | Sampling | (906-A) |
| | Multiple tube fermentation technique for Uniforms | |
| | a) Standard total coliform test | (905-A) |
| | b) Fecal conform MPN procedure | (908-B) |

The proposed monitoring program, shown in Table 8-3, is intended as a guide that may be used in designing the laboratory facilities and equipment in the coastal plant laboratory. Testing frequency may be adjusted to suit the requirements of the monitoring agency or other reporting requirement.

It should be noted that data collected from the proposed program is also necessary for establishing a database that can be used in developing and implementing future pollution control programs in Lebanon.

### *8-6-8-3 Monitoring of Environmental Impacts*

Monitoring of the impacts of discharge on the environment constitutes an important part of any comprehensive program for monitoring the performance of treatment plants and sea-outfalls. A successful monitoring program takes into account scientific, technological, financial and economical considerations as well as the pollution monitoring requirements of local, national and international agencies and organizations. The environmental monitoring program proposed in this section is divided into two parts covering the inland and the coastal treatment plants.

a) Inland Treatment Plants:
A treatment plant that is performing well should have little or almost no effect at all on the environment or on public health. Aside from aesthetic aspects, impacts of a treatment plant are limited to those exercised on receiving bodies. Most of the treatment plants in Jbeil Caza discharge inland into creeks varying widely in size, the largest being Nahr Ibrahim, all others being perennial. Guidelines for the quality of discharges into rivers have been established by MOE in its resolution No. 52/1 dated 29th July 1996. These are listed in Table 8-5.

***Table 8-5 Water Quality Requirement for Aquatic Life***

| Parameter | Maximum Allowable Limit |
|---|---|
| Temperature °C | Maximum increase in temperature of the stream 1.5 degree. |
| Dissolved Oxygen | • > 9 mg/L 50% of samples<br>• > 7 mg/L 100% of samples |
| pH | 6 - 9 |
| TSS mg/L | < 25 mg/L |
| $BOD_5$ | <3 mg/L |
| Phosphorus (total) | 0.2 mg/L $PO_4$ |
| Nitrite | <0.01 mg/L |
| Ammonia ($NH_3$) | < 0.005 mg/L |
| Ammonium Ion (NH4+) | < 1 mg/L |
| Residual Chlorine | < 0.005 mg/L HOCL |
| Zinc | < 0.3 mg/L Z |
| Copper | < 0.04 mg/L |

*From Appendix 3, MOE resolution 52/1.*

*Table 8-6 Microbiological Characteristic for Recreational Water*

| Parameter | Unit | Max. Value |
|---|---|---|
| Aerobic Bacteria | CFU / 100 ml | < 100 |
| Total Coliforms | CFU / 100 ml | < 10 |
| Fecal Coliforms | CFU / 100 ml | 0 |
| Staphylococci | CFU / 100 ml | 0 |

*From Appendix 4 (Resolution 52/1).*

For WWTPs discharging into running rivers and creeks, the monitoring program should include sampling points suitable for indicating the quality of the receiving bodies and the impact of discharges. Typically these points can be based on the river flow rate and the organic loading imposed. However MOE resolution 52/1 has indicated 50m downstream of the discharge point for the monitoring of the parameters in Table 8-3. These points should be sampled periodically, each month for example, or when erratic functions of the treatment plant result in excessive organic loading on the river.

b) Coastal Treatment Plant:
The present study being undertaken by ACE does not include coastal treatment plants or sea outfalls. The responsibility of serving most of the coastal communities falls on the French Protocol Consultant. However, the two studies compliment each other, and the EIA study has to cover the whole area if it is to be complete. Hence a separate section catering for the coastal treatment plant and sea outfall was considered necessary, and the following paragraph covers these aspects

The parameters listed in Table 8-5 above are applicable to bathing waters also. In addition to Resolution 52/1, the Mediterranean Action Plan has listed several standards for water quality that include bathing waters and fisheries. Similar standards have been established on worldwide basis, and are listed in Table 8-6, taking into account local considerations such as immunology and other issues. A minimal monitoring program should include counts of total and fecal coliforms every two weeks. Testing frequency depends usually on various factors and on the season of the year; in general, testing frequency may be reduced in winter and during time of rough sea; in summer, pollution of bathing beaches is more critical and frequent monitoring becomes imperative. Selection of sampling locations should constitute part of an integrated national program to monitor pollution in seawater near bathing areas, and coastal areas in the proximity of existing outfalls. Sampling locations should also include areas of the sea near to discharge points. Locations of proposed sampling points are proposed below.

