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EXECUTIVE SUMMARY

Objectives

Identification of environmental hot spots and initiation to public participation. The environmental audit of Haifa is one of four audits sponsored by MEDCITIES --a network of Mediterranean coastal cities-- and funded by a grant from the European Commission’s LIFE programme. The other cities are Silifke (Turkey), Tetouan (Morocco), and Gaza. The goal of these audits is to use rapid urban environmental assessment techniques promoted by the World Bank to put in place a comprehensive technical assistance program whose objectives are to (1) initiate an informed process of public participation in planning environmentally-sustainable urban development; (2) develop a cost-effective, rapid appraisal methodology for identifying environmental needs and supporting policy actions and interventions; (3) build local capacity for environmental planning and management; and (4) develop a methodology for evaluating the impacts of environmental degradation.

Key Findings

Industrial center with an older population and a high standard of living. The Haifa conurbation has 460,300 people living in three areas: the core (city proper), the inner ring (seven localities), and the outer ring (six localities). It enjoys a high standard of living, with excellent schools, universities, and specialized research institutes. Its percentage of college-educated people and number of hospital beds are higher than in other cities in Israel. Since Haifa’s population is older than Israel’s, however, it has a relatively lower birth rate and a higher death rate than the average Israeli population. Haifa’s average disposable income is 10 percent higher than Israel’s. As one of Israel’s largest industrial centers, it includes three major industrial areas: a petrochemical district, source of industrial pollution; a high-tech center; and a light industry area within the city. Haifa is generally green and clean; residents have a good quality of life enhanced by a very successful ethnic integration.

Big air quality improvement in the past ten years. One of Haifa’s biggest environmental successes is the air quality improvement achieved in the past 10 years: ambient concentrations of sulfur dioxide (SO$_2$) have been reduced by more than 90 percent. What is even more impressive is that this reduction was achieved very cost-effectively by a switch to low sulfur fuel without costly scrubbers. This success is due to Personal Orders that make the managers of each industrial facility personally responsible for compliance. There is still room for improvement; half hour SO$_2$ concentrations exceed the standard at times. Efforts must be pursued to ensure full compliance with all of the standards. The reduction in air pollution has been limited to SO$_2$; much remains to be done with particulate matter, nitrogen oxides, volatile organic compounds, and odors. Efforts to better monitor and control emissions from vehicles and to encourage public transportation will help Haifa reduce the ambient concentrations of these other air pollutants.
Two environmental hot spots: Haifa’s uncontrolled waste dump and the Kishon river. Haifa’s waste management situation is mixed. Streets are clean thanks to a well organized operations department within the municipality. Once Haifa collects its waste, however, it does not manage it properly. Its recycling is well below the targets specified by the Ministry of the Environment; Haifa could certainly learn from other nearby municipalities that have successfully implemented very efficient recycling and composting programs. Haifa’s worst waste management problem is undoubtedly its landfill, a waste dump with severe negative impacts on the environment. Haifa’s industries send their hazardous inorganic wastes to Israel’s hazardous waste management facility in Ramat Hovav; there is no treatment, however, for organic wastes that are stored on site by industries or in Ramat Hovav.

A Kishon river choked by the discharge of untreated toxic effluents. As it flows across Israel’s largest industrial area, the Kishon has become Israel’s most polluted river. The water quality downstream prevents aquatic life and consumption for human use. The sediments of the Kishon are heavily contaminated with toxic pollutants. Haifa should strengthen the control of industrial discharges to the Kishon through permits, inspections, and progressive cleanup programs. Haifa should apply to liquid effluents the same procedure that was applied to air emissions (i.e., Orders specifying effluent standards and penalties in case of non-compliance).

Lack of accessible green areas and danger of losing them. Haifa’s 6 km² of parks are well preserved and guarantee the ecological functions of the urban green areas. Though not large compared to the municipality’s total area, Haifa’s green areas form a system interconnected with the Carmel National Park and the continuous farmland in the Kishon floodplain. But these green areas do not fulfill their social function; children and old people cannot access most of them because they are too steep. In addition, current regulations may not protect open areas adequately. Population growth due to immigration and demand for high-quality housing will increase pressure for building in open areas, which may be possible given the lack of strong regulations and of a global urban plan.

High water losses and water breaks. Haifa’s old water distribution network, mainly made of iron, results in relatively high losses (20 percent) and water breaks (600 per year). Water quality could be improved; in 1996, 1.6 percent of water samples showed non-acceptable levels of Coli bacteria. Given the scarcity of water resources in Israel and in Haifa, Haifa must improve its management of water in terms of quantity and quality.

Inconvenient public transportation. The urban sprawl and the growth of a metropolitan area around Haifa are increasing traffic. Although the central bus station is connected by a short gallery to the train station, there is no ticket integration among various means of transportation on an urban or metropolitan scale. There is no intermodal exchange between the Carmelit subway and private transportation and no integration with bus tickets.

Inadequate urban maintenance in lower Haifa. The housing problem depends on the area of the city and the social level. While the middle and higher classes have
moved to the new residential areas between the green valleys up on the Carmel, some of Haifa’s lower parts suffer from inadequate urban maintenance and the population decreases or moves away. This process leads to degradation and loss of dwelling units.

**Strategy**

**Eight quality objectives to mitigate existing hot spots and prevent new ones.** Through public consultation, government and local officials, industry, academia, and NGOs review the environmental priorities established by the audit team and set up an environmental strategy, with short-term (within one to two years) and long-term (within ten years) environmental quality objectives. The goal of this environmental strategy is to mitigate the hot spots identified during the audit and prevent new ones. The Haifa municipality also has developed a six-step program to implement the strategy and identified seven priority projects and potential sources of funds to implement these projects. The strategy’s eight objectives are (see Table A):

1. Improve waste management;
2. Reduce effluent discharges;
3. Clean up the Kishon;
4. Improve air quality;
5. Preserve green areas;
6. Improve water management;
7. Improve public transportation; and
8. Shift to urban renewal.

**First step toward a master plan.** Haifa’s ambitious development plans involve a shift from heavy industries to high tech, tourism, and business. Haifa lacks, however, a master plan that could identify future environmental hot spots and recommend mitigation measures to minimize environmental degradation. Such a plan must be developed with full public participation, thus preventing or minimizing future protests against development projects. As part of the plan, Haifa’s municipality may want to consider establishing environmental management and planning procedures consistent with the ISO 14000 environmental standards. Developing such a plan will not be done overnight. This environmental strategy is a first step toward this master plan.

---

**TABLE A**

**SUMMARY OF HAIFA ENVIRONMENTAL STRATEGY**

Haifa Environmental Audit  Executive Summary, Page Page numbers
<table>
<thead>
<tr>
<th>Issue</th>
<th>Objective(s)</th>
<th>Time frame (years)</th>
</tr>
</thead>
</table>
| Strategy implementation                                              | Establish a Municipal Steering Committee  
Strengthen cooperation between Haifa’s decision makers and the public  
Organize a symposium to present the audit results and strengthen public participation | One One One        |
| Inadequate waste management                                          | Prepare a solid waste management master plan  
Prepare a management plan for industrial (hazardous and non-hazardous) and medical waste  
Implement the plan | Two Two Five       |
| Inadequate treatment of industrial effluents                         | Issue Permit Orders specifying effluent discharge standards for each plant  
Reinforce the polluter pays principle for industrial effluents, thus encouraging waste minimization and clean technologies | Five Five          |
| Pollution of the Kishon                                              | Prepare the Kishon watershed plan  
Develop recreation areas along the Kishon’s banks  
Implement the plan | Two Five Seven     |
| Ambient concentrations of air pollutants above standards            | Avoid adding new stationary sources of SO₂ (unless reducing existing ones) and further reduce the emissions of particulate, SO₂, NOₓ, VOC, and odors  
Improve monitoring  
Strengthen enforcement of car emission testing  
Encourage the use of non-polluting vehicles (e.g., electric buses) | Two Two Three Ten |
| Lack of accessible green areas                                       | Increase the accessibility of green areas to the public  
Preserve Haifa’s green valleys by restricting future construction  
Create the Mount Carmel Biosphere Reserve | Five Five Ten      |
| High water losses and water breaks                                  | Prepare a plan to upgrade the distribution network  
Implement the plan  
Reduce water consumption through awareness and education | Two Five Five      |
| Inconvenience of public transportation                              | Increase train frequency, promote intermodal exchange, and integrate, programs, fares, and schedule  
Add new bus routes and increase bus frequency  
Reduce fees through all-day bus tickets and free transfer between lines and for connections with the Carmeil Subway and suburban trains | Three Two One     |
| Inadequate urban maintenance in lower Haifa                         | Shift to urban renewal of old residential neighborhoods  
Improve the conservation and renovation of residential units | Five Five          |
1. INTRODUCTION

This chapter summarizes the objectives and methodology of this environmental audit, introduces the audit team, identifies the study area for the audit, and presents the report organization.

1.1 Objectives and Methodology

The environmental audit of Haifa is one of four audits sponsored by MEDCITIES --a network of Mediterranean coastal cities-- and funded by a grant from the European Commission’s LIFE programme. The other cities are Silifke (Turkey), Tetouan (Morocco), and Gaza. In 1993, the Mediterranean Environmental Technical Assistance Program (METAP) had received a grant from the European Commission to fund the environmental audits of five cities: Tetouan, Morocco; Oran, Algeria; Sousse, Tunisia; Limassol, Cyprus; and Tripoli/El-Mina, Lebanon.

The goal of these audits is to use rapid urban environmental assessment techniques promoted by the World Bank to put in place a comprehensive technical assistance program whose objectives are to (1) initiate an informed process of public participation in planning environmentally-sustainable urban investments; (2) develop a cost-effective, rapid appraisal methodology for identifying environmental investments needs and supporting policy actions and interventions; (3) build local capacity for environmental planning and management; and (4) develop a methodology for evaluating economic, social, health, and ecological impacts of environmental degradation.

1.2 Audit Team

The audit was conducted by a team of seven experts between November 24 and December 6, 1996:

1. Jean Tilly, environmental economist and chemical engineer, was the technical and strategy coordinator. Mr. Tilly is the general manager of ECODIT FRANCE, an environmental consulting firm headquartered in Paris, France, with offices in Arlington, United States and Rabat, Morocco;

1. Dr. Mira Baron, economist, prepared the socio-economic and environmental management chapters. Dr. Baron teaches at the Technion’s Faculty of Industrial Engineering and Management and has worked as a Research Fellow for the Natural Resources and Environmental Research Center;

1. Bella Ben David, chemical and environmental engineer, was responsible for air quality management. As the Chief of the Air Resources Division of the Haifa District Environmental Association of Municipalities, Ms. Ben David has been responsible for designing, planning, purchasing, and operating the new expanded Haifa Region Monitoring Network;
• Giovanni Cafiero, architect, was in charge of urban planning. Mr. Cafiero is a consultant to ECOMED, the Rome-based Agency for Sustainable Development in the Mediterranean;

• Giulio Conte, biologist, was responsible for natural resources and the Kishon river rehabilitation. Mr. Conte is a consultant to ECOMED, the Rome-based Agency for Sustainable Development in the Mediterranean;

• Dr. Enric Ibáñez, chemical engineer, was responsible for waste management, including hazardous, medical, and municipal waste. Dr. Ibáñez is a project engineer with RESA, a Barcelona-based company implementing waste management projects in Spain and abroad; and

• Mr. Joan Parpal, mechanical engineer, was responsible for water and wastewater management. Mr. Parpal works for the Municipality of Barcelona where he is responsible for the coordination of international projects.

These experts assessed Haifa’s current state of the environment, identified major environmental issues, and made recommendations to improve the environment. Using the Urban Environmental Indicators Questionnaire, they reviewed and analyzed available data on environmental indicators and environmental management, and interviewed key government officials and representatives from academia, industry, and Non-Governmental Organizations (NGOs).

1.3 Study Area

The geographic area defined by the municipal boundaries of Haifa is the starting point for this environmental audit. The audit examines activities affecting the environment and describes the state of the environment (land, water, and air) in this area. The environmental audit is not limited, however, to the municipal boundaries of Haifa and extends to neighboring areas, as needed, depending on the environmental topic addressed. For example, air quality issues have been assessed for nine municipalities including Haifa that belong to the Haifa District Environmental Association of Municipalities (HDEAM). HDEAM operates an air quality monitoring network that has data on air quality. In Haifa, environmental data are often presented for HDEAM’s existing borders; this report focuses on HDEAM’s borders. Socio-economic data are available either for individual localities or for two different definitions of the


2. The audit could also have used the Functional Economic Area (FEA) based on the labor market; Haifa attracts workers from a wider area, workers who commute to the city for their livelihood. Over time, since people change their residence but not their workplace, and also due to changes in the transportation network, the borders of the labor market change. Other study areas could have been the airshed—area affected by air pollution, but these borders remain vague— or the watershed of a river (e.g., the Kishon).
agglomeration -- each one is a continuous area with economic, social, and cultural connections:

1. **conurbation**: defined in the 1972 Census of Housing and Population, it includes the core (city proper), and the inner and outer rings. The inner ring includes Tirat Karmel in the south, Nesher in the southeast, Qiryat Yam, Qiryat Motzkin, and Qiryat Bialik in the north, and Qiryat Atta in the east. The outer ring includes Rekhasim and Qiryat Tivon in the east. The area does not include Carmel National Park nor the druze villages.

2. **metropolitan area**: in the 1995 Census of Housing and Population, the Committee for Geographical Classification of the Public Advisory Committee for Statistics replaced the conurbation by the Metropolitan area of Haifa. The metropolitan area reflects the notion of commuting area. Any locality with at least 20 percent of its residents employed in the center (the core) of the metropolitan area is in the metropolitan area. This definition enlarges the metropolitan area to Nahariyya in the north, Zichron Yaakov in the south, and Carmiel and Migdal Haemek in the east.

The district is another entity. The Haifa District is larger than the conurbation in the south since it reaches Hadera in the south. In this report, socio-economic data are for the conurbation; environmental data are for the region covered by HDEAM. The conurbation includes Tirat Karmel; the HDEAM area does not.

**1.4 Report Organization**

The remainder of this report is divided into eight chapters:

2. Socio-economic background
3. Environmental management
4. Urban planning
5. Natural resources and ecosystems
6. Air quality
7. Water and wastewater management
8. Waste management
9. Environmental strategy
The Haifa conurbation has 460,300 people living in three areas: the core (city proper), the inner ring (seven localities), and the outer ring (six localities). It enjoys a high standard of living, with excellent schools, universities, and specialized research institutes. Its percentage of college-educated people and number of hospital beds are higher than in other cities in Israel. Since Haifa’s population is older than Israel’s, however, it has a relatively lower birth rate and a higher death rate than the average Israeli population. Haifa’s average disposable income is 10 percent higher than Israel’s. As one of Israel’s largest industrial centers, it includes three major industrial areas: a petrochemical district, source of industrial pollution; a high-tech center; and a light industry area within the city.

In 1996, 188 Israeli localities were ranked according to socio-economic factors such as mean income per capita, unemployment, car ownership, educational achievement, etc. (the highest ranked locality was awarded the number 188 and the lowest ranked one the number 1). Depending on their rank, the localities were grouped into 10 clusters (the highest ranked localities in Cluster 10 and the lowest ranked ones in Cluster 1). Haifa’s localities are in Clusters 3 to 8. Haifa is in Cluster 7, like Tel Aviv; Jerusalem is in Cluster 6 (see Table 1).

<table>
<thead>
<tr>
<th>Locality</th>
<th>Rank</th>
<th>Cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tel Aviv</td>
<td>154</td>
<td>7</td>
</tr>
<tr>
<td>Jerusalem</td>
<td>130</td>
<td>6</td>
</tr>
<tr>
<td>Haifa</td>
<td>148</td>
<td>7</td>
</tr>
<tr>
<td>Nesher</td>
<td>133</td>
<td>6</td>
</tr>
<tr>
<td>Qiryat Atta</td>
<td>95</td>
<td>4</td>
</tr>
<tr>
<td>Qiryat Bialik</td>
<td>141</td>
<td>7</td>
</tr>
<tr>
<td>Qiryat Motzkin</td>
<td>145</td>
<td>7</td>
</tr>
<tr>
<td>Qiryat Tivon</td>
<td>159</td>
<td>8</td>
</tr>
<tr>
<td>Qiryat Yam</td>
<td>88</td>
<td>4</td>
</tr>
<tr>
<td>Rechasim</td>
<td>83</td>
<td>4</td>
</tr>
<tr>
<td>Tirat Karmel</td>
<td>45</td>
<td>3</td>
</tr>
</tbody>
</table>


This chapter presents Haifa’s socio-economic background in five sections:

1. Population;
2. Education;
3. Health;
4. Economy; and
5. Industry.
2.1 Population

At the end of 1994, there were 5.47 million people in Israel, including 4.44 million Jews (81 percent) and 1.03 million non-Jews (19 percent).\(^3\) There were 1.45 million households, including 1.27 million of Jewish households.\(^4\) The average household size is 3.58 (3.34 per Jewish household, and 5.27 per non-Jewish household); this figure has steadily decreased (in 1960, it was 3.8 for Jews and 5.6 for non-Jews). From 1990 to 1994, the population grew at a 3.7 percent annual rate. The large population increase in the past years reflects the large wave of immigration that started in 1989. From 1989 to 1994, 649,000 people immigrated to Israel.

As explained in Chapter 1, Haifa’s conurbation includes the core (city proper), the inner ring (seven localities), and the outer ring (six localities). The population increase between 1983 and 1995 was much larger in the inner and outer rings than in the core (see Table 2). The inner ring population is almost the same as the core population. The large wave of immigration (mostly from the former Soviet Union) that has swept the country since 1989 has brought 51,000 new people to the core and 41,000 to the inner ring.

Israel’s population is relatively young --the median age is 27.8; only 10.7 percent are 65 years and older. Haifa’s conurbation is relatively older: in the core, 18 percent are 65 and older; in the inner and outer rings, the percentage varies between 5 and 14.

2.2 Education

In 1994, the median number of school years of the Israeli population was 11.9.\(^5\) Table 3 shows that the median number of school years varies by origin, gender, and age group. Females and non-Jews have a smaller number of school years than males and Jews.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Haifa</td>
<td>140</td>
<td>183</td>
<td>219.6</td>
<td>225.6</td>
<td>252.3</td>
<td>11.8</td>
</tr>
<tr>
<td>Inner ring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nesher</td>
<td>6.5</td>
<td>8.1</td>
<td>9.4</td>
<td>9.7</td>
<td>18.1</td>
<td>86.6</td>
</tr>
<tr>
<td>Qiryat Atta</td>
<td>8.0</td>
<td>19.1</td>
<td>28.8</td>
<td>32.9</td>
<td>43.9</td>
<td>33.4</td>
</tr>
<tr>
<td>Qiryat Bialik</td>
<td>2.8</td>
<td>9.6</td>
<td>17.9</td>
<td>30.7</td>
<td>35.7</td>
<td>16.3</td>
</tr>
</tbody>
</table>

\(^3\)Central Bureau of Statistics, 1995, Table 2.1.

\(^4\)Central Bureau of Statistics, 1995, Table 2.30.

\(^5\)Central Bureau of Statistics, 1995, Table 22.1.
### TABLE 3
NUMBER OF SCHOOL YEARS OF THE ISRAELI POPULATION

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage with zero school years</th>
<th>Percentage with 16 school years or more</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Jews</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1.9</td>
<td>16.8</td>
</tr>
<tr>
<td>Female</td>
<td>4.9</td>
<td>12.6</td>
</tr>
<tr>
<td><strong>Non-Jews</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>4.7</td>
<td>5.7</td>
</tr>
<tr>
<td>Female</td>
<td>15.3</td>
<td>2.9</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>4.5</td>
<td>13</td>
</tr>
</tbody>
</table>

Haifa is well endowed with schools and universities. The municipality, responsible for enforcing the laws on education and for reinforcing the educational system, has developed over the years a sound infrastructure of educational institutions. In academic year 1992-1993, 54,600 children studied in Haifa. There are more high school students in Haifa who get their diplomas (54 percent) than in other cities (48 percent in Tel Aviv and 44 percent in Ramat Gan). There are more college-educated people in Haifa (30 percent) than in Tel Aviv (25 percent) and in Israel (21 percent).

Haifa’s largest colleges include the Technion (10,260 students in 1994 working in more than 20 engineering fields) and Haifa University (10,000 students in 1994 in social sciences, humanities, and law). Haifa also has specialized research institutes such as the Oceanographic and Limnological Research Institute (specialized in seas, lakes, and coastal zones) and the Pinhas Cohen Biological Institute (with a zoological and botanical garden whose main purpose is to educate school children on nature and the environment).

### 2.3 Health

Israelis have a high life expectancy (similar to what it is in European countries) due to good living conditions and a good health care system. The life expectancy varies by gender and by population group (see Table 4).

### TABLE 4
LIFE EXPECTANCY AT BIRTH BY GENDER AND POPULATION GROUP

<table>
<thead>
<tr>
<th>Population group</th>
<th>Gender</th>
</tr>
</thead>
</table>

---

<table>
<thead>
<tr>
<th>Qiryat Motzkin</th>
<th>4.2</th>
<th>8.9</th>
<th>17.6</th>
<th>26.6</th>
<th>33.6</th>
<th>26.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qiryat Yam</td>
<td>7.8</td>
<td>10.3</td>
<td>18.9</td>
<td>29.7</td>
<td>40.9</td>
<td>37.7</td>
</tr>
<tr>
<td>Tirat Karmel</td>
<td>5.2</td>
<td>11</td>
<td>14.6</td>
<td>15.5</td>
<td>17.6</td>
<td>13.5</td>
</tr>
<tr>
<td>Outer ring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rechasim</td>
<td>0</td>
<td>1.8</td>
<td>2.4</td>
<td>3.7</td>
<td>5.1</td>
<td>37.8</td>
</tr>
<tr>
<td>Qiryat Tivon</td>
<td>4.5</td>
<td>9.5</td>
<td>9.9</td>
<td>11.2</td>
<td>13.1</td>
<td>17.0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>179</td>
<td>261.3</td>
<td>339.1</td>
<td>385.6</td>
<td>460.3</td>
<td>19.4</td>
</tr>
</tbody>
</table>

Source: Central Bureau of Statistics, Statistical Abstract of Israel, 1996, Table 2.14
The birth and death rates vary between Jews and non-Jews. In 1994, Israel’s rates were 21.2 and 6.2 per 1,000 population, respectively (18.4 and 6.9 for Jews). Six These rates are respectively higher and lower than in European countries –10 and 9 in Spain and Italy, 13 and 9 in France, and 10 and 11 in Germany). Since Haifa’s population is older than Israel’s, it has a lower birth rate (14.1) and a higher death rate (9) similar to the European rates.

Diseases are the major causes of death (see Table 5). The causes of morbidity are different. Only a few causes are quoted. In 1992, the morbidity rate of malignant neoplasm was 248.4 per 1,000 among females and 254.7 among males. The rates of asthma among chronically ill were 25 per 1,000 among females and 26 among males.

### TABLE 5

DEATHS BY GENDER AND CAUSE IN 1993 (Crude Rates per 100,000 Population)

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Gender</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart disease</td>
<td></td>
<td>187</td>
<td>210</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td></td>
<td>70</td>
<td>59</td>
</tr>
<tr>
<td>Malignant neoplasm</td>
<td></td>
<td>133</td>
<td>142</td>
</tr>
<tr>
<td>External cause</td>
<td></td>
<td>25</td>
<td>48</td>
</tr>
<tr>
<td>Other cause</td>
<td></td>
<td>183</td>
<td>196</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>598</td>
<td>655</td>
</tr>
</tbody>
</table>

Source: Ministry of Health, Health in Israel, Selected Data, Health Information and Computer Services, 1996

Haifa has more hospital beds per person than Israel (see Table 6). Since the 1970s, the number of beds per 1,000 population has steadily decreased from 6.82 in 1975 to 6.05 in 1994; so has the number of days in the hospital from 8.6 in 1970 to 4.6 in 1994.

### TABLE 6

NUMBER OF HOSPITAL BEDS

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of hospital beds</th>
</tr>
</thead>
</table>

---

6 Although Jews have a higher life expectancy, they have a higher death rate than non-Jews because they are older (11 percent of Jews are 65 years and older; only 3.1 percent of non-Jews are 65 years and older).


### 2.4 Economy

In 1994, Israel's per capita Gross Domestic Product (GDP) was $13,800, which is similar to Spain's ($13,590 in 1993). In the past five years, the GDP has increased at about 6 percent per year in real terms (see Table 7); this rate is expected to decrease (in 1996, it should be around 3 percent). The GDP per capita has increased at a much slower rate, due to the rapid population growth.

**TABLE 7**

<table>
<thead>
<tr>
<th>Year</th>
<th>GDP increase in real terms (%)</th>
<th>GDP</th>
<th>GDP per capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>6.3</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>6.6</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td>3.5</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>6.85</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td>7.1</td>
<td>4.4</td>
<td></td>
</tr>
</tbody>
</table>

Wages vary by locality. In 1994, Israel's average annual wage per employee's post was $15,650. Most localities in the area have above average income per capita; Haifa’s average disposable income (per employee) was 10.3 percent above the national average (Tel Aviv's was 24 percent higher and Jerusalem's was only 1.8 percent higher).

In 1993, the poverty line, defined as 50 percent of the median income was 9,100 NIS ($3,030) per standardized capita; 17.3 percent of Israel's population was below the poverty line. Haifa's percentage of families below the poverty line (17.7) is higher than in Tel Aviv (16.8) but lower than in Jerusalem (20.3). The income distribution is uneven, and the Gini coefficient is 0.329 (see Table 8).

**TABLE 8**

<table>
<thead>
<tr>
<th>Population quintile</th>
<th>Percentage of income</th>
</tr>
</thead>
</table>

---


<sup>12</sup> The Gini coefficient measures income inequalities; a coefficient of 0 represents absolute equality and a coefficient of 1 represents absolute inequality.
2.5 Industry

As one of Israel’s largest industrial centers, Haifa includes three major industrial areas: (1) south of the Qrayot, an area of 20,800 dunams, called Mifratz (belongs to Haifa, Nesher, and Qiryat Atta); (2) south of the city, an area of 800 dunams, called Hof Hakarmel (belongs to Haifa and Tirat Hakarmel); and (3) within the city. Mifratz includes several petrochemical plants getting their feedstock from the refinery, a power plant, food processing plants, machine shops, etc. This area is a source of industrial pollution. The Hof Hakarmel’s high-tech center includes plants producing and developing computers, electronics, etc. Within the city, there is light industry, such as printshops. Mifratz and Hof Hakarmel were initially dedicated to industry. In the past 15 years, however, shops have penetrated these zones, thus exposing shoppers to certain risks (e.g., leaks of poisonous materials).

There are 157,800 people working in the city of Haifa, including 98,200 residents of Haifa. Table 9 shows that in all economic sectors, the number of employees is larger than the number of employees living in Haifa, which means that the city concentrates employment within the metropolitan area. For example, among the 28,400 persons working in industry, only 16,600 live in Haifa --i.e., the city ‘imports’ 11,800 industrial workers from the inner and outer rings.

<table>
<thead>
<tr>
<th>Economic Sector</th>
<th>Number of employees</th>
<th>Number of employees living in Haifa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>27,900</td>
<td>15,800</td>
</tr>
<tr>
<td>Utilities (electricity and water)</td>
<td>4,500</td>
<td>2,600</td>
</tr>
<tr>
<td>Construction</td>
<td>13,000</td>
<td>5,100</td>
</tr>
<tr>
<td>Commerce, restaurants</td>
<td>19,600</td>
<td>12,800</td>
</tr>
<tr>
<td>Transport, storage, communication</td>
<td>12,900</td>
<td>7,000</td>
</tr>
<tr>
<td>Financing and business services</td>
<td>18,500</td>
<td>13,600</td>
</tr>
<tr>
<td>Public and community services</td>
<td>40,500</td>
<td>30,900</td>
</tr>
<tr>
<td>Other services</td>
<td>10,400</td>
<td>6,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>147,300</strong></td>
<td><strong>93,800</strong></td>
</tr>
</tbody>
</table>

In 1992, Haifa’s sub-district had 1,036 companies (with at least five employees) with 38,900 employees; the city had 612 companies with 19,500 employees. As shown in Table 10, there are two major sectors: chemical and oil products (5,100 employees) in the Mifratz area and electrical and electronics equipment (9,200 employees) in the Hof Hakarmel area. Annual wages in these two sectors are high. In Haifa, average wages, salaries, and labor expenses per employee are 53,700 NIS for all sectors. In the chemical and oil products sector, this figure is 74,500 NIS; it is 76,100 in the electrical and electronics equipment sector.13

**TABLE 10**  
NUMBER OF COMPANIES AND EMPLOYEES BY MAJOR SECTOR  
FOR HAIFA AND HAIFA’S SUB-DISTRICT IN 1992

<table>
<thead>
<tr>
<th>Sector</th>
<th>Haifa Companies</th>
<th>Haifa Employees</th>
<th>Haifa’s sub-district Companies</th>
<th>Haifa’s sub-district Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food beverage and tobacco</td>
<td>106</td>
<td>3,700</td>
<td>152</td>
<td>4,600</td>
</tr>
<tr>
<td>Clothing and made-up textiles</td>
<td>0</td>
<td>0</td>
<td>109</td>
<td>3,100</td>
</tr>
<tr>
<td>Wood and wood products</td>
<td>0</td>
<td>0</td>
<td>155</td>
<td>1,800</td>
</tr>
<tr>
<td>Printing and publishing</td>
<td>53</td>
<td>900</td>
<td>62</td>
<td>1,100</td>
</tr>
<tr>
<td>Rubber and plastic products</td>
<td>N.A.</td>
<td>N.A.</td>
<td>31</td>
<td>700</td>
</tr>
<tr>
<td>Chemical and oil products</td>
<td>14</td>
<td>1,200</td>
<td>31</td>
<td>5,100</td>
</tr>
<tr>
<td>Non-metallic mineral products</td>
<td>53</td>
<td>1,700</td>
<td>65</td>
<td>2,300</td>
</tr>
<tr>
<td>Basic metal</td>
<td>7</td>
<td>600</td>
<td>11</td>
<td>800</td>
</tr>
<tr>
<td>Metal products</td>
<td>106</td>
<td>2,300</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>Machinery</td>
<td>40</td>
<td>1,000</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>Electrical and electronic equip.</td>
<td>59</td>
<td>4,100</td>
<td>61</td>
<td>9,200</td>
</tr>
<tr>
<td>Transport equipment</td>
<td>23</td>
<td>900</td>
<td>37</td>
<td>1,200</td>
</tr>
</tbody>
</table>

N.A.: Not Available


---

3. ENVIRONMENTAL MANAGEMENT

Institutions, legislation, and public participation play an important role in environmental management and policy. At the institutional level, the Ministry of Environment, created in 1988, formulates the national environmental policy, which is implemented locally by the district administration. Several legislative and regulatory tools exist for the protection of the environment including the Planning and Building Law, the Hazardous and Substances Law, the Licensing of Business Law, the Maintenance and Cleanliness Act, the Environmental Impact Statements regulation, national Master Plans, and Personal Orders.

In Haifa, the Environmental Protection Unit (EPU), established in 1977, was expanded to eight neighboring towns in 1982 and became the Haifa District Environmental Association of Municipalities (HDEAM). Its responsibilities include monitoring air, water, noise, solid/hazardous waste pollution, environmental education, planning, and supervision of industrial activities affecting the environment. HDEAM's budget has more than tripled in the past five years. The municipality of Haifa provides the following environmental services: water supply, sewerage, drainage, solid waste collection, street cleaning, and park maintenance. The municipal budget’s share of environmental expenses has decreased slightly in the past three years, especially its development budget and its contribution to HDEAM’s budget.

Finally, the public actively participates in improving the environment through yearly cleanups and Non-Governmental Organizations advocating environmental protection.

This chapter summarizes Haifa’s environmental management in eight sections:

1. Institutions;
2. Legislation and regulations;
3. Enforcement;
4. Personal Order;
5. Environmental Impact Statement (EIS);
6. Licensing of businesses;
7. Public participation; and
8. Municipal budget.

3.1 Institutions

In 1973, the Israeli government established the Environmental Protection Service (EPS) within the Ministry of the Interior. EPS’ original mandate was to advise ministries and planning bodies on environmental matters, design a system of environmental impact statements, collect and distribute environmental data, and prepare educational materials to increase environmental awareness. EPS’ most important achievements include the introduction of environmental considerations into the planning process and the establishment of environmental units in municipalities.

In 1977, EPS established Local Environmental Protection Units (EPUs) within Israel's main municipalities, the first one within the Haifa Municipality. The Haifa EPU's main tasks included collecting information on pollution sources within the area,
monitoring air quality and overseeing air and noise pollution, providing environmental advice on business licenses and building permit applications, inspecting industrial plants, and enforcing the environmental requirements included in their operating licenses.

### 3.1.1 Ministry of the Environment (MOE)

It soon became clear that legal authority, enforcement powers, and concentration of responsibility were imperative for developing and implementing a comprehensive, long-range environmental policy. In December 1988, the government established the Ministry of the Environment (MOE). MOE operates at the national, regional, and local levels; it formulates the national environmental policy and develops strategies and standards for environmental protection.

The district administration, created after MOE, implements the national environmental policy. It provides a forum for communication between local and land-use planning authorities, as well as a link between the national staff and municipal units. District offices, such as MOE's Haifa District Office, work closely with the local sector to assess environmental problems and promote solutions.

### 3.1.2 Haifa District Environmental Association of Municipalities (HDEAM)

Since the environmental impact of the large concentration of industries in the Haifa Bay area also affects Haifa's surrounding municipalities, the Haifa Municipality EPU was expanded to Haifa's neighboring towns in 1982 and became the Haifa District Environmental Association of Municipalities (HDEAM) according to a 1977 legislative order calling for its creation. HDEAM covers 165 km² and serves nine municipalities with a total population of almost half a million residents (see Table 11). HDEAM was charged with:

- Environmental control of:
  - a. Air pollution (monitoring and source control)
  - b. Industrial wastewater
  - c. Pollution of rivers and aquifers
  - d. Pollution of the sea and shoreline
  - e. Solid and hazardous waste
  - f. Noise pollution
  - g. Hazardous materials

- Environmental education;

- Environmental planning; and

- Supervision of industrial activities affecting the environment.

### TABLE 11

<table>
<thead>
<tr>
<th>MUNICIPALITIES INCLUDED IN HDEAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haifa Environmental Audit</td>
</tr>
</tbody>
</table>
As shown in Table 12, HDEAM’s budget (in current NIS) has more tripled in the past five years while the contribution of the municipality of Haifa to HDEAM’s budget has not even doubled. Therefore, the contribution of the municipality of Haifa to HDEAM’s budget has been reduced from 9 percent in 1992 to 3.9 percent in 1996 (see Figure 1). In 1997, MOE also reduced its contribution by 45 percent. HDEAM’s budget comes mostly from industry. Industry’s contribution to HDEAM’s budget for some services, such as air quality monitoring, is consistent with the polluter pays principle; but HDEAM is also one of Haifa’s key environmental agencies and a stronger financial link with industry could compromise its objectivity in the future. Therefore, the larger share of HDEAM’s budget should remain from the municipality of Haifa, other municipalities, and MOE.