The interim environment quality criteria for bathing waters, adopted during the convention for the protection of the Mediterranean Sea against pollution

(MAP technical report series No 38, UNEP, Athens 1990), recommended adopting one of two methods for measurement of fecal contamination:

- "Determination of fecal coliform in sea water by membrane filtration culture method", (MFC).
- No. 22, "Determination of fecal coliform in sea-water by the multiple test tube method", (MPN).

The criteria recommend the inclusion, to the extent possible, of all coastal recreational beaches in the national monitoring programs, within the frame work of MEDPOL-Phase II. Table 8-7 below shows the various international bacteriological standards for bathing waters for comparison purposes.

***Table 8-7 Bacteriological Standards for Recreational Water Quality***

| Standard | Organism | Limits | Remark |
|---|---|---|---|
| U.S. Recommended | | 200 fecal coliforms, /100ml | |
| WHO | E.Coli<br>E.Coli | 100 CFU / 100 ml<br>1,000 CFU / 100 ml | Highly Satisfactory<br>Acceptable |
| Med Action Plan UNEP | Fecal Coliform<br>Fecal Coliform | 100 / 100mL (50%)<br>1,000 / 100 ml (90%) | Limit (minimum number of samples 10) |
| EEC | Total Coliform<br>Fecal Coliform<br>Fecal Streptococci | 500 / 100 ml<br>100 / 100 ml<br>100 / 100 ml | 10,000 (95%)<br>2,000 (95%) |
| MOE | | | see Table 8.4 above |

The coliform count method (MPN) is also recommended in the criteria for shellfish waters in the Mediterranean.

According to the criteria set out in the two methods previously indicated (MFC and MPM), the following sampling and analyses plan may be suggested:

1) <u>Sampling location</u>: should be selected to include most of the beaches and coastal areas used for bathing and other recreational purposes. As a minimum, four sampling locations must be selected to measure the pollutants according to the program suggested in Table 8-1.

2) <u>Sampling points</u>: should be located around 1 to 1.5 km north and south of the location of the sewage headworks and sea outfall, depending on location and length of sea outfall, unless otherwise determined by modeling the flume from the outfall. Other sampling points could be added to include other beaches used for recreation. Additional sampling points include the water column above the outfall diffuser section, and an intermediate point near the shore.

Discharge of pre-treated sewage through sea-outfalls affects the biological, physical and chemical characteristics of sea water in the vicinity of the discharge area. This part of the monitoring program should be designed to measure long-term effects of discharge on the marine environment. Discharge of wastewater adds nutrients that could affect the environmental balance in the vicinity of the outfall diffusers, and selected species may develop more than others, altering the ecological balance. The proposed environmental monitoring program should include measurements of biological activity in the benthos, along with measurement of chemical characteristics in the water column above the outfall. Typical chemical characteristics include total organic carbon (TOC), pH, alkalinity and other significant parameters. This program should ideally be initiated before commissioning of the outfall, and samples should initially be taken at a high frequency to assess the impact on the environment during the transition period. The sampling frequency may be decreased significantly after commissioning of the outfall as the marine environment approaches steady-state.

### *8-6-8-4 Required Staffing Structure*

The program is designed to carry out sampling of wastewater for the measurement of indicative parameters on the premises, and to prepare samples that need more sophisticated analysis for dispatching to other off-site locations.

The central laboratory (FPZ) should employ technicians familiar with bacteriological and chemical testing in addition to 2 skilled operators. Sampling at the remote district plant can be collected by automatic samplers-compositors and transported to the central laboratory.