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haifa</td>
<td>265,500</td>
</tr>
<tr>
<td>Kiriat Ata</td>
<td>50,000</td>
</tr>
<tr>
<td>Kiriat Bialik</td>
<td>40,000</td>
</tr>
<tr>
<td>Kiriat Yam</td>
<td>43,000</td>
</tr>
<tr>
<td>Kiriat Mozkin</td>
<td>38,000</td>
</tr>
<tr>
<td>Nesher</td>
<td>21,000</td>
</tr>
<tr>
<td>Kiriat Tivon</td>
<td>14,000</td>
</tr>
<tr>
<td>Rechassim</td>
<td>6,000</td>
</tr>
<tr>
<td>Zvulun</td>
<td>7,600</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>485,100</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>HDEAM’s Budget (Current NIS)</th>
<th>Contribution of Haifa’s Municipality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Current NIS</td>
</tr>
<tr>
<td>1992</td>
<td>1,758,267</td>
<td>158,910</td>
</tr>
<tr>
<td>1993</td>
<td>2,736,000</td>
<td>183,140</td>
</tr>
<tr>
<td>1994</td>
<td>3,002,000</td>
<td>234,450</td>
</tr>
<tr>
<td>1995</td>
<td>3,590,000</td>
<td>220,670</td>
</tr>
<tr>
<td>1996</td>
<td>5,610,050</td>
<td>220,670</td>
</tr>
</tbody>
</table>

**FIGURE 1**
CONTRIBUTION OF HAIFA’S MUNICIPALITY AS A PERCENTAGE OF HDEAM’S BUDGET
3.2 Legislation and Regulations

The basis for Israel's environmental management program is the land-use planning system established under the 1965 Planning and Building Law. The law establishes a comprehensive legislative framework regulating all building and land-use activities in Israel, public and private, within a three-level hierarchy: national, district, and local.

3.2.1 National

The National Planning and Building Board (National Board) oversees national planning. Chaired by the director general of the Ministry of the Interior, it includes representatives of government ministries, local government, and public and professional organizations, such as nature protection bodies. The National Board provides a broad and extensive forum for deliberation by all concerned bodies. Discussion at this level mobilizes professional input and expertise from many disciplines. MOE is a member of the National Board and participates in many of its subcommittees.

The National Board's primary responsibilities are to enact national master plans, review regional outline plans, and serve as an appeal board for decisions of the district planning and building commissions. National master plans (mostly sectoral master plans laying down the planning structure for Israel) are prepared for issues of national significance or for land uses that serve national interests (see Box 1). The master

<table>
<thead>
<tr>
<th>BOX 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISRAEL'S LONG-RANGE MASTER PLAN (2020)</td>
</tr>
</tbody>
</table>

Israel's long-range master plan (Israel 2020) includes general forecasts and recommendations. It analyzes the main aspects of Israel's long-term development, starting with the absorption of large inflows of immigrants and focusing on non-renewable natural resources.

Since the mid-1960s, Israel’s population has nearly doubled, but the built-up areas has quadrupled due to rising living standards. From a sparsely-populated country with 800,000 residents over 21,000 km² in the late 1940s, Israel today has become a densely-populated nation, in which 92 percent of its five million population live on only 40 percent of the land.

The need for a long-range national plan has become even more compelling because of the recent influx of immigrants from the former Soviet Union and Ethiopia; the peace process; and the transformation of Israel into a post-industrial society. Over the next 30 years, Israel may again double its present population and triple its built-up area; increased stress will be placed on a diminishing pool of land resources.

In 1989, Israel’s leading planners, architects, and engineers urged the government to start preparing a long-range master plan. Leading professionals and researchers from the academic community and representatives of government bodies were called to form a professional team. The project officially began in May 1991. Its goal is to prepare comprehensive and non-statutory strategic documents that will form a framework for national plans over the next 30 years. The project adopted a three-stage methodology:

1. outline and analyze from various perspectives and disciplines a broad spectrum of forecasts for Israel’s future;
2. synthesize this knowledge into a number of alternative integrated planning directions for Israel’s future development. Each alternative has a different focus —economic development, social issues, protection of open spaces, and continuation of current trends. Special teams were set up to study environmental and transportation issues;
3. evaluate these alternatives and develop the preferred one into a set of policy recommendations.

Ten projects formed the substantive and empirical foundations for the planning: society and demography, land, energy and water resources, future technologies, environmental sustainability, transport and telecommunication, and security. Taking into account anticipated population and economic growth, the environmental team identified the following problems and conflicts likely to be of concern in 2020:

1. increase in built-up area and density, especially in the center of the country, making land a very scarce resource;
2. growth in transportation, both inland and international;
3. increase in water demand for non-agricultural use;
4. increase in total emissions from human activity, including domestic and industrial waste and wastewater and air pollution, mostly from vehicular sources.

Plans are commissioned by the National Board and then submitted to the government for approval. Once approved and announced in the official gazette, they become legally binding plans. There are 34 master plans under various stages of approval or preparation. Some of the most relevant master plans for the audit are in Table 13.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Roads and Highways</td>
<td>Approved in 1976</td>
</tr>
<tr>
<td>6</td>
<td>Distribution of Population</td>
<td>Approved in 1975; update under preparation</td>
</tr>
<tr>
<td>7</td>
<td>Institutions</td>
<td>Approved</td>
</tr>
<tr>
<td>8</td>
<td>National Parks and Nature Reserves</td>
<td>Approved in 1981</td>
</tr>
</tbody>
</table>

---


Haifa Environmental Audit

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<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Power Plants</td>
<td>Approved</td>
</tr>
<tr>
<td>12</td>
<td>Tourism and Recreation</td>
<td>Under preparation</td>
</tr>
<tr>
<td>13</td>
<td>The Mediterranean Coast</td>
<td>Approved in 1983; update under preparation</td>
</tr>
<tr>
<td>15</td>
<td>Airports</td>
<td>Under preparation</td>
</tr>
<tr>
<td>16</td>
<td>Solid Disposal</td>
<td>Approved in 1989</td>
</tr>
<tr>
<td>30</td>
<td>The North Bay of Haifa</td>
<td>Under preparation</td>
</tr>
</tbody>
</table>

Master Plan 30 --still under preparation-- is of special interest for the audit; its goal is to resolve disputes on land use in Haifa Bay and to suggest amendments to approved master plans (or master plans under preparation). The plan will suggest a site for a power plant, assess the extension and potential relocation of the port and airport, road infrastructure, and other issues that cannot be decided by local committees.

The national level of the planning hierarchy also includes two additional statutory committees: the Agricultural Lands Committee, responsible for protecting lands of agricultural value and minimizing the loss of agricultural land to building, and the Territorial Waters Committee (MOE is a member), responsible for approving all offshore structures. No plan or building permit regulating agricultural lands or offshore projects may be endorsed without prior approval of these committees.

3.2.2 District

Six district planning and building commissions are responsible for regional planning. The district commissions include regional representatives of government ministries, such as MOE and representatives of local authorities within the district. District commissions serve as links between the national planning and local implementation. They receive and comment the national outline schemes, prepare their regional outline schemes for approval by the National Board, and assess plans submitted to them by the local level of the hierarchy. Israel’s six districts have comprehensive regional plans (district outline schemes), either approved or in preparation. The objectives of these schemes are of general importance to the district (e.g. sites for urban development, industrial development, waste disposal, open spaces for protection and recreation).

The study area for this audit is the Haifa District (see Chapter 1). The Haifa District Plans were submitted in 1967 and 1975 but were not approved. A new district plan will be prepared in the near future.

3.2.3 Local

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16 Master Plan 10 (power plants) has been approved but with no reference to the Haifa power plant. A decision on a new site will require a formal plan update. Any amendments to Master Plan 10 could be approved as part of Master Plan 30.

17 There are six districts: Northern, Haifa, Central, Tel-Aviv, Jerusalem, and Southern.
The local level consists of about a hundred local planning and building commissions, serving one or more local authorities and composed of the elected members of the municipal councils. The local commissions prepare outline and detailed schemes for their areas, showing planned land use allocations, and submit them for approval to the District Commissions. Local schemes set out conditions for land and building use in local areas to ensure, inter alia, appropriate levels of health, welfare and cleanliness, abate nuisances, preserve historical buildings, and protect and develop sites important from the point of view of nature and beauty. Such conditions may include regulations on building density, setbacks, roads, etc. The local commissions are also responsible for decisions on development applications, building permits, and action against illegal building.

Haifa’s most recent local plan was prepared during the British Mandate and approved in 1934 (see Chapter 4). The plan separates the industrial zone\(^{18}\) from residential areas, classifies the valleys as ‘nature reserves’ (which is binding in terms of land use although the reserves do not have the legal status of those nature reserves declared due to their unique natural value), preserves the shore, etc. More recent plans (e.g., the 1967 local plan) were not approved and thus have no legal status --the 1967 plan was approved locally (an approval that has the status of a recommendation), but not at the district level. Developers interested in constructing in the local area must apply to the local committee for an amendment of the approved plan. This tedious procedure has been criticized because of its duration. It often provides a narrow outlook, not an overview of impacts and priorities.

The Carmel Beach Towers project illustrates some of the difficulties to coordinate between the national and local levels. Master plan 13 (Mediterranean Coast) forbids construction within 100 meters from the coast line, unless the construction is for a specific land use such as tourism which is not entirely the case of the Carmel Beach Towers. The plan to construct the Carmel Beach Towers was submitted to the local committee in the 1970s as an amendment to the local approved plan of 1934 and to the yet to be approved 1967 local plan. It was approved by the local committee, a few years before the national master plan was approved in 1983. Though the project was approved by the local committee, it modifies the yet to be approved 1967 local plan.

3.3 Enforcement

Enforcement is based on effective legislation, which provide clear and practical requirements. The environmental legislation is a combination of national legislation, local by-laws, and international conventions. The law is enforced through administrative, civil, and criminal measures.

Environmental requirements such as licensing and permitting are a crucial step in enforcement. Permits are used for business licensing, planning, and building. To be

\[^{18}\text{The refinery and some of the adjacent industrial plants are in an extra-territorial area, outside of Haifa’s or any other municipality’s jurisdiction. Consequently, they are not subject to local planning laws and have to comply only with the district or national planning authorities. This special status should be changed; the plants should be in one municipality, either Haifa or Qiryat Atta.}\]
effective, inspection is done by government inspectors or by independent bodies. MOE operates the Environmental Inspection Patrol (also authorized by the Minister of the Police) that formally investigates suspected violators. They focus on such issues as hazardous waste disposal, solid waste disposal sites, littering, cleanliness (through the Maintenance and Cleanliness Act), etc. MOE also operates specialized units in marine and coastal inspection, poisonous substances, and river monitoring. On the local level, local authorities have their own supervisory authority.

The Hazardous and Substances Law (1993) requires licensing through the Licensing of Business Law, for any premise engaged in the sale of hazardous substances, and a poison permit for any person dealing with toxic substances. The law enables an authorized inspector to enter any premise dealing with hazardous substances.

3.4 Personal Order

Personal Orders have a strong deterrent effect because they make general managers of companies personally responsible for any environmental violations caused by their companies. There are 32 plants in Israel that must comply with Personal Orders. Cases against polluters are handled under criminal law and general managers can be prosecuted. Criminal proceedings often precede the prosecution; since they carry a social stigma, they are very effective.

In Haifa, Personal Orders have been issued to reduce air emissions, noise, and odor pollution from several companies (see Chapter 6): power plant, refinery, Gadiv and Haifa Chemicals (petro-chemical plants), Deshanim (fertilizer plant), Nesher (cement plant), and Shemen (food plant). These plants are monitored continuously; when compliance is inadequate, indictments are prepared.

3.5 Environmental Impact Statement (EIS)

Prevention, rather than treatment, has always been the focus of environmental policies in Israel, given the rapid rate of development in the country. Since the early 1970s, attention focused on incorporating environmental considerations into all major development projects to ensure sustainability. Environmental evaluation and assessment were introduced into planning at the national, regional, and local levels, and EIS were established to check the environmental impacts of specific detailed plans and proposals (see Box 2).

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**BOX 2**

**EIS PROCEDURES**

The 1982 regulations specify four kinds of projects for which an EIS is mandatory: power plants, airports, ports, and hazardous waste disposal sites. The regulations also recommend EIS for landing strips, marinas, national water supply arteries, dams and reservoirs, wastewater treatment plants, quarries, waste disposal sites and industrial plants located outside designated industrial zones, if the National Board or HDEAM (for Haifa) consider that the project will have significant environmental
impact beyond its immediate vicinity. In addition, any planning authority (national, district or local) or ministerial representative may require an EIS if they consider that the project may have a significant impact on environmental quality.

An EIS includes five sections:

1. description of the existing environment before project implementation;
2. reasons for the proposed site;
3. description of the activities resulting from project implementation;
4. assessment of future environmental impacts and description of mitigating measures; and
5. findings and proposed conditions to be included in the project.

The developer prepares the EIS according to guidelines prepared by MOE. While the regulations do not specify how an EIS should be reviewed, MOE has examines all EISs since 1987. Between 1982 and 1991, 84 EISs were submitted; the number of EISs had increased to 248 by the end of 1993. Several EISs have been conducted in Haifa: refinery, construction of a power plant and construction of a CCR (Continuous Catalytic Reformer) to obtain a high octane fuel; Nesher, new cement plant; Israel Electric, new power plant, etc.

The EIS procedure resulted in a 1982 national law mandating EIS for strategic plans; it can also be prescribed for detailed plans with a personal order or by MOE's representative in the Building Committee. MOE is in charge of the final evaluation. The Municipality can make observations and modifications. The EIS generally evaluates the impacts of a single project. The identification of alternative sites must be consistent with the existing master plans. One more reason for Haifa to establish a new master plan (see Chapter 4).

The EIS has been a very effective tool for a limited number of complex projects in which severe environmental impacts are anticipated. The EIS is now part of the planning procedure and is often required for the extensions of existing plants. The EIS is not appropriate for multiple small projects whose cumulative impact may be significant. For smaller-scale proposals, MOE representatives evaluate accumulated effects and make recommendations to the planning authorities.

Environmental impacts --even substantial-- result from a sum of ‘ordinary’ transformations, such as road works, construction, changes in end uses, and commercial activities. These transformations do not require EIS because they are considered ordinary building activity. In the long run, mitigating measures on each transformation would upgrade urban and environmental quality. The Municipal Building Commission can play a vital role provided the guidelines are clear and transparent.

3.6 Licensing of Businesses

Under the 1968 Licensing of Businesses Law, the Minister of the Interior, in consultation with the Ministers of Health and the Environment, designates businesses that require licenses to protect public health and the environment. Operating a business without a license or without complying with the conditions of the license is a criminal offense. Business licenses are issued by the head of a local authority after approval by the relevant minister, depending on the type of business.
The May 1995 amendment to the Licensing of Business Law distinguishes businesses requiring prior MOE approval from those that do not. MOE waived its authority for businesses with no significant impact on the environment. Out of the 250,000 businesses operating in Israel in 1995 and requiring a business license, 100,000 have environmental impacts and the amendment applies to them. MOE is currently drafting environmental requirements for up to 1,000 types of businesses, such as gas stations, parking lots, garages.

Each year, HDEAM reviews hundreds of business license applications; only about 10 percent of these applications need additional environmental requirements (see Table 14). Businesses with environmental requirements include garages, metal plants, printshops, marble plants, etc.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of applications</th>
<th>Number of applications needing additional environmental requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>375</td>
<td>33</td>
</tr>
<tr>
<td>1994</td>
<td>333</td>
<td>48</td>
</tr>
<tr>
<td>1995</td>
<td>398</td>
<td>40</td>
</tr>
</tbody>
</table>


3.7 Public Participation

Haifa’s population is involved in environmental protection at various levels: cleanup, plan review, and Non Governmental Organizations (NGOs).

3.7.1 Cleanup

Children and public trustees are involved in cleanup. The Municipality of Haifa encourages children to clean the city during spring and the Passover holiday (Minaal HaTiful, 1996). In the 1996 campaign, planning and coordination started in December 1995, and cleaning was done in March and April 1996. Children in primary schools clean their neighborhoods; high school children clean valleys and beaches. Such campaigns are repeated annually; they are advertised and there are various competitions among schools.

According to Israel’s 1984 Maintenance and Cleanliness Law, anyone who throws waste, building debris or vehicle scrap into the public domain, can be fined or...
jailed. Under the law, MOE can appoint cleanliness trustees from the general public in addition to inspectors who are government and public agencies employees. In 1996, there were 130,000 trustees; in 1995, 10,000 complaints were filed, a large percentage of them by trustees.

### 3.7.2 Plan review

The Planning and Building Law provides for public notification and participation. According to the 1992 Abatement of Nuisances (Citizen Suit) Law, anyone who feels affected by a plan that has been submitted, can file an objection. Any amendment to existing plans and any new plans are advertised in the newspapers; the public has the right to object to the plan. In practice, these ads too often remain unnoticed, and the public does not exercise their right.¹⁹ The ads are in very fine print, the concerned area is referred to in terms of land parcels -- the public does not recognize the specific location, and the proposed amendments are often vague (e.g., percentage change in area for construction) and expressed in terms that the general public does not understand. Recently, however, on several occasions, Haifa’s residents have organized and objected to proposed plans: in 1996, an entire neighborhood objected to the Carmel Tunnel and another group fought against a road going through a valley.

According to a 1996 amendment to the law, non-profit organizations can sue on behalf of their members. Seven organizations were granted the right to sue. Adam Teva Ve Din (Israel Union for Environmental Defense) used that right to sue Haifa Chemicals -- plan to build a pipeline to dump sewage into the beach -- and Carmel Beach Towers -- violations in the construction of their first building along the beach.

### 3.7.3 Non Governmental Organizations (NGOs)

Over the years the number of groups involved in environmental protection has increased.

Founded in 1954, the Society for the Protection of Nature in Israel includes people who care for nature (general public and academia). The society has members throughout the country and various activities. The society is active in education: organizing nature walks, operating field schools in various nature reserves and national parks, educating teachers, etc. The society has a few research centers on mammals, reptiles, caves, birds, etc. It has been initiated the movement to enact laws to protect nature reserves and parks, such as the Camel National Park. In the Haifa area, the society has fought against air pollution, objected to a stone quarry in the Nesher area, and promoted preservation of green areas within the city, specifically the valleys.

¹⁹ This was one of the main issues of concern for many participants to the public consultation organized in Haifa to share the audit’s results and prepare Haifa’s environmental strategy.
The Haifa Public Planning Committee\textsuperscript{20} has been active for the past 20 years; it includes people from academia, members of the Association of Engineers and Architects, members of The Society for the Protection of Nature, and interested individuals. It started as part of The Council for a Beautiful Israel. The Committee is currently working on the future marina and the Carmel Beach Towers, preservation of buildings, and construction in the valleys. They are concerned that the role of the public is limited to objecting to the plans. They would rather see the public involved in the evaluation of the alternatives in the early stages of the plans.

Greenpeace is relatively new in Israel. It has raised public awareness of Haifa Chemicals’ plan to dump its sewage to the bay. Greenpeace vessels have visited Haifa Bay on a few occasions, trying to connect with officials and the public.

Adam Teva V’Din (Israel Union for Environmental Defense (IUED)\textsuperscript{21}) is a law and science organization active in: environmental legal aid --supplying free legal counsel and representation, government oversight, hazard assessment, research and training, and education. In the Haifa region, IUED sued Haifa Chemicals in 1994 for contaminating the Kishon River and Haifa Bay by dumping untreated acid waste with high concentrations of heavy metals and nutrients. The suit was settled out of court in November 1996 (see Chapter 7). Based on the settlement, Haifa Chemicals will treat its effluent according to a pre-specified schedule. IUED has also sued the Carmel Beach Towers project (see Chapter 4), arguing that the construction violates the approved amendments to the local plan. Haifa’s district court has issued a temporary stop order prohibiting the construction of the second tower. The suit is ongoing.

3.8 Municipal Budget

Haifa’s annual municipal budget consists of an ordinary budget (for operation and maintenance) and a development budget (for capital improvements). The city provides the following services: water supply, sewerage, drainage, solid waste collection, street cleaning, street lighting, parks and recreation, and education. In 1997, the ordinary and development budgets are 885 and 374 million NIS (in 1996 NIS), respectively (see Table 15). In the past three years, the ordinary budget has steadily increased while the development budget has steadily decreased. Haifa’s total budget went from 1.268 billion NIS in 1996 to 1.259 billion NIS in 1997, a 0.7 percent reduction.

In 1997, environmental expenses (as defined in Table 15) represent 17 percent of the ordinary budget and 17 percent of the development budget. These percentages have steadily decreased in the past three years (see Figure 2); in 1995, environmental expenses represented 21 percent of the ordinary budget and 22 percent of the development budget.\textsuperscript{22} Between 1995 and 1997, all environmental expenses

\textsuperscript{20}Discussion with Dr. A. Varansky and P. Plaut, December 1996.


\textsuperscript{22}As explained in Table 15, the 1995 figures for sanitation, parks’ maintenance, water, sewage, and drainage include pension payments, therefore, it is difficult to compare 1995 with 1996 or 1997 for these
decreased, except expenses for parks’ maintenance (up 7 percent) and Haifa’s contribution to the Kishon River Authority (up 26 percent). The ordinary budget’s share of environmental expenses went from 21.2 percent in 1995 to 17.6 percent in 1997, a 17 percent decrease. The reduction of the development budget’s share of environmental expenses is even larger, from 22.1 percent in 1995 to 17.2 percent in 1997, a 22 percent decrease.

### TABLE 15
(In 1996 1,000 NIS)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ordinary Budget</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sanitation</td>
<td>66,869.8</td>
<td>55,847.4</td>
<td>54,971.5</td>
<td>(17.8)</td>
</tr>
<tr>
<td>Parks' maintenance</td>
<td>13,122.9</td>
<td>11,555.4</td>
<td>14,039.5</td>
<td>7.0</td>
</tr>
<tr>
<td>Water</td>
<td>65,246.5</td>
<td>61,134.0</td>
<td>64,715.0</td>
<td>(0.8)</td>
</tr>
<tr>
<td>Sewage</td>
<td>11,537.8</td>
<td>9,092.0</td>
<td>9,504.9</td>
<td>(17.6)</td>
</tr>
<tr>
<td>Drainage</td>
<td>1,174.0</td>
<td>1,062.0</td>
<td>1,014.9</td>
<td>(13.6)</td>
</tr>
<tr>
<td>Wastewater treatment plant</td>
<td>11,350.9</td>
<td>11,000.0</td>
<td>10,909.1</td>
<td>(3.9)</td>
</tr>
<tr>
<td>HDEAM</td>
<td>227.7</td>
<td>220.6</td>
<td>200.6</td>
<td>(11.9)</td>
</tr>
<tr>
<td>Kishon River Authority</td>
<td>108.1</td>
<td>110.0</td>
<td>136.4</td>
<td>26.2</td>
</tr>
<tr>
<td><strong>Total Environmental</strong></td>
<td>169,637.7</td>
<td>150,021.4</td>
<td>155,491.9</td>
<td>(8.3)</td>
</tr>
<tr>
<td><strong>Total Ordinary Budget</strong></td>
<td>800,973.0</td>
<td>860,500.0</td>
<td>885,481.9</td>
<td>10.6</td>
</tr>
<tr>
<td><strong>Environmental Share (%)</strong></td>
<td>21.2</td>
<td>17.4</td>
<td>17.6</td>
<td>(17)</td>
</tr>
<tr>
<td><strong>Development Budget</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water, sewage, and drainage</td>
<td>50,895.2</td>
<td>42,790.0</td>
<td>31,818.2</td>
<td>(37.5)</td>
</tr>
<tr>
<td>Administration of operations</td>
<td>43,878.2</td>
<td>34,616.0</td>
<td>32,409.1</td>
<td>(26.1)</td>
</tr>
<tr>
<td><strong>Total Environmental</strong></td>
<td>94,773.4</td>
<td>77,406.0</td>
<td>64,227.3</td>
<td>(32.2)</td>
</tr>
<tr>
<td><strong>Total Development Budget</strong></td>
<td>428,410.2</td>
<td>407,951.0</td>
<td>374,030.5</td>
<td>(12.7)</td>
</tr>
<tr>
<td><strong>Environmental Share (%)</strong></td>
<td>22.1</td>
<td>19.0</td>
<td>17.2</td>
<td>(22.2)</td>
</tr>
</tbody>
</table>

Notes:
1. The inflation in Israel was 8.1% in 1995 and 10.6% in 1996. The expected inflation in 1997 is 10%.
2. The exchange rate of the dollar was 3.12 NIS at the end of 1995 and 3.28 NIS at the end of 1996; the expected rate of depreciation of the shekel is 6%.
3. The 1995 figures for sanitation, parks’ maintenance, water, sewage, and drainage include pension payments. As of 1996, a special budget line was set aside for pension payments, thus making difficult any comparison between 1995 and the following years.

A large share of operating costs (36.3 percent) is for education and culture. The municipality does not employ the teachers in the primary schools; it employs the clerks and the maintenance staff, manages some of the high schools, and is responsible for the schools’ construction and upkeep. Other major expenses are for minaal ha’tifuul (18.4%).

budget lines. It is possible, however, to compare the other budget lines.
FIGURE 2
TRENDS IN THE ENVIRONMENTAL SHARE OF HAIFA’S BUDGET

Haifa Environmental Audit
Urban planning in Haifa is based on the 1967 master plan which has never been completely approved. Integration of environmental considerations in land use planning has been carried out through environmental compensation schemes, participation of local authorities, and environmental impact statements (EIS).

The land use structure of Haifa has been influenced by several factors including topography (the development of the coastal zone is regulated by the National Master Plan for the Mediterranean Coast), historic development, immigration (affecting housing), and strategic needs. Functions such as the port of Haifa, the railway facilities, and industry have strongly shaped the development of Haifa’s conurbation.

Haifa’s ambitious development plans involve a shift from heavy industries to high tech, tourism, and business. Haifa lacks, however, a master plan that could identify future environmental hot spots and recommend mitigation measures to minimize environmental degradation. Such a plan must be developed with full public participation, thus preventing or minimizing future protests against development projects. Given the scarcity of coastal land resources, Haifa would benefit from strict EIS procedures for each new development project. Haifa should also shift from urban expansion to urban renewal and maintenance and improve public transportation.

Due to the strong influence of national interest activities in Haifa, national plans determine the present and future assets of Haifa’s territory and human activities. Haifa has Israel’s most active port in terms of cargo and size of ships; passengers presence and transit are also intense. There are important railway facilities with several stations for passengers and goods transportation. The bay has an airport for local and regional transportation. Haifa is one of Israel’s main industrial centers with national interest facilities (power plant, refinery, fertilizer, cement).

Since 1994, Haifa has experienced an economic renaissance unmatched throughout its history. Haifa’s ambitious development plans involve a shift from heavy industries to high tech, tourism, and business. The Haifa Marina resort complex, International Convention center, and other major private and public sector projects will attract thousands of visitors from Israel and abroad. Table 16 summarizes 22 development projects. There is strong public opposition to some of these projects, especially the Carmel Beach Towers, the Haifa Marina, and the airport extension. The audit team heard many critics during the audit and the public consultation organized for the preparation of the environmental strategy. The audit team did not have enough time to study each one of these projects in detail. What is clear is that local authorities and developers must comply with proper procedures on public participation and Environmental Impact Statements. Most people against these projects are not against Haifa’s development; they just want to ensure that all options are carefully studied before moving forward.

There is a plan to extend the airport’s runway into the bay and transform the airport into an international airport. Clearly, the EIS for this extension should address several environmental issues, including noise and safety; the airport is close to Haifa’s petro-chemical complex and oil storage tank farms.
TABLE 16
HAIFA’S DEVELOPMENT PROJECTS

<table>
<thead>
<tr>
<th>Project name</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haifa Marina</td>
<td>Hotels, residences, tourism, and commercial facilities</td>
</tr>
<tr>
<td>Hotel-Bat Galim</td>
<td>300 rooms</td>
</tr>
<tr>
<td>The Peleg Center on the street level</td>
<td>Office and commercial space</td>
</tr>
<tr>
<td>Retirement Home Kiryat Eliezer</td>
<td>300 residents</td>
</tr>
<tr>
<td>City Center</td>
<td>Office and commercial space</td>
</tr>
<tr>
<td>The German Colony</td>
<td>Restoration and improvement of the German Colony infrastructure</td>
</tr>
<tr>
<td>Arch Center</td>
<td>Office and commercial space</td>
</tr>
<tr>
<td>Ein Dor Towers</td>
<td>Office and commercial space</td>
</tr>
<tr>
<td>City Windows</td>
<td>Office and commercial space</td>
</tr>
<tr>
<td>May Center</td>
<td>Office and commercial space</td>
</tr>
<tr>
<td>Lev Hadar</td>
<td>Office, commercial, and residential space</td>
</tr>
<tr>
<td>Bahai Hanging Gardens</td>
<td>Ornamental gardens and fountains</td>
</tr>
<tr>
<td>Expansion of the Nof Hotel</td>
<td>Addition of 100 rooms for a total of 200 rooms</td>
</tr>
<tr>
<td>Panorama Regency Hotel</td>
<td>105 hotel rooms and 135 apartment units</td>
</tr>
<tr>
<td>Central Carmel Auditorium and new parking facilities</td>
<td>Office and commercial space</td>
</tr>
<tr>
<td>Apartment Hotel Vardia</td>
<td>Office and commercial space</td>
</tr>
<tr>
<td>City Gate</td>
<td>Office and commercial space</td>
</tr>
<tr>
<td>“Grand Canyon” Shopping Mall</td>
<td>Commercial, office, and residential space, hotel and tourism facilities</td>
</tr>
<tr>
<td>Haifa Shopping Mall</td>
<td>Commerce and office space</td>
</tr>
<tr>
<td>The Haifa Conference and Exhibition Center</td>
<td>Exhibitions and conferences, commercial space and tourist services, 300 hotel rooms</td>
</tr>
<tr>
<td>Carmel Beach Towers</td>
<td>Residences, commercial, and tourism facilities</td>
</tr>
<tr>
<td>Klal Building (Bet Galim)</td>
<td>Office and commercial space</td>
</tr>
</tbody>
</table>

Source: Building the Future Now, Haifa Economic Development Bureau, Haifa Municipality

This chapter summarizes Haifa’s main urban planning issues in six sections:

1. Land use;
2. Coastal zone;
3. Haifa port;
4. Housing;
5. Historical sites; and
6. Transportation.

4.1 Land Use

The total municipal surface area is 58.6 km² --39.6 km² of built-up space, including 19.1 km² (32%) for residential uses and 9.6 km² (16%) for industrial and commercial uses and 19 km² of non-built space (parks, green areas, natural areas, wetlands, and vacant areas), including 6 km² (10.4%) of green areas. These figures are based on map measurements made in 1986. Since there has been no land survey in the past 20 years, these figures are outdated, which should be taken into consideration.
that Haifa’s non-built area is only 32 percent, lower than most European cities, except Paris.

4.1.1 Land use structure

The land use structure of Haifa and its hinterland has been influenced by several factors including topography, historic development, immigration, and strategic needs. Functions of national importance such as the port, railway, power plant, refinery, and other industries have strongly influenced the development of Haifa’s conurbation.

**TABLE 17**

**NON-BUILT AREA IN SELECTED EUROPEAN CITIES**

<table>
<thead>
<tr>
<th>City</th>
<th>Population</th>
<th>Total area (km²)</th>
<th>Non-built area (km²)</th>
<th>Percentage non-built</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haifa</td>
<td>250,000</td>
<td>59</td>
<td>19</td>
<td>32</td>
</tr>
<tr>
<td>Barcelona</td>
<td>1,635,067</td>
<td>99</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Berlin</td>
<td>3,456,891</td>
<td>889</td>
<td>589</td>
<td>66</td>
</tr>
<tr>
<td>Copenhagen</td>
<td>465,000</td>
<td>88</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Moscow</td>
<td>8,818,000</td>
<td>996</td>
<td>465</td>
<td>47</td>
</tr>
<tr>
<td>Milan</td>
<td>1,406,818</td>
<td>182</td>
<td>105</td>
<td>58</td>
</tr>
<tr>
<td>Oslo</td>
<td>467,090</td>
<td>427</td>
<td>292</td>
<td>68</td>
</tr>
<tr>
<td>Paris</td>
<td>2,152,423</td>
<td>105</td>
<td>26</td>
<td>25</td>
</tr>
<tr>
<td>Prague</td>
<td>1,212,010</td>
<td>495</td>
<td>295</td>
<td>60</td>
</tr>
<tr>
<td>Rome*</td>
<td>2,775,250</td>
<td>1,290</td>
<td>950</td>
<td>74</td>
</tr>
<tr>
<td>Stockholm</td>
<td>684,574</td>
<td>188</td>
<td>124</td>
<td>66</td>
</tr>
<tr>
<td>Zurich</td>
<td>365,043</td>
<td>92</td>
<td>62</td>
<td>67</td>
</tr>
</tbody>
</table>

Source: Europe's Environment Statistical Compendium 1995, Except (*)

Figure 3 shows a map of the city. There are three distinct areas:

• 11 The lower city -- area between the port and Allenby Road in the northwest, the old neighborhood of Bat Galim, now a tourist area with beaches and promenades, and in the southeast the industrial zone with the power plant. At the beginning of the century, Derek Ha Azma’ut (parallel to the port) was the core of Haifa.

• 12 Haddar Carmel on the foot of the mountain between 60 and 120 meters above sea level, developed after the old Technion (Institute of Technology) was built in 1925, and now an area with offices, administrative buildings, and residential and commercial facilities.

• 13 The Carmel area (about 250 meters above sea level) with tourist facilities and hotels in central Carmel, and residential areas spreading toward Carmel National Park and the Eshkol tower of the University of Haifa. Haifa’s middle and high class prefers these new residential areas in the upper and greener neighborhoods.

The industrial area is in Haifa Bay next to the Kishon port and along the Kishon floodplain. It includes several facilities connected to the port, the inner city, and the
national railway. The area also includes Haifa’s landfill and wastewater treatment plant in the south, and the fishing port and the airport near the Kishon Port. Parallel to the coast, between the refinery and the areas next to the Kishon Port, is the main road to the Qrayots. The first houses in the Qrayots were built in the 1930s. Several workers settlements were built in the 1950s; there are now several municipalities with more than 200,000 people. All of the municipalities are part of the Haifa conurbation and metropolitan system. The areas next to the main road between the Qryots and the Checkpost include old buildings for small-scale industries and some new commercial facilities attracting people from a larger area. The Checkpost is now a critical junction for traffic from the Qrayots and the north of the metropolitan area, and traffic from and toward the inland and the Galilee.

4.1.2 Master plan

In 1934, the British master plan was approved; in 1967, the Haifa municipality designed a new master plan. Although the 1967 master plan (submitted in 1981) has not been completely approved, urban planners and the municipality refer to it as the current plan; it is the administrative and legal tool for ordinary activity. Most long-term urban policy initiatives are planned as modifications of the 1967 plan; over the years, the 1967 plan has been modified many times. The 1934 and 1967 plans cannot effectively guide, harmonize, and coordinate today’s land use planning.
FIGURE 3
MAP OF HAIFA
4.1.3 Environmental management in land use planning

In the past two decades, Israel has used the land use planning system as an effective framework for implementing environmental policies. Environmental considerations appeared in the physical planning system in the early 1970s, as the environmental advisor to the National Board started operating. Today, 20 planners represent MOE at the national and regional levels of planning, while on the local level, environmental planners actively participate as advisors in the deliberations of local commissions. Most of the ongoing day-to-day integration of environmental considerations in the planning process is achieved by the participation of these environmental planners at the national and district levels. Thanks to their advice, outline schemes at the national, district, and local levels now incorporate resource evaluation, technologically feasible alternatives, and environmental impact statements (EIS).

Environmental compensation; the Hadera coal-fired power plant provides the first example of “environmental compensation.” A park was established for Hadera residents as compensation for the siting of the power plant. Ashkelon received funds for a marina project to ensure that the power plant would not affect its tourist industry. Environmental compensation (planting, re-greening, energy recovery) should comply with existing regulations. For each area, there should be specifications on materials, road layout, enclosures, and distances.