The laboratory equipment shall include temperature probes, pH meters, remote probes for measuring DO (dissolved oxygen), vacuum pump and associated instruments and materials in addition to oven, furnace, and precision balance for the measurement of TSS/VSS. This laboratory should be equipped for the analysis and preparation of a large number of samples, arriving daily from the district plants.

### *8-6-8-5 Discharge Standards*

The recommended overall approach to the control of pollution is primarily based on setting discharge standards on the quality of wastewater that is being discharged to the sewers and then the quality of the treated effluent that is discharged into natural surface waters or a marine environment as would be the case in Jbeil Caza.

Control measures and discharge standards, necessary to meet the objectives of the National Plan have been established as presented below.

The protocol for the protection of the Mediterranean Sea Against Pollution from Land Based Sources (LBS Protocol) is used as the basis for identifying substances to be prescribed or limited for direct discharge to the water environment.

*8-6-8-5-1 General Physical and Chemical Parameters*

1) A color value not to exceed 20 mg/l Pt/Co scale after simple filtration for water to be abstracted for human consumption. No abnormal change in color for bathing waters.
2) Odor not to exceed dilution number 3 at 25°C for water to be abstracted for human consumption.
3) The pH value to be greater than pH 6.5 and less than pH 8.5 for water to be abstracted for human consumption. The pH value to be grater than pH 6 and less than pH 9 for any other part of the surface water environment.
4) No persistent foam, floating matter or solid objects.
5) No free or visible oil or grease.
6) Separable and/or extractable oil or grease not to exceed 1.5 mg/l.
7) Dissolved or emulsified hydrocarbons after extraction with petroleum ether not to exceed 50 μg/l.
8) Dissolved oxygen to be greater than 80% of saturation for bathing water, greater than 50% of saturation for perennial rivers, except classified fisheries.

*8-6-8-5-2 Prescribed Substances*

Substances prescribed for direct discharge to the water environment are based on the list shown in Table 8-8 for which Environment Quality Standards are recommended.

*Table 8-8 Substances Prescribed for Direct Discharge to the Water Environment*

| COMPOUND | RECOMMENDED EQSs | | |
|---|---|---|---|
| | Fresh Water | Estuarine Water | Marine Water |
| Mercury (Hg) and Mercury Compounds | 1 µg total Hg/l | 0.5 µg dissolved Hg/l | 0.3 µg dissolved Hg/l |
| Cadmium (Cd) and Cadmium Compounds | 5 µg total Cd/l | 5 µg dissolved Cd/l | 2.5 µg dissolved Cd/l |
| Total Organohalogen Compounds | 100 µg/l in total | 100 µg/l in total | 100 µg/l in total |
| Aldrin, Dieldrin, Endrin, Isodrin ('drins) | 0.03 µg total 'drins/l (1) | 0.03 µg total 'drins/l (1) | 0.03 µg total 'drins/l (1) |
| Atrazine | 2 µg atrazine/l (2) | 2 µg atrazine/l (2) | 2 µg atrazine/l (2) |
| Trichloromethane (CF) (Chloroform) | 12 µg CF/l | 12 µg CF/1 | 12 µg CF/1 |
| DDT | 0.025 µg DDT/1 | 0.025 µg DDT/l | 0.025 µg DDT/1 |
| Endosulfan | 0.003 µg endosulfan/1 (2) | 0.003 µg endosulfan/1 (2) | 0.003 µg endosulfan/l (2) |
| 1.2 Dichloroethane (EDC) | 10 µg EDC/1 | 10 µg EDC/1 | 10 µg EDC/1 |
| Hexachlorobenzene (HCB) | 0.03 µg HCB/1 | 0.03 µg HCB/1 | 0.03 µg HCB/1 |
| Hexachlorobutadiene (HCBD) | 0.1 µg HCBD/1 | 0.1 µg HCBD/1 | 0.1 µg HCBD/1 |
| Hexachlorocyclohexane (HCH) | 0.1 µg HCH/l | 0.02 µg HCH/l | 0.02 µg HCH/l |
| Pentachlorophenol (PCP) | 2 µg PCP/1 | 2 µg PCP/1 | 2 µg PCP/1 |
| Simazine | 2 µg simazine/1 | 2 µg simazine/1 | 2 µg simazine/1 |
| Tetrachloroethene (PER) (Perchloroethylene) | 10 µg PER/1 | 10 µg PER/1 | 10 µg PER/1 |
| Tetrachloromethane (CTC) (Carbon tetrachloride) | 12 µg CTC/1 | 12 µg CTC/1 | 12 µg CTC/1 |
| Trichlorobenzene (TCB) | 0.4 µg TCB/1 | 0.4 µg TCB/1 | 0.4 µg TCB/1 |
| Trichloroethene (TCE) (Trichloroethylene) | 10 µg TCE/1 | 10 µg TCE/1 | 10 µg TCE/1 |
| Trifluralin | 0.1 µg trifluralin/1 (2) | 0.1 µg trifluralin /1 (2) | 0.1 µg trifluralin/1 (2) |
| Total Organophosphorus Compounds | 1 µg/1 in total | 1 µg/l in total | 1 µg/1 in total |
| Azinphos-methyl | 0.01µg azinphos methyl/l (2) | 0.01µg azinphos methyl/l (2) | 0.01µg azinphos methyl/l (2) |
| Dichlorvos (DCV) | 0.001 µg DCV/1 | 0.04 µg DCV/l | 0.04 µg DCV/l(2) |
| Fenitrothion | 0.01 µg fenitrothion/1 (2) | 0.01 µg fenitrothion/1 (2) | 0.01 µg fenitrothion/1 (2) |
| Malthion (MLT) | 0.01 µg MLT/1 | 0.02 µg MLT/1 | 0.02 µg MLT/1 (2) |
| Organotin compounds | 0.02 µg total/1 | 0.002 µg total/1 | 0.002 µg total/1 (3) |