Participation; full participation of local authorities in the elaboration and implementation of planning policies should be enhanced, as recommended in paragraph 28 of “Agenda 21,” the final document adopted by the UN Conference on Environment and Development (UNCED - Rio De Janeiro 1992). Citizens have the right to participate as much as possible in urban planning and there should be a specific effort to involve categories that are particularly weak and underrepresented. This policy has two major implications: (1) identify and/or create “sites” where all involved stakeholders and environmental organizations can meet and discuss urban planning strategies, experiments initiated at block-level, and urban projects; and (2) always analyze the impacts of urban policies on the least represented citizens.

4.1.4 Local land use and National Master Plans

Haifa's development program must be elaborated according to the National Master Plans prepared for land uses and projects of national significance, especially Master Plans 12 (Tourism and recreation) and 13 (Mediterranean Coast) (see Chapter 3). Environmental aspects are integrated into all relevant national master plans; in some cases, they are the dominant considerations. In 1993 alone, MOE representatives participated in the preparation of the following plans: power supply, airports, ports, roads and interchanges (including the Trans-Israel Highway); water and wastewater; afforestation, tourism and recreation; and storage of liquefied petroleum gas (LPG).

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With the exception of the National Master Plan for Immigrant Absorption (see Section 4.4) coordinating the rapid absorption of immigrants from the Soviet Union, National Master Plans generally fall into six categories:

1. National significance (e.g., power plants, ports, and airports);

2. Infrastructure to be integrated within a national network (e.g., roads, railways, and transmission lines);

3. Essential goods and services (e.g., quarries and building materials, waste disposal sites, watersheds and aquifer recharge areas, cemeteries, and jails);

4. Regional and local (e.g., population distribution, public institutions, tourism and recreation, and gas stations);

5. National natural and cultural heritage (e.g., nature reserves and national parks, natural and manmade forests, and memorial and historic sites); and

6. Sensitive or problematic areas (e.g., Mediterranean coastal area, Lake Kinneret (Sea of Galilee) shores, the Gulf of Eilat, and Haifa Bay).

The implementation of environmental guidelines in urban planning meets a number of difficulties resulting from the various national schemes and coexistence of several strategic activities in Haifa. As the different strategic sectors depend on various authorities and plans at the national level, local institutions and communities have difficulties to consistently link the different areas and ensure an orderly development of the territory. Even the locations for new investments and constructions to improve business, tourism, and residential areas are strongly influenced and often turned off from the natural and historical structure of the city. An orderly and sustainable development of the territory of Haifa depends mainly on the level and efficiency of coordination and listening among various authorities and institutions.

4.1.5 Emergence of the Metropolitan level

In Israel, the district is the main planning institution between the municipality and the national government. The district approves the plans developed by the municipalities. In the past year, the cities’ strong influence on their surrounding areas has pushed further the metropolitan area concept; this concept is being studied in the academic and institutional circles. Recently, a metropolitan structure plan has been ordered for the Haifa metropolitan area.

The first step is to define the concept and the physical boundaries of such an area; the second is to create a metropolitan authority. In Haifa and generally in Israel, the creation of a metropolitan authority seems far off in the future and nobody currently knows how and when these steps will be taken. The rise of environmental issues has led to HDEAM’s creation (see Chapter 3), direct result of an increasing awareness of the necessity of collaborating among cities.
Local population, international markets, and tourist flows can be better served through integrated systems. In Europe, transportation problems (especially underground and railway) are solved at the metropolitan level. First, London and Paris, followed by Barcelona and Rome in the last decade, have solved transportation and urban policy problems at the metropolitan level.

4.2 Coastal Zone

As further described in Chapter 5, the role of nature and recreational areas gave a strong footprint to the identity of the city and the whole metropolitan territory. The Carmel National Park, the sea and the coastal zone, the remaining open areas in the Kishon floodplain, and the hills east of Tivon create a rich semi-natural system rarely seen in Israel and in other Mediterranean cities.

Because of its natural and topographic characteristics, Haifa is called the mountain city by the sea. The coastal zone strongly influenced Haifa’s early development. After several destructions and rebuilding, Haifa’s urban development has been steady since the second half of the XIX century. When German templar immigrants arrived in 1868-9, the old city began to extend along the coast, toward the north. In 1900-1905, the railway built by the Turks along the coast gave an impulse to the city’s economy. In 1933, the British government developed the new port in front of the lower city. In the 1930s, Jewish immigrants from Germany and other countries settled in Hadar Ha Carmel. After World War II and the foundation of the State of Israel, Haifa’s population grew from 150,000 to 251,000 in the early 1990s. At the same time, the industrial and transport facilities rapidly grew because of national interest; the Port and Railway Authority is now responsible for a long segment of the coastal line from Bat Galim on one end to the Kishon port on the other end, including the coastal areas in front of the lower city.

Given the land use structure of the coastal zone, the search for new location focused on the southern non-built areas starting from the narrow coastal line between the end of Mount Carmel and the sea. A new High Technology Industry nucleus has been built at the southern end of Haifa’s municipal territory. In the surrounding areas, there are recreation and commercial centers and a conference and exhibition center; a new bus and railway station is also planned. The coastal shore from this nucleus to the cape of Mount Carmel is an area of beaches and recreational activities where several new building and tourist facilities are planned (900 hotel rooms at the Carmel Beach Towers (see Box 3), 1,500 hotel rooms at the southern beaches, and 1,500 hotel rooms at the future marina at the bottom of Mount Carmel). Haifa’s coastal zone development must comply with the National Master Plan for the Mediterranean Coast (see Box 4).

**BOX 3**
THE CARMEL BEACH TOWERS PROJECT

The Carmel Beach resort is located on the Mediterranean coast, at Haifa’s southern entrance, along a 950 meter long coastal strip, bordering Shikmona Beach in the north, Zamir and Dado beaches in the south, and the Haifa-Tel Aviv highway in the east. The project’s planned area is about 360 dunams.
Carmel Beach Towers, a large vacation, hotel, tourism, sports, boating, entertainment, and commercial project will be the first along Haifa’s beaches and the largest of its kind in northern Israel. It will offer various services and attractions to all customers: four apartment hotels (1,100 apartments), two hotels (900 rooms and suites), an international convention center, beaches, a diving and sailing club, sports clubs and health spas including swimming pools, a jacuzzi, sauna, tennis courts, various gym and fitness rooms, dozens of coffeeshops and restaurants facing the sea, cinemas, shops and boutiques, a supermarket, a bank, a post office, a car rental office, an art gallery, a synagogue, a marine “lagoon”, lawns and fountains, and 2,000 parking spaces.

The project will be built in four stages. Stage 1 is now under construction; the first building was completed in 1996. Stage 1 is built on private land owned by Carmel beach resort 89 Ltd., according to “Plan HP/864A--Plan for the Development of Carmel Beach in Haifa.” On February 28, 1993, the Haifa Municipality gave the building permits for the two apartment hotels in Stage 1.

4.3 Haifa port

When it was inaugurated, in October 1933, the new British port was the largest and most efficient port in the Eastern Mediterranean.26 The plan for the new port came out after a competition. British engineer Palmer, who proposed a modern port in front of the city, won over Architect Richard Kauffmann who wanted to locate the port around the estuary of the Kishon river. The port was built by dredging the large anchorage basin and depositing the dredged sand onto the shoreline in order to erect a highway as a commercial facade. Behind the port were established oil terminals, a storage tank farm, and a commercial area at the main railway station of the time (Plummer square).

After the foundation of Israel, the need was felt for additional berths, loading and unloading areas and storage sheds; in 1951, work began on the Kishon port as an auxiliary. Six hundred meters of breakwaters were laid along the port and the power plant, and a large area was allocated to warehouses behind the port. In the 1960s, the Kishon river was widened, docks were dredged for the Israel Shipyards Company, and a fishing port and chemical wharf were built. In the 1970s, the importance of the Kishon port rose with the growth of containerized transport, requiring large storage areas. The part of the bay between the two ports was reclaimed with storage areas and an access road for containers. In 1976, the eastern container terminal was built. The "old" port began to lose its importance; it is now used by small and medium ships, mainly passengers ferries, grain ships, and navy vessels. Most port activities take place in the eastern container terminal and around the Kishon port.

The plan is to extend the main breakwater and reclaim from the sea big areas to the east and the north. The old port in the inner city will become a passenger port, open to the city. The future extension of the port to the east and to the north could bring new civil uses such as tourism, recreation, offices, and commerce.

BOX 4
NATIONAL MASTER PLAN FOR THE MEDITERRANEAN COAST

26 Haifa, Capital of the North, Page 35.
Recognizing the national value of Israel’s coastline, the National Board ordered the preparation of national plans for Israel’s sea and lake shores in 1970. The first stage of the National Outline Scheme for the Mediterranean Coast was approved in 1983; it includes: prevention of development unrelated to the coast; protection of large sections of the coastline as nature reserves, national parks, and coastal reserves; and allocation of coastal areas for tourism and recreation. The master plan includes a highly effective clause prohibiting development within 100 meters of the coastline.

The National Board commissioned a more detailed document for the resource management of the Mediterranean coastline for tourism and recreation, in order to provide a comprehensive long-term guide to planning policies beyond the general guidelines developed in the approved master plan. This more detailed document, prepared by MOE, bases development policies on principles of suitability and sensitivity of coastal resources. Suitability for tourism and recreation development was assessed on the basis of geological, vegetation, and landscape surveys; the allocation of the level of intensity of development for each site along the Mediterranean coastline was checked in relation to resource sensitivity.

The overall national policies proposed for resource management of the coast include:

1. Development not for recreation or tourism should not be permitted along the coast and its immediate hinterland;
2. Policies for resource protection should range from absolute protection within a designated reserve to the identification of sensitive resources to be considered within the detailed plan for site development;
3. Highly intensive uses should be confined to existing urban centers;
4. Offshore construction for recreation and water sport activities should be restricted to urban centers; and
5. A public footpath should be created along the coastline to ensure public access by foot to and along the coastline.

4.4 Housing

In 1995, Haifa had 97,780 dwelling units (99 percent of them with all basic facilities). There is less than one occupant per room (0.84) with an average surface area of 28.9 m² per person. Available space is about 90 m³ per person; on average, units are not overcrowded.

From 1983 to 1995, the population of Haifa’s conurbation increased by 19 percent. Most of this increase was due to immigration (especially from Eastern Europe after 1989). The population increase is not likely to be the main problem in local housing politics. While the natural increase remains steady, about 50 percent of the immigrants who arrived before 1991 left the city between 1991 and 1994.

The population increase has not been uniform in the city. For example, according to the 1995 Census of population and housing publication number 1, the
population of Statistical Quarter 6 (one of Haifa’s old mid-downtown areas) increased only by 0.8 percent (from 37,400 in 1983 to 37,700 in 1995); in fact, the population of Subquarter 6.1 decreased by 7.8 percent. The same Quarter 6 had 50,800 residents in 1961. The population decrease in some old quarters results more from a socio-economic depression and from the move of higher income families to other quarters than from the expulsion of poor families or the increase in price of the dwelling units. The old lower residential quarters are often abandoned by the local middle class who prefers residential areas up on Mount Carmel in Haifa’s greener and more recent neighborhood. Immigrants and lower class residents settle in the old Haifa.

Housing problems vary by area, depending on the geographical situation and the age of the building. Housing problems and residential uses of various urban sectors are linked to urban maintenance and rehabilitation. Adding new housing to an old neighborhood, after improving its services, seems to be the best integrated way to solve housing problems. To help municipalities with housing problems, the 1994 National Law allows municipal authorities to increase planned residential densities by 20 percent.

In the midst of accelerated development, one accomplishment deserves special mention: increased awareness of the importance of preserving open space landscape. A breakthrough was achieved with the establishment in 1990 of a team --including representatives of Israel’s major nature and environmental bodies-- to classify the country’s entire open space landscape into characteristic landscape units according to their attributes and functions. This classification was accompanied by the recommendations for the appropriate levels and features for the protection/development of each landscape unit. The open landscape classification maps were integrated into the National Master Plan for Immigrant Absorption (see Box 5) and will continue to be used in environmental lobbying and conservation campaigns.

**BOX 5**

**NATIONAL MASTER PLAN FOR IMMIGRANT ABSorption**

Substantial environmental management and resource protection measures are an integral part of the most recently approved master plan for immigrant absorption. Recognition of the need to coordinate planning efforts by all sectors of government to absorb the hundreds of thousands of immigrants who have come to Israel since 1989 led the National Board to commission a National Outline Scheme for Immigrant Absorption in June 1990. For the first time, various subjects, previously addressed within the framework of sectoral master plans, were integrated within one outline scheme. The scheme, approved by the National Board in August 1992 and by the government in January 1993, sets out directives on development and management of the country’s resources during a period of accelerated development and immigration absorption.

The plan contains an environmental guidelines map showing environmental constraints and restrictions on residential development, based on an evaluation of the sensitivity of areas to development. It denotes areas in which building is not permitted --areas of high natural and landscape value designated for protection and areas exposed to environmental degradation such as noise, air pollution or risks. It also designates areas where development could be permitted if measures were taken to prevent environmental degradation (e.g., areas of high sensitivity to water pollution).

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The planning documents emphasize environmental management principles, including:

- Development should be confined to existing urban settlements, using existing infrastructures;
- Rural development should be limited to minor expansion of existing settlements, within an overall policy of open space protection of rural agricultural landscapes;
- High quality areas of natural and landscape value should be strictly protected;
- Development should not be permitted in areas exposed to environmental degradation;
- Development must be accompanied by the adequate provision of facilities for sewage treatment;
- Development of industrial parks must include regulations to prevent environmental pollution;

The National Outline Scheme for Immigrant Absorption contains a non-statutory development plan to help guide the investment decisions of the various sectoral ministries. It includes investment priorities for sewage treatment facilities and for solid waste disposal sites.

The planning efforts of the early 1990s are marked by the challenges of immigrant absorption and the responsibility for providing each new immigrant with a roof. While the National Master Plan for Immigrant Absorption is a good example of the integration of environmental aspects in planning decisions, environmental mistakes were not always avoided in other areas. On the district and local levels, environmental aspects were at times side-stepped as development pressures mounted.\(^{28}\)

The Planning and Building Process Law, a two-year emergency order enacted by the Knesset in mid-1990, illustrates the dangers of hasty decision making. Normally, environmental planning is based on the careful and detailed assessment of the environmental impact of building and development proposals. However, the pressing need to provide housing and employment to a massive wave of new immigrants led the Knesset to enact an emergency order accelerating the approval process for residential construction and creating new and less cumbersome planning institutions. Although a MOE representative was included as a full member of both residential and industrial emergency building committees, approval was given for residential units at sites exposed to environmental nuisances or at sites lacking public services. The most acute environmental problem was the lack of sewage treatment facilities. All of Israel's green groups have opposed the emergency order, extended in recent years to cope with the country’s housing shortage.

In June 1994, the government decided to significantly accelerate residential building throughout the country to better cope with rising housing costs and shortages. In light of past mistakes, however, the government agreed to MOE’s request to include an environmental clause in the housing program stipulating that building permits for new residential neighborhoods will not be granted until the completion of sewage and solid waste disposal facilities and public systems. MOE opposes residential building in areas exposed to environmental pollution and in areas of high natural or landscape value; it has recommended, instead, that new settlements be directed at sparsely-populated areas, such as the Negev, and that high-rise buildings be introduced into the central region to avoid urban sprawl and preserve open space land reserves.

\(^{28}\)The Environment in Israel, Ministry of the Environment, Jerusalem, 1994, page 164.
Throughout the years, there have been various attempts to shorten approval by Israel’s planning authorities. A 1988 amendment, for example, sets a strict time limit on the approval of plans once they are submitted. Another significant amendment requires planning authorities to state their policies. While the amendment only refers to building permits at present, the same philosophy, if successful, will apply to developers.

4.5 Historical Sites

According to Addition 31 (1991) to the national law on urban planning, each municipality must establish a list and create a commission to preserve historical sites. The commission includes the mayor or his/her delegate, three members of the municipal council, one town planning expert named by the mayor among the municipal employees, and one external expert in historical sites preservation named by the mayor, with no right to vote.

Even before Addition 31, Haifa’s preservation team had already established a list, including gardens and panoramic sites. More than 200 historical sites are registered (houses, building complexes, street facades, gardens). Most of the sites are classified based on three levels of transformation allowed: (1) restoration and ordinary maintenance of monuments, (2) preservation of facades, and (3) preservation of areas. The preservation team advises the building commission of the municipality.

Haifa has many historical sites including archeological sites like Khayfa al Atika (Ancient Haifa) and the Burial Caves. Most of the historical sites are single building or groups of building like the Carmelite Church, the Greek churches in Harat al Kanais (Churches Quarter), the Stella Maris Monastery, the Mosques of al-Jarina and ez-Za’ir. There are also several civil buildings like the Anglo Palestine Company Bank, the Hijaz Railway Station, and the Old Technion. Entire parts of the city have potential historical and artistic values. One of the more famous and interesting is the Old German Colony near Ben Gourion Avenue. Others include the Arab quarters behind the port, Hadar with several Bauhaus style buildings, streets, and square corners characterized by a high architectural quality.

To preserve and in some case restore the urban quality of such areas, it is necessary to recognize the historical identity of the various urban areas, preserve the original residential tissue, and pay attention to materials and urban arrangement of the external public spaces. Tourists are usually very sensitive to urban civilization and historical identity; they appreciate the continuity between artistic values and local residential tissues and services.

4.6 Transportation

In 1995, Haifa had 950 km of paved roads and 66,647 cars (337.4 vehicles/1,000 people), comparable to Austria (388 vehicles/1,000 people) and Spain (308 vehicles/1,000 people). The urban sprawl and the growth of a metropolitan area around Haifa are increasing traffic. Traffic results from internal trips mainly from the neighborhoods on Mount Carmel and other outer residential areas and external trips.
from the bay towns (180,000 residents) and from a bigger area of influence in the north (about 300,000 residents).

Two national companies provide public transportation: the Egged bus company and the Port and Railway Authority. The railway plays only a minor role in Haifa and more generally in Israel. Even if the bus and railway facilities are connected (the central bus station is connected by a short gallery to the train station), there is no ticket integration between different means of transportation on an urban or metropolitan scale.

Haifa’s small subway, the Carmelit, connects Central Carmel to Kikar Paris downtown in the old city. The Carmelit can carry about 200-250 passengers per trip. There is no intermodal exchange with private transportation and no integration with bus tickets.

Two new bus and train stations are planned to access Haifa’s new developing areas: near the high tech areas in the south of Haifa (shopping center-convention Hall) and in the center bay area (just behind an existing shopping center) along the road from the Checkpost to the Kriots.

4.7 Conclusions and Recommendations

Haifa needs a new master plan and take some steps to improve environmental compensation, EIS, the conservation and renovation of old residential neighborhoods, and public transportation.

1. **New master plan.** The 1967 master plan seems rigid and its objectives remain unclear; therefore, approving modifications takes longer than it should and environmental issues such as landscape are not addressed because they are not clearly specified as key principles. Because of the plan’s age and the variety of projects, Haifa’s population (even in the professional and academic communities) remains unaware of Haifa’s future.

Haifa’s new plan should be prepared with full public participation, consider the entire metropolitan system, and strengthen the roles of Haifa and the adjacent municipalities in the implementation of the metropolitan perspective. The metropolitan area will gain more weight at the national level. In countries with a centralized public administration, local institutions are the main engines of innovation. The effort to accelerate the creation of a metropolitan authority to coordinate and harmonize general national interests with local needs and environmental safeguards has to be done by important and progressive municipalities such as Haifa. Such a plan will also affect investments in public transportation and in sectoral plans (e.g., port and railway) currently in the hands of national authorities.

Haifa’s topographical structure makes the construction of an extensive subway system difficult.
2. **Improved environmental compensation.** The regulations on land and urban transformation and management should promote historical, landscape, ecological, and health values. Parks and historical sites are necessary but not sufficient; a ratio between the impacts of each new infrastructure or settlement project and compensation should be developed. For each project, various options highlighting landscape, ecological or health values should be assessed. All of these regulations on environmental compensation are the necessary complement to urban planning standards. Environmental compensation is not limited to green areas. Attention should also focus on transportation (energy and environmental considerations), water supply, wastewater collection and treatment, and energy (bioclimatic performance of buildings and residential units and use of renewable resources).

3. **Improved EIS procedures.** Procedures and requirements established in EIS (see Chapter 3) or in the master plans are necessary but not sufficient to guarantee full democracy and transparency for the choices leading to land transformations. The municipal authority --the closest institution to the citizens-- must promote and initiate all means to ensure full participation of all relevant stakeholders, thus setting goals and requirements even stricter and more precise than those set by the national law.

Haifa’s municipal and private development projects such as Carmel Beach Towers, Haifa Marina, and the airport extension may change the roles played by various parts of the city. A single project could have negative impacts on others and new developments could marginalize existing neighborhoods. To avoid such impacts, it is necessary to conduct an integrated analysis of the socio-economic and environmental implications at the municipal and metropolitan levels.

Haifa also needs to strengthen coordination between local and national programs. EIS of local plans and national programs with strong influence on land use and environment will allow Haifa to reach the best long-term environmental equilibrium. Given the undervaluation of scarce coastal land resources, strict EIS procedures should be required for each new development project in coastal areas. Environmental compensation should be extended to ordinary building activity (depending on the impact) according to defined rules and the general plan for land use. EIS should avoid wasting land between areas of different uses and around parcels and promote physical continuity of the non-built areas (mainly the green valleys) by integrating these areas in the urban environment and not considering them as a “by-product” of built areas. Haifa (either the municipality or private developers) must use legal (through building licenses) and financial means (through bank assurances) to manage external areas and borders, especially near roads and land parcels.

4. **Improved conservation and renovation of old residential neighborhoods.** The housing problem depends on the area of the city and the social level. While the middle and higher classes move to the new residential areas between the green valleys up on the Carmel, some of Haifa’s lower parts suffer from inadequate urban maintenance and the population decreases or moves away. This process leads to
degradation and loss of dwelling units. To resolve this housing problem, Haifa should:

- Promote public programs and incentives to add new dwelling units to the old neighborhood, after improving services;
- Improve the urban quality in the old quarters to keep residents;
- Extend regulations on building materials, external areas, and public space from single historical buildings to urban areas;
- Improve the conservation and renovation of residential units;
- Shift from expansion to urban renewal and maintenance; and
- Improve landscape and historical sites preservation, within the legal framework and general rules of the master plan.

5. Improved public transportation. The urban sprawl and the growth of a metropolitan area around Haifa are increasing traffic. Although the central bus station is connected by a short gallery to the train station, there is no ticket integration among various means of transportation on an urban or metropolitan scale. There is no intermodal exchange between the Carmelit subway and private transportation and no integration with bus tickets. To improve public transportation, Haifa should:

- Improve the use of trains and buses by increasing frequency, adding new routes (between residential areas and railway lines and stations and between downtown and the Carmel ridge), promoting intermodal exchange, and integrating programs, fares, and timetable;
- Extend the Carmelit subway to the Central Bus station and the Ahuza area;
- Increase national subsidies to reduce fares for public transportation through all-day bus tickets and free transfer between lines and for connections with the Carmelit subway and suburban trains; and
- Develop infrastructure (e.g., Carmel Tunnel) for reducing traffic through the city.
5. NATURAL RESOURCES AND ECOSYSTEMS

Haifa’s 6 km² of parks are well preserved and form a system interconnected with the Carmel National Park and the continuous farmland in the Kishon floodplain. Haifa’s large green areas (25 m² per person) do not completely fulfill their social function; children and old people cannot access many of them because they are too steep. New areas could be created in the floodplain and the mouth of the Kishon, once the Kishon is rehabilitated.

Strengthening the enforcement capabilities of responsible institutions and creating a system to monitor effluents and prevent the discharge of non-complying effluents would improve the Kishon water quality. Given the importance of the effluent from the wastewater treatment plant --80 percent of all of the effluents discharged into the Kishon, the Nesher ponds could be used as an artificial wetland that would provide a buffer between the Kishon and the wastewater treatment plant.

The Kishon River Authority (KRA) is preparing a master plan whose goals are to (1) achieve an undisturbed aquatic life habitat along the river from the Baruch reservoir to Haifa Bay and (2) restore the riparian ecosystem. KRA and the Kishon Drainage Authority are working together on a flood prevention strategy that will be coordinated with the Kishon’s rehabilitation project.

At the intersection of four phytogeographic and zoogeographic zones -- Mediterranean, Irano-Turasian (steppe), Saharo-sindic, and Sudanese, Israel has a rich variety of plant and animal life. Over 2,600 species of plant life, 454 bird, 128 mammal, 8 amphibian, and 106 reptile species exist or have existed in Israel.

Haifa has a rich biodiversity due to its special location around and on Mount Carmel and its topographic and lithological variety. The flora is almost entirely Mediterranean. The Municipality and the Carmel National Park have about 1,500 plant species (more than half of the total number in Israel, most of them annual and perennial herbs) over 147 km², while Rome’s inner part has only 1,200 plant species over 360 km². Mount Carmel is phytogeographically significant because it is the southern limit of many arboreal and herbaceous species. Plants in Mount Carmel’s natural landscape include: Ceratonia siliqua - Pistacia lentiscus association, the evergreen oak Quercus calliprinos together with Pistacia palestina, and Pinus halepensis - Hypericum serpyllifolium.

Haifa’s most important ecological systems include:

- Urban valleys;
- Small wetlands and ponds around the Checkpost and the Sahadia Spring;
- Carmel National Park;
- Haifa Bay; and
- Kishon river and its floodplain, especially the agricultural area belonging to the Kibbutz.

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30 The survey in Rome did not consider the entire territory (nearly 1,200 km²), but only the urban developed area within the beltway surrounding the city.
The next five sections describe each of these systems, the sixth section presents the institutional and regulatory framework, and the seventh and last section presents conclusions and recommendations.

5.1 Urban Valleys

Topography influences deeply Haifa’s layout: from transportation systems up to residential expansion and green space. In the beginning, a propensity toward flat areas leads to settled areas in the lower city. Then the city “moves” up on the Carmel, creating a chain of isolated neighborhoods on the ridges, while the valleys often with very steep slopes remain non-built creating a network of green areas, important for the city’s ecological health. Most of the valleys have been declared natural reserves and improve the urban biodiversity and microclimate. Haifa has more than 6 km² (about 10.4 percent of the municipal territory) of parks and other green areas, less than most European cities (see Table 18).

<table>
<thead>
<tr>
<th>City</th>
<th>Population</th>
<th>Total area (km²)</th>
<th>Green area (% of total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haifa</td>
<td>250,000</td>
<td>59</td>
<td>10</td>
</tr>
<tr>
<td>Barcelona</td>
<td>1,635,67</td>
<td>99</td>
<td>9</td>
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<tr>
<td>Brussels</td>
<td>951,217</td>
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<td>Hannover</td>
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<tr>
<td>Prague</td>
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<td>Rennes</td>
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<tr>
<td>Zurich</td>
<td>365,043</td>
<td>92</td>
<td>24</td>
</tr>
</tbody>
</table>

Source: Europe’s Environment Statistical Compendium 1995

The Carmel National Park and the farmland in the Kishon floodplain are not within Haifa’s municipal borders. From an ecological viewpoint, these areas are closely connected to Haifa: they are physically linked with the green valleys in the urban context and preserve the continuity of the green system between extra-urban and urban areas. If only a small section of the Carmel National Park (88 km²) were regarded as part of the municipality of Haifa, the green area in Haifa would be much larger than in most European cities.

The green valleys improve the quality of life by giving the perception of a pleasant city (see Box 6); this is an important social aspect, as many studies have already proved. In Haifa, most of the 6 km² of open area are public, while green areas in many European cities are private; available green space per person (around 25 m²) is

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higher than in Europe (less than 2 m\(^2\) in Madrid to 7 m\(^2\) in Paris and 17 m\(^2\) in Moscow). Children and old people cannot, however, access many of the city’s green valleys because they are too steep.\(^\text{32}\)

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**BOX 6**

**IMPORTANCE OF OPEN SPACE IN CITIES**

From the very onset of urban culture, a great importance has been attached to non-built areas. The ancient cities already reserved great parts of their area to parks and gardens. The value of open spaces within the urban fabric is increasingly been rediscovered. Open space includes various green areas, such as formal and informal parks, remnants of natural systems along watercourses; agricultural land, private gardens, urban public spaces such as city squares and areas around cultural monuments, and habitats developing on unused land such as industrial sites. Spatial planning systems, through development control powers, are the main mechanism to keep these spaces open. Local authorities are increasingly trying to set minimum targets for open space in land use plans. All open space should be viewed as an integral part of the natural framework within which all built development is set, rather than simply the “space left over after planning.”

Until now, open space has been retained because of its social functions (i.e., meeting places, areas of entertainment, recreation, and relaxation) and its amenity value (i.e., quality of life, aesthetic enjoyment, feeling of security and freedom from the urban noise and pollution). The new emphasis in sustainability is to maximize the ecological role of open spaces within the urban fabric while maintaining its amenity and social functions, i.e.; multi-use of open spaces. Open green space fulfills several ecological functions:

- buffer air pollutants, an essential function of vegetation;
- manage storm water and control non point water pollution due to urban runoff;
- create a better microclimate, especially in hot and dry countries like Israel;
- conserve urban biodiversity, even though the city is mainly shaped by an artificial landscape created by man, it is an ecosystem where a great number of animal and plant species interact with each other and with the physical environment.

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**5.2 Urban Wetlands**

One of the amazing aspects of the nature in Haifa is the large number of birds along the road to the Checkpost, one of Haifa’s most urbanized areas. There are many seagulls --attracted by the landfill-- or the common species of the order of Passeriformes, widespread in urban areas. Several species of the orders of Pocipediformes, Pelecaniformes, Anseriformes, Ciconiformes, and Falconiformes are still nesting in the area of the mouth of the Kishon, or spending there some months in the winter or the summer, after migrating from the north or the south. This is due to:

- the remaining small winter ponds between the railway and the main road;
- the Sahadia Spring and the channel to the Kishon river; and
- the Kishon river itself, an important wetland for wildlife conservation despite its heavy pollution.

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\(^{32}\) Meeting with Orna Haril Peleg of the Long Term Planning Department of Haifa’s municipality.
These areas, although heavily degraded, play an important ecological and social role.

5.2.1 Ecological function

These small zones represent what is left of large wetlands that once covered the area of the mouth of the Kishon, probably a succession of freshwater ponds and salt marshes. In the past, these areas were used as resting zones by the migratory fauna; in recent years, most of them have been dried up for agriculture and urban use. Despite the reduction of these ecosystems throughout the world, many migratory birds still use them, although they are in highly urbanized areas. In 1971, the International Union for the Conservation of Nature established the Ramsar Convention to protect remaining wetlands.

5.2.2 Social function

These small natural ecosystems in the urban area are important for education. They show how nature and man can share a common environment and how, even in a highly urbanized area, a careful management of natural resources can partially preserve the original characteristics of the natural environment. People, especially children, can easily access these areas near the center of Haifa; they provide a good opportunity for environmental education.

5.3 Carmel National Park

The role of nature and recreational areas becomes even more important at a metropolitan scale. The Carmel National Park, the sea and the coastal zone, the remaining open areas in the Kishon floodplain, and the hills east of Tivon create a rich semi-natural system rarely seen in Israel and in other Mediterranean cities. The British Mandate acknowledged the importance of Mount Carmel as a nature site by preserving its forest. In the early 1950s, Israel recognized its uniqueness and its ability to attract recreationers; the Knesset declared the area a National Park. This declaration underscores the importance given to Mount Carmel at the national level.

The park covers 88 km² from Haifa’s Danya neighborhood in the north to Moshav Elyaquim in the south, from the slopes and agricultural lands of the Carmel Coast in the west to Kibbutz Yagur and Yoqneam in the east. There are four access routes to the park from Atlit, Nesher, Elyaquim, and Haifa. The park’s landscape and natural formation are not homogeneous. There are several different activity areas and a wide range of land uses. It contains the remnants of human activities from different historical periods.

5.3.1 Current activities

About one third of the park is a natural reserve, essentially a forest preservation area that can only be developed for education, scientific research, and observation. The reserve protects the natural systems from non-natural disturbances, thereby preserving wildlife and flora. The aim is to minimize the contact between the reserve and the
outside world, prevent qualitative changes in the character of the area and its landscape, whether the landscape is essentially undisturbed or results from man’s interference. The remaining parts of the park can be developed for entertainment, visiting, and recreation.

The problem, as is the case in protected areas located in highly urbanized territory, is to find an appropriate balance between the preservation of the park and its development. There is a conflict between recreational needs and preservation. To preserve the feeling of enjoying the nature without destroying it, the number of visitors to the park must be reduced, development prevented, and easy access discouraged. Over-development will destroy the natural systems and complete preservation will seriously limit the number of people using the park. Thus, the development of the park is being carefully undertaken.

The park offers a wide range of activities: picnics and recreation near camping areas, walking-trips along hiking trails and routes with scenic views, motorized trips in vehicles designed for educational tours and active recreation. There are 80 km of recreational and picnic routes and 50 km of walking trails. Currently, more than 2 million people visit the park each year; in 2000, this number should reach 2.5 million. On spring and summer Sabbaths, the number of visitors exceeds 20,000; on a winter Sabbath, there are 10,000 visitors; and on holidays, there are more than 50,000 persons. In the winter, the most common activity is hiking; in the summer, typical activities are picnicking and recreation near the camping areas.

The Carmel National Park is a national asset that cannot be replaced. Those who initiated its establishment saved it from being lost and preserved its landscape from damage caused by construction and other uses. Many urban development plans were stopped to establish the park. The park’s administrators and planners confront many struggles and controversies; they continue to develop the Park as an open recreation area for a growing urban population, while preserving its natural value.

5.3.2 Biosphere reserve

While none of Israel’s reserve is large enough to preserve the entire ecological systems encompassing a variety of habitats, an exciting initiative may pave the way toward declaring the Carmel National Park and Nature Reserve a biosphere reserve. Monitoring and research activities are implemented by the National Reserve Authority, within the framework of a three-year agreement between Germany and Israel.

After the devastating fire that hit the heart of the Carmel National Park in September 1989, major long-range planning issues on the management of the park surfaced. A specially-appointed expert committee, chaired by MOE’s chief scientist, studied the development and restoration of the park. During workshops and deliberations, the concept of a biosphere reserve was first raised, and an attempt was

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33The Environment in Israel, Ministry of the Environment, Jerusalem, 1994, page 141.
made to introduce long-range planning considerations related to climate change and the sensitivity of Mediterranean ecosystems to desiccation.

In a biosphere reserve, nature conservation and development are managed sustainably in cooperation with users of the area. This is achieved by dividing the reserve into three zones: (1) a core with strict conservation regulations; (2) a buffer with active conservation management practices, outdoor leisure, educational activities, and scientific research; and (3) a transition where the infrastructures for tourism, education, and scientific research are located and where the human population is concentrated.

The Mount Carmel Biosphere Reserve would cover nearly 500 km² encompassing the mountainous area of the Carmel, the coastal plain, and the seashore. The major objectives of the proposed reserve are:

- Conserve natural biological resources;
- Provide channels for sustainable development;
- Use a living, outdoor laboratory in reconstruction ecology; and
- Develop a model for a new global concept - a climatic transition zone biosphere reserve.

### 5.4 Haifa Bay

Haifa Bay’s degradation is mainly due to the Kishon river (see Section 5.5), main source of pollution to the bay. The mercury pollution from a chloralkali plant that has been discharging its effluent into the bay since the mid-1950s has been reduced drastically since 1976, after the plant installed pollution control equipment. The port and the ship traffic also contribute to pollution of the bay; the Kishon river, main source of pollution, brings eutrophication and algal blooms, the bay’s main pollution problems. Currently, the pollution of the bay does not seem to affect the quality of the water for swimming. If the effluent of the industrial area were to be discharged after treatment directly into the sea, it might be endanger the bay ecosystem.

#### 5.4.1 Water quality

The major source of information on Haifa Bay’s environmental condition is a study conducted jointly by Israel and Danish companies and funded by the European Investment Bank (EIB). According to the EIB study (Box 7), the bay’s water is well oxygenated and the surface water is oversaturated with dissolved oxygen. Oversaturation reached maximum values (up to 182%) at sites where plankton bloom was identified. The pH was normal for seawater, with the exception of the bloom sites, where the values were higher than normal. O-phosphate concentrations in most of the bay (especially in the Kishon estuary) were higher (sometimes by two orders of

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34 Study on improving the quality of water in Haifa Bay and the Kishon River, European Investment Bank, HDEAM 1996, Tahal Consulting Engineers, Israel Oceanographic and Limnological research Ltd., Danish Hydraulic Institute, Water Quality Institute, Hostrup-Shultz & Sorensen.
magnitude) than in open waters of the eastern Mediterranean Sea. The concentrations of nitrogenous nutrients (nitrate, nitrite, and ammonia) and chlorophyll-a ranged from low levels, similar to those in the surface layers of open waters of the eastern Mediterranean Sea, to very high levels, up to one order of magnitude higher than in open waters. The highest concentrations of chlorophyll-a were not always continuous. On various occasions, dark patches (limited diameter of about 15 m) with high concentrations were observed.

5.4.2 Sediments

Sediments in Haifa Bay’s northern part contain high mercury levels (up to 1 ppm). Mercury contamination is due to a chloralkali plant that has been discharging effluents into the bay since the mid-1950s. The mercury content in the sediment increases close to the plant outfall; the dominant area of contamination extends approximately 3 km to the north and south of the factory outfall, and about 1 km offshore, to a water depth of 12 m. The amount of mercury discharged was drastically reduced in 1976, after the plant installed pollution control equipment. Current discharges of mercury into the bay are about 35 kg/yr, down from 1,900 kg/yr in 1975. The cumulative discharge of mercury from this plant to the bay is about 20 tonnes.

The sediments opposite the Kishon estuary are contaminated by heavy metals (Hg, Cd, Cu, Pb, Zn, and others) introduced by river-borne sediment particles. The level of contamination in this area varies seasonally.

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**BOX 7**

**EIB STUDY**

In 1993, HDEAM initiated a study on improving the quality of the water in Haifa bay and in the Kishon River. The study had four objectives:

1. Assess the existing environmental situation of the Kishon River and the Haifa Bay and develop a mathematical model to determine qualitative and quantitative limits of pollution discharges;

2. Make proposals on the adaptation of environmental legislation and standards and identify the major sources of existing pollution incompatible with the recommended standards;

3. Assess the physical requirements to reduce the risk of future flooding (including the dredging of polluted river sediments) and make recommendations for the environmentally safe disposal of such material; and

4. Assess the economic justification of intended actions and identify measures including appropriate wastewater tariffs needed to provide potential polluters with incentives to avoid polluting.
The 510,000 ECU study was financed by the European Investment Bank within the METAP program. The study started in 1994 and was completed in 1996; it was managed by HDEAM and performed by: Tahal Consulting Engineers Ltd., Israel Oceanographic and Limnological Research Ltd., Danish Hydraulic Institute in Association with Water Quality Institute, and Hostrup-Schultz & Sorensen.

The study’s main recommendations are:

- Treat wastewater before discharge to the river (instead of building marine outfalls); it will provide an acceptable water quality of the river and improve the condition in the bay. Wastewater treatment should be combined with the use of clean technologies; and

- Dispose of the polluted sediment from the river in an environmentally safe, land-based disposal site. Polluters should pay the cost of disposal, according to the quantities of pollutants discharged. New effluent standards are recommended so that future sediments will be less contaminated.

5.4.3 Fish

Although Haifa Bay receives all of the effluents from the bay’s heavy industries, it also serves as a fishing ground for fishermen from the Acre and Kishon ports. Haifa Bay is unique along the Israeli coast with extensive rocky ridges sheltering rich benthic associations. Although extremely important to fisheries and of great scientific interest, the biota of the rocky substrate of Haifa Bay has not been intensively studied. Four hundred benthic species were collected on the soft substrate of Haifa bay, many of them Indo-Pacific immigrants. Forty-three fish species were collected on the coralligenous bottom just outside the bay. Eleven of them were of Indo-Pacific origin.

Haifa bay fishermen use trawling and purse seining in the sandy and muddy areas and artisan fisheries, including longlines, trammel nets, and gill nets on both hard and soft bottoms. The artisan fishery and the trawling supply highly valuable fish and crustaceans, in terms of price per kg. According to the annual bulletin of fisheries statistics prepared by the Fisheries Department of the Ministry of Agriculture, Haifa Bay’s commercial catch is about 400 to 600 tons per year.

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35 See Section 5.4.6 of the EIB study.

36 Since the opening of the Suez Canal, the Levant basin has been accessible to Indo-Pacific fauna. Ecological, geographical, and historical factors have favored the success of the colonization process. According to the EIB study, nearly 300 species (many of them of great commercial importance) have established themselves on the Israeli coast.
Trace metals (Hg, Cd, Cu, Fe, Mn, and Zn) in inshore and offshore fish throughout the bay and in benthic organisms of the shallow sandy strip have been regularly monitored since 1975 and 1980, respectively. The levels of trace metals are normal, except for mercury, higher in shore fish in the bay as well as in benthic fauna near the chloralkali plant. Mercury in fish and benthic fauna has markedly decreased since the installation of wastewater treatment facilities at the plant. The levels of mercury in the biota near the plant are higher, however, than in the same species along the coast. Although mercury levels are still not normal, all the fish checked have less than 1 ppm Hg (US-EPA standard) and are therefore safe for human consumption. The mercury content in the muscle of Diplodus sargus (standard weight of 150 g) indicates that the level of mercury in the bay, although higher than normal, is now acceptable.

5.5 Kishon River and Floodplain

The Kishon river is certainly one of Haifa’s major environmental challenges. It has both an ecological and a socio-economic value, as it flows across an urban area of crucial importance for Israel’s future development. The Kishon’s main problems are:

- **Water quality**: as it flows across Israel’s largest industrial area, it has become Israel’s most polluted river. The water quality downstream prevents aquatic life and consumption for human use. The sediments of the river are heavily contaminated with toxic compounds and other pollutants. Upstream, water quality is also poor: the benthic community lacks oxygen due to domestic sewage, agricultural pollution, and abnormally high salinity.

- **Flooding**: the risk of flooding has long been known; according to a 1976 report, the river will overflow once every five years. In 1992, heavy rain flooded 500 hectares --settlements like Kiriat Bialik or Kiriat Ata and infrastructure like Histadrut Boulevard-- with more than one meter of water. Studies have been conducted and action has been taken to increase the river capacity. Until now, however, efforts have focused on the last few kilometers of the river; no study has ever been conducted at the watershed scale. Attention should focus on alternatives to reduce runoff, dilute the flow peak in a longer time, increase the buffering capacity of the watershed for nutrients and salts, decrease soil erosion and the amount of sediments in the water, and rehabilitate the riparian ecosystem.

- **Degradation of banks and ecosystems**: the riparian ecosystems along the Kishon have been greatly altered over the past years. The withdrawal of water for human use, the reclamation of land for farming --crops often encroach on the land up to the very edge of the river-- water salinization and pollution, and the modification of the river channel and its meanders have seriously damaged --probably irreversibly-- the river and its banks. Nevertheless, much can still be done to improve the quality of the river for

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37 The Northern Kishon River, from the Jalame Bridge to the sea, Master Plan by TAHAL, Water Planning for Israel, October 1976.
leisure and partially restore a riparian zone and a river ecological community by creating riparian flooded areas, a two stage riverbed, and buffer stripes riparian zones.

5.5.1 Water quality

**Lower Kishon:** the Kishon has the highest values of Biological Oxygen Demand (BOD), ammonia, and suspended solids in Israel (see Table 19).

<table>
<thead>
<tr>
<th>TABLE 19</th>
<th>WATER QUALITY IN SELECTED RIVERS IN ISRAEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>River</td>
<td>BOD</td>
</tr>
<tr>
<td>Kishon</td>
<td>61</td>
</tr>
<tr>
<td>Alexander</td>
<td>4-15</td>
</tr>
<tr>
<td>Yarkon</td>
<td>1</td>
</tr>
<tr>
<td>Zippori</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Source: Israel Environment Bulletin

More recent data show that the levels of pollutants in the Kishon are several times above the limits of the 78/659 European Directive for the protection of aquatic life (see Table 20). Concentrations of BOD and suspended solids in the Kishon are even higher than the limits for effluents from wastewater treatment plants in Europe -- CEE 91/271 limits BOD to 25 mg/l and suspended solids to 35 mg/l.

<table>
<thead>
<tr>
<th>TABLE 20</th>
<th>WATER QUALITY IN THE LOWER KISHON (BAILEY BRIDGE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>pH</td>
</tr>
<tr>
<td>11/94</td>
<td>5.7</td>
</tr>
<tr>
<td>4/95</td>
<td>5.8</td>
</tr>
<tr>
<td>5/95</td>
<td>5.8</td>
</tr>
<tr>
<td>11/95</td>
<td>3.9</td>
</tr>
</tbody>
</table>

Source: Kishon river and tributaries: ecological and environmental survey within the boundaries of the Kishon River Authority, Gasith A., Kleinhaus S, 1996.

The pollution of the lower Kishon is not limited to water quality. The Haifa industrial area discharges large quantities of chemical compounds and heavy metals that deposit on the sediments. For this reason, the EIB study (see Section 5.4) focused on the contamination of sediments. Trace metal contamination in the sediments of the lower Kishon was first observed in 1973. Systematic studies in Haifa Bay during the 1980s indicate that the Kishon is a major contributor of trace metals to the sediments of
the southern part of Haifa. In the lower Kishon, concentrations of mercury, cadmium, zinc, copper, and other metals in almost all samples are higher than in the upper Kishon, sometimes by two orders of magnitude. Elements from the natural environment, such as aluminum and iron, do not show major differences between the lower and upper Kishon. There are high concentrations of phosphorus and sulfur downstream of the Deshanim fertilizer plant. Organic carbon concentrations in the sediments are lower in the upper Kishon (less than 2 percent) than in the lower Kishon (up to 14%).

Upper Kishon: if the lower Kishon is seriously polluted, the upper Kishon (from Haifa’s industrial zone to the end of the area managed by the Kishon River Authority) is not much better. Table 21 shows some water quality parameters recently analyzed at the station of Kefar Hasidim Road, next to the end of the area managed by the Kishon River Authority. These values are high and often incompatible with aquatic life. Only one sample had acceptable concentrations of dissolved oxygen. Ammonia and BOD are always very high and suspended solids are even higher than the 35 mg/l limit for effluents from wastewater treatment plants in Europe.

Our biological assessment of the benthic community confirmed the poor quality of the Kishon in two sampling stations upstream of the Haifa Industrial zone: one just downstream of the Kefar Hasidim road and another one just downstream of the Turkish bridge.

<table>
<thead>
<tr>
<th>Date</th>
<th>pH</th>
<th>Dissolved Oxygen (mg/l)</th>
<th>BOD</th>
<th>Phosphate (mg/l)</th>
<th>Chloride (mg/l)</th>
<th>Ammonia (mg/l)</th>
<th>Suspended Solids (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.94</td>
<td>7.6</td>
<td>0.4</td>
<td>123</td>
<td>11.6</td>
<td>783</td>
<td>55.4</td>
<td>817</td>
</tr>
<tr>
<td>11.94</td>
<td>7.8</td>
<td>7.4</td>
<td>23</td>
<td>1.5</td>
<td>980</td>
<td>3.6</td>
<td>111</td>
</tr>
<tr>
<td>4.95</td>
<td>7.9</td>
<td>14</td>
<td>14</td>
<td>99</td>
<td>772</td>
<td>2.0</td>
<td>72</td>
</tr>
<tr>
<td>11.95</td>
<td>8.0</td>
<td>3.3</td>
<td>18</td>
<td>7.3</td>
<td>838</td>
<td>6.7</td>
<td>284</td>
</tr>
<tr>
<td>Maximum levels of pollutant concentration for aquatic life</td>
<td>6-9</td>
<td>5</td>
<td>9</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Kishon river and tributaries: ecological and environmental survey within the boundaries of the Kishon River Authority, Gasith A., Kleinhaus S, 1996.

Biological assessments are essential tools for detecting aquatic life impairments and assessing their relative severity. Unlike chemical assessments, biological assessments integrate water quality over a longer period of time and thus better reflect the general ecological conditions of a watercourse. Most assessment methods for running water are based on community structure analysis and use biological indicators characteristic of a certain degree of pollution. Biological indicators of water quality may belong to several taxonomic groups. For running water, the biological communities are plankton, periphyton, microphytobenthos, macrozoobenthos, aquatic vegetation, and fish. Numerous intercalibration exercises and European meetings have clearly demonstrated that the most successful assessment methods are based on benthic
macroinvertebrate communities. These methods express the water quality in an index or a score.

To obtain such a number, however, the method must be calibrated according to the ecological conditions of the biogeographical area of study. Such an in-depth analysis was beyond the scope of this audit. We present the sampling results of the structure of the benthic community without any number index.

In the first station, we detected a consistent community of *Chironomus thummi* and other organisms of the *Chironomidae* family. The station environment was characterized by numerous bacterial filaments and sediments of fine anaerobe. The lack of other *Diptera* families and other taxonomic groups, even those tolerating pollution, such as *Mollusca, Crustacea, Oligocheta*, show serious pollution.

In the second station, the water stream is rapid and dissolved oxygen is likely to increase due to turbulence. We detected four taxonomic groups that tolerate pollution: three families of *Chironomidae, Simulidae*, and *Ceratopogonidae dipterans* and a family of *philum Oligocheta* (*Tubificidae*). The benthic community appears to be very poor.

A river with a similar benthic community in northern Mediterranean countries would get the lowest quality rating (five for a heavily polluted river). To verify whether the structure of the benthic community was due to any particular ecological and zoogeographical features of the area or to abnormal salinity, we spoke with Dr. Shani Kleinhaus, ecologist and consultant to the Kishon River Authority. She reported that other rivers with high salt concentrations showed better conditions of the benthic community. Moreover, the list of taxa of invertebrates living along the Kishon in natural conditions showed a much richer potential for a benthic community than what was found. According to Dr. Kleinhaus, the poor benthic community may be due more to periodic failures of the wastewater treatment systems of the small settlements in the area (e.g., military zones) than to salinity.

### 5.5.2 Flooding

The Kishon river watershed is about 1,100 km² and includes the northeastern flank of the Carmel mountains, the Yzreel Valley, and the upper Galilee to the north. It is divided into three main sub-watersheds: the eastern basin that flows into the Kefar Baruch Reservoir, the upper river (from the Kefar Baruch Reservoir up to where the

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39In such a sublayer (medium size rocks and gravel), under normal conditions, there are larva of many varieties of insects such as *Ephemeroptera, Tricoptera*, and *Coleoptera*.

40Kishon river and tributaries: ecological and environmental survey within the boundaries of the Kishon River Authority, Gasith A., Kleinhaus S., 1996.
Tsipori river meets the Kishon), and the lower river (from the junction with the Tsipori to the estuary into the Bay, including the Tsipori and the Gedora river watersheds).

Most of the water from the watershed upstream of the Kefar Baruch Reservoir is currently used for farming. The Kefar Baruch Reservoir, formerly used to store water for farming, is not used today due to the excessive salinity of the water and the land. A network of deep drainage pipelines was built to drain the salt water in the area; most of the water flowing into the Kishon comes from this network. According to the Organization for the River Rehabilitation in Israel, the average flow of the Kishon downstream of the Kefar Baruch Reservoir is about 2.5 million m$^3$ per year; the Kishon's full rehabilitation requires 17.5 million m$^3$ per year.

The Kishon’s main hydrometric station is in Jalame, where the Yizreel valley narrows to a width of about 1 km, before it widens again in the alluvial plain of the Zevulun valley. The values of the Jalame station show high flows in January and February and low flows from June to October. The high flow reaching the Zevulun valley often causes flooding. In the 1991/92 winter, the lower Kishon flooded four times; the worst flooding occurred on 25-26/2/1992, causing $50 million of damage in the Zevulun valley. The flooding prompted numerous studies by consultants to the Zevulun Drainage Authority. The EIB study has reviewed these studies. The studies assessed the highest flow at the end of the watershed, where the Kishon flows into Haifa Bay. The EIB Study reviewed the method to calculate the peak of the highest flood downstream of the Jalame Station --between 300 and 424 m$^3$/s, depending on further urban development of the Zevulun Valley and the resulting increase in surface runoff.

The studies recommended enlarging the river to increase its capacity to receive high flows and to speed up water discharge into the bay. This flood prevention approach, quite popular from the 1950s to the 1980s worldwide, is now criticized for its negative impact on the river ecosystems and for its failure to reduce flooding: raising the speed of water runoff increases the flood peaks and generates flooding just downstream of the enlargement.\(^\text{41}\)

Although enlarging the end of the Kishon would not create downstream problems, it may not be necessary and the costs and benefits of other solutions involving greater environmental and economic benefits should be assessed.

A river’s ecological functions depend on the interaction of the different parts of the ecosystem: a river is a complex system formed by the flowing water, the physical and chemical conditions of the water and riverbed, the physical and biological conditions of river banks and particularly of the riparian vegetation. Riparian forests effectively control non point source pollution in several types of watersheds. Riparian forests also control the physical and chemical environment of streams and provide wood debris for streams and near shore water bodies (Box 8). The virtual total lack of riparian vegetation is certainly one of the causes of poor water quality in the upper Kishon. The riparian ecosystem of the Kishon is badly preserved. Upstream of the industrial area,

some parts of the river are lined with willows. The riparian vegetation is limited to a narrow strip of Tamerix and herbaceous vegetation.

5.6 Institutional and Regulatory Framework

This section presents the institutional and regulatory framework for nature conservation and river rehabilitation.

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**BOX 8**

**BENEFITS OF RIPARIAN FOREST**

The riparian environment is particularly important because it:

- provides diverse habitat for terrestrial and aquatic wildlife, corridors for wildlife movement, and organic matter to watercourses;
- controls temperature in the water body through shading;
- works as a buffer for soil erosion and non point source pollution; and
- enhances the visual quality and amenity of the landscape.

A rich and natural vegetation along rivers and streams allows several ecological functions. Riparian buffer zones control the stream environment: temperature and light, habitat diversity, channel morphology, food webs and species richness. All of these factors are important to the ecological health of a stream and are best provided by a riparian forest ecosystem similar to the original native vegetation.\(^{42}\)

Riparian forests also work as a buffer against pollution transported through surface runoff or shallow ground water. Riparian forests control sediment and sediment borne pollutants, a big problem in the Kishon that has high levels of suspended solids. Properly managed forests should provide a high level of control of sediment and sediment borne chemicals regardless of the physiographic region. Natural riparian forest studies indicate that forests are particularly effective in promoting co-deposition of sediment as water infiltrates and in filtering fine sediments.

Riparian forests control nitrate in shallow ground water. When ground water moves in short, shallow flow paths, the removal of nitrate is nearly 100 percent. By contrast, nitrate removal may be minimal in areas where water moves to deep ground water: the degree to which nitrate (or other groundwater pollutants) will be removed in riparian forests, depends on the proportion of ground water moving in or near the biologically active root zone and the residence time of ground water in these biologically active areas.

Riparian forests also control dissolved phosphorus in surface runoff or shallow ground water. Control of sediment borne phosphorus is generally effective. Although most phosphorus is transported with sediment, dissolved phosphorus can substantially contribute to total phosphorus. All of the soluble phosphorus is generally bioavailable, making the potential impact of dissolved phosphorus greater for

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\(^{42}\)Richard Lawrence of USDA-ARS, communication at the international Conference on Buffer Zones: their processes and potential in water protection, Oxford, September 1996.
each unit of phosphorus reaching the water bodies. To effectively retain phosphorus, riparian forests must be properly managed.

5.6.1 Nature conservation

The 1963 National Parks and Nature Reserves Law first provided the legal structure for protecting natural habitats, wildlife, and sites of historic and architectural interest in Israel. Under the law, two authorities were created: the Nature Reserves Authority under the Ministry of Agriculture and the National Parks Authority under MOE. Sites designated for protection are declared by the Ministry of the Interior, after consultation with the relevant ministries (Environment, Agriculture or Defense).

In 1992, an entirely updated version of the law was enacted - the National Parks, Nature Reserves, National Sites and Memorial Sites Law. The new version broadens MOE’s authority within the National Parks and Natural Reserves Council who decides on policy issues. It protects areas designated in the national master plans as national parks and natural reserves but not yet declared and developed as such, and prohibits damage, trade, and commerce in protected natural assets.

The 1926 Forests Ordinance authorizes the Minister of Agriculture to declare forest reserves and closed forest areas.

The 1965 Streams and Springs Authority Law allows the establishment of streams authorities. These authorities are responsible for preserving landscape and nature along streams and preparing these areas as gardens, recreation, and sports, as long as they are not included in an area protected under the National Parks, Natural Reserves, National Sites and Memorial Sites Law.

The administrative and legal framework also offers other opportunities for protecting green areas and biodiversity. The planning hierarchy consists of a national level (national outline schemes), a regional level (six district planning and building commissions), and a local level (about 100 local planning and building commissions). Local plans may define areas to be protected for their ecological and social importance (see Chapter 4).

5.6.2 River rehabilitation

In Israel, all water resources belong to the state. Management decisions on water withdrawal and supply rest with the Water Commissioner who reports to the Minister of Agriculture. MOE is responsible for pollution prevention and the Ministry of Health for the quality of drinking water. The Ministry of the Interior, local authorities, and a few other bodies have subsidiary roles.

The Water Commissioner allocates water to local authorities and other large users. Local authorities are responsible for developing, maintaining, and operating the water supply systems within their jurisdiction. This includes metering residential, public, commercial and industrial use, levying progressive water charges, and publishing information to encourage efficient use.

The Water Commission has two main operational arms: Mekorot, a public corporation responsible for the water supply infrastructure, and Tahal, a government corporation responsible for overall planning and design.

The 1959 Water Law establishes a framework for controlling and protecting Israel’s water resources. In 1974, a Committee proposed to classify Israel’s water bodies into four categories based on potential uses and specified corresponding quality requirements; there was no water quality class for aquatic life. These proposals did not achieve legal status.

In 1996, the Kishon River Authority (KRA), in cooperation with MOE, established a professional advisory Committee to determine the Kishon’s water quality targets. These targets are almost as stringent and in some cases (i.e., Cu and Pb) more stringent than the EU aquatic life parameters (see Table 22). These targets should restore the Kishon to a state of undisturbed aquatic life habitat.

### Table 22

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Kishon’s water quality target</th>
<th>EU aquatic life (lowest class)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>pH units</td>
<td>6-5-9</td>
<td>6-9</td>
</tr>
<tr>
<td>BOD</td>
<td>mg/l</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>“</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>“</td>
<td>&gt;5 (24 hours)</td>
<td>&gt;8 (50%) / &gt;5 (100%)*</td>
</tr>
<tr>
<td>NH₄-N</td>
<td>“</td>
<td>1.5</td>
<td>0.2**</td>
</tr>
<tr>
<td>Detergents</td>
<td>“</td>
<td>Below detection</td>
<td>0.2</td>
</tr>
<tr>
<td>As</td>
<td>“</td>
<td>-</td>
<td>0.05</td>
</tr>
<tr>
<td>Cd</td>
<td>“</td>
<td>0.001 (upper Kishon)</td>
<td>0.0002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.01 (lower Kishon)</td>
<td></td>
</tr>
<tr>
<td>Cu</td>
<td>“</td>
<td>0.005</td>
<td>0.04</td>
</tr>
<tr>
<td>Hg</td>
<td>“</td>
<td>0.0001</td>
<td>0.00005</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>“</td>
<td>-</td>
<td>0.2</td>
</tr>
<tr>
<td>Phenolic substances</td>
<td>“</td>
<td>Below detection</td>
<td>0.01</td>
</tr>
<tr>
<td>Ni</td>
<td>“</td>
<td>0.1</td>
<td>0.075</td>
</tr>
</tbody>
</table>

44 The Committee included members from MOE, the Water Commission, the Ministry of Health, the Kishon River Authority’s ecological consultants, the Israel Oceanographic and Limnological Research Institute, the Technion, and the Kishon River Authority.
Until recently, no administrative body was in charge of river protection; this is probably why most of Israel's rivers are heavily polluted and degraded. In November 1993, the National River Administration was established to oversee the restoration of Israel's rivers. The Administration includes representatives of various ministries and green NGOs and coordinates efforts to clean up rivers, restore landscapes, and rehabilitate ecosystems, flora, and fauna.

The National River Administration has created several river authorities, including the Kishon River Authority (KRA), approved in May 1994. KRA’s domain is limited to the lower Kishon, starting at the end of the Jezreel valley up to the mouth of the river. KRA is not very strong: in fact, all of the previously existing administrative bodies are still in force.

The Israeli administrative framework doesn’t have any watershed based authority to coordinate the authorities managing water resources. Each authority is responsible for a single aspect: water withdrawal, distribution, pollution prevention, river ecosystem restoration, land use in the watershed. This administrative framework differs from the European one, where each watershed has a River Authority with the responsibility to design --and the power to enforce-- a Watershed Plan coordinating the different aspects and to guarantee that sectoral plans are compatible among them and with the conservation of the river ecosystems.

5.7 Conclusions and Recommendations

This section summarizes conclusions for the previous sections and presents recommendations to improve Haifa’s green areas, improve water quality in the bay and the Kishon, and prevent flooding.

5.7.1 Improve Haifa’s green areas

The 6 km² of parks are well preserved and guarantee the ecological functions of the urban green areas. Though not very large compared to the total area of the municipality, Haifa’s green areas form a system interconnected with the Carmel National Park and the continuous farmland in the Kishon floodplain. Haifa’s green areas (25 m² per person) do not completely fulfill their social function; children and old people cannot access most of them because they are too steep.

Rehabilitating the floodplain and the mouth of the Kishon provides an opportunity to solve this problem. Currently, the area is degraded by Haifa’s landfill, the random development of the commercial area around the Checkpost, and the pollution of the Kishon. This empty space in the floodplain of the Kishon will be developed for...
commercial and residential uses. Consideration should be given to the creation of green areas and parks for public use. There is already an agreement between KRA, the Municipality, and the Port Authority to create a park on the banks of the Kishon.

Another green area could be created along the Sahadia Canal and the winter pond just between the main road to Tivon and the railway. This area is quite degraded. Part of the winter pond (between the road to Tivon and the railway, just southeast of the Checkpost) is already under construction; another part is unused and could be preserved. At least, a small channel should be preserved to allow water runoff to reach the Kishon, after receiving the water from the Sahadia Spring. Instead of building a concrete channel for urban runoff, some small ponds should be preserved and linked by a channel to operate as a stormwater control, a natural ecosystem, and a recreational area.\textsuperscript{45}

Current regulations may not protect open areas adequately. Population growth due to immigration and demand for high-quality housing will increase pressure for building in open areas. The lack of strong regulations and of a global urban plan may lead to building in open areas. Israel has already confronted this kind of problem.\textsuperscript{46} The valleys within the city limits are zoned for green areas or roads. The permission to turn the valleys into roads is endangering their future status. A law should prevent non-reversible construction in green areas, for the sake of visual impact, photosynthesis, walking trails, etc.

Adequate planning instruments should be included in a Global Urban Plan. For example, the owners of green areas could give their land to the Local Authority in exchange for the right to build in other areas with a lower environmental value. Another example would be to provide private companies with incentives for the economic management of green areas. Chapter 4 provides a more in-depth understanding of urban planning strategies.

We support the enlargement of the Carmel National Park and its transformation into a biosphere reserve, as suggested by the expert Committee specially appointed for the Carmel National Park after the fire of 1989.\textsuperscript{47} Biosphere reserves constitute a network of areas of international ecological importance, acknowledged by UNESCO and other international organizations (IUCN, UNEP); a biosphere reserve is recognized at the international level and an international consensus is needed to modify its land. In addition, the management of the biosphere reserve (division in core, buffer, and

\textsuperscript{45}Urban wetlands for nature conservation and stormwater control, S. Simmons & A. Barker, Nature conservancy council, UK, 1989.

\textsuperscript{46}The Environment in Israel, Ministry of the Environment, Jerusalem, 1994, page 164: “while the National Outline Scheme for Immigrant Absorption provides a positive example of the incorporation of environmental aspects in planning decisions, environmental mistakes were not always avoided in other areas. On the district and local levels, environmental aspects were at times sidestepped as development pressures mounted.”

\textsuperscript{47}The Environment in Israel, Ministry of the Environment, Jerusalem, 1994, page 141.
transition zones) is undoubtedly the most innovative and efficient approach to reconcile biodiversity conservation and economic development.

5.7.2 Improve water quality in the bay and the Kishon

The EIB study carefully considers the environmental impacts of various scenarios to improve the Kishon's water quality: enforce standards on industries' effluents, flush the river with cooling water to dilute the river water, and discharge untreated sewage directly to Haifa Bay, through a marine outfall. The study assesses which scenario is best suited to rehabilitate the Kishon to the lowest quality class --absence of nuisance without human contact. A direct discharge to Haifa Bay through a marine outfall would improve the Kishon, but increase the risk of eutrophisation of the Bay. The only option to reach aquatic life standards is to introduce and enforce quality standards for the local industries and the wastewater treatment plant.

Chapter 7 provides more insight on industrial wastewater treatment and cleaner technologies to reach higher quality standards. The 1959 Water Law already introduced standards on effluents, but they were never enforced. Progress could be made with KRA, in charge of controlling and enforcing the standards. The lack of an adequate working structure and necessary resources, however, is a major obstacle. KRA's staff is limited --only a director, a technical expert, a secretary, and a part-time inspector.

Recently, after an environmental organization sued Haifa Chemicals, an out of court settlement was reached; according to the settlement, Haifa Chemicals will have to comply with new standards, similar to those of the EIB Study (see Chapter 7). Standards are efficient only if the authority in charge of compliance can shut down the plant if its effluents exceed the standards.

Four conditions must be met to improve the Kishon’s water quality:

- The plants pretreat their liquid wastes according to effluent standards;
- Discharge of effluent above the standards is strictly prohibited;
- A monitoring system continuously analyzes effluent quality; and
- Effluents above the standards are sent to a temporary reservoir and returned to the plant for further treatment.

The first two conditions depend on enforcement capabilities. Responsible institutions should have the legal power and resources (i.e., employees and budget) to enforce the standards. Setting standards and establishing authorities will not be enough to rehabilitate the Kishon, if there is no compliance with standards and if competent authorities lack power and resources. The problem of enforcement of environmental rules is common and widespread throughout the world.48 Other instruments should also

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48 Israel Environment Bulletin, winter 1996 issue (Vol.19, No.1): How best to change human behavior so that environmental requirements are complied with? Environmental agencies worldwide have been grappling with the problem for years. The solution may well lie in just the right blend of education, motivation, administrative enforcement, judicial enforcement, and prosecution.
be used, ranging from administrative enforcement to voluntary agreement in the more
difficult cases.

The last two conditions would create a system to prevent failures of the
companies' treatment plants from affecting water quality. Some of the people we met in
Haifa believe there is a need to build a central plant that would further treat physically
and chemically effluents already pre-treated by each company. The central plant should
further improve water quality and guarantee treatment even when the companies'
treatment plants fail. The EIB study does not call, however, for a central treatment
plant. Instead, it proposes a monitoring system with a downstream reservoir that would
receive effluents in case of failure and then send them back to the plant. This solution
seems preferable to a central plant treating the effluents of each company. A system is
required to avoid the direct discharge of untreated water into the Kishon. Each
company should treat and guarantee the quality of its effluents. With a central plant,
companies will not feel really responsible. A storage reservoir to collect untreated
wastewater in case of failure could be a good option. The monitoring authority should
be able to stop the discharge --and possibly shut down the plant responsible for the
discharge-- when the amount of untreated effluent exceeds the capacity of the reservoir.

The discharge from the Haifa wastewater treatment plant represents about 80
percent of all of the effluents discharged into the lower Kishon. To improve the quality
of this effluent, the Nesher ponds and maybe some of the fields around the ponds could
be used as an artificial wetland. The use of wetlands as a buffer zone between the
treatment plant and the water body is increasingly widespread throughout the world
(EPA 1993, International Association on Water Quality 1996). The Technion is already
doing some research on constructed wetlands as a means of river rehabilitation. The
research will evaluate two types of constructed wetlands for restoring the Alexander
river and providing a buffer between the river and the wastewater treatment plant.
Improving the effluent from the wastewater treatment plant is important because that
effluent guarantees the river flow during most of the year. A buffer in the area of the
Kishon is perfectly compatible with the other functions of the Nesher ponds (i.e.,
sludge trap and flow regulation in the winter).

One of the EIB study’s options for rehabilitating the Kishon is the construction of
a marine outfall to discharge effluents directly into the bay. Discharging untreated
sewage would increase the risk of eutrophisation of the bay. It may be useful, however,
to use the EIB study model to assess the effect of discharging treated industrial effluent
on the bay ecosystem using different standards (out of court settlement, EIB study, and
stricter ones).

49 Constructed Wetlands for Wastewater Treatment and Wildlife Habitats, U.S. Environmental Protection
Agency, EPA832-R-93-005, September 1993 and Quality Natural and Constructed Wetlands for waste
water treatment and reuse, International Association on Water, Proceeding of the Conference held in
Perugia, Italy, October 1996.

5.7.3 Prevent flooding

For the hydraulic management of the Kishon, drainage authorities have used the “straight and fast” approach --i.e., the river collects water and drains it to the sea as fast as possible. According to this approach, the rapid drainage of water is the best way to avoid flooding and hydraulic action should increase the speed of the runoff by straightening waterways, reshaping the riverbed, and eliminating all elements slowing the flow (riparian vegetation, meanders). The straight and fast approach has led to projects aimed at straightening the waterways, modifying the riverbeds, cutting the vegetation and other actions to drain water to the sea as fast as possible.

Numerous studies have highlighted the negative effects of this approach on the environment;\textsuperscript{51,52} in addition, increasing the speed of the current and surface runoff increases riverbed and banks erosion, flow peaks, and flooding risks. In many countries, since the post-war period, buildings have been located in overflow areas and rivers have been shrinking within narrower banks. The gradual reduction in the overflow areas that keep water in case of flooding dramatically increased the speed of the stream flow. The flooding risk and the scale of damage increase proportionally to the height of the flood peak; measures to reduce the maximum flow of each flood will ensure long-term hydraulic safety.

A new “wide and slow” approach to river management is rapidly spreading. It guarantees the “vital space” of the river by avoiding the construction of buildings and facilities in the overflow areas and slows the stream flow. The wide and slow approach is universally recognized as the best for hydraulic safety and the environment. It proposes solutions at a watershed scale (forestation, best agricultural practices) or at a small scale (remeandering, two-stage riverbeds, high flow reservoirs, agreements with farmers for periodical floods); these solutions will retain water runoff and rehabilitate the waterways’ natural integrity and functions, such as flood regulation and self-regeneration.