(1) EC total "drin" standard has now been superseded by standards for each compound, but the former standard is likely to be more practical in Lebanon.
(2) UK draft annual average EQS for freshwater.
(3) Based on UK EQS for triorganotin compounds.

*8-6-8-5-3 Other Pollutants*

As required by the LBS protocol, EQSs are also recommended for substances included in the EC Grey List as presented in Table 8-9.

***Table 8-9 Environmental Quality Standards for Water Environment***

| COMPOUND | RECOMMENDED EQSs | |
|---|---|---|
| | **Fresh Water** | **Estuarine and Marine Waters** |
| Arsenic (As) | 50 μg dissolved As/1 | 25 μg dissolved As/1 |
| Boron (B) | 2,000 μg total B/1 | 7,000 μg total B/1 |
| Chromium (Cr) | 50 μg dissolved Cr/1 | 15 μg dissolved Cr/1 |
| Copper (Cu) | 50 μg dissolved Cu/1 | 5 μg dissolved Cu/1 |
| Iron (Fe) | 1,000 μg dissolved Fe/1 | 1,000 μg dissolved Fe/1 |
| Lead (Pb) | 20 μg dissolved Pb./1 | 25 μg dissolved Pb/1 |
| Nickel (Ni) | 100 μg dissolved Ni/1 | 30 μg dissolved Ni/1 |
| Tin (Sn) (inorganic) | 25 μg total Sn/1 | 10 μg total Sn/1 |
| Vanadium (Vn) | 60 μg total Vn/1 | 100 μg total Vn/1 |
| Zinc | 50 μg total Zn/1 | 40 μg dissolved Zn/1 |
| Cyanide | 50 μg CN/1 | 50 μg CN/1 |
| Sulphide | 10 μg S/1 | 10 μg S/1 |
| Phenols | 1 μg/l total | 1 μg/1 total |
| Polycyclic aromatic hydrocarbons (PAH) | 0.2 μg/1 | 0.2 μg/1 |
| Total pesticides not otherwise prescribed | 1 μg/1 | 1 μg/1 |

*8-6-8-5-4 Standards for Discharge To Public Sewers & Municipal WTWs*

Industrial wastewater entering the public sewers and municipal wastewater treatment works should be subject to monitoring and control and should undergo the necessary pre-treatment.The standards for the general prohibitions and proscribed substances are listed below

1) No material that may physically damage the sewer or interface with the free flow of its contents should be discharged, thrown or otherwise allowed to enter the public sewer system.
2) No steam or any liquid at a temperature greater than 43°C should be discharged.
3) No substance should be discharged in a concentration that, in its pure state or in combination with other substances in sewage, may cause injury or harm to human health.
4) No carbides of any form should be discharged.
5) No flammable or explosive materials, or any other substance that may produce a flammable or explosive vapor, should be discharged.
6) No free or visible oil or grease should be discharged.