To expand the time taken by the rain to become a waterway and drain into the sea, action must be taken on all the watershed to reduce soil water-resistance and enlarge the forest area. Introducing bushes and hedgerows in farmlands and rehabilitating the riparian vegetation along the water bodies are some of the strategies currently tested in many countries. For example, there is a project under way in the United Kingdom under the Ministry of Agriculture Habitat Scheme called the Water Fringe Scheme. The water fringe is based on a voluntary agreement between the


\textsuperscript{52}A survey of all the modifications of the main rivers in the northern hemisphere (North America, Europe and former USSR) divides them into three classes of fragmentation due to dams or other regulating works and highlights the environmental and hydraulic problems caused by the old approach, see Fragmentation and flow regulation of river systems in the northern third of the world, M.Dynesius & C.Nilsson, Science and Nature, Vol.266:753-762, 4 November 1994.
Ministry and the farmers who own land along a water body. Farmers who participate in the scheme follow a set of management requirements and receive in return an annual payment for each hectare of land in the scheme.53

A prerequisite to the wide and slow approach is the possibility of planning hydraulic defense action at the watershed scale and integrating it into a global strategy for flood control and protection of the land, the river ecosystem, and the quality of the water and its correct use. For this integrated planning, many countries have created a new tool, the Watershed Plan, to provide guidelines to other plans relevant to other aspects. The Watershed Plan regulates water withdrawal for various uses; prevents building in the areas close to the river; encourages reforestation and farming practices reducing the speed of the runoff; identifies the need for wastewater treatment due to the self-regeneration capability of the stream; and promotes the creation of buffer zones to reduce pollution from non-point sources. The Watershed Plan can modify the regional and local plans when they do not protect resources adequately at the watershed scale.

Creating a Watershed Plan for the Kishon, however, would be difficult because different authorities are responsible for water, the river, and the land in the watershed. There are two drainage authorities: one for the upper Kishon --from the source to the Kefar Baruch Reservoir-- and another for the lower Kishon --form the reservoir to the sea. The Water Commission and its operating arms --Mekorot and Tahal-- are responsible for water supply (see Chapter 7). KRA has ambitious goals, but does not have the human and financial resources nor the administrative power to achieve them. There are also various local authorities responsible for land use (see Chapter 4). The creation of a Watershed Plan could take many years; a solution to prevent flooding is urgently needed.

KRA is responsible for rehabilitating the river ecosystem, the water quality, and the river banks. KRA is preparing a master plan whose goals are to (1) achieve an undisturbed aquatic life habitat along the river from the Baruch reservoir to Haifa Bay and (2) restore the riparian ecosystem. KRA’s strategy is based on two steps:

1. Allow recreation along the Kishon’s banks and avoid scum and odors; and
2. Remove pollutants from the Kishon to achieve an undisturbed aquatic life habitat.

The Kishon Drainage Authority (KDA) is responsible for preventing floods. KRA and KDA are working together on a flood prevention strategy that will be coordinated with the Kishon’s rehabilitation project. The strategy will assess:

53Contact for the Water Fringe Scheme: Neil Cumberlidge, MAFF, Room 144, Nobel House, 17 Smith Square, London, SW1P 3JR, UK; ++44-171-2386276 N.Cumberlidge@lucc.maff.gov.uk. Also interesting experience in Italy to provide incentives for hedgerows plantation in agricultural areas trough local planning procedures; contact:: Dr.Daniel Franco, Via Negroponte 7c, Lido - Venezia, 30126, Italy. ++39-41-5264372; daniel.franco@iol.it. Other interesting experience in the USA; contact: Prof.Richard Lowrance, Southeast Watershed Research Laboratory. USDA-ARS, Georgia, Coastal Plain Experimental Station, Tifton, GA, 31793, USA; ++1-912-3863894; lorenz@tifton.cpes.peachnet.edu.
- Sources of pollution at a watershed scale (point and non point);

- Self regenerating potential of the river and how to improve it (restoration of the water channel and buffering vegetation, artificial wetland);

- Positive interactions among measures to increase the self regenerating potential, reduce flooding, and restore the river habitat;

- Possibility of using the Nesher ponds and part of the river corridor for regulating small floods (once in 3-10 years);

- Possibility of using farm lands for regulating heavy floods (once in 50 years), reducing the speed of runoff, and increasing aquifer recharge; and

- Connections with the National Outline Scheme for Afforestation.
6. AIR QUALITY

In the past ten years, Haifa has successfully reduced emissions of sulfur dioxide from its main industrial polluters as well as ambient concentrations of sulfur dioxide. This success has been achieved very cost-effectively with Personal Orders and an Intermittent Control System relying on the use of low sulfur content fuel. There is still room for improvement; half hour SO\textsubscript{2} concentrations still exceed the standard at times. Efforts must be pursued to ensure full compliance with all of the standards.

The reduction in air pollution has been limited, however, to sulfur dioxide; much remains to be done with particulate matter, nitrogen oxides, volatile organic compounds, and odors. Efforts to better monitor and control emissions from transportation and to encourage public transportation will help Haifa reduce the ambient concentrations of these other air pollutants.

For many years, Haifa was one of Israel's cities with the worst air quality. Intense industrial activity in the Haifa Bay, coupled with difficult atmospheric dispersion conditions due to the influence of the Mediterranean Sea and the complex topography of Mount Carmel, makes this area one of the most problematic in terms of air pollution. Dense vehicular traffic is also a major contributor to air pollution emissions in the heavily populated urban centers of Haifa and satellite towns. After reviewing the institutional and regulatory framework to control air pollution, this chapter describes Haifa's main emission sources and reviews air quality, highlighting the improvement recorded in the past ten years.

6.1 Institutional and Regulatory Framework

A strong institutional and regulatory framework protects Haifa's air quality. This section reviews key institutions, legislation, and standards, and highlights the Personal Order, the primary legal instrument for controlling industrial air pollution in Haifa and throughout Israel.

6.1.1 Institutions

The Haifa District Environmental Association of Municipalities (HDEAM) monitors air quality and noise and controls and supervises air pollution from industries using Personal Orders (see Section 6.1.4). There are 2,000 industrial facilities and 160,000 registered vehicles in the region served by HDEAM. HDEAM advises municipal officials on industrial air pollution monitoring and control; HDEAM also imposes special environmental limits for business licenses under the 1968 Licensing of Business Law.\textsuperscript{54} These limits for air pollutant emissions may be based on U.S. Environmental Protection Agency regulations, on emission standards issued by the Federal Government of Germany, or on any other standards acceptable to the Ministry of the Environment (MOE). In addition, HDEAM advises local planning authorities on the environmental effects of proposed development plans by reviewing Environmental Impact Statements prepared by developers.

\textsuperscript{54} The Environment in Israel, Ministry of the Environment, Jerusalem, 1994, page 65.
According to a by-law enacted by a 1977 legislative order, major industrial sources\(^\text{55}\) of air pollution must finance HDEAM’s air monitoring activity, including the routine operation of the monitoring network (i.e., employee salaries, legal advice, electricity, phone, fax, etc.), insurance, alarm system service, equipment’s upgrading, and maintenance (i.e., repairs, spare parts and expendable supplies such as calibration gases, and instrument calibration). In the past four years, this budget has increased by 60 percent from 2.2 million NIS in 1994 to 3.5 million NIS in 1997.

### 6.1.2 Legislation

The 1961 Abatement of Nuisances Law, also known as the Kanowitz Law, states that a person shall not cause unreasonable pollution of the air from any source, if it disturbs anyone nearby.\(^\text{56}\) The law grants the Minister of the Environment the authority to promulgate regulations defining air and olfactory pollution. The law also allows private actions against violators responsible for nuisances and requires licensed businesses to comply with the law’s provisions.

Regulations promulgated under the Abatement of Nuisances Law include:

- \(^\text{60}\)The 1962 regulation on air pollution from premises prohibiting emissions of black smoke into the air and the 1963 regulation prohibiting the emission of black smoke from motor vehicles;

- \(^\text{61}\)The 1971 regulation on air quality --revised and expanded in 1992-- defines ambient air quality standards for pollutants (see Section 6.1.3);

- \(^\text{62}\)The 1972 regulation on emission of particulate matter in the air defines the permissible emission rate of particulate matter from an industrial facility in terms of the quantity of raw materials supplied to the production process (this regulation is obsolete and no longer in use);

- \(^\text{63}\)The 1972 regulation on air pollution from heavy fuel oil burners used for household heating, prohibiting households from using heavy fuel oil for central space heaters; and

- \(^\text{64}\)The 1990 regulation on prevention of unreasonable air and odor pollution from solid waste disposal sites, prohibiting waste burning at solid waste disposal sites and requiring measures for preventing air pollution emissions, smoke, and odors.

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\(^\text{55}\)Major industrial sources of air pollution are defined as industries using more than 3,000 tons of fuel oil per year. In 1995, industrial contributions to HDEAM’s monitoring budget were: power plant (53%); refinery (26%); Nesher (11.15%); Carmel Olefins (4%); Gadiv (4%); Deshanim (0.96%); and Telma (0.35%).

\(^\text{56}\)The Environment in Israel, Ministry of the Environment, Jerusalem, 1994, page 64.
The 1982 Environmental Impact Statement (EIS) regulations under the Planning and Building Law preserve air quality by restricting emissions of air pollutants from planned installations, according to emission standards based on Best Available Technology (BAT). EIS are required for power plants and any activity likely to significantly affect the environment.

6.1.3 Standards

**Air quality.** The 1971 Israeli ambient air quality standards set permissible levels of pollutants in the air and the corresponding time periods for measuring these levels. Levels were set for sulfur dioxide (SO\(_2\)), hydrogen sulfide, oxidants (ozone), lead and related inorganic compounds, carbon monoxide, nitrogen oxides, opacity, and total suspended particulate matter. These standards also set a percentage of the time during the calendar year above which the level cannot be exceeded.

Revised and expanded standards became effective in May 1992; they cover 21 air pollutants, including gases and particulate not covered previously. Standards for dichloroethane, dichlorometane, toluene, tetrachloroethylene, styrene, formaldehyde, vanadium, and cadmium are based on the 1987 World Health Organization Air Quality Guidelines. The new standards (SO\(_2\) excepted)\(^{57}\) cannot be exceeded.

The new air quality standards are more stringent and require industrial plants, especially those located in polluted industrial areas such as Haifa, to invest substantial financial resources to reduce emissions, especially SO\(_2\). The new and old Israeli Air Quality Standards are in Annex A.

**Emission standards.** MOE has recently drafted emission standards; emission standards for combustion installations are primarily based on the relevant European Communities Directive (EC, 1988) and emission standards for industrial activities are based on the 1986 technical instructions of the German Federal Ministry of the Environment’s Air Quality Division and Department of Legal Affairs. The draft standards have been distributed to the relevant government agencies and to the general public for comment.

6.1.4 Personal Orders

According to Section 8 of the Abatement of Nuisances law, MOE can issue administrative decrees (Personal Orders)\(^{58}\) requiring a specific polluter to take necessary steps for preventing air pollution. Such orders have become the primary legal

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\(^{57}\) The new SO\(_2\) half-hour average standard of 500 \(\mu\text{g/m}^3\) can be exceeded 45 times during the year (0.25% of the time) with a maximum permissible concentration of 1,000 \(\mu\text{g/m}^3\). The previous SO\(_2\) half-hour standard was 780 \(\mu\text{g/m}^3\) and could not be exceeded more than one percent of the time during the year; the maximum permissible concentration was 1,560 \(\mu\text{g/m}^3\).

\(^{58}\) These decrees are called Personal Orders because the manager of each facility is personally responsible for complying with the order’s requirements; failure to comply is a legal offense.
instrument for controlling industrial air pollution in Haifa and throughout the country. HDEAM experts and Israel’s Environmental Protection Service (today MOE) prepared the orders for Haifa’s industries. In the Haifa district, HDEAM’s managing director is the supervising authority for these orders. For each facility, these orders specify emission standards and provide instructions for continuously monitoring and sampling stack emissions, treating obnoxious odors, documenting, and real time reporting to the supervising authority.

In 1984, MOE issued the first orders for Haifa’s power plant and oil refinery. In 1986, MOE issued orders for the Nesher Cement plant, the Haifa Chemicals plant, the Chemicals & Fertilizers plant, and Gadiv Petrochemical Industries. The orders for these facilities have been amended several times since their issuance. For each facility, Annex B presents the Personal Orders’ latest modifications.

6.2 Emission Sources

Israel’s main sources of air pollution are energy production, industry, and transportation. These sources are concentrated in the coastal plain where the highest levels of pollution have been detected.

One of the most problematic air pollutants, as confirmed by air quality monitoring conducted since 1975, is sulfur dioxide (SO\textsubscript{2}). Until recently, the Haifa Bay area has recorded high concentrations of SO\textsubscript{2}, emitted mostly by Haifa’s power plant and oil refinery. Intense industrial activity in the Haifa Bay area, coupled with difficult atmospheric dispersion conditions due to the influence of the Mediterranean Sea and the complex topography of Mount Carmel, makes this area one of the most problematic in terms of air pollution. Additional pollution sources in the Haifa area include a cement plant, chemical and petrochemical plants, quarries, and several other industries.

Dense vehicular traffic is also a major contributor to air pollution emissions in the heavily populated urban centers of Haifa and satellite towns. Increased motorization and diesel buses and trucks have a major impact on the deterioration of air quality. The high amount of solar radiation in Israel has lead to increasing levels of photochemical air pollution.

Table 23 shows the major sources of air pollution in the HDEAM region. For each pollutant, Figures 4 to 7 show the relative contribution of these sources in 1995. The next paragraphs present each of these sources.

<table>
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<th>Source</th>
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<td></td>
<td>SO\textsubscript{2}</td>
</tr>
<tr>
<td>Haifa Power Plant</td>
<td>1.65</td>
</tr>
<tr>
<td>Haifa Refinery</td>
<td>0.88</td>
</tr>
<tr>
<td>Nesher Cement Plant</td>
<td>0.40</td>
</tr>
<tr>
<td>Haifa Chemicals</td>
<td>-</td>
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<tr>
<td>Gadiv</td>
<td>0.1</td>
</tr>
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</table>

Table 23 shows the major sources of air pollution in the HDEAM region. For each pollutant, Figures 4 to 7 show the relative contribution of these sources in 1995. The next paragraphs present each of these sources.
<table>
<thead>
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<th>Source</th>
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<th>NO(_x)</th>
<th>VOC</th>
</tr>
</thead>
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<td>Carmel Olefines</td>
<td>0.1</td>
<td>0.009</td>
<td>0.003</td>
</tr>
<tr>
<td>Deshanim</td>
<td>0.06</td>
<td>0.050</td>
<td>0.020</td>
</tr>
<tr>
<td>Other industri. SO(_2) sources*</td>
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<tr>
<td>Vehicular sources</td>
<td>0.075</td>
<td>2.0</td>
<td>0.86</td>
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<tr>
<td>Other industri. VOC sources**</td>
<td></td>
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<td>0.52</td>
</tr>
</tbody>
</table>

*Shemen, Telma (These two smaller industries burn more than 3,000 ton fuel oil per year and are included in the by-law financing HDEAM's air monitoring activities (see Section 6.1.1). **Gas farms, other industries

FUNCTION 4
SO\(_2\) EMISSIONS IN THE HAIFA AREA

FUNCTION 5
PARTICULATE EMISSIONS IN THE HAIFA AREA

FUNCTION 6
NO\(_x\), EMISSIONS IN THE HAIFA AREA
6.2.1 Energy -- Haifa Power Plant (HPP)

HPP belongs to Israel Electric (IE), Israel’s national electric company. Along the coast, IE operates conventional steam power plants burning coal and residual fuel oil; throughout the country, IE operates gas turbines fueled by gas oil. IE’s total installed capacity was 6,920 MW at the end of 1995.

HPP, a residual fuel oil fired steam power plant, has a 426 MW capacity (two units of 72 MW each and two units of 141 MW each). HPP also has two back-up gas oil fired jet gas turbines, with an additional 80 MW capacity; therefore, HPP’s installed capacity is 506 MW. The main pollutants from residual fuel oil combustion are SO$_2$, NO$_x$, and particulate matter.

In the past, HPP used heavy residual fuel oil with a high sulfur content (3 to 4 percent sulfur), thus emitting unacceptably large quantities of SO$_2$ (3.4 tons of SO$_2$ per hour in 1982). As a result, the SO$_2$ air quality standards were frequently exceeded in the Haifa area. In 1983, HDEAM implemented an Intermittent Control System (ICS) to reduce SO$_2$ emissions (see Section 6.3). In 1984, MOE issued a Personal Order (see Annex B) requiring HPP to comply with ICS. Immediately after the Personal Order, HPP
reduced SO$_2$ emissions by 38 percent from 3.4 tons per hour in 1982 to 2.11 tons per hour in 1985. The use of lower sulfur content fuels has gradually increased since 1985. HPP’s Personal Order has been amended periodically, limiting the fuel oil sulfur content under normal operation (“Green” conditions) and under ICS requirements (“Yellow” and “Red” conditions). In 1995, low and low-low sulfur content fuels represented 55 percent of HPP’s total fuel consumption and HPP’s SO$_2$ emissions were reduced to 1.65 tons per hour, a 22 percent reduction from their 1985 level. Figure 8 shows HPP’s reduction of SO$_2$ emissions from 1985 to 1995.

HPP’s environmental costs have ranged from US$3.75 million to US$8.2 million in the past six years (see Table 24). The cost of low sulfur fuel is the incremental cost (difference between low sulfur fuel and regular fuel) that HPP has to pay when using low sulfur fuel.$^{59}$ In addition, HPP puts chemical additives into the flue gases to neutralize SO$_3$ emissions.$^{60}$ HPP is also the largest contributor to HDEAM’s monitoring budget (US$535,000 per year) and paid half of HDEAM’s monitoring network (US$750,000) in 1989-1990.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost of low sulfur fuel (US$ million)</th>
<th>Cost of chemical additives (US$ million)</th>
<th>Total Cost (US$ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>3.5</td>
<td>0.81</td>
<td>4.31</td>
</tr>
<tr>
<td>1991</td>
<td>4.8</td>
<td>0.99</td>
<td>5.79</td>
</tr>
<tr>
<td>1992</td>
<td>5.1</td>
<td>0.95</td>
<td>6.05</td>
</tr>
</tbody>
</table>

$^{59}$The decrease in the cost between 1993 and 1994 results from a decrease in the market price of the low sulfur fuels, not from a decrease in the quantities of fuel used. The market price for 1% S fuel went down from US$19 per ton (US$33 per ton for 0.5% S fuel) in 1993 to US$7.9 per ton (US$19.9 per ton for 0.5% S fuel) in 1994 and to US$6.3 per ton (US$16 per ton for 0.5% S fuel) in 1995.

$^{60}$SO$_3$ and particulate emissions cause acid pitting on cars and other equipment near the power plant.
HPP's increased combustion efficiency reduced HPP's particulate matter emissions by 30 percent in 1992, thereby achieving the required particulate matter limit and a certain reduction of opacity. Opacity has been further reduced in the past years at HDEAM's request. Public awareness of high opacity has pressured HDEAM to ask for opacity reduction. In 1995, the particulate emission rate was 0.137 ton per hour and the NO\textsubscript{x} emission rate was 0.38 ton per hour, equivalent to 3,300 tons per year.

6.2.2 Industry

Haifa Refinery (HR)

Oil Refineries Limited is one of Israel's largest industrial companies with refineries in Haifa and Ashdod. With a capacity close to 8 million tons of crude oil per year, HR produces most of the feedstock for the Haifa Bay petrochemical industry: LPG (liquefied petroleum gas), gasoline, diesel oil, solar fuel, and feedstock for ethylene production (Carmel Olefines) and for the Gadiv aromatic plant. HR operates two crude distillation units, each with atmospheric and vacuum columns, and various stripper columns for light ends, and vis-breakers for improving gasoline yields. HR has a platforming unit for better quality, higher octane products and a fluid catalytic cracker (FCC) unit for light products from heavy bottom oils and residues from other units. HR has two hydrodesulfurizing units, both fitted with amine extraction and conventional sulfur recovery units (SRU). The FCC has an additional SRU. A new SRU became operational in 1995. These units convert sulfur compounds from the desulfurization units into solid, elementary sulfur, used as raw material for manufacturing fertilizers.

Heavy residual oil is processed in an asphalt unit. HR has a lubricating oil (lube oil) plant, with a propane extraction unit, two extraction de-waxing units, and a lube oil hydro-treater. In 1996, a new continuous catalytic reformer (CCR) became operational; it produces high quality gasoline fractions from naphtha, with hydrogen and aromatics as by-products.

HR operates a combined heat (270 tons of steam per hour) and electric power plant (33 MW), comprised of a double boiler facility fired by a mixture of low sulfur residual fuel oil (1 percent sulfur) and process gas. This boiler plant provides steam and electric power to HR and to nearby chemical and petrochemical plants. Most HR units are connected to two flare headers, one shared with the ethylene plant of Carmel Olefines.

Until 1982, HR used heavy residual fuel oil (3 to 4 percent sulfur content) for combustion in its refining processes. HR's and HPP's combined SO\textsubscript{2} emissions represented 85 percent of the Haifa District's SO\textsubscript{2} emissions. In 1982, HR emitted 3.92 tons of SO\textsubscript{2} per hour. In 1985, after the ICS, HR's SO\textsubscript{2} emissions went down to 3.21 tons per hour. To comply with the Personal Order’s increasing demands (see Annex B), HR used increasing amounts of low sulfur content residual fuel. HR also used process
gases scrubbed free of sulfur as fuel. HR’s Personal Order has reduced SO\(_2\) emissions by 73 percent from 3.21 tons per hour in 1985 to 0.88 ton per hour in 1995. Figure 9 shows HR’s reduction of SO\(_2\) emissions over the period 1985-1995.

HR’s low sulfur fuel costs have ranged from US$1.5 million to US$6 million in the past six years (see Table 25). The cost of low sulfur fuel is the incremental cost (difference between low sulfur fuel and regular fuel) that HR has to pay when using low sulfur fuel. HR also contributes to HDEAM’s monitoring budget (US$250,000 per year) and to the Meteorological Service for ICS operation (US$300,000). HR paid half of HDEAM’s monitoring network (US$750,000) in 1989-1990. HR has invested $US39.6 million to reduce SO\(_2\) emissions (installation of tail gas treatment, amine treatment, system for switching to low sulfur fuels).

HR also emits particulate matter from high asphaltene containing residual fuel and from their production processes (e.g., catalyst particulate from the FCC). HR’s particulate emission (FCC excluded) is 47 kg/hour. FCC emits 10 kg per hour, with concentration of 125 mg/m\(^3\) in the flue gas.

**FIGURE 9**

HR’S REDUCTION OF SO\(_2\) EMISSIONS FROM 1985 TO 1995

**TABLE 25**

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost of low sulfur fuel (US$ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>2.3</td>
</tr>
<tr>
<td>1991</td>
<td>3.2</td>
</tr>
<tr>
<td>1992</td>
<td>6.0</td>
</tr>
<tr>
<td>1993</td>
<td>3.4</td>
</tr>
<tr>
<td>1994</td>
<td>1.5</td>
</tr>
</tbody>
</table>
HR is the District’s major odor pollutant, emitting 7,500 tons per year of volatile organic compounds (VOC) including sulfur compounds (e.g., mercaptans and sulfides). These odors are released primarily from the waste treatment units. HR will reduce odors from wastewater treatment by enclosing the existing DAF and API treatment units (investment of US$600,000) and installing a new, more efficient, DGF unit that will handle most of the waste.

HR also emits NO\textsubscript{x} from fuel combustion and a future amendment of HR’s Personal Order will be required to reduce NO\textsubscript{x}. HR’s NO\textsubscript{x} emissions from fuel combustion sources are 0.57 ton per hour (5,000 tons per year). HR intends to reduce these emissions by installing low-NO\textsubscript{x} burners (investment of US$300,000).

In the past few years, HR has taken several additional steps to reduce air pollution, such as replacing many short stacks with a smaller number of tall stacks (maximum height of 80 meters allowed in the Haifa Bay area, because of the nearby airport); renewing and replacing older equipment with less polluting units; and constructing two sulfur recovery units (SRU). A third new SRU, using modern tail gas treatment technology, was installed in 1995.

Nesher Cement plant

Nesher Israel Cement Enterprises Ltd operates three cement plants in Israel: Nesher Ramle (new dry process and older wet process), Nesher Har Tuv (semi-dry process), and Nesher Haifa (NH) the oldest (wet process).\(^{62}\)

NH has three kilns, each with its own stack. In each of the stacks, electrostatic precipitators with a 99.9 percent efficiency remove particulate matter released from the kilns with the flue gas. The dust collected by the precipitators is continuously removed and dumped in an adjacent field.

NH’s major pollutant is particulate matter from the kiln stacks and the overall ground area of the facility. SO\textsubscript{2} is also emitted from fuel oil combustion; ambient concentrations of SO\textsubscript{2} in the town of Nesher have exceeded the standards even when HR and HPP were operating under "Red" conditions. NH’s Personal Order (see Annex B) has been amended to include the reduction of the sulfur content of the fuel. NH’s Personal Order has led to many physical and operational changes that have significantly reduced the emission of particulate matter. NH’s particulate and SO\textsubscript{2} emission rates are 14 kg/hr and 0.4 ton per hour, respectively.

\(^{61}\) HR also will invest $2.8 million to improve vacuum and acidic wastewater treatment systems after surveying sources of obnoxious odors.

\(^{62}\) In the wet process, limestone, clay, and water are ground in a ball mill to a paste fed to a rotary kiln. The kiln is fired with residual fuel oil to a temperature of 1500\textdegree{}C. The lime produced (with the simultaneous release of CO\textsubscript{2}) combines with the silica of the clay to produce a clinker. The clinker is removed from the kiln, air-cooled, and ground with 5 percent gypsum in a ball mill to produce cement.
NH is planning to build a new dry-process kiln to replace the old ones. As a first step for the EIS required by MOE, NH started a survey of particulate matter (PM10) ambient concentrations in November 1996. For one year, they will operate four PM10 High-Vol Samplers in various sites (most of them coinciding with HDEAM monitoring sites) within a radius of 10 km of the existing plant. HDEAM will provide quality assurance and quality control of the measurements (mainly equipment calibration).

**Haifa Chemicals (HC)**

HC manufactures fertilizers and industrial chemicals primarily for export. These include potassium nitrate (KNO$_3$) and phosphoric acid produced by a proprietary alcoholic-solvent-based integrated process. For this process, two units produce nitric acid on site from ammonia. These compounds are used to manufacture several derivatives used as fertilizers and other industrial chemicals, such as sodium tripolyphosphate (STPP) and phosphate salts. HR supplies HC with steam; therefore, there is no on-site combustion of fuel.

HC’s main air pollutants are NO$_x$, primarily brown fumes of NO$_2$ from nitric acid manufacture and chemical dust mainly from KNO$_3$ and STPP.

HC’s Personal Order (see Annex B) led to the installation of a catalytic converter to reduce NO$_x$ to N$_2$ in one of the HNO$_3$ plants and to the installation of an additional absorption tower in the other. NO$_x$ emissions are now on average 60 kg/hr. NO$_x$ emissions have exceeded their limits several times a year despite the catalytic converter and the absorption tower --the high summer temperature reduces the efficiency of the absorption tower. In 1995, HDEAM complained to the police because NO$_x$ emissions were above the limits; the complaint is being investigated.

Particulate emissions were reduced with venturi scrubbers in the KNO$_3$ stacks and a conventional scrubber in the STPP stacks. Particulate emissions average 10 kg per hour; HC operates within the Personal Order’s limits for particulate.

**Gadiv Petrochemical Industries**

The Gadiv plant fractionates the Haifa Refinery platformer product in a series of columns to produce benzene, toluene, and xylene. Gadiv also produces phthalic anhydride by oxidizing xylene as well as succinic and fumaric acids as by-products.

Gadiv’s main air pollutants are SO$_2$ (0.1 ton/hr) and particulate matter (9 kg/hr) from the combustion of a mixed fuel (process gases and residual fuel oil) in the process and for energy production. The Gadiv boiler house, the process heating units, and the plant’s flare have high opacity emissions.

In 1995, Gadiv exceeded the Personal Order’s opacity limits (see Annex B) for the flue gases from the boiler house and from the production units. Most of the exceedances occurred when the plant operated above its nominal capacity, between
January and August 1995. In September 1995, HDEAM complained to the police; the complaint is being investigated.

According to the stack tests performed periodically, Gadiv complies with the particulate matter requirements.

SO$_2$ emissions from this plant are low; in early 1995, Gadiv decided on its own to switch from a two to a one percent sulfur content fuel oil. As a result, the average sulfur content of their mixed fuel (fuel oil + process gas) is now 0.85 percent throughout the year, which does not trigger the ICS.

Flue gas opacity will be reduced by expanding process capacities. The additional units will produce more steam, thus reducing demand on the boiler house.

Carmel Olefines Ltd (CAOL)

CAOL is in the industrial zone, next to HR. Established in 1991 through a merger of companies owned by Oil Refineries Ltd (ORL) and Israel Petrochemical Enterprises Ltd., CAOL produces ethylene, low density polyethylene, polypropylene, and polystyrene. HR supplies CAOL with naphtha and LPG. The ethylene plant cracks and fractionates HR’s naphtha and LPG into ethylene, propylene, and other by-products used as raw materials at the polyethylene and polypropylene plants. The polystyrene plant imports styrene monomer to produce crystalline high-impact polystyrene.

CAOL’s air pollutants are SO$_2$ (0.1 ton/hr), particulate matter (9 kg/hr), and high opacity from fuel oil combustion in the three boilers of the ethylene plant. CAOL’s main air pollution nuisance is the large quantity of black smoke from the "smokeless" flare of the ethylene plant during the plant’s start-ups and shut-downs. The boilers burn low-sulfur fuel oil (less than one percent sulfur). HDEAM and MOE are currently preparing a Personal Order specifying: a maximum particulate matter concentration of 50 mg/m$^3$ in the flue gas, opacity limits similar to those of other industries, continuous opacity monitoring of the ethylene boiler stacks, the construction of a ground-level flare to reduce black smoke during the ethylene plant’s start-ups and shutdowns, and documenting and reporting of monitoring and sampling results.

Chemicals and Fertilizers Ltd (Deshanim)

This plant is being reorganized. Until recently, it produced ammonia, sulfuric acid, nitric acid, and phosphoric acid. The latter was shut down two years ago and the acid is now imported. Using these chemicals, the plant produces various fertilizers (solid and liquid) and raw materials and basic chemicals for industry. The liquid fertilizers produced include solutions of ammonium nitrate, urea, NP, and NPK. The solid fertilizers include super-phosphates, di-calcium phosphate, potassium sulfate, urea, and ammonium sulfate. Deshanim also produces other chemicals for industry, such as licorice, sodium tripolyphosphate, and aluminum sulfate and chloride. In 1988, a new plant started making di- and trichlorocianuric (TCCA) acids (for swimming pool
sterilization). In 1995, another plant started making aromatic acid derivatives for the pharmaceutical industry, such as 5-nitro-isophthalic acid and 3-nitrobenzoic acid.

Deshanim’s main air pollutants are particulate matter from the production processes, NO\textsubscript{x} from nitric acid production, hydrogen fluoride from super phosphate production, the dispersion and settling of phosphate dust, and recently, HCl fumes from an old potassium sulfate plant due to a HCl scrubbing malfunction. After the Personal Order (see Annex B), all plants were equipped with wet scrubbers and bag filters to comply with the particulate matter requirements. The potassium sulfate plants also have HCl scrubbers and the aromatic acid derivatives plant has scrubbers for NO\textsubscript{x} and SO\textsubscript{x}.

In 1996, Deshanim started to reorganize; several processes have been shut down and others will be shut down in the near future. The following plants have already been closed: superphosphate compacting (the major source of particulate pollution), STPP, two older potassium sulfate units (the major HCl polluters), and the sulfuric acid plant. The following are scheduled to be closed in the next two years: the urea plant, ammonia production, the newer potassium sulfate units, the superphosphate production plant, and probably the dicalcium phosphate plant. Thus, Deshanim’s major sources of air pollution will be eliminated. The plants that will remain open are: di- and TCCA, aromatic acids, liquid fertilizers, ammonium sulfate, licorice, and nitric acid.

In 1995 (prior to the closure of the superphosphate compacting plant), Deshanim’s total particulate emission rate was 50 kg/hr. In the past five years, the plant gradually reduced particulate matter emissions to comply with the Personal Order. In 1995, an increase was recorded, due to maintenance problems in the particulate’s filter systems in the superphosphate compacting plant. The closure of this plant and of several others will reduce particulate emissions. In 1995, the NO\textsubscript{x} emission rate of the nitric acid plant was 20 kg/hr.

Shemen Industries

The Shemen plant produces household cleansers and edible oils. Its main air pollutants are odors, particulate matter from processes and fuel combustion, and SO\textsubscript{2} (0.05 ton/hr) and opacity from a boiler burning residual fuel oil.

After the Personal Order (see Annex B), the old boiler was replaced by a new one, thus reducing black smoke and opacity to a minimum. Equipment to reduce particulate matter was installed on grain silos (bag filters) and on a soya bean roaster (multicyclones). Odors from the wastewater treatment plant have been treated by improving the plant’s maintenance.

6.2.3 Transportation

Urban Transportation (especially diesel vehicles) is a major contributor to ambient concentrations of CO, NO\textsubscript{x} (see Figure 6), VOC (see Figure 7), and particulate matter. The concentrations of these pollutants have risen dramatically over the past
decade. Vehicle safety is checked once a year for the car’s annual registration, but not CO emissions. Authorized examiners of the Ministry of Transportation and MOE, in coordination with the police, can spot check vehicle emissions against the standards in the Abatement of Nuisances Regulations, but both ministries are short in staff and equipment. Only a small percentage of vehicles are actually checked.

Transportation in the Haifa area is increasingly becoming one of the most important sources of air pollution. Traffic jams throughout the city of Haifa and the surrounding towns (Qrayot) are increasing each year together with the growth of the motorization rate in the area. At the end of 1995, there were about 1,459,000 vehicles in Israel, with an average motorization rate of 260 vehicles per 1000 residents. Haifa’s motorization rate is 338 vehicles per 1000 residents. In 1995, there were about 131,000 vehicles registered in the area covered by HDEAM (see Table 26).

For each type of vehicle, we calculated the vehicular pollution (CO, NO\textsubscript{x}, and VOC) using the above data and emission factors expressed as grams of pollutant per kilometer traveled. Annual quantities of pollutants emitted by transportation in the HDEAM region are: 74,500 tons of CO, 17,200 tons of NO\textsubscript{x}, and 7,500 tons of VOC.

### TABLE 26
VEHICLES REGISTERED IN THE AREA COVERED BY HDEAM

<table>
<thead>
<tr>
<th>Vehicles</th>
<th>Fuel used</th>
<th>Number registered</th>
<th>Average distance traveled (km/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private cars</td>
<td>gasoline</td>
<td>106,067</td>
<td>16,000</td>
</tr>
<tr>
<td>Trucks</td>
<td>diesel</td>
<td>19,138</td>
<td>35,000</td>
</tr>
<tr>
<td>Buses</td>
<td>diesel</td>
<td>804</td>
<td>64,000</td>
</tr>
<tr>
<td>Taxis</td>
<td>diesel</td>
<td>604</td>
<td>70,000</td>
</tr>
<tr>
<td>Two-wheelers</td>
<td>diesel</td>
<td>4,121</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>130,734</strong></td>
<td></td>
</tr>
</tbody>
</table>

Public transportation depends on buses almost exclusively. The Carmelit subway connects three commercial centers but is not convenient to the public and does not serve its needs. Because Haifa’s bus system is not sufficiently flexible, the public prefers private transportation. For example, there is no direct connection between several residential neighborhoods (Central Carmel, Ramat Alon, Ahuza, Ramat Golda, Denia, etc.) and the Checkpost, Nesher, and the industrial centers (e.g., Haifa Bay, Matam).

There have been several improvements: construction of the Nesher bypass road and several underpasses for vehicles and pedestrians, street lanes reserved for public transportation, and the widening of congested streets. Other improvements are under different stages of design or implementation. Major ones include the Carmel Tunnel that

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\textsuperscript{63} Traffic jams are a persistent (almost throughout the day) problem in the commercial centers of Haifa (downtown, Central Carmel, Hadar). In addition, the roads between Haifa and the suburban Qrayot are overcrowded during most of the day. The situation worsens from year to year, primarily due to the increasing use of private vehicles.
will allow north to south travel to bypass the city center (already under implementation) and the suburban train system (already operating and being expanded).

**Lead (Pb) content in fuel:** The Ministry of Transportation issued regulations prohibiting the import of cars that cannot use unleaded gasoline. Since August 1991, the import of cars with an engine capacity exceeding 2,000 cc and not equipped with a catalytic converter has been prohibited. The import of cars with engines above 1,600 cc and below 1,400 cc without catalytic converter has been banned since August 1992. In August 1994, a similar ban was extended to the import of cars with engines between 1,400 cc and 1,600 cc. The lead content in gasoline used in Israel has steadily decreased over the past few years from 0.42 g/l (up till 1984) to 0.30 g/l in 1988 and to an average of 0.15 g/l in 1990 (0.2 g/l in 96 octane and 0.1 g/l in 91 octane). Since 1991, unleaded fuel (less than 0.013 g/l Pb) has been introduced.

6.3 Air Quality

6.3.1 Meteorology and topography

Haifa's air pollution problem is exacerbated by difficult dispersion conditions related to the area's topographical structure. The meteorology of the Mediterranean Coastal Plain of Israel has a relatively high air pollution potential. It is characterized by a high frequency of stable stratifications, both ground-based and aloft. The elevated inversions are usually caused by a combination of anticyclonic subsidence and marine layer intrusion due to meso-scale sea breeze circulation. However, the Haifa Bay Area airshed may show some significant peculiarities in its dispersion conditions due to its geographic situation and complex terrain configuration, i.e. the existing concentration of polluting industries and the presence of a close topographical obstacle (the Carmel Ridge). High SO$_2$ concentrations occurred usually at night or early in the morning, especially in the transitional seasons of the year (spring and fall), whereas in Ashdod and Tel Aviv, they occur mostly in the summer during the hot hours of the day.

Based on a five-year climatological record of the eastern Mediterranean, Dayan identified six typical synoptic patterns (Table 27).$^{64}$ In 1987, the Soreq Nuclear Research Center assessed the critical conditions for dispersion and transport of plumes from tall stacks in the Haifa area.$^{65}$ They estimated the meteorological and synoptic conditions that cause an impact of the plumes on the Carmel Ridge. They analyzed comprehensive upper air meteorological measurements, based on the evidence of a strong correlation between some synoptic patterns and the occurrence of air pollution episodes. This analysis of the thermal and wind profiles characterized the various inversions and evaluated the potential of plume transport toward the Carmel.

---


<table>
<thead>
<tr>
<th>Category</th>
<th>Synoptic pattern</th>
<th>Frequency (percent)</th>
<th>Height of inversion base (m)</th>
<th>Depth of convective layer (m)</th>
<th>Multi-annual frequency of radiative inversion (percent)</th>
<th>Wind characteristics</th>
<th>Multi-annual frequency of wind direction toward the Carmel (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Shallow Persian Trough</td>
<td>17</td>
<td>100</td>
<td>450</td>
<td>60</td>
<td>70</td>
<td>2</td>
</tr>
<tr>
<td>B (winter)</td>
<td>Cold sector of a cold depression</td>
<td>14</td>
<td>470</td>
<td>940</td>
<td>60</td>
<td>120</td>
<td>0.5</td>
</tr>
<tr>
<td>B (summer)</td>
<td>Deepening of the Persian Trough</td>
<td>60</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>Warm sector of a warm and shallow depression</td>
<td>24</td>
<td>250</td>
<td>690</td>
<td>60</td>
<td>90</td>
<td>4</td>
</tr>
<tr>
<td>C2</td>
<td>Red Sea Trough (in its inactive mode)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Warm sector of a cold depression</td>
<td>18</td>
<td>*</td>
<td>*</td>
<td>60</td>
<td>70</td>
<td>1</td>
</tr>
<tr>
<td>E</td>
<td>Subsidence caused by a barometric High</td>
<td>6</td>
<td>160</td>
<td>470</td>
<td>60</td>
<td>60</td>
<td>1.5</td>
</tr>
<tr>
<td>Unclassified configurations</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* No mean value was assigned due to the large variability of the limited sample for this category.

(WS = wind speed ; WD = wind direction)
Three synoptic configurations can cause air pollution on the Carmel:
1. weakening of the Persian Trough, occurring in the summer (synoptic category A);
2. a dynamic subsidence caused by a barometric High, typical of spring and early summer (category E); and
3. an intrusion of the Red Sea Trough in its inactive mode, occurring mainly in the winter (category C).

These configurations, together with a critical wind direction, occur about 10-15% of the time, usually in only part of the diurnal periods.

6.3.2 Monitoring

Since 1991, HDEAM has been operating an extended air quality monitoring network consisting of 13 stationary monitoring stations and one mobile station. The network activates an Intermittent Control System (ICS) of SO$_2$ emissions, in the absence of flue gas desulfurization at the main industrial SO$_2$ sources. ICS prevents excessive air pollution by asking industries to switch to low sulfur fuel when high SO$_2$ ambient concentrations are monitored by the network or predicted by the Israel Meteorological Service on the basis of atmospheric conditions (Box 9).

**BOX 9 INTERMITTENT CONTROL SYSTEM (ICS)**

ICS’ purpose is to reduce SO$_2$ emissions, and thereby, ambient SO$_2$ concentrations. The Personal Orders for the Haifa power plant, the oil refinery, and Gadiv mandate compliance with ICS. ICS was started in 1983 since none of these plants was willing to install equipment capable of reducing SO$_2$ from flue gases. In 1984, ICS was included in these plants’ Personal Orders.

When ICS detects high ambient SO$_2$ concentrations (“yellow” or “red” situations), HDEAM asks plants to switch from the fuel oil they commonly use (“green” situation) to fuels with a lower sulfur content (one percent under yellow and 0.5 percent under red). These yellow or red situations are defined by either one of two environmental conditions:

1. one or more of HDEAM’s or the power plant’s monitoring stations records SO$_2$ half hour concentrations above 300 $\mu$g/m$^3$ (yellow) or above 500 $\mu$g/m$^3$ (red), which triggers an automatic alarm that calls the cellular phone of HDEAM’s duty officer on call 24 hours a day;

2. atmospheric conditions reported by the Israel Meteorological Service (IMS) will prevent an effective dispersion of pollutants, predicting either a yellow or a red situation. IMS’ meteorological daily prediction is based on mathematical models using on-line data from HDEAM’s and the power plant’s monitoring stations, as well as synoptic and meteorological data obtained by an automatic Doppler Acoustic Sounding System and ground wind measurements in their own local stations in the Haifa refinery compound.

Continuing violations of the Israeli SO$_2$ air quality standard over the years led to a decision to improve the monitoring system with a computerized system operating in real time. In 1989, HDEAM prepared an international tender for purchasing eight new monitoring stations in addition to the five SO$_2$ monitoring stations already in place since 1982 and for purchasing a computerized communication center for data collection,
processing, and analysis. According to the "polluter pays" principle, the Ministry of Energy (i.e., Oil Refineries and Israel Electric) financed the US$1.5 million project. The new monitoring network --13 stations, five existing ones plus eight new ones-- began operating at the end of 1990. A mobile station was also purchased immediately afterwards.

HDEAM engineers carefully chose the locations of the monitoring stations, far from roads, to monitor air pollution from industrial sources. Table 28 and Figure 10 show the locations of the stations and the pollutants monitored. Six stations are in Haifa: Neve Shaanan, Einstein, Ahuza, Shuk Talpiot, Shprinzak, and Kiriat Haim. The seven remaining stations are in the other municipalities supporting HDEAM: Nesher, Kiriat Ata, Tivon, Kiriat Bialik, Kiriat Yam, Kiriat Mozkin, and Kfar Hassidim. The network also includes four additional SO\(_2\) monitoring stations operated by Israel Electric’s environmental unit. Therefore, the network consists of 17 monitoring stations. The Israel Meteorological Service (in the Tel Aviv area) is also linked in real time, both to HDEAM’s and Israel Electric’s monitoring stations.

The monitoring stations are in shelters with the appropriate monitoring instrumentation, a calibration system, a data acquisition system (DAS), and auxiliary equipment and material. Next to each shelter, a 10 meter high meteorological tower measures meteorological parameters. When SO\(_2\) ambient concentrations exceed a preset level at a station, the DAS triggers an alarm that calls the HDEAM "on-duty" engineer’s cellular phone. Once the engineer validates the information, a state of alert is declared and the plants must switch to a lower sulfur fuel. The entire warning and control procedure is based on data obtained from the real-time monitoring of air quality and meteorological conditions.

HDEAM’s computer center includes several personal computers (PC) linked by phone to the DAS of each station. The computers perform various tasks including data storage and processing, automatic communication with the monitoring stations, and data analysis.

SO\(_2\) annual average ambient concentrations have been reduced by 90 percent since 1984, the year ICS started operating and reducing SO\(_2\) emissions from Haifa’s main industrial pollution sources: refinery, power plant, Gadiv. This reduction of SO\(_2\) emissions and ambient concentrations results from: (1) Personal Orders mandating compliance with ICS; and (2) frequent amendments of the Personal Orders enhancing ICS.

<table>
<thead>
<tr>
<th>Station site</th>
<th>Pollutants Monitored</th>
<th>Meteorological Parameters Monitored</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neve Shaanan</td>
<td>SO(_2), NO(_x), CO, O(_3), NMHC, Dust</td>
<td>WS, WD, RH, BPR, PCIP, TEMP, SR</td>
</tr>
</tbody>
</table>

TABLE 28
HDEAM MONITORING NETWORK
<table>
<thead>
<tr>
<th>Location</th>
<th>Parameters Monitored</th>
<th>Meteorological Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nesher</td>
<td>SO₂, NOₓ, CO, O₃, NMHC, Dust</td>
<td>WS, WD, RH, BPR, PCIP, TEMP, SR</td>
</tr>
<tr>
<td>Qiryat Ata</td>
<td>SO₂, NOₓ, CO, O₃, NMHC, Dust</td>
<td>WS, WD, RH, BPR, PCIP, TEMP, SR</td>
</tr>
<tr>
<td>Qiryat Haim</td>
<td>SO₂, NMHC</td>
<td>WS, WD, TEMP</td>
</tr>
<tr>
<td>Shuk Talpiot</td>
<td>SO₂, NOₓ</td>
<td>WS, WD, TEMP</td>
</tr>
<tr>
<td>Einstein</td>
<td>SO₂</td>
<td>WS, WD, TEMP</td>
</tr>
<tr>
<td>Ahuza</td>
<td>SO₂</td>
<td>WS, WD, TEMP</td>
</tr>
<tr>
<td>Tivon</td>
<td>SO₂</td>
<td>WS, WD, TEMP</td>
</tr>
<tr>
<td>Qiryat Shprinzak</td>
<td>SO₂</td>
<td>WS, WD</td>
</tr>
<tr>
<td>Qiryat Mozkin</td>
<td>SO₂</td>
<td>WS, WD</td>
</tr>
<tr>
<td>Qiryat Yam</td>
<td>SO₂</td>
<td>WS, WD</td>
</tr>
<tr>
<td>Qiryat Bialik</td>
<td>SO₂</td>
<td>WS, WD</td>
</tr>
<tr>
<td>Kfar Hassidim</td>
<td>SO₂</td>
<td>WS, WD</td>
</tr>
<tr>
<td>Mobile station</td>
<td>SO₂, NOₓ, CO</td>
<td>WS, WD</td>
</tr>
<tr>
<td>Ben Dor *</td>
<td>SO₂</td>
<td>WS, WD</td>
</tr>
<tr>
<td>Central Carmel *</td>
<td>SO₂</td>
<td>WS, WD</td>
</tr>
<tr>
<td>French Carmel *</td>
<td>SO₂</td>
<td>WS, WD</td>
</tr>
<tr>
<td>Tel-Amal *</td>
<td>SO₂</td>
<td>WS, WD</td>
</tr>
</tbody>
</table>

WS = Wind Speed; WD = Wind Direction; RH = Relative Humidity; BPR = Barometric Pressure; PCIP = Precipitation; TEMP = Temperature; SR = Solar Radiation; NMHC = Total Hydrocarbons; Dust = Respirable Particulate or PM10

* Israel Electric Co. Monitoring Stations
FIGURE 10
LOCATIONS OF AIR MONITORING STATIONS
6.3.3 Air quality

In 1978, HDEAM started measuring air quality in the Haifa region with a limited monitoring network. In 1991, HDEAM's real time monitoring network was expanded to 13 stationary monitoring stations. Since 1991, all data collected have been continuously recorded, processed, and saved, together with data from the four monitoring stations belonging to the Haifa Power Plant. These data are then summarized in HDEAM's annual report. The following data are from the air quality chapter of HDEAM's 1995 annual report.

Sulfur dioxide (SO$_2$)

1995 SO$_2$ concentrations. Each of the network's monitoring stations uses the pulsed fluorescence method to measure SO$_2$. For each of the stations, Table 29 summarizes the highest half hour and daily SO$_2$ concentrations in 1995 as well as annual averages; Figure 11 shows the highest half hour SO$_2$ concentrations at each of HDEAM's 13 stations. If all of the annual averages and highest daily concentrations are below their respective standards, three half hour concentrations exceeded the standard: one at the Nesher station (belonging to HDEAM) and two at the Central Carmel (see Box 10) and French Carmel stations (both belonging to the Haifa Power Plant). The standards were also exceeded three times in 1994.

---

**BOX 10**
FIRST SERIOUS AIR POLLUTION INCIDENT SINCE 1991

On June 15, 1995, at 9:00 p.m., the SO$_2$ half hour concentration exceeded the standard by 60 percent (1,615 $\mu $g/m$^3$) at the Central Carmel station. This was the first serious air pollution episode since 1991, when the French Carmel station recorded a similar value. At the same time, nearby monitoring stations also recorded high (but below the standard) SO$_2$ concentrations. Investigation of this episode led to the following conclusions:

1. A combination of all emission sources in the Haifa region resulted in these high SO$_2$ half hour concentrations;
2. A strong aloft inversion layer in Haifa Bay in the 24 hours before the episode reduced dispersion;
3. This episode occurred although Haifa's main SO$_2$ emission sources (i.e., power plant and oil refinery) had been burning low-low sulfur fuel oil (0.5% S) since the previous day; and
4. HDEAM concluded that the Intermittent Control System (ICS, see Section 6.3.2) cannot always prevent exceedances of the SO$_2$ half hour air quality standard, especially during extreme meteorological conditions.

---

**TABLE 29**
1995 SO$_2$ CONCENTRATIONS ($\mu $g/m$^3$) IN THE HAIFA DISTRICT

---
<table>
<thead>
<tr>
<th>Station</th>
<th>Highest half hour</th>
<th>Highest daily</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>1,000</td>
<td>280</td>
<td>60</td>
</tr>
<tr>
<td>Neve Shaanan</td>
<td>484</td>
<td>82</td>
<td>11</td>
</tr>
<tr>
<td>Nesher</td>
<td>1,421</td>
<td>88</td>
<td>17</td>
</tr>
<tr>
<td>Qiryat Ata</td>
<td>312</td>
<td>55</td>
<td>10</td>
</tr>
<tr>
<td>Qiryat Haim</td>
<td>499</td>
<td>72</td>
<td>10</td>
</tr>
<tr>
<td>Einstein</td>
<td>671</td>
<td>78</td>
<td>7</td>
</tr>
<tr>
<td>Talpiot Market</td>
<td>364</td>
<td>78</td>
<td>12</td>
</tr>
<tr>
<td>Yiron</td>
<td>754</td>
<td>73</td>
<td>12</td>
</tr>
<tr>
<td>Ahuza</td>
<td>595</td>
<td>59</td>
<td>8</td>
</tr>
<tr>
<td>Q. Shprinzak</td>
<td>705</td>
<td>83</td>
<td>8</td>
</tr>
<tr>
<td>Q. Bialik</td>
<td>209</td>
<td>42</td>
<td>13</td>
</tr>
<tr>
<td>Q. Yarm</td>
<td>302</td>
<td>47</td>
<td>12</td>
</tr>
<tr>
<td>Q. Mozkin</td>
<td>442</td>
<td>41</td>
<td>6</td>
</tr>
<tr>
<td>Kfar Hassidim</td>
<td>476</td>
<td>109</td>
<td>12</td>
</tr>
<tr>
<td>Ben-Dor</td>
<td>520</td>
<td>91</td>
<td>14</td>
</tr>
<tr>
<td>Central Carmel</td>
<td>1,615</td>
<td>104</td>
<td>18</td>
</tr>
<tr>
<td>French Carmel</td>
<td>1,012</td>
<td>74</td>
<td>15</td>
</tr>
<tr>
<td>Tel-Amal</td>
<td>750</td>
<td>111</td>
<td>20</td>
</tr>
</tbody>
</table>

**FIGURE 11**

**HIGHEST SO₂ HALF HOUR CONCENTRATIONS IN 1995 AT EACH OF HDEAM’S 13 STATIONS**

Trends in Neve Shaanan. Until five years ago, Neve Shaanan was Haifa’s most polluted area and recorded the highest number of SO₂ exceedances. In recent years, the main SO₂ emission sources have increasingly used low sulfur fuel oil (and the refinery has also used sometimes gaseous fuels), which has substantially reduced ambient SO₂ concentrations in Neve Shaanan. Figure 12 shows the reduction of SO₂ emissions from the two main sources (Haifa’s refinery and power plant) from 1985 to 1995. Figure 13 shows the consequent reduction in annual average SO₂ concentrations in Neve Shaanan during the same period.

**FIGURE 12**
Nitrogen oxides (NO\textsubscript{x}), Ozone (O\textsubscript{3}), and Particulate Matter (PM 10)

HDEAM measures NO\textsubscript{x}, O\textsubscript{3}, and PM10 --Respirable Suspended Particles (RSP) less than 10 \( \mu \)m diameter-- at three stations: Neve Shaanan, Nesher, and Kiriat Ata. NO\textsubscript{x} is also measured at the Talpiot Market. NO\textsubscript{x} is measured by chemiluminescence, O\textsubscript{3} by UV spectrophotometric absorption, and PM10 by the \( \beta \)-gauge method, in addition to the High-Volume sampler method for subsequent particulate analysis. Table 30 summarizes 1995 NO\textsubscript{x}, O\textsubscript{3}, and PM10 concentrations.

**TABLE 30**

1995 NO\textsubscript{x}, O\textsubscript{3} AND PM10 CONCENTRATIONS IN THE HAIFA DISTRICT
### NO\textsubscript{2} concentrations (\(\mu g/m^3\))

<table>
<thead>
<tr>
<th>Station</th>
<th>Highest Half hour</th>
<th>Number of times above standard</th>
<th>Highest Daily</th>
<th>Annual mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>940</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neve Shaanan</td>
<td>699</td>
<td>0</td>
<td>186</td>
<td>36</td>
</tr>
<tr>
<td>Nesher</td>
<td>942</td>
<td>1</td>
<td>132</td>
<td>27</td>
</tr>
<tr>
<td>Kiriat Ata</td>
<td>1,350</td>
<td>1</td>
<td>94</td>
<td>32</td>
</tr>
<tr>
<td>Talpiot Market</td>
<td>1,090</td>
<td>2</td>
<td>230</td>
<td>49</td>
</tr>
</tbody>
</table>

### O\textsubscript{3} concentrations (\(\mu g/m^3\))

<table>
<thead>
<tr>
<th>Station</th>
<th>Highest Half hour</th>
<th>Number of times above standard</th>
<th>Highest Daily</th>
<th>Annual mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>230</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neve Shaanan</td>
<td>368</td>
<td>2</td>
<td>100</td>
<td>48</td>
</tr>
<tr>
<td>Nesher</td>
<td>273</td>
<td>2</td>
<td>98</td>
<td>54</td>
</tr>
<tr>
<td>Kiriat Ata</td>
<td>308</td>
<td>1</td>
<td>95</td>
<td>51</td>
</tr>
</tbody>
</table>

### PM10 concentrations (\(\mu g/m^3\))

<table>
<thead>
<tr>
<th>Station</th>
<th>Highest Daily</th>
<th>Number of times above daily standard</th>
<th>Annual mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>150</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Neve Shaanan</td>
<td>405</td>
<td>2</td>
<td>37</td>
</tr>
<tr>
<td>Nesher</td>
<td>329</td>
<td>5</td>
<td>48</td>
</tr>
<tr>
<td>Kiriat Ata</td>
<td>185</td>
<td>1</td>
<td>30</td>
</tr>
</tbody>
</table>

**PM10 -- Respirable Suspended Particles.** PM10 concentrations have exceeded their daily standard every year since 1991. As shown in Figure 14, the number of days above the standard at one or more monitoring stations ranges from 22 in 1992 (six percent of the time) to five in 1995 (1.4 percent of the time). Since 1991, the highest daily concentrations at each monitoring station have been exceeding the standard by more than 100 percent (see Figure 15). PM10 annual averages have not exceeded the standard, although the values at the Nesher station are very close to the standard (see Figure 16). Most of the PM10 exceedances are due to natural dust pushed to the region from nearby deserts by strong eastern winds. Nesher’s local industries, such as the cement plant and the stone quarry, also contribute to these high PM10 concentrations.

**FIGURE 14**
NUMBER OF DAYS WHEN THE PM10 DAILY STANDARD WAS EXCEEDED, 1991 - 1995
**FIGURE 15**
HIGHEST PM10 DAILY CONCENTRATIONS, 1991 - 1995

**FIGURE 16**
PM10 ANNUAL AVERAGES IN NESHER, 1991 - 1995
Based on the PM10 concentrations at each monitoring station, wind direction, and meteorological conditions, HDEAM concluded that 30 percent of the exceedances were caused by industrial sources; therefore, efforts should be pursued to lower the particulate matter emission guidelines.

The Technion, in cooperation with HDEAM, is conducting a PM10 characterization study in the Haifa District. Samples from High-Volume samplers were analyzed for \( \text{SO}_4^{2-}, \text{NO}_3^-, \) and \( \text{Pb} \) by the atomic absorption method. Pb concentrations are well below the 5 \( \mu g/m^3 \) standard (see Table 31). In 1990, the lead content of gasoline in Israel was reduced from 0.42 g/l to 0.15 g/l. Sulfate salt levels were generally below the 25 \( \mu g/m^3 \) standard, but some exceedances were measured.

**TABLE 31**

<table>
<thead>
<tr>
<th>Station</th>
<th>Pb</th>
<th>NO(_3^-)</th>
<th>SO(_4^{2-})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neve Shaanan</td>
<td>0.03-0.29</td>
<td>2.1-7.5</td>
<td>8.4-28.3</td>
</tr>
<tr>
<td>Nesher</td>
<td>0.01-0.24</td>
<td>2.4-12.1</td>
<td>7.6-34.6</td>
</tr>
<tr>
<td>Kiriat Ata</td>
<td>0.01-0.26</td>
<td>2.3-13.3</td>
<td>6.1-26.0</td>
</tr>
</tbody>
</table>

**Photochemical Air Pollution.** Ground-level ozone (\( \text{O}_3 \)) causes detrimental effects on human health and vegetation. Elevated \( \text{O}_3 \) concentrations are primarily due to local emissions of precursors (i.e., \( \text{NO}_x \) and Volatile Organic Compounds -- VOC). Because of Haifa’s unique geographical setting, with Mount Carmel causing offshore air masses to rise and recirculate, pollutants are confined within the Haifa Bay’s airshed whenever there are weak eastern winds together with strong aloft inversions. In such cases, all three monitoring stations record simultaneously high \( \text{O}_3 \) concentrations, sometimes above the standard. The region has also experienced persistent episodes for up to two consecutive days.

Between 1991 and 1995, the \( \text{O}_3 \) half-hour standard was exceeded between five and nine times a year (see Table 32). The \( \text{O}_3 \) half-hour standard was exceeded at one
or more monitoring sites between two and six days a year. At Nesher in 1991, the highest \( \text{O}_3 \) half-hour concentration exceeded the standard by 80% (see Figure 17). Most exceedances are recorded in the morning, during strong aloft inversion conditions in the Haifa Bay region that last till noon. This gives rise to rapid ascents of \( \text{NO}_x \) and \( \text{VOC} \) (\( \text{O}_3 \) precursors), and together with strong sun radiation, to subsequent rapid atmospheric photochemical reactions. As a result, high \( \text{O}_3 \) concentrations are measured simultaneously at Neve Shaanan, Nesher, and Kiriat Ata. On June 14, 1995, the standard was exceeded at the same time in Kiriat Ata and Neve Shaanan (see Figure 18).

### TABLE 32

<table>
<thead>
<tr>
<th>Year</th>
<th>Neve Shaanan</th>
<th>Nesher</th>
<th>Kiriat Ata</th>
<th>Number of Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>1992</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>1993</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>1994</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>1995</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

FIGURE 17
HIGHEST \( \text{O}_3 \) HALF HOUR CONCENTRATIONS IN NESHER, 1991 - 1995

FIGURE 18
\( \text{O}_3 \) HALF HOUR CONCENTRATIONS ON JUNE 14, 1995
6.4 Conclusions and Recommendations

Although annual sulfur dioxide (SO$_2$) concentrations in the Haifa area remain below the standard, some half hour SO$_2$ readings still exceed the standard (three in both 1994 and 1995). Currently, the Haifa area maintains a "delicate balance" to stay below the SO$_2$ standard. Adding new SO$_2$ sources or switching to fuels with higher sulfur content could result in recurrent violations of the standard. Much remains to be done to better monitor and control other air pollutants, such as particulate matter (PM), nitrogen oxides (NO$_x$), Volatile Organic Compounds (VOC), and ozone (O$_3$). To improve Haifa's air quality, we recommend six steps:

1. Avoid adding new SO$_2$ sources to the area, unless existing ones reduce their emissions or adopt additional abatement devices (i.e., install FGD units or switch to natural gas when available);

2. Increase efforts to reduce emissions of particulate, NO$_x$, VOC, and odors from industry by introducing more stringent requirements into the Personal Orders;

3. Improve monitoring:
   - Measure PM2.5 (particulate with a diameter below 2.5 microns) continuously with monitors; according to a Technion survey characterizing particulate matter in the Haifa area, the fine fractions (below 2.5 microns) are the richest in sulfur and there is strong evidence in the United States of health damage due to these fine particles;
   - Install continuous monitoring stations at major traffic intersections to assess air pollution from transportation and in the future Carmel Tunnel.
(65 percent of NO\textsubscript{x} emissions in the area are from transportation, the rest is from industry);

- Add O\textsubscript{3} monitors to the network, mainly in Haifa's periphery: Tivon, Kfar Hassidim, and Kiriath Shprinzak and measure NO\textsubscript{y}, a parameter including all nitrogen oxides, and not only NO and NO\textsubscript{2} (NO\textsubscript{x}); NO\textsubscript{y} also includes nitric compounds which could be significant in an industrial area like Haifa and have substantial health impacts; and

- Improve VOC monitoring methods.

4. Conduct studies:

- Study O\textsubscript{3} precursor interactions to establish the strategy needed to reduce O\textsubscript{3} levels in the Haifa area (i.e., reduce NO\textsubscript{x}, VOC or both);

- Study odor dispersion in the area and develop methods to reduce odor intensities at the source by strengthening enforcement of Personal Orders and permit requirements; and

- Estimate the impacts of air pollution on health, identify substances with a damaging effect, and study the costs and benefits of reducing air pollution emissions in the area.

5. Enforce testing of air pollutant emissions during the annual tests of cars (CO, NO\textsubscript{x}); and

6. Encourage projects (e.g., Carmel Tunnel) for reducing transportation through the city center and surroundings and encourage the use of non-polluting vehicles (e.g., electric buses).
7. WATER AND WASTEWATER MANAGEMENT

Haifa’s population is subject to the same water shortage as Israel’s population. Israel’s water potential, about 330 m$^3$ per year, is among the lowest in the world and water shortage may be one of the most crucial environmental problems facing Israel today, touching upon its very existence. Water scarcity is exacerbated by the deteriorating quality of water resources due to demographic, industrial and agricultural pressure. Haifa’s old water distribution network, mainly made of iron, results in relatively high losses (20 percent) and water breaks (600 per year). Water quality could be improved; in 1996, 1.6 percent of water samples showed non-acceptable levels of Coli bacteria.

Haifa must implement actions to reduce water consumption through education and awareness, progressive fees, loss reduction in the distribution network, etc. Preserving the Carmel and Haifa Bay aquifers should be one of Haifa’s main environmental objectives. Haifa should develop a plan to increase the current upgrading effort on the distribution network.

Haifa’s sewage policy faces three challenges: (1) the fragility of Haifa Bay’s biomass equilibrium; (2) the high contamination of the Kishon River; and (3) the high salinity of the water that makes it difficult to recycle. The wastewater treatment plant’s extension should lower the plant’s organic discharge to the Kishon and improve the Kishon’s rehabilitation, since the plant’s discharge to the Kishon represents more than 95 percent of the total organic load discharged by point sources to the Kishon.

Haifa should strengthen the control of industrial discharges to the sewage network through permits, inspections, and progressive cleanup programs. Haifa should issue Permit Orders (under the Water Law) specifying effluent discharge standards for each plant and penalties in case of non-compliance.

### 7.1 Water

Since Haifa’s water resources come from the National Water Carrier, Haifa’s population is subject to the same water shortage as Israel’s population. Israel’s water potential, about 330 m$^3$ per year, is among the lowest in the world (see Table 33). Water shortage may be one of the most crucial environmental problems facing Israel today, touching upon its very existence. Water scarcity is exacerbated by the deteriorating quality of water resources due to demographic, industrial and agricultural pressure. Since the mid-70s, demand has, at times, outstripped supply.

This section is divided into seven subsections. The first five review water resources, supply, distribution, demand, and quality control. The sixth describes the institutional framework; the last one presents conclusions and recommendations.

### TABLE 33

WATER RESOURCES AND DEMAND IN VARIOUS COUNTRIES
7.1.1 Resources

Haifa's water resources are relatively abundant due to a high rainfall (over 600 millimeters per year) and to the geology of Mount Carmel allowing rapid water infiltration. There are two main aquifers: Haifa Bay (about 20 million m$^3$ per year), made up of Quaternary sands overlying Neogene marl and chalk and supplied by direct rainfall and by the Na’aman and Kishon rivers; and Mount Carmel aquifer (about 40 million m$^3$ per year) including the mountain and the adjacent coastal strip and made up of limestone and dolomite.

The Kishon and Na’aman river watersheds cover 1,080 km$^2$ and 317 km$^2$, respectively. The water quality of both rivers in their final stretch is very poor (see Chapter 5). Agricultural pollution adds up to the natural salinity in the upper Kishon. Further down the river, urban and industrial dumping have killed all biological activity. Finally, the river’s estuary is salty. The small streams on Mount Carmel have water only when there is heavy rain.

7.1.2 Supply
Haifa receives its water from the Regional Water Use System, mostly supplied by the National Water Carrier, mainly from Lake Kinneret. The Haifa Bay and Mount Carmel aquifers provide a second source of supply. Water is also supplied, to a smaller extent, by fresh water springs, salt water springs, agricultural drainage, and wastewater reuse.

Water supply is managed by Mekorot, a public company under the authority of the National Water Commission directed by the Water Commissioner who reports to the Minister of Agriculture. Haifa receives 100,000 m$^3$ of water per day (65,000 m$^3$ from surface water and 35,000 m$^3$ from ground water). There are three reception points: south (seven million m$^3$ per year), northeast, by the Nazareth Road (three million m$^3$ per year), and north, on the Accra Road (20 million m$^3$ per year).

7.1.3 Distribution

The distribution network is 700 km long. The network is organized into nine distribution levels from sea level to a height of 481 m. The capacity of regulating reservoirs is only 71,000 m$^3$.

The Mekorot North connection supplies water under a pressure of three bars to the Rushmia distribution and pumping area. This allows distribution to the lower levels by gravity. In Rushmia, a control center centralizes information on the reservoir levels and can turn the pumps on and off. There is no centralized information, however, on the pressure or volume, nor is there a remote control system of automatic valves to open and close sections of the network.

The diameters of the pipes in the distribution network range from 2 to 24 inches. Ninety-five percent of the network is made of iron; the new pipes are lined inside and outside with cement. The network is old; some pipes are 40 years old, while the average age is 20 years. Because of this and because of the high pressure in some areas, there are many water breaks (between 600 and 700 a year) and more than 20 percent of losses, a serious concern in a country with a severe water supply problem. One of the current objectives of the Water, Sewage and Drainage Department is to reduce the amount of water lost during distribution. Staff can receive bonuses equal to 5-6 percent of their salaries; last year, the Department reduced losses by three percent.

Each year, a maximum of 20 km of pipes are replaced; at that rate, it will take 30 years to replace the entire network. The rate of replacement should be increased. A radical seven to ten year replacement program in the most critical areas could halve the losses. This would cost about US$20 million.

7.1.4 Demand

Water demand in Haifa is largely domestic; most of the large consumers in the Kishon Delta are supplied directly by Mekorot. Demand has grown for many years with the city; it is now stable, even slightly decreasing. It went from 27.3 million m$^3$ in 1990 to
25.1 million m$^3$ in 1991. The Water Department of the Municipality foresees an increase to 34 million m$^3$ in 2000 and 40 million m$^3$ in 2010 (see Tables 34 and 35).

**TABLE 34**
WATER USES IN HAIFA

<table>
<thead>
<tr>
<th>Uses</th>
<th>1990</th>
<th>1991</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water Quantity</td>
<td>Consumption per capita</td>
</tr>
<tr>
<td></td>
<td>million m$^3$</td>
<td>(m$^3$ per year)</td>
</tr>
<tr>
<td>1 housing including hot water &amp; gardening</td>
<td>12.237</td>
<td>51.0</td>
</tr>
<tr>
<td>2 offices, institutions commerce &amp; entertainment</td>
<td>1.463</td>
<td>6.1</td>
</tr>
<tr>
<td>3 education</td>
<td>1.001</td>
<td>4.3</td>
</tr>
<tr>
<td>4 health</td>
<td>0.55</td>
<td>2.3</td>
</tr>
<tr>
<td>5 green areas recreation sport clubs</td>
<td>0.538</td>
<td>2.3</td>
</tr>
<tr>
<td>6 hotels</td>
<td>0.214</td>
<td>1.0</td>
</tr>
<tr>
<td>7 special uses</td>
<td>1.412</td>
<td>5.9</td>
</tr>
<tr>
<td>8 small industries</td>
<td>0.546</td>
<td>2.4</td>
</tr>
<tr>
<td>9 port &amp; railways</td>
<td>0.518</td>
<td>2.2</td>
</tr>
<tr>
<td>10 engineering</td>
<td>0.267</td>
<td>1.2</td>
</tr>
<tr>
<td>11 losses, other issues*</td>
<td>5.095</td>
<td>21.3</td>
</tr>
<tr>
<td>Subtotal**</td>
<td>23.989</td>
<td>100</td>
</tr>
<tr>
<td>Total city consumption</td>
<td>26.541</td>
<td>122.9</td>
</tr>
<tr>
<td>Total consumption***</td>
<td>27.312</td>
<td>122.9</td>
</tr>
</tbody>
</table>

*Losses represent the quantity of unsold water (consumers who are not charged such as schools, hospitals, municipality, people who steal, defective meters, and leaks); as shown in Table 35, these losses are expected to decrease to 15 percent in 2000 and 12 percent in 2010.