The standards for the General Physical-Chemical Limitations are listed below

1) The pH value to be greater than pH 6 and less than pH 10.

2) Cyanide and cyanogen compounds, which may produce hydrogen, cyanide on acidification not to exceed 2 mg CN/l.
3) Carbon disulphide not to exceed 2 mg/l.
4) Sulphide, polysulphide, and any other sulphur-containing compound which may produce hydrogen sulphide on acidification, except carbon disulphide, not to exceed 2 mg S/l.
5) Sulphate (as $SO_4$) not to exceed 1,500 mg/l (based on the assumption that the existing sewer network is constructed from pipes containing Class 1 Ordinary Portland Cement).
6) Separable and/or extractable oil or grease not to exceed 100 mg/l.

*8-6-8-5-5 Discharge Standards For Industries Discharging Into Public Sewers*

The concentrations given below in Table 8-10 should not adversely affect the operation of municipal wastewater treatment works, when established, and should generally ensure adequate dilution of wastewater discharged directly from public sewer to the water environment, as is currently the case. In practice, very few of these substances are likely to be discharged by existing industry in Lebanon.

Due to the nature of the industrial establishments in Lebanon, the potential constituents of the wastewaters generated will be diverse. A recommendation is adopted that the final discharge standards and pollutant loads for industrial wastewaters to public sewers for non-prescribed substances should be decided on a case by case basis, by the operator of the municipal wastewater treatment works, when known.

However, before decisions regarding the final discharge standards and pollutant loads for non-prescribed substances are made, the environmental regulator may consider freezing the loads of these pollutants in any significant discharges from existing industrial facilities.The following is a list of potential non-prescribed substances that could be considered in the proposed schemes.

1) Metals and their compounds including Aluminum, Antimony, Arsenic, Beryllium, Chromium, Copper, Iron, Lead, Molybdenum, Nickel, Selenium, Silver, Tin, Vanadium, and Zinc;
2) Salts including Nitrides, Nitrites, Nitrates, Chlorates, Hypochlorites, Perchlorates, Fluorides and Sulphites (Sulphates are dealt with in General Chemical Limits);
3) Ammonia or ammoniacal compounds;
4) Thiourea compounds;
5) Phenols, Cresols, and their simple derivatives;
6) Tar and tar oils (in addition to the general oil standard in General Chemical Limits);
7) Mineral Oils, Oil emulsions, and Grease (in addition to the general oil standard in General Chemical Limits);
8) Organosilicon compounds;

9) Organosulphur compounds containing nitrogen which are not Prescribed Substances listed in Table 8-10;
10) Solvents and other organic liquids which are not Proscribed or Prescribed Substances listed below;
11) Acrylonitrile;
12) Formaldehyde;
13) Surface active agents including soaps and detergents;
14) Dyestuffs;
15) Carbohydrates;
16) Yeast;
17) Paint wastes;
18) Pharmaceuticals including steroids and hormones;
19) Wood Preservatives other than the Prescribed Substances listed below;
20) Herbicides, Pesticides, Insecticides, Fungicides, and Biocides other than the Prescribed Substances listed below; and
21) Other substances of concern to the wastewater treatment works operator.