**Subtotal includes household uses, offices, commerce, and other uses, except industry.

***These figures do not include Qiryat Haim and Qiryat Shmuel in the north eastern part of Haifa. In 1994, Qiryat Haim’s consumption was 2.441 million m$^3$ (estimated to be 3.7 million m$^3$ in 2010) and in 1996, Qiryat Shmuel’s consumption was 0.262 million m$^3$.

Source: Department of Water Sewage and Drainage, Haifa Municipality

**TABLE 35**
FUTURE WATER USES IN HAIFA

<table>
<thead>
<tr>
<th>Uses</th>
<th>2000</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water Quantity</td>
<td>Consumption per capita</td>
</tr>
<tr>
<td></td>
<td>million m$^3$</td>
<td>(m$^3$ per year)</td>
</tr>
<tr>
<td>1 housing including hot water &amp;</td>
<td>15.25</td>
<td>52.0</td>
</tr>
</tbody>
</table>

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2 offices, institutions 
commerce & 
entertainment 1.93 6.6 2.20 6.6
3 education 1.47 5.0 1.67 5.0
4 health 0.74 2.5 0.93 2.8
5 green areas 
recreation 
sport clubs 0.74 2.5 0.86 2.6
6 hotels 0.95 3.2 58.5 1.36 4.1 62.5
7 special uses 1.65 5.6 2.03 6.1
8 small industries 0.88 3.0 1.00 3.0
9 port & railways 0.76 2.6 1.00 3.0
10 engineering 0.53 1.8 0.60 1.8
11 losses, other 
issues 4.40 15.0 4.00 12.0
Subtotal* 29.30 100 122.0 33.30 100 133.0
12 industry 4.70 20.0 6.70 27.0
Total consumption** 34.00 142.0 40.00 160.0

*Subtotal includes household uses, offices, commerce, and other uses, except industry.
**These figures do not include Qiryat Haim and Qiryat Shmuel in the north eastern part of Haifa. In 1994, Qiryat Haim's consumption was 2.441 million m$^3$ (estimated to be 3.7 million m$^3$ in 2010) and in 1996, Qiryat Shmuel's consumption was 0.262 million m$^3$.

Source: Department of Water Sewage and Drainage, Haifa Municipality

Because of the general water shortage in Israel, great importance is placed on improving system efficiency and conservation. National policies encourage more realistic prices, education and information, technical assistance, and economic incentives. Low consumption taps and low and variable flow toilets have been encouraged and have reduced household consumption. Water retention tanks are mandatory in all new buildings in Israel. In Haifa, drip irrigation has been generalized in parks and gardens and the network rehabilitation is encouraged to reduce losses. Industry is also contributing to water reduction by using techniques to control process water, reduce pressure, recycle cooling water, and reuse wastewater.

A far-reaching national campaign has been developed to educate citizens in water savings, especially in drought years, with the slogan “Every Drop Counts.” Water conservation has been included in the national school curriculum. After the 1990/1991 campaigns, urban water consumption went down from 85 m$^3$ per person in 1989 to 70 m$^3$ per person in 1991 (from 110 to 102.4 in Haifa) and household consumption went down from 60 m$^3$ per person in 1989 to nearly 50 m$^3$ per person in 1991 (from 51 to 52.2 in Haifa). After two rainy years, per capita consumption has gone up again.

7.1.5 Quality control

According to the 1989 national bacteriological standards for drinking water, water is unfit for drinking if micro-biological tests reveal more than 3 coliform microbes and/or 1 fecal coliform in 100 milliliters. Mekorot and the Municipality of Haifa perform the
tests, under the supervision of the Ministry of Health. Mekorot tests water sources and supply lines before the connection to the consumer; the Municipality tests the microbiological quality of drinking water sources and distribution pipes at 20 points along the network five times a week. Three chlorination plants along the network maintain the levels of chlorine already provided by Mekorot. Mekorot also adds fluoride to the water supply.

Like similar companies in Europe, Mekorot controls at the source and prior to delivery the levels of organics, heavy metals, nitrates, salinity, hydrocarbons, toxicity, etc. These controls help protect public health and maintain and preserve the resource for the future. The Water Commission uses the control results to establish strategies.

In 1996, out of 2,062 samples, 34 had non-acceptable levels (1.6 percent of the samples).66 The presence of coli is due to improper water storage within the city of Haifa. Haifa’s water supply is currently stored in 42 water reservoirs. The reservoirs should be cleaned twice a year; they are usually cleaned once every few years (up to five years). When the samples show non-acceptable levels of coli, the reservoirs are cleaned and chlorination is increased. Mekorot plans to start filtering the water in 1999; the water will require less chlorination, which will improve water quality.

7.1.6 Institutional framework

The Water, Sewage and Drainage Department of Haifa’s municipality is in charge of drinking water distribution.67 The Department plans, builds and maintains the network (pipe laying and pumping stations, reservoirs, etc.), connects users, installs and maintains water meters, and manages water supply. The Department also extends the network along new streets and roads built by the Ministry of Transportation through Netivay Carmel, a mixed company (State and Haifa Municipality).

The Department’s budget is balanced, without taking into account extraordinary investments, such as the already mentioned replacement. The Department’s annual budget for all activities including wastewater treatment and urban drainage is 80 million NIS, supplied by the connection fees for the drinking water and sewage networks and by the sale of drinking water (3 NIS/m³) and the wastewater treatment tax in the water bill (1 NIS/m³).68 The cost of water supplied by Mekorot is 1 NIS/m³. Only two thirds (20 million m³) of the 30 million m³ supplied are invoiced. About 6 to 7 million m³ are not invoiced (street cleaning, free supply to various institutions, losses).

7.1.7 Conclusions and recommendations

66 Conversation with Mr. Menahem Tal, District Engineer, Ministry of Health, 11 March 1997.

67 The Department also manages the city’s sewage and drainage services and the sewage treatment plant. The Department employs 140 persons.

68 Metering and charging is done by the Department of Treasury and Economical Administration of Haifa’s municipality.
Haifa's old distribution network, mainly made of iron, results in relatively high losses (20 percent) and water breaks (600 per year). Given the scarcity of water resources in Israel and in Haifa, Haifa must improve its management of water. To improve water management, Haifa should:

1. Perform a comprehensive water survey to identify major leaks and set priorities for upgrading;

2. Prepare a plan to upgrade the water distribution network to reduce water losses due to breaks and leaks. Such a plan will include recommendations on budget and schedule;

3. Implement actions to reduce water consumption through education and awareness, and a progressive fee schedule; and

4. Upgrade the central distribution of municipal water by improving its control of pressure and flows to provide better services.
7.2 Wastewater Management

7.2.1 Main sources of pollution

Haifa has two main sources of pollution: (1) sewage discharged into the network --80,000 to 95,000 m$^3$ per day-- and its effluent after treatment and (2) industries in the lower Kishon --11,300 to 13,000 m$^3$ per day. Pollution loads into Haifa Bay, and the Naaman and Hilazon rivers are estimated at 11,800 (mostly from Frutarum Akko, a PVC and caustic soda producer), 2,500, and 6,600 m$^3$ per day, respectively. The power plant discharges 80,000 m$^3$ per hour of cooling water into the bay.

Sewage: thirty percent of the sewage discharged into the Haifa sewage network comes from industry; the rest is from households and businesses. Haifa's sewage is high in organics (BOD$_5$ of 600 mg/l, about 2.5 times higher than in Rome or Barcelona) and in salts (chlorides between 300 and 600 mg/l). High organic concentrations come from the food industry (margarine and edible oil), slaughterhouses, and the population's good water conservation practices that tend to reduce the quantity of water available for dilution. The textile industry and the kosher way of slaughtering also tend to increase the initially high salinity (200 mg/l) of Haifa's water. The electroplating industry discharges heavy metals.

Industry: the pollution in the lower Kishon comes from three sections: (1) between Jalame Bridge, about 17 km from the river mouth, and the point where the Kishon meets one of its tributaries, the Tispori; (2) between this point and the meeting with another tributary, the Gadora; and (3) between this last point and the sea.

1. the effluents, mostly from agriculture and small rural or residential settlements, are not too polluting. The Nesher cement plant uses a wet process, but effectively controls its discharges (suspended solids) and has only a minor impact on the river.

2. this 3.5 km long section receives one of Israel's heaviest pollution load from six sources: five industries (Haifa Oil Refinery, Carmel Olefines, Gadiv Petrochemicals, Haifa Chemicals, and Fertilizers and Chemicals, see Chapter 6) and Haifa's wastewater treatment plant --treats about 95,000 m$^3$ per day, with a conventional primary treatment without oil and grease separation and a secondary treatment with two parallel processes: activated sludge and trickling filters (older process). Table 36 and Figure 19 show the various polluting loads of these sources. In recent years, some polluters (i.e., refinery, Carmel Olefines, and wastewater treatment plant) have taken various actions to control their effluents and comply with their Personal Orders (see Chapter 6). Gadiv Petrochemical, Fertilizers and Chemicals, and Haifa Chemicals have yet to develop plans to comply with acceptable effluent standards.

3. the last section has one main polluter, Gadot Biochemical Industries, a producer of citric acid and industrial chemicals.

<table>
<thead>
<tr>
<th>Source</th>
<th>Polluting load</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE 36 POLLUTING LOADS TO THE KISHON</td>
<td></td>
</tr>
</tbody>
</table>

Haifa Environmental Audit  Chapter 7, Page Page numbers
### Table 1

<table>
<thead>
<tr>
<th>Source: EIB Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIGURE 19</td>
</tr>
<tr>
<td>RELATIVE CONTRIBUTIONS OF POLLUTING LOADS TO THE KISHON</td>
</tr>
<tr>
<td>Discharge (m³/day)</td>
</tr>
<tr>
<td>Refinery</td>
</tr>
<tr>
<td>Haifa Chemical</td>
</tr>
<tr>
<td>Gadiv Petrochemicals</td>
</tr>
<tr>
<td>Fertilizers and Chemicals</td>
</tr>
<tr>
<td>Carmel Olefines</td>
</tr>
<tr>
<td>Wastewater treatment plant</td>
</tr>
<tr>
<td>TOTAL</td>
</tr>
</tbody>
</table>

7.2.2 Municipal sewage management

Haifa’s unitary sewage network covers almost all of its territory, except for a few rural homes. Evacuation is done by gravity with the help of pumping stations for in some flat or elevated areas. Two improvements are needed: (1) expand the pumping station west of the port to avoid overflows into the port at peak times, and (2) rehabilitate the network in Qiryat Haim to avoid flooding and health problems due to sewage overflow. The network cannot drain off rain water because the surface is flat.
and because the pipe and pumping stations are too small. The municipal Water, Sewage and Drainage Department evaluates both projects at US$2 and 30 million, respectively. The Department also needs to avoid the buildup of sand and other sediments in Haifa’s lower part and to repair some of the mechanical and hydraulic failures of the network’s piping.

Two areas are prone to flooding; the problem could be solved by improving the evacuation of rain water. One of these areas is at the junction of the Gadora and the Kishon; it affects the industrial area on the right bank of the Kishon and the suburbs of Qiryat Bialik and Qiryat Atta. The other one is near Bar Yedua Road and Histadrut Bvd (where a small stream crosses) and extends to the sea throughout the industrial area next to the port. There is still a marshy area in this zone (see Chapter 5), left over from the wetlands of the mouth of the Kishon, home to interesting flora and fauna, including migratory birds. The area is bordered by Haifa’s landfill. A plan to evacuate rain water should consolidate and expand as much as possible the wetlands that could act as a buffer and regulate the flow of the river. This would reduce the cost of draining off flood waters from the industrial area and provide Haifa with a central small natural area. All of the above should be coordinated with the plan to close Haifa’s landfill.

The municipality of Haifa and eight other local administrations manage the network of principal drainage reservoirs and the wastewater treatment plant, through HDEAM. About 600,000 people produce between 80,000 and 95,000 m³ of sewage per day (see Section 7.2.1). The wastewater treatment plant has two secondary treatment processes: trickling filters (older) and activated sludge. This last process is more expensive but produces treated water of better quality (less BOD, suspended solids, and heavy metals). The primary treatment is common, as is the sludge digestion system and the sludge drying beds. Fifty to sixty percent of the treated water is reused in agriculture (see Section 7.2.3) and the rest is discharged into the Kishon. The digested and dried sludge is sold to a compost distributor for agriculture. The digestion gas produces electricity for the plant --no connection to the grid for selling surpluses.

The plant is correctly operated and maintained, but does not control enough its discharges. The effluent to be reused is treated better than the one discharged into the river. Sometimes in the summer, there are excessive loads or accidents caused by toxic or salty discharge into the Kishon. This problem will be almost completely solved once the 50 million NIS plant expansion is completed. Treatment capacity will increase by 50,000 m³/day—an additional load equivalent to 340,000 people. The extension of the activated sludge process will increase the BOD discharge from 46,250 to 75,250 kg/day and suspended solids from 53,500 to 87,000 kg/day.

To prevent pollution of the Kishon by toxic chemicals discharged into the sewage network, it is necessary to better control industrial discharges. A safety system could monitor the quality of the sewage upstream of the treatment plant and send toxic waste to a storage and regulation reservoir before it could destroy the treatment plant’s biological process. Finally, it may also be worth building a marine outfall to be used in case of failures of the wastewater treatment plant (e.g., mechanical breakdown or power failure). The impact on the bay would be minimum (one-time event) whereas it could cause important damage to the ecosystem of a rehabilitated Kishon.
7.2.3 Impacts

Effluents from Haifa’s wastewater treatment plant and industries are discharged into:

1. Haifa Bay;
2. rivers, especially the Kishon; and
3. aquifers --Haifa Bay and Mount Carmel.

**Haifa Bay:** because of Haifa Bay's shallow depth (see Figure 20) and despite its open shape, there is little exchange with the Mediterranean, low in nutrients and other pollutants. Therefore, the bay is undergoing a process of eutrophication, with high levels of nutrients and relatively high levels of chlorophyll brought by the Kishon and Na’amen rivers and by industries discharging their effluents directly into the bay. The exchange of water with the Mediterranean limits the growth of phytoplankton, but the already upset balance around the port and along the coast and the high levels of nutrients make the bay very vulnerable. Such a situation favors algae blooming, especially if the water exchange decreases for a while because of the weather. This has already occurred in the past; therefore, the levels of nutrients going into the bay must be controlled very closely.

Most of the heavy metals from the Kishon deposit in the sediments near the port and do not reach the bay. Metal levels in the bay are within recommended standards.

**Kishon:** polluted by organics, nutrients, and heavy metals (see Chapter 5), the Kishon is anoxic, smells bad, and is aesthetically repulsive in its last few kilometers. Its flow is smaller than all of the effluents discharged into its last stretch, mainly from the wastewater treatment plant, except during flooding when the flow can increase to 200 m$^3$/s (once every 10 years) or even 350 m$^3$/s (once every 100 years).

**FIGURE 20**
MAJOR DISCHARGE SOURCES TO HAIFA BAY

(To insert)
To rehabilitate the Kishon, industries must use cleaner technologies and improve effluent treatment or build new wastewater treatment plants (public or private). The level of rehabilitation depends on the final quality desired, which in this case is that of a river used for recreation and with an undisturbed aquatic life habitat.

Aquifers: Haifa’s aquifers are already degraded and a few wells had to be shut down. The volume of ground water extracted should be controlled to avoid salt water intrusion. The refinery controls its installations continuously to prevent ground water infiltration. It is also necessary to control nutrients and pesticides from agriculture, especially in recharge areas, the vertical pollution between aquifers via deep non impermeable wells, and infiltration from the sewage network, especially in the Mount Carmel aquifer. Some industries (fertilizers and petro-chemical) should keep their above ground storage tanks on impermeable floor.

7.2.4 Wastewater reuse

The effluent of Haifa’s wastewater treatment plant is an additional source of water that can somewhat alleviate the water scarcity problem. Mekorot, under the authority of the National Water Board, uses it to irrigate two zones in the Kishon watershed: one in the valley of Jezreel, 30 km from the treatment plant, and another in the Kishon Delta, around the plant, mainly for Kibbutz Yagur. The water irrigates cotton fields and other crops such as corn, and, under certain conditions, orchards.

The valley of Jezreel system has reused 53 million m$^3$ of effluents for irrigation in its first five years of operation –from 1984-85 to 1989-90.$^{69}$ The goal of the reuse system is to replace about two thirds of the fresh water used for irrigation (current need is 50 million m$^3$ a year). In each of the past two years, about 10 million m$^3$ of Haifa’s treated wastewater were reused (see Table 37). Figure 21 shows the location and the dimensions of the system’s major components. Table 38 shows the characteristics of raw, treated, and stored wastewater across the reuse system. Secondary effluents from Haifa’s wastewater treatment plant are pumped to a small (14,000 m$^3$) regulation tank next to the plant where they are chlorinated. They are then sent via a 29 km long asbestos pipe to a stabilization reservoir (maximum capacity of 12 million m$^3$) in the valley of Jezreel. The effluents are chlorinated again in a contact reservoir of 20,000 m$^3$ and flow by gravity to a central reservoir (maximum capacity of 9 million m$^3$) that stores the effluents in the winter and irrigates the cotton fields in the summer; it also stores water from the Sea of Galilee.

<table>
<thead>
<tr>
<th>Year</th>
<th>Volume (million m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-89</td>
<td>8.1</td>
</tr>
</tbody>
</table>

The Kibbutz Yagur system reuses between 1 and 2 million m$^3$ per year from a 30,000 m$^3$ stabilization reservoir with chlorine treatment.

Water reuse has shaped Haifa’s sewage policy. The quality criteria set by the reuse project authorities affect the operation of Haifa’s wastewater treatment plant. Initially, the plant could not reduce total suspended solids to less than 50 mg/l. The construction of a regulation reservoir before the 29 km pipe helped solve this problem by giving organics more time to settle. The reused effluent comes from the activated sludge process, more expensive but better (for BOD and TSS) than the trickling filter process. The lower quality effluent from the trickling filters is discharged into the Kishon. This problem will be solved once the extension of the activated sludge process is completed.

### TABLE 38
CHARACTERISTICS OF RAW, TREATED, AND STORED WASTEWATER ACROSS THE JEZREEL SYSTEM

<table>
<thead>
<tr>
<th>Characteristic (mg/l)</th>
<th>Raw</th>
<th>Treated</th>
<th>After stabilization reservoir</th>
<th>After central reservoir</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD</td>
<td>466</td>
<td>47</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>COD</td>
<td>1,230</td>
<td>164</td>
<td>42</td>
<td>60</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>704</td>
<td>44</td>
<td>15</td>
<td>70</td>
</tr>
<tr>
<td>NH$_4^+$</td>
<td>41</td>
<td>37</td>
<td>11</td>
<td>0.5</td>
</tr>
<tr>
<td>PO$_4^{3-}$</td>
<td>38</td>
<td>22</td>
<td>15</td>
<td>0.5</td>
</tr>
<tr>
<td>Cl$^-$</td>
<td>357</td>
<td>369</td>
<td>380</td>
<td>460</td>
</tr>
</tbody>
</table>

Source: Phone communication with Mr. Azov.

FIGURE 21
JEZREEL WASTEWATER REUSE SYSTEM
(To insert)
Reusing treated wastewater could have long-term negative consequences on water quality. The salinity of the effluents to be reused must be controlled and reduced because of its effect on soil, harvests, and, in some cases, aquifers. Controlling sodium, chlorides, and other salts is one of the main goals of Haifa’s wastewater treatment plant. Some farmers are reluctant to use treated wastewater because of its salinity and because of its price. Agricultural demand tends to weaken in rainy years; the Water Commission and the National Sewage Administration are trying to strengthen this demand and to find other users.

As shown in Table 39, wastewater reuse will increase substantially from 3 percent of available water resources in 1985 to 17.5 in 2025. Water demand from households should increase from 610 million m$^3$ in 1985 to 1,100 million m$^3$ in 2025, while demand from agriculture should remain almost the same. To meet this increased demand, Israel’s strategy is to transfer to households some of the water used in agriculture and increase wastewater reuse in agriculture.

### TABLE 39
ISRAEL'S WATER BALANCE (MILLION M$^3$ PER YEAR)

<table>
<thead>
<tr>
<th>Resources and demand</th>
<th>Year</th>
<th>1985</th>
<th>2000</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resources</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground water</td>
<td></td>
<td>1,217</td>
<td>985</td>
<td>1,120</td>
</tr>
<tr>
<td>Kinneret</td>
<td></td>
<td>610</td>
<td>630</td>
<td>650</td>
</tr>
<tr>
<td>Flood runoff</td>
<td></td>
<td>0</td>
<td>35</td>
<td>80</td>
</tr>
<tr>
<td>Desalinated water</td>
<td></td>
<td>3</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>Wastewater reuse</td>
<td></td>
<td>60</td>
<td>300</td>
<td>500</td>
</tr>
<tr>
<td>Brackish ground water</td>
<td></td>
<td>175</td>
<td>230</td>
<td>290</td>
</tr>
<tr>
<td>Agricultural drainage</td>
<td></td>
<td>50</td>
<td>80</td>
<td>120</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>2,115</td>
<td>2290</td>
<td>2,810</td>
</tr>
<tr>
<td><strong>Demand</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household</td>
<td></td>
<td>610</td>
<td>710</td>
<td>1,100</td>
</tr>
<tr>
<td>Industry</td>
<td></td>
<td>104</td>
<td>160</td>
<td>200</td>
</tr>
<tr>
<td>Agriculture</td>
<td></td>
<td>1,560</td>
<td>1440</td>
<td>1,580</td>
</tr>
<tr>
<td>Nature and recreation</td>
<td></td>
<td>50</td>
<td>160</td>
<td>150</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>2,324</td>
<td>2,470</td>
<td>3,030</td>
</tr>
</tbody>
</table>


The primary goal of the national authorities, especially the Water Commission, should be to assist with and encourage the adoption of clean technologies that can prevent pollution at the source and generate cleaner effluents for reuse.

### 7.2.5 Regulatory and institutional framework

$^{70}$Industrial effluents from the water purification process have high concentrations of salts.
Israel is trying to preserve and increase its water resources and comply with the 1975 Barcelona Convention and its protocols that protect the Mediterranean Sea against pollution. These efforts have resulted in laws, regulations, and national planning systems. The 1959 Water Law and its 1971 and 1991 amendments, the 1988 Prevention of Sea Pollution (Land-Based Sources) Law, the 1962 Local Authorities Sewage Law, the 1962 Streams and Springs Law, and the 1981 Model Local Authorities By-Law (Discharge of Industrial Sewage into the Sewage System) reflect this national will to prevent water pollution. Various Ministries --Interior, Environment, Health, and Agriculture-- operate in this field, as well as the national Water Commission and Water Commissioner, and the newly created National Sewage Administration, responsible for preparing national plans and policies on sewage.

The planning, construction, and management of Haifa’s sewage treatment system must meet the following objectives, once 100 percent of the users are connected:

1. Preserve Haifa Bay’s biological balance and prevent eutrophication (algae blooming);

2. Improve water quality in the rivers, especially the Kishon, to established quality standards;

3. Preserve and improve aquifers; and

4. Reuse treated sewage as much as possible, primarily in agriculture.

To reach these objectives, a collective will and financial means are necessary; in addition, responsible authorities must coordinate their efforts. To be effective, fees and incentives, quality objectives for water or effluent standards, pollution prevention and control, inspection and enforcement require participation, consensus, and coordination.

In December 1994, MOE and the Municipality of Haifa created the Kishon River Authority (KRA) to rehabilitate the last 25 km of the river; the Authority controls water quality and substances dumped into the Kishon. It has a Council of 26 members, presided by a MOE representative and includes representatives of the Ministries of the Interior, Home Affairs, Tourism, Agriculture, and Housing, the main local entities of the area, the Port Authority, land owners, industries, etc. The Mayor of Haifa presides a nine member Board.

The Kishon’s master plan is currently being developed; it will integrate aspects of ecological rehabilitation, drainage, public use of the banks, control of effluents, etc. One or two parks have been set up along the Kishon’s banks; they bring the population closer to the river and highlight the natural values of its surroundings. They raise public awareness of the river rehabilitation project. A large park is planned between the fishing port and Julius Simon Bridge, central to Greater Haifa, thanks to the Port Authority who has donated the land.
Systematic inspections of effluent discharges have begun with the cooperation of the industries and the treatment plant. A real-time effluent monitoring system or an automated sampler are being considered. The most significant task is the progressive implementation of programs to control discharges to the Kishon and to the sewage network. KRA may also be very effective because of its broad composition.

HDEAM could also play a major role given its successful experience in reducing Haifa’s air pollution. HDEAM could set up a team to control Haifa’s polluting industrial activities as integrated processes instead of focusing on one medium (e.g., water and air). This integrated approach to pollution control is embedded in the ISO 14000 standards and a new European directive.

Improvement programs are going forward, even when there are differences of criteria and a consensus has not been achieved. During the audit (last week of November), Haifa Chemicals settled a law suit out of court. According to the settlement, Haifa Chemicals will treat its effluents according to a four-year schedule. The first effluent must be treated four months from now, the last one in four years. HDEAM will enforce this settlement. In the next five years, Haifa Chemicals will give $50,000 a year to a new independent body that will promote environment education and awareness.

The EIB study, completed in September 1996, analyzes the ecosystems of the bay and the Kishon, estimates the environmental impacts of the pollution received, and uses models to evaluate alternative rehabilitation scenarios (see Chapter 5). The EIB study proposes modifications of the effluent standards in the 1981 Model By-Law for Local Authorities (Discharge of Industrial Wastes into the Sewage Systems); it adapts these standards to the assimilative capacity of the Kishon and the bay, the quality objectives for water and sediments, and the nature of the pollutants. The EIB study also proposes a strategy based on strict compliance with standards, real-time monitoring of effluents, and a single collection of effluents before the Kishon – effluents above the standards would return to their source for appropriate treatment. KRA would implement this strategy, perhaps with the participation of the industries who would pay for monitoring (industries already pay for air monitoring, see Chapter 6).

The feasibility of this proposal depends on the consensus that can be achieved with the polluters. It may also be technically difficult to return the effluents that do not comply with the standards. KRA and the water supply authorities (Water Commission and Mekorot) should coordinate this integrated action to correct the salinity that remains in the treated effluent.

7.2.6 Conclusions and recommendations

Haifa faces the challenge of treating municipal and industrial discharges. The wastewater treatment plant’s extension should lower the plant’s organic discharge to the Kishon and improve the Kishon’s rehabilitation, since the plant’s discharge to the Kishon

The Kishon River Authority’s strategy is based on creating a temporary intermediary state of water quality that will allow recreation on the Kishon’s banks and avoid the scum and the odors. To reach this state, the Kishon River Authority will establish industrial effluent standards and regularly monitor their implementation. Once the pollutants are removed from the Kishon, the water quality target will be reached.
represents more than 95 percent of the total organic load discharged by point sources to the Kishon. This extension will not reduce water salinity, however, and it will still be difficult for the wastewater treatment plant to sell its treated effluent to Mekorot. Most industrial effluents are discharged to the Kishon without treatment. To improve the treatment of municipal and industrial effluents, Haifa should:

1. Coordinate with MOE to issue Permit Orders (under the Water Law) specifying effluent discharge standards for each plant. These standards should be consistent with the Kishon's water quality targets and the protection of the Kishon's ecosystem. Industries could decide whether they want to have a common industrial wastewater treatment plant. There should be a similar process for effluents discharged into Haifa Bay (e.g., discharge of mercury from the PVC plant near Acre).

2. Strengthen the control of industrial discharges to the sewage network through inspections, progressive cleanup programs, etc. Current human and financial resources of the organizations in charge (i.e., Haifa municipality and wastewater treatment plant) are very limited.

3. Reinforce the "polluter pays" principle for liquid effluents from industry --through municipal sewage or effluent discharge fees, thus encouraging companies to minimize waste and use clean technologies --the Kishon River Authority (KRA) could use these revenues to implement its program.

4. Establish a monitoring system to analyze continuously the main industrial and urban effluents discharged to the Kishon.

5. Establish a buffer system at the Kishon-Gedova junction to prevent effluents from polluting the river and the bay; effluents above the standards would be returned to the treatment plant for further treatment.

6. Expand the main pumping station of the municipal sewage network to prevent accidental overflows into the port.
8. WASTE MANAGEMENT

Haifa’s waste management situation is mixed. Haifa’s streets are clean thanks to a well organized operations department within the municipality. Once Haifa collects its waste, however, it does not manage it properly. Its recycling is well below the targets specified by the Ministry of the Environment; Haifa could certainly learn from other nearby municipalities that have successfully implemented very efficient recycling and composting programs. Haifa’s worst waste management problem is undoubtedly its landfill, a waste dump with severe negative impacts on the environment.

Haifa’s industries send their hazardous inorganic wastes to Israel’s hazardous waste management facility in Ramat Hovav; there is no treatment, however, for organic wastes that are stored on site by industries or in Ramat Hovav.

Haifa’s population and industries generate municipal, medical, and hazardous waste. For each of these waste categories, this chapter presents waste quantities and characteristics, waste management practices, and applicable laws and regulations.

8.1 Municipal Solid Waste

Haifa’s collection of municipal solid waste is quite efficient; its disposal in an uncontrolled landfill, however, is a disgrace.

8.1.1 Collection

The operations department of Haifa’s municipality cleans the streets and collects municipal solid waste. The department has divided the city into five areas: Carmel, Neve Sha’anan, Hadar, Downtown and Western, and Qiryat Haim. The department has 230 street cleaners and 130 drivers and workers collecting waste two to three times a week usually in the morning; the department is trying to improve the afternoon collection, due to traffic problems. The collection equipment consists of trucks and sweepers (see Table 40) and containers and bins: big metal containers of 32, 15, 12, 8, and 6 m$^3$, plastic containers of 1.1 m$^3$ and 800 liters, and plastic bins of 360 and 400 liters. The department is now trying to standardize the system with 1.1 m$^3$ containers and compaction trailers, a system more useful than the older one because pick-up trucks could only transport the big containers one by one. Table 41 and Figure 22 show the shift from big metal containers to plastic containers over the past four years.
<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roll-off truck (for big metal containers)</td>
<td>35</td>
</tr>
<tr>
<td>Truck with mechanized arm (for trees and waste piles)</td>
<td>8</td>
</tr>
<tr>
<td>Compaction trailer</td>
<td>28</td>
</tr>
<tr>
<td>Double axle truck</td>
<td>2</td>
</tr>
<tr>
<td>Mechanized sweeper</td>
<td>5</td>
</tr>
</tbody>
</table>

**TABLE 41**

NUMBER OF CONTAINERS AND BINS IN THE PAST FOUR YEARS

<table>
<thead>
<tr>
<th>Type of container or bin</th>
<th>1992</th>
<th>1993</th>
<th>1994</th>
<th>1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small plastic bins</td>
<td>15,173</td>
<td>13,829</td>
<td>11,832</td>
<td>10,399</td>
</tr>
<tr>
<td>Plastic containers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>360-400 l</td>
<td>1,636</td>
<td>1,912</td>
<td>2,051</td>
<td>2,303</td>
</tr>
<tr>
<td>800 l</td>
<td>616</td>
<td>732</td>
<td>646</td>
<td>667</td>
</tr>
<tr>
<td>1,100 l</td>
<td>0</td>
<td>146</td>
<td>647</td>
<td>1,751</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2,252</td>
<td>2,790</td>
<td>3,344</td>
<td>4,721</td>
</tr>
<tr>
<td>Big metal containers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 m³</td>
<td>149</td>
<td>66</td>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>6 m³</td>
<td>302</td>
<td>266</td>
<td>235</td>
<td>168</td>
</tr>
<tr>
<td>8 m³</td>
<td>606</td>
<td>585</td>
<td>561</td>
<td>532</td>
</tr>
<tr>
<td>12 m³</td>
<td>11</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>15 m³</td>
<td>134</td>
<td>134</td>
<td>128</td>
<td>150</td>
</tr>
<tr>
<td>32 m³</td>
<td>11</td>
<td>12</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1,213</td>
<td>1,065</td>
<td>960</td>
<td>867</td>
</tr>
</tbody>
</table>

Source: Operations Administration, Haifa Municipality, 1995 Annual Report

**FIGURE 22**

BIG METAL AND PLASTIC CONTAINERS IN THE PAST FOUR YEARS
8.1.2 Quantities and characteristics

In 1995, the department collected about 570 tonnes of waste per day, six days a week, including 420 tonnes of domestic and commercial waste and 150 tonnes of yard, furniture and street cleaning waste. This waste quantity represents an average of 1.88 kg per person per day, a waste production rate higher than the average in the United States (1.6 kg per person per day\textsuperscript{72}) and in most European cities and among the highest of Mediterranean cities. This rate is also higher than the Israeli average, 1.6 kg per person per day in 1994 according to Israel’s Ministry of the Environment (MOE).\textsuperscript{73} This high waste production rate results from rising standards of living and food consumption patterns; families buy vegetables that are thrown away if not prepared immediately. As shown in Table 42, this rate varies by district; the Qiryats’ rate (2.44 kg/person/day) is almost twice as high as the Carmel’s (1.34 kg/person/day).

Haifa’s population also produces 30 tonnes per day of cardboard and paper waste (collected and recycled by a paper company) and 300 tonnes per day of commercial and industrial waste (similar to municipal solid waste, generally from small businesses around the port). This waste is collected and managed by private companies such as Ramsa, one of the largest companies. Ramsa sends its waste to a small landfill near the municipal landfill and also recovers some paper and cardboard (included in the 300 t/d).

<table>
<thead>
<tr>
<th>TABLE 42</th>
</tr>
</thead>
<tbody>
<tr>
<td>WASTE PRODUCTION BY DISTRICT</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>District</th>
<th>Waste quantity (tonnes/day)</th>
<th>Population</th>
<th>Daily production rate (kg/person/day)</th>
</tr>
</thead>
</table>


\textsuperscript{73}The Environment in Israel, Ministry of the Environment, Jerusalem, 1994, page 66.
The composition of domestic waste in northern Israel (no data available for Haifa) is the following: 55.2% organic, 19.7% paper and cardboard, 11.1% plastic, 4.1% textile and rubber, 4.1% metals, 2.7% glass, and 3.1% other materials. MOE’s estimates are similar: 50-54% organic, 16-21% paper and cardboard, 10-12% plastic and synthetic material, 3-5% metals, 3-4% textiles, and 0-15% miscellaneous.

### 8.1.3 Recycling and composting

Theoretically, all solid waste components can be recycled. Practically, MOE’s current goal is to reach a 10 percent recycling rate in 1995 and about 25 percent by 2000. Haifa is far away from this goal since only about five percent of domestic waste (30 tonnes/day of paper and cardboard out of 600 tonnes/day of domestic waste) is recycled. Three years ago, the municipality tried to implement a recycling program; the effort was successful but too costly (Box 11).

According to the operations department of Haifa’s municipality, recycling would be too expensive and would complicate waste collection. Haifa recycles two other waste types: used oil (Box 12) and batteries (Box 13).

If Haifa does not strongly promote recycling, other municipalities very close to Haifa are national models for recycling. Qiryat Tivon, a municipality less than 10 miles away from Haifa with 13,500 people has a pioneer recycling program with a wide-based educational component established since the start. So far, the results have been encouraging. Out of 450 tons of waste produced each month, over 13 percent (weight) and 30 percent (volume) are collected for recycling, through six drop-off recycling centers and a curbside commingled collection program for paper, plastics, glass, and textiles. Over 60 percent of the population participates in the project. The Qiryat Bialik compost plant is another successful recycling example in Haifa’s metropolitan area (Box 14).

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Carmel</td>
<td>121.2</td>
<td>77,740</td>
</tr>
<tr>
<td>Neve Sha’anen</td>
<td>88.6</td>
<td>51,740</td>
</tr>
<tr>
<td>Hadar</td>
<td>118.2</td>
<td>42,380</td>
</tr>
<tr>
<td>Downtown</td>
<td>148.8</td>
<td>55,640</td>
</tr>
<tr>
<td>Qiryats</td>
<td>92.6</td>
<td>32,500</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>569.4</td>
<td>260,000</td>
</tr>
</tbody>
</table>

**BOX 11**

SUCCESSFUL BUT SHORT-LIVED RECYCLING ATTEMPT

In 1993, the municipality of Haifa, HDEAM, and MOE started a four-month recycling pilot project for about 250 apartments in one of Haifa’s middle class areas. Apartment residents were asked to separate glass, metal, plastic bottles (PET), and other plastics from organic waste. Haifa’s municipality provided outside containers for the recycled materials, HDEAM provided leaflets (with the assistance of boy scouts) and coordinated meetings to explain the goals of the pilot project, and MOE provided apartment residents with plastic bags.

---


Participation was high (77 percent) and exceeded HDEAM's expectancies; ninety-eight percent of participants wanted to continue the pilot project. The project collected 53 kg of glass, 13.5 kg of metals, 58.5 kg of PET, and 28 kg of other plastics. HDEAM identified companies interested in buying these materials but they wanted a long-term agreement and a regular flow of materials. The municipality decided that it was too costly and the recovered materials were disposed of in the Shemen landfill.

Source: Meeting with Eva Zidoni of HDEAM

BOX 12
USED OIL RECYCLING

The quantity of motor oil used in Israel, mostly by garages and industrial plants, is estimated at 50,000 tons per year, of which over 15,000 tons are recyclable. The 1993 Used Oil Regulations prohibit the burning and improper disposal of used oil. Oil sellers, users, and consumers must collect used oil in specially-designated receptacles sent for final disposal to Ramat Hovav or to a recycling facility. Today, only 7,000 tons per year are recycled, largely due to the high cost of buying and transporting used oil and to the tax requirements. About 3,000 tons per year are collected for unregulated fuel use or incineration; the remainder goes into sewage, soil, and water sources.

Israel has two used oil recycling facilities, including the Haifa-based Paz company. Until 1993, Paz used an old technology (treatment with sulfuric acid) producing large quantities of acid sludges that had to be sent to Ramat Hovav. Paz is now using a new hydrocracking system.

BOX 13
BATTERY RECYCLING

Each Israeli family uses 1.4 kg of batteries on average; the annual quantity is estimated at 1,500-1,800 tons. In Israel, only car batteries are recycled; the relatively small quantity of household batteries has thus far prevented the development of a viable industry for collecting and recycling of batteries. In 1993, MOE, in cooperation with local authorities and environmental units launched a national battery-collection campaign. MOE has already provided local authorities with over 43,000 specially-designed battery-collection containers. Local authorities are responsible for distributing the containers in convenient locations, collecting them once they are full, and sending them to Ramat Hovav. In 1995, after a two-year collection effort, the municipality of Haifa and HDEAM sent 2.3 tons of batteries to Ramat Hovav.

BOX 14
THE QIRYAT BIALIK COMPOST PLANT

Located north of Haifa, near Acre, the Qiryat Bialik compost and materials recovery facility receives wastes from municipalities in Haifa’s metropolitan area. The plant belongs to the Western Galilee and Haifa Bay compost company Ltd., a public company set up and founded by the municipalities of Qiryat Bialik, Qiryat Motzkin, Qiryat Yam, Acre, and Nahariya and the regional councils of Mate Asher and Na’aman. The regional councils of Nesher and Rechasim joined the company later.

The plant receives 450 tonnes/day of waste (300 tonnes of domestic waste and 150 tonnes of yard waste) from about 300,000 people, each generating about 1.5 kg/day of wastes. Trucks coming to the plant are weighed and their originating municipality is recorded. The yard waste is shredded and the

76 The Environment in Israel, Ministry of the Environment, Jerusalem, 1994, page 75.
77 The Environment in Israel, Ministry of the Environment, Jerusalem, 1994, page 77.
78 Profile and plant information, the Western Galilee & Haifa Bay company Ltd., 1996.
domestic waste is discharged into the pit of a sorting plant. A brand new sorting plant (built six months ago at a cost of US$2.5 million) processes the 300 t/d in eight hours. A conveyor belt sends the waste from the pit to a drum. Before the drum, four workers remove materials such as tires, big cardboards, and metal pieces that could create problems. The drum separates the waste into putrescible materials (falling through the drum’s holes into a container) and inorganic and recoverable materials (staying in the drum).

Inorganic materials are sorted manually in a series of stations isolated from the rest of the plant to avoid dust and odors and maintain a good quality environment for the workers; materials recycled include cardboard, paper, newspapers, steel, aluminum, and glass. Recycled materials are conveyed to containers or to a centralized compactor to be packaged in bundles.

Fermentable materials (50% of the domestic waste is organic) are mixed with the shredded yard waste and sent to the Dano composting system consisting of three aerobic horizontal reactors (Danish technology). The compost from reactors is then laid on a concrete surface and turned and ventilated in open air with a Scarab mechanical vehicle. The compost is finally crushed, sifted, and blended with additives, depending on the clients’ needs and compost use.

The plant recovers 60 percent of domestic waste: 30 t/d of valuable materials (glass, paper and cardboard, metals, plastics) and 150 to 200 t/d of compost. About 120 t/d of refuse are sent to the landfill near the plant and more than 100 t/d are lost in the production of compost in the form of CO₂ and methane and through water evaporation.

About 30 people work at the plant: three in management and administration, one at the weighbridge, 12 in the sorting and recycling area, and 14 in the compost area. Municipalities pay the company 45 NIS per ton of waste sent to the plant. The plant sells two kinds of compost: rough (15 NIS/m³) and fine (33 NIS/m³). Plant management complained that some recovered materials’ prices were too low due to a monopoly situation. The paper and cardboard are sold to the American-Israel Paper Mills’ Hadera plant (50 NIS/t for newspapers, 100 NIS/t for office paper, and 200 NIS/t for cardboard). The metal is sold at 100 NIS/t. The PET is sold at 555 NIS/t and sent to Italy and Holland, because Israel does not recycle PET yet. Other plastics are sold at 200 NIS/t to Amnir Recycling Industries (a subsidiary of American-Israel Paper Mills) and are turned into garbage bags, irrigation pipelines, detergent containers, injection materials, etc.

8.1.4 Disposal

All of the municipal solid waste goes to the Dano transfer plant; it is then loaded into 32 m³ containers with a tractor and sent to a landfill in the middle of Haifa’s territorial area in an alluvial area. The land belongs to the Port authority, its surface area is 0.28 km². Its use as a landfill began under the British mandate. A tractor covers the waste with a layer of earth or construction debris. The landfill, opened from 6 am to 4 pm, is surrounded by a metal fence. After working hours, the entrance is closed with a metal gate. There are no liners nor any systems to prevent rainfall or runoff water from entering the waste. Nor is there any gas extraction and venting system.

79 The Port Authority also sends daily 20 to 30 tonnes of wastes, such as food waste from the ships and the port’s dining rooms, construction debris, and cleaning materials.
There are piles of construction debris and demolition waste, along the roads into and out of Haifa and on the flat lands around the roads. Haifa's municipality disposes of construction and demolition debris in another landfill, the Dori landfill, located in a curve, at the border of Haifa's territorial area. This location has created some problems with the adjacent municipality whose mayor has asked Haifa's municipality to stop sending its construction debris to the Dori site. The Dori site is temporarily closed and Haifa disposes of construction debris in its solid waste landfill.

### 8.1.5 Waste management costs

As shown in Table 43, waste collection and disposal costs represent almost 60 percent of the operations department's annual budget of about US$31.25 million (maintenance of sidewalks, streets, street lights, seashore, gardens, food (meat) control, and traffic lights).

<table>
<thead>
<tr>
<th>Waste management operation</th>
<th>Annual Cost (million US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Street cleaning</td>
<td>7.50</td>
</tr>
<tr>
<td>Waste collection</td>
<td>10.67</td>
</tr>
<tr>
<td>Disposal</td>
<td>0.23</td>
</tr>
<tr>
<td>Total</td>
<td>18.40</td>
</tr>
</tbody>
</table>

The annual quantity of waste collected is 177,840 tonnes (570 tonnes per day, six days a week, 52 weeks a year). Therefore, the waste management unit cost is 61.3 US$/tonnes (US$60 for collection and US$1.3 for disposal). As shown in Table 44, this cost is higher than the unit cost in Algeria and Tunisia, but lower than the unit cost in Spain and Denmark, primarily because Haifa does not properly treat or dispose of its municipal solid waste.

<table>
<thead>
<tr>
<th>City</th>
<th>Cost (US$/tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haifa, Israel</td>
<td>61.3</td>
</tr>
<tr>
<td>Algiers, Algeria</td>
<td>20</td>
</tr>
<tr>
<td>Alicante, Spain</td>
<td>72</td>
</tr>
<tr>
<td>Tarragona, Spain</td>
<td>85</td>
</tr>
<tr>
<td>Sfax, Tunisia</td>
<td>21</td>
</tr>
<tr>
<td>Kairouan</td>
<td>23</td>
</tr>
<tr>
<td>Tunis, Tunisia</td>
<td>26</td>
</tr>
<tr>
<td>Copenhagen, Denmark</td>
<td>165</td>
</tr>
<tr>
<td>Roskilde, Denmark</td>
<td>115</td>
</tr>
</tbody>
</table>
As shown in Table 44, Haifa’s collection costs are comparable to the collection costs of Spanish cities with a similar economic level (Israel’s 1993 per capita Gross Domestic Product --13,920 US$/year-- is comparable to Spain’s --13,590 US$/year), Haifa’s collection costs are also comparable to Argentina’s collection costs, despite a much lower GDP for Argentina (6,050 US$/year). Haifa’s disposal costs, however, are much lower than the treatment and disposal costs of Spanish cities and less than 15 percent of the landfill costs of La Plata, capital of Buenos Aires province, in Argentina. All of the Spanish cities and La Plata have either an incinerator or a sanitary landfill.

8.1.6 Laws and regulations

The storage, collection, and disposal of solid waste are primarily within the jurisdiction of municipalities and are largely governed by municipal by-laws that determine the legal and administrative arrangements for collection and disposal. Regulations promulgated under the Planning and Building Law set out requirements for the size and type of waste containers as well as the size and type of structures for housing these containers.

<table>
<thead>
<tr>
<th>City (year)</th>
<th>Collection cost (US$/t)</th>
<th>Treatment/disposal cost (US$/t)</th>
<th>Treatment/disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haifa, Israel (1995)</td>
<td>60</td>
<td>1.3</td>
<td>Landfill</td>
</tr>
<tr>
<td>Barcelona, Spain (1995)</td>
<td>69</td>
<td>33</td>
<td>Incineration, Landfill, Recycling</td>
</tr>
<tr>
<td>Valencia, Spain (1993)</td>
<td>55</td>
<td>14</td>
<td>Recycling/compost, landfill</td>
</tr>
<tr>
<td>Valladolid, Spain (1993)</td>
<td>40</td>
<td>6.3</td>
<td>Landfill</td>
</tr>
<tr>
<td>La Plata, Argentina (1994)</td>
<td>52</td>
<td>10.5</td>
<td>Landfill</td>
</tr>
</tbody>
</table>


Municipalities are also responsible for siting landfills and other waste management facilities according to regulations under the Planning and Building Law and according to the National Outline Scheme for Solid Waste Disposal. According to MOE, the Scheme’s goal is to minimize environmental pollution by operating a few large landfills serving as large a population as possible. There is no timetable, however, for establishing new landfills nor for shutting down unauthorized dumps; their continued use is allowed until an alternative is found. In June 1993, the government took a landmark decision to establish central landfills, shut down hundreds of illegal dumps, and create an infrastructure for environmentally-safe solid waste disposal in the short and long

80The Environment in Israel, Ministry of the Environment, Jerusalem, 1994, page 78.
terms. This decision does not seem to have had any impact on Haifa’s dump, which, according to MOE, already had no landfill space left in 1993.\textsuperscript{81}

Solid waste management is also subject to several other laws:

- \textsuperscript{72} The 1984 Maintenance of Cleanliness Law prohibits throwing any waste, construction debris, and vehicle scrap into the public domain, or from the public domain into the private domain. The law also establishes a Cleanliness Maintenance Fund administered by the Ministry of the Environment. The Fund is financed by a cleanliness fee on manufacturers and importers of disposable beverage containers and from fines paid by violators of the law. In 1993, the Fund’s budget totaled $365,000 --$233,000 from the cleanliness fee and $132,000 from fines.

- \textsuperscript{73} Under the 1961 Abatement of Nuisances Law, regulations to prevent odors and air pollution from solid waste disposal sites were promulgated in 1990. Under the same law, regulations against burning waste in solid waste disposal sites and against the improper disposal of used oil were promulgated in 1993. Used oil generators must collect used oil in specially-designated receptacles and send it to the Ramat Hovav hazardous waste site (see Section 8.3) or to a recycling facility.

- \textsuperscript{74} The 1993 Collection and Disposal of Waste for Recycling Law provides the principles and framework for recycling. The law allows municipalities to pass by-laws specifying procedures for collecting and disposing of waste for recycling.

### 8.2 Medical Waste

Haifa’s three hospitals (Bnei-Zion-Rotschild, Carmel, and Rambam) have a total of 2,000 beds. Rambarn is the largest one with about 1,000 beds. Israel’s Ministry of Health has defined four categories of medical wastes: infectious (biological, e.g., bandages, syringes, test tubes, infected cotton wool, incontinence pads, and sanitary towels), toxic (chemical), radioactive, and municipal (primarily food). Hospitals separate their wastes in situ into these four categories.

#### 8.2.1 Quantities

Assuming that the average waste production rate of Haifa’s hospitals is the same as European hospitals --2 kg per bed and per day, including 1.6 kg of municipal waste and 0.4 kg of infectious and toxic wastes (excluding radioactive waste), Haifa’s three hospitals generate 4 tonnes of waste per day --3.2 tonnes of municipal waste and 0.8 tonnes of special wastes. Israel’s hospitals produce 2,000 tons (1,818 metric tonnes)

\textsuperscript{81} The Mayor of Haifa told us that there was a plan to send Haifa’s waste by train to a landfill south of Haifa; details of the plan remain sketchy.
per year of infectious and toxic (non-radioactive) wastes.\textsuperscript{82} Haifa’s annual production (292 tonnes) represents 16.1 percent of Israel’s, whereas Haifa’s population is only five percent of Israel’s; this high production of medical waste is due to the fact that the largest hospitals in northern Israel are in Haifa.

\textbf{8.2.2 Waste management}

In Haifa, infectious wastes are collected into black bags and treated on site with steam (autoclave) or ethylene oxide. Once the waste is no longer infectious, it is mixed with urban waste, collected by the municipality’s operations department, and sent to Haifa’s solid waste landfill.

Toxic wastes (analyses reagents, pharmaceutical products) are sent to the Ramat Hovav hazardous waste site (see Section 8.3). HDEAM’s Industrial Department controls toxic and infectious wastes. In 1994, Haifa’s hospitals sent 60 tons of toxic waste to Ramat Hovav; in 1995, they sent 29.3 tons. These figures indicate that less than 20 percent of the 292 tons of toxic and infectious wastes are toxic and that the remainder is infectious.

Radioactive wastes are controlled and collected by Nahal Sorek, a state company reporting directly to the prime minister’s office.

\textbf{8.2.3 Laws and regulations}

Israel does not have laws on medical wastes; a joint committee of the Ministries of the Environment and Health, working according to World Health Organization guidelines for managing biological wastes, has called for the establishment of 15 to 20 regional disposal centers at main hospitals throughout the country.\textsuperscript{83}

\textbf{8.3 Hazardous Waste}

There are about 200 companies in Haifa’s industrial area, including Israel’s largest refinery and petrochemical complex. The refinery is the largest one and employs 1,323 persons; many small companies (e.g., cleaning products) employ a handful of persons. Most of these companies produce hazardous waste.

\textbf{8.3.1 Quantities and characteristics}

In 1992 and 1993, Haifa sent 11,449 tons and 13,606 tons of hazardous waste (see Table 46), respectively, to the Ramat Hovav disposal site (see Section 8.3.2). In 1994 and 1995, these quantities were more than halved after the refinery obtained a permit to inject 7,000 tons of spent caustic soda in deep wells (see Box 15).

\textsuperscript{82}The Environment in Israel, Ministry of the Environment, Jerusalem, 1994, page 92.

\textsuperscript{83}The Environment in Israel, Ministry of the Environment, Jerusalem, 1994, page 91.
These figures do not include all of the hazardous waste generated; some industries store organic materials on site. For example, the refinery stores 500 tons per year of organic sludges in open ponds while waiting for the construction of a hazardous waste incinerator in Ramat Hovav. There are years when Haifa’s industries generate more hazardous waste after cleaning up storage areas or backyards where waste had been accumulated prior to the hazardous waste regulations (the refinery and the petrochemical plant began operating in the 40’s). Some dredged sediments from the Kishon river also need proper disposal (Box 16).

**TABLE 46**

<table>
<thead>
<tr>
<th>Company</th>
<th>1993</th>
<th>1994</th>
<th>1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil refineries (refinery)</td>
<td>8,471</td>
<td>45</td>
<td>273</td>
</tr>
<tr>
<td>Paz (oil recycling)</td>
<td>2,049</td>
<td>1,547</td>
<td>1,051</td>
</tr>
<tr>
<td>Zica (electrodes)</td>
<td>177</td>
<td>238</td>
<td>91</td>
</tr>
<tr>
<td>Klii (aluminum)</td>
<td>172</td>
<td>134</td>
<td>171</td>
</tr>
<tr>
<td>Galvanotecnia</td>
<td>171</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Carmel Olefines (petrochemical)</td>
<td>161</td>
<td>67</td>
<td>158</td>
</tr>
<tr>
<td>Frutarom (essences)</td>
<td>156</td>
<td>232</td>
<td>318</td>
</tr>
<tr>
<td>Gadiv (petrochemical)</td>
<td>98</td>
<td>1,343</td>
<td>454</td>
</tr>
<tr>
<td>Carmel Forge</td>
<td>79</td>
<td>86</td>
<td>59</td>
</tr>
<tr>
<td>Haifa Chemicals (fertilizers)</td>
<td>79</td>
<td>86</td>
<td>59</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>13,606</td>
<td>5,784</td>
<td>4,635</td>
</tr>
</tbody>
</table>

Source: HDEAM’s 1994 Annual Report

**BOX 16**

HAIFA’S DREDGED SEDIMENTS

The hydraulic discharge capacity of the Kishon river has been reduced considerably (see Chapter 5). In 1992, after heavy rains, the Kishon flooded the industrial area. Urgent and structural flood control measures were required. The Zevulun Drainage Authority started to dredge the sediments from the river (about 500,000 m$^3$) and stored them into ponds lined with HDPE, along the banks of the river. The sediments have been sampled extensively over the past four years. The concentrations of cadmium, mercury, and total hydrocarbons exceed the maximum values allowed for unrestricted disposal at sea.

The dredged sediments, unlike the sludges of the Haifa wastewater treatment plant that are composted, cannot be used in agriculture because of their high cadmium concentration. The sediments are in the west and east ponds and they are waiting for proper disposal. According to the EIB study, the sediments from the ponds should be transferred to a land-based disposal site properly designed to avoid

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pollution. The cost of building such a site and transferring the sediments is about 50 million NIS; polluters should pay according to the quantities of pollutants they discharge.

BOX 15
HAZARDOUS WASTES GENERATED BY THE REFINERY

As explained in Chapter 6, the Haifa refinery produces most of the feedstock for the Haifa Bay petrochemical industry. The refinery generates the following hazardous wastes:

- **Crude tank bottoms.** About 500 tons per year generated from the cleanup of storage tanks. This waste stream contains sand, silt, and insoluble metals. MOE denied a permit to burn this waste in a special burner, due to the waste’s heavy metal content. Until 1993, this organic waste was sent to Ramat Hovav; Ramat Hovav’s storage capacity for organic wastes is exhausted, however, and the refinery currently stores this waste in open ponds while waiting for the construction of a hazardous waste incinerator in Ramat Hovav (see Section 8.3.2).

- **Spent catalysts.** About 50-100 tons every 3-4 years; they contain heavy metals: mostly nickel and molybdenum.

- **Spent caustic soda.** About 7,000 tons per year of liquids (density of 1.1 kg/l) with a high content of mercaptans and other foul-smelling sulfur compounds. This waste must remain in an enclosed area. Until 1993, this waste was sent to Ramat Hovav; in 1994, the refinery obtained a permit to inject this waste in an abandoned oil well (Kochav-1) in the south of Israel at Nearkhalon.

- **Industrial wastewater treatment sludges.** The refinery’s wastewater treatment plant—capacity of 200-300 m$^3$/h—has the following treatment processes: physical (gravity), chemical-physical (colloids and emulsions), biological (destruction of organic matter), chemical clarifier (using lime), water cooling and a last step of fine chemical clarifier. This plant generates 27 tons per day of sludges, mostly from the biological treatment and the chemical clarifier. These sludges contain heavy metals and cannot be used for agriculture. MOE denied a permit to burn these sludges in the Nesher cement plant. The refinery is now storing these sludges while waiting for a treatment less expensive than Ramat Hovav. The total quantity of these sludges (27 tons per day or 10,000 tons per year) represents almost a quarter of the quantity of hazardous waste reaching Ramat Hovav yearly.

Until 1993, the refinery was Ramat Hovav’s largest client in Haifa, and probably in all of Israel. Since 1994, the permit to inject the spent caustic soda in deep wells has drastically reduced the quantities of hazardous wastes sent by the refinery to Ramat Hovav.


8.3.2 Hazardous waste management

In 1977, Israel established a national disposal site for hazardous waste in Ramat Hovav, in an arid area of the Negev desert, with suitable geological, hydrological, and demographic conditions. From the time of Ramat Hovav’s opening in 1979 until 1987, wastes arriving at the site were haphazardly received, stored, and treated. Facilities for treating heavy metals, cyanides, acids, and inorganic material began operating in 1988,
but there are no facilities to treat organic waste. The quantities of hazardous wastes reaching Ramat Hovav increased from 7,000 tons in 1985 to 25,000 in 1988 and 48,500 in 1993. There is a plan to build a 15,000 tons per year incinerator; over the years, this incinerator also will burn 60,000 tons of waste already buried at Ramat Hovav. There are, however, serious problems related to the siting and operation of Ramat Hovav and new sites are being considered (Box 15).

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**BOX 15**

**UPCOMING CLOSURE OF RAMAT HOVAV**

Several studies have confirmed that hazardous leachate from Ramat Hovav has contaminated ground water and the Besor River, the largest of Negev’s rivers. MOE has set aside a special budget to conduct a survey on water and soil pollution in the area. MOE has also decided to close Ramat Hovav and open a new site. Five alternative sites in the south of Israel are currently being considered. It will be necessary to clean, neutralize, and cover the existing Ramat Hovav site.


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8.3.3 Laws and regulations

In 1990, pursuant to the Licensing of Businesses Law and the Public Health Ordinance, MOE promulgated regulations requiring all hazardous waste to be disposed of in Ramat Hovav, Israel’s national disposal site for hazardous waste, no later than six months after production. While most of Israel’s large industries comply with these regulations, hundreds of small industries, some producing only a few tons of waste per year do not comply because of the high transportation costs and the high fees charged by Ramat Hovav ($160 to $400 per ton, see Table 47). Efforts are underway to find economically-feasible solutions to transport hazardous wastes produced by these plants to Ramat Hovav.

---

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Fee (US$ per ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyanides (less than 5 g/l)</td>
<td>200</td>
</tr>
<tr>
<td>Chromates (less than 1 g/l)</td>
<td>160</td>
</tr>
<tr>
<td>Toxic solid waste</td>
<td>200</td>
</tr>
<tr>
<td>Laboratory waste</td>
<td>215</td>
</tr>
<tr>
<td>Toxic medical waste</td>
<td>215</td>
</tr>
<tr>
<td>Organic waste</td>
<td>400</td>
</tr>
</tbody>
</table>

**TABLE 47**

FEES FOR HAZARDOUS WASTE DISPOSAL IN RAMAT HOVAV

HDEAM controls the proper management of Haifa’s hazardous waste according to the 1990 hazardous waste regulations. HDEAM’s engineers advise the municipality

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*The EcoAdvocate, Volume 6 Number 2, Fall 1996, page 6, published quarterly by Adam Teva V’Din – The Israel Union for Environmental Defense.

*Ramat Hovav is operated by the Environmental Services Company, a government-owned company under MOE’s responsibility.
according to the municipality’s by-laws. Each month, HDEAM receives a report from Ramat Hovav with the types and quantities of hazardous wastes sent by Haifa’s industries. HDEAM relies on these data, business licenses, and the experience gained over the past 13 years to control the management of hazardous waste from the 200 companies in the industrial area.

One of HDEAM’s problems is to determine which waste streams are toxic without any laboratory control. HDEAM’s budget does not allow routine analysis. If a company disagrees with HDEAM’s determination, the company must pay to get its waste analyzed by an independent laboratory approved by MOE. The samples are taken by HDEAM’s engineers.

8.4 Conclusions

Haifa’s streets are clean. The municipality’s operations department uses modern equipment to keep the garbage out of Haifa’s streets. Haifa’s residents, however, deserve better than Haifa’s solid waste landfill. They must also understand that they will have to pay a higher price for an integrated solid waste management system, in line with what other European cities are paying.

Haifa’s solid waste landfill has severe negative impacts on the environment:

- Landscape and visual; since the landfill is below the urban area, at the bottom of Mount Carmel and close to the Neve Sha´anan district, the “mountain” of waste can be seen from far away.

- Traffic jams; its location near a major road with heavy traffic creates many traffic jams.

- Air pollution; from the production of methane (which contributes to the greenhouse effect), dust from the garbage trucks (the road from the gate to the dumping area is unpaved), and the products of incomplete combustion that occurs from time to time.

- Water contamination; there are no data on the landfill leachate characteristics. Based on the waste water content and similar meteorological conditions of other landfills in the Mediterranean area, the leachate could contaminate the Kishon river, probably through the nearby Saada stream.

- Urbanism; there is a big pressure to improve this area for different uses. Investors do not want to buy land near the landfill. There is a project to improve the road and construct a highway.

It is surprising that all of HDEAM’s municipalities but Haifa and Qiryat Ata (i.e., Qiryat Yam, Qiryat Motzkin, Qiryat Bialik, Nesher, and Rechasim-Kefar Hasidim) manage their municipal solid waste properly. They send their waste to the Qiryat Bialik
compost plant producing valuable materials (compost and recovered materials that can be recycled) and reducing by 73 percent the amount of refuse requiring disposal.

It was not possible to know why Haifa did not join the Qiryat Bialik compost plant. It may be because the plant’s initial capacity was to small to receive the waste by Haifa’s population. There may also be financial reasons; the municipalities of the “Western Galilee and Haifa Bay” pay 45 NIS/ton for waste treatment and disposal whereas Haifa’s cost is only 4 NIS/ton.

Medical wastes are properly treated, but like municipal waste, their disposal in Haifa's solid waste landfill is not acceptable. Once medical wastes are treated, they must be disposed of in a controlled landfill.

Hazardous wastes are basically controlled; there is no treatment available, however, for hazardous organic wastes (basically liquids and sludges). They are now stored either on site by industries or in Ramat Hovav.

Some industrial wastes such as industrial wastewater treatment sludges or dredged sediments are not hazardous but are not innocuous either because they contain heavy metals. Sending these materials to Ramat Hovav is quite expensive. Some of these wastes are stored; some smaller companies send these wastes to landfills in the Galilee and in the north.

8.5 Recommendations

Haifa’s first step should be to prepare a “solid waste management master plan” based on the technical and economic feasibility study of a new integrated waste management system including source reduction, recycling and composting, treatment, and a new controlled landfill. Such a plan should be developed with full public participation and coordinated with national authorities such as the Ministry of the Environment. Haifa’s population is among the world’s largest solid waste generators (on a per capita basis); it needs to be aware of the need to modify its consumption habits and reduce solid waste production. Haifa’s plan should:

- Study various treatment and disposal alternatives (recovery/recycling, compost, incineration, and sanitary landfill). Like neighboring municipalities, Haifa should recycle and recover valuable materials from its municipal solid waste in an economically and environmentally safe manner. Haifa must commit to a realistic schedule that will bring the city to MOE’s recycling targets.

- Analyze how to integrate, pay, and manage various treatment and disposal alternatives (investments and loans required, operating costs, subsidies, tipping fees, public/private partnerships).

- Assess whether Haifa’s municipality could agree with the municipalities of the “Western Galilee and Haifa Bay Compost” plant to send part of Haifa’s
municipal solid waste to the plant (in which case the plant will have to expand). The sludge from the wastewater treatment plant could be co-composted with the municipal waste. Because of Haifa's scarce land resources, a metropolitan treatment/disposal system may be the most appropriate.

- Study how to close and reclaim the old dump, and develop a complete system for monitoring and treating gases and leachate.

- Study how to better control building licenses and the disposal of construction debris.

Haifa also needs to prepare a management plan for industrial (hazardous and non-hazardous) and medical waste. Such a plan should identify options to manage industrial non-hazardous waste; for hazardous waste, the plan should assess alternatives to Ramat Hovav (e.g., land farming, thermal treatment). The plan should also reinforce legally and technically HDEAM's industrial group.
ENVIRONMENTAL STRATEGY

A gorgeous city with a wonderful view of the bay from Mount Carmel, Haifa is generally green and clean; residents have a good quality of life enhanced by a very successful ethnic integration. Some environmental hot spots remain, however, and Haifa’s environmental strategy will try to minimize their impacts. The strategy has eight objectives:

1. Improve waste management;
2. Reduce effluent discharges;
3. Clean up the Kishon;
4. Improve air quality;
5. Preserve green areas;
6. Improve water management;
7. Improve public transportation; and
8. Shift to urban renewal.

To reach these objectives, Haifa will seek additional funds from the national government and from the European Commission and will encourage private entrepreneurs.

This report summarizes Haifa’s draft environmental strategy and is divided into three sections:

1. **Approach** summarizes the various steps that have led to the draft environmental strategy;

2. **Environmental objectives** presents the eight objectives of the strategy; and

3. **Funding** identifies seven priority projects and potential sources of funds to implement these projects.

9.1 **Approach**

To prepare its environmental strategy, Haifa used the following approach:

- Presentation of the preliminary audit findings to the Mayor of Haifa by the audit team on December 3, 1996;

- First public consultation on December 3, 1996, with government and local officials, academia, and Non-Governmental Organizations (NGOs);

- Second public consultation on February 18, 1997 (Box 16) with government and local officials, industry representatives, academia, and NGOs to review the environmental priorities established by the audit team and set up short-term and long-term environmental quality objectives; and
Debriefing for the Mayor of Haifa on February 20, 1997 (Box 17).

<table>
<thead>
<tr>
<th>BOX 16</th>
</tr>
</thead>
</table>

PUBLIC CONSULTATION ON FEBRUARY 18, 1997

A group of 25 people from academia, NGOs, elected officials, local authorities (Municipality of Haifa, Kishon River Authority, HDEAM), government (Ministry of the Environment), industry (Refinery, Carmel Olefines, Haifa Chemicals) came to Haifa's City Hall on February 18, 1997.

The consultation started with a presentation of the audit findings and of the main recommendations. The goal of the consultation was to gather the participants’ thoughts on what should be the main objectives of Haifa’s environmental strategy. The participants were divided into two work groups: (1) pollution (air, water, and waste) and (2) urban planning (green space, transportation, development). Two of the experts in the audit team facilitated the work group discussions: Bella Ben David of HDEAM was with the first group --she was assisted by Dr. Bernanda Flicstein, HDEAM's Deputy Director-- and Dr. Mira Baron of the Technion was with the second group. Jean Tilly, technical coordinator, explained that the division into two groups was somewhat arbitrary and that there were interactions between the two themes; the primary reason for the division was to facilitate the discussion and ensure that all of the participants had a chance to express their views.

The work groups reviewed the recommendations of the audit team and added a few recommendations of their own. The group reporters presented these recommendations in a plenary session at the end of the afternoon (the summaries of these recommendations are in Annex A). Based on these discussions, it seems that the public is concerned by various issues, especially related to urban development (i.e., Carmel Beach Towers, Marina, and airport extension). Participants expressed their concern for the lack of public participation in urban planning. They agreed on the need for development but stressed that a thorough analysis of alternatives must be conducted.

One of the key issues raised during the plenary session is the implementation of the strategy. What will happen when the dust settles, once the audit and strategy work is completed? Will these reports be shelved and fall into oblivion? Who will carry the torch? Participants made several proposals. One of them is to give the coordinating role to the municipality of Haifa, the only institution with enough legal authority and financial resources to implement such an environmental strategy. An alternative is to appoint an independent body that will provide an objective advice on environmental issues, the final decision resting with the municipality.

Moshe Matri, Head of Haifa’s Strategic Planning and Research Unit, concluded the public consultation by making three recommendations:

1. **Coordinate at the national level**: some environmental issues such as waste management cannot be resolved by Haifa alone and must be coordinated at the national level.

2. **Allocate the proper budget for implementation**: addressing environmental issues requires financial resources.

3. **Prioritize issues**: given the reduced municipal budget, it is not possible to resolve all of the issues; there is a need to prioritize and make budget allocations based on this prioritization.

**BOX 17**

HAIFA’S MAYOR WILL ORGANIZE A SYMPOSIUM TO STRENGTHEN PUBLIC PARTICIPATION

After the public consultation, Moshe Matri established a six-step program to implement the strategy. Moshe presented this program to Amram Mizna, the Mayor of Haifa, during the February 20 debriefing. Amram Mizna approved the program. The six steps are as follows:

1. Present the audit results to:
2. Present the audit results to the City Council

3. Present the audit results to the Ministry of the Environment

4. Ask Haifa’s Strategic Planning and Research Unit to formulate recommendations on how to reinforce public participation on environmental issues in Haifa

5. Establish a Municipal Steering Committee to implement the strategy; the Committee will include:
   - General Director (Chairman)
   - Secretary General
   - City Engineer
   - City Treasurer
   - Head of Operation Administration
   - Strategic Planning Director
   - General Director of Haifa District Environmental Association of Municipalities
   - General Director of Kishon River Authority
   - General Director of Haifa’s District Bureau for the Environment

6. Establish a schedule of meetings for the Municipal Steering Committee (the Committee will work closely with the Council’s Environmental Committee).

7. These committees will invite representatives from academia, NGOs, industry, and business associations to participate to their meetings.

   Amram Mizna agreed to strengthen public participation. He pledged to organize a symposium that will review various ways to make public participation more effective. Amram Mizna confessed that he was not optimistic about developing a master plan soon; he agreed, however, that several steps could be taken now without waiting for the master plan. These steps include protection of green areas, urban renewal, improvement of air and water quality, and wastewater management.

9.2 Environmental Objectives

A gorgeous city with a wonderful view of the bay from Mount Carmel, Haifa is generally green and clean; residents have a good quality of life enhanced by a very successful ethnic integration. One of Haifa’s biggest environmental successes is the air quality improvement achieved over the past 10 years: ambient concentrations of sulfur dioxide have been reduced by more than 90 percent. What is even more impressive is that this reduction was achieved very cost-effectively by a switch to low sulfur fuel without costly scrubbers.

Some environmental hot spots remain, however, and Haifa’s environmental strategy will try to minimize their impacts. Two of these hot spots are the Kishon river and the uncontrolled waste dump between downtown and the industrial area. Haifa will now focus on water pollution and force industries to treat their toxic effluents before they are discharged to the Kishon.

Haifa’s ambitious development plans involve a shift from heavy industries to high tech, tourism, and business. Haifa lacks, however, a master plan that could identify...
future environmental hot spots and recommend mitigation measures to minimize environmental degradation