***Table 8-10 Limits for Discharges into Public Sewers for Prescribed Substances***

| COMPOUND | LIMIT FOR ISCHARGES (not to exceed) | SUGGESTED EQSs |
|---|---|---|
| Mercury and Mercury Compounds | 0. 1mg Hg/l | 1 µg Hg/l |
| Cadmium and Cadmium Compounds | 0.5 mg Cd/l | 5 µg Cd/l |
| Total Organahalogen Compounds | 10 mg/l | |
| Aldrin, Dieldrin, Endrin, Isodrin ('drin") | 3 µg total 'drins/l | 30 ng 'drins/l (1) |
| Atrazine | 200 µg atrazine/l | 2 µg/l (2) |
| Trichloromethane (CF) (Chloroform) | 1.2 mg CF/l | 12 µg CF/1 |
| DDT | 2.5 µg DDT/1 | 25 ng DDT/1 |
| Endosulfan | 300 ng endosulfan/l | 3 ng/l (2) |
| 1.2 Dichloroethane (EDC) | 1 mg EDC/l | 10 µg EDC/1 |
| Hexachlorobenzene (HCB) | 3 µg HCB/1 | 30 ng HCB /1 |
| Hexachlorobutadiene (HCBD) | 10 µg HCBD/1 | 0.1 µg HCBD/1 |
| Hexachlorocyclohexane (HCH) | 10 µg HCH/l | 0.1 µg HCH/1 |
| Pentachlorophenol (PCP) | 200 µg PCP/l | 2 µg PCP/1 |
| Simazine | 200 µg simazine/1 | 2 µg/1 |
| Tetrachloroethene (PER) (Perchloroethylene) | 1 mg PER/l | 10 µg PER/1 |
| Tetrachloromethane (CTC) (Carbon tetrachloride) | 1.2 mg CTC/1 | 12 µg CTC/1 |
| Trichlorobenzene (TCB) | 40 µg TCB/1 | 0.4 µg TCB/1 |
| Trichloroethene (TCE) (Trichloroethylene)) | 1 mg TCE/1 | 10 µg TCE/1 |
| Trifluralin | 10 µg/1 | 100 ng/1 (2) |
| Total Organophosphorus Compounds | 100 µg/l | |
| Azinphos - methyl | 1 µg/l | 10 ng/l (2) |
| Dichlorvos | 100 ng/l | 1 ng/l (2) |
| Fenitrothion | 1 µg/l | 10 ng/l (2) |
| Malathion | 1 µg/l | 10 ng/l (2) |
| Organotin compounds | 2 µg total/l | 0.02 µg/l (2) |

(1) EC total "drin" standard has now been superseded by standards for each compound, but the former standard is likely to be more practical in Lebanon.
(2) UK draft annual average EQS for freshwater.
(3) Based on UK EQS for trioganotin compounds.

*8-6-8-5-6 Standards For Discharge To Water Environment*

Currently no recent reliable flow data exist for the majority of rivers in Lebanon. This results in the difficulty to suggest discharge standards that will ensure environmental protection in all rivers. Therefore, the recommended discharge limits and related conditions were based on the recommended EQSs as previously described. These discharge limits and related conditions were also recommended to be adopted as minimum national standards for significant discharges to the sea and perennial rivers.

In addition to industry, standards should also be set for the discharge of these proscribed as well as the prescribed substances in the final effluent of any municipal wastewater treatment works discharging into the environment. The discharge limits for prescribed substances should only be exceeded in exceptional circumstances, to be agreed in writing with the Regulator for discharges to the water environment, and subject to the recommended implementation program.

The standards for the general prohibitions and proscribed substances are listed below.

1) No matter, other than matter specifically authorized or limited by numerical conditions in a license to discharge, should be discharged at such an extent to cause the receiving waters to be poisonous or injurious to fish, fish spawn, spawning grounds, or the food of fish.
2) No substance in any concentration should be discharged such that it would be classified as hazardous waste on the basis of the definition established for the National Plan.
3) No persistent foam, floating matter, or solid objects should be discharged.
4) No liquid should be discharged at a temperature that will cause the ambient water temperature to rise by more than 1.5°C for classified salmon fisheries and more than 3°C for other inland waters, measured at point not more than 50m downstream of the thermal discharge.
5) Subject to the above, no liquid should be discharged that will cause the water temperature to rise above 21.5°C for classified salmon fisheries, 25°C for surface water designated to be abstracted for human consumption, and more than 28°C for other inland water. Temperature should be measured at a point not more than 50m downstream of the thermal discharge.
6) No liquid at a temperature greater than 35°C should be discharged to the sea from any sources other than thermal power generating plants.
7) No carbides of any form should be discharged.
8) No other substances that may react with water to cause explosion or fire should be discharged.
9) No free or visible oil or grease should be discharged.

The standards for the General Physical-Chemical Parameters are listed below.

1) The discharge must not cause any abnormal changes in colour at a point 50m downstream of the point of discharge and must not cause the receiving water to fail any organoleptic standards set for water to be abstracted for human consumption.
2) The pH value to be greater than pH 6.5 and less than pH 8.5 for discharges to waters to be abstracted for the purposes of drinking water. The pH value to be greater than pH 6 and less than pH 9 for discharges to any other part of the water environment.
3) Separable and/or extractable oil or grease not to exceed 15mg/l.
4) Dissolved or emulsified hydrocarbons after extraction with petroleum ether not to exceed 500 µg/l.
5) Concentration of suspended solids not to exceed 30 mg/l.
6) Biochemical oxygen demand ($BOD_5$) not to exceed 30 mg/l.
7) Chemical oxygen demand (COD) not to exceed 100 mg/l.
8) Ammonia not to exceed 10 mg $NH_3$/l.

*8-6-8-5-7 Other Chemical Pollutants*

Similar to discharges to public sewers, the diverse nature of industrial wastewaters warrants the consideration of discharge standards for chemical pollutants beyond the prescribed substances that can potentially be discharged to the water environment. The list of other chemical pollutants listed earlier is mainly based on the EC Grey List and the associated EC Directives, for which EQSs were recommended. However, additional pollutants were also identified due to their potential for being constituents of certain industrial wastewaters.

The recommendation was given that the substances listed below in Table 8-12 must not be present in any concentration that causes the water to fail to comply with standards, which have been designated as applicable to that standard. An additional recommendation was that, if sufficient samples are available, compliance criteria should be based on a 95% percentile compliance scale, with no single sample being twice the suggested limit. However, in the immediate term, when there will be little sampling data available, the application of these discharge standards should be absolute limits not to be exceeded.

*Table 8-11 Limits for Discharges to Water Environment for Prescribed Substances*

| COMPOUND | LIMIT FOR DISCHARGES (NOT TO EXCEED) | | |
|---|---|---|---|
| | FRESH WATER | ESTAURINE WATER | MARINE WATER |
| Mercury (Hg) and Mercury Compounds | 10 µg total Hg/l | 5 µg dissolved Hg/l | 5 µg dissolved Hg/l |
| Cadmium(Cd) and Cadmium Compounds | 50 µg total Cd/l | 50 µg dissolved Cd/l | 50 µg dissolved Cd/l |
| Total Organohalogen Compounds | 1,000 µg/l in total | 1,000 µg/l in total | 1,000 µg/l in total |
| Aldrin, Dieldrin, Endrin, Isodrin ('drins) | 0.3 µg total 'drins/l | 0.3 µg total 'drins/l | 0.3 µg total 'drins/l |
| Atrazine | 20 µg atrazine/l | 20 µg atrazine/l | 20 µg atrazine/l |
| Trichloromethane (CF) (Chloroform) | 120 µg CF/l | 120 µg CF/l | 120 µg CF/l |
| DDT | 0.25 µg DDT/l | 0.25 µg DDT/l | 0.25 µg DDT/l |
| Endosulfan | 0.03 µg endosulfan/l | 0.03 µg endosulfan/l | 0.03 µg endosulfan/l |
| 1.2 Dichloroethane (EDC) | 100 µg EDC/l | 100 µg EDC/l | 100 µg EDC/l |
| Hexachlorobenzene (HCB) | 0.3 µg HCB/l | 0.3 µg HCB/l | 0.3 µg HCB/l |
| Hexachlorobutadiene (HCBD) | 1 µg HCBD/l | 1 µg HCBD/l | 1 µg HCBD/l |
| Hexachlorocycloexane (HCH) | 1 µg HCH/l | 0.2 µg HCH/l | 0.2 µg HCH/l |
| Pentachlorophenol (PCP) | 20 µg PCP/l | 20 µg PCP/l | 20 µg PCP/l |
| Simazine | 20 µg simazine/l | 20 µg simazine/l | 20 µg simazine/l |
| Tetrachloroethene (PER) (Perchloroethylene) | 100 µg PER/l | 100 µg PER/l | 100 µg PER/l |
| Tetrachloromethane (CTC) (Carbon tetrachloride) | 120 µg CTC/l | 120 µg CTC/l | 120 µg CTC/l |
| Trichlorobenzene (TCB) | 4 µg TCB/l | 4 µg TCB/l | 4 µg TCB/l |
| Trichloroethene (TCE) (trichloroethylene) | 100 µg TCE/l | 100 µg TCE/l | 100 µg TCE/l |
| Trifluralin | 1 µg trifluralin/l | 1 µg trifluralin/l | 1 µg trifluralin/l |
| Total Organophosphorus Compounds | 10 µg/l in total | 10 µg/l in total | 10 µg/l in total |
| Azinphos-methyl | 0.1 µg azinphos methyl/l | 0.1 µg azinphos methyl/l | 0.1 µg azinphos methyl/l |
| Dichlorvos (DCV) | 0.01 µg DCV/l | 0.4 µg DCV/l | 0.4 µg DCV/l |
| Fenitrothion | 0.1 µg fenitrothion/l | 0.1 µg fenitrothion/l | 0.1 µg fenitrothion/l |
| Malathion (MLT) | 0.1 µg MLT/l | 0.2 µg MLT/l | 0.2 µg MLT/l |
| Organotin Compounds | 0.2 µg total/l | 0.02 µg total/l | 0.02 µg total/l |

*Table 8-12 Limits for Discharge to Water Environment for Other Chemical Pollutants*

| SUBSTANCE | SUGGESTED DISCHARGE LIMITS | |
|---|---|---|
| | **Fresh Water** | **Estuarine and Marine Waters** |
| **Metals** | | |
| Aluminum | 3,000 µg total Al/1 | 3,000 µg total Al/l |
| Arsenic | 500 µg As/l | 250 µg As/l |
| Barium | 1,000 µg Ba/l | 1,000 µg Ba/l |
| Boron | 20,000 µg B/l | 70,000 µg B/l |
| Chromium | 500 µg Cr/l | 150 µg Cr/l |
| Cobalt | 2,000 µg Co/l | 2,000 µg Co/l |
| Copper | 500 µg Cu/l | 50 µg Cu/l |
| Iron | 10,000 µg Fe/l | 10,000 µg Fe/l |
| Lead | 200 µg Pb/l | 250 µg Pb/l |
| Manganese | 1,000 µg Mn/l | 1,000 µg Mn/l |
| Nickel | 1,000 µg Ni/l | 300 µg Ni/l |
| Selenium | 100 µg Se/l | 100 µg Se/l |
| Silver | 100 µg Ag/l | 100 µg Ag/l |
| Tin (inogranic) | 250 µg Sn/l | 100 µg Sn/l |
| Vanadium | 600 µg Vn/l | 1,000 µg Vn/l |
| Zinc | 500 µg Zn/l | 400 µg Zn/l |
| Not more than 10,000 µg/l (10 mg/l) of any other metal and the total metals concentration not to exceed 10,000 µg/l (10 mg/l) | | |
| **Inorganic Anions** | | |
| CYANIDE | 500 µg CN/l | 500 µg CN/l |
| Sulphide | 100 µg S/l | 100 µg S/l |
| **Organic Substances** | | |
| Petroleum hydrocarbons | 500 µg total/l | 500 µg total/l |
| Phenols | 10 µg total/l | 10 µg total/l |
| Polycyclic aromatic hydrocarbons (PAH) | 2 µg/l | 2 µg/l |
| Total pesticides not otherwise prescribed | 10 µg/l | 10 µg/l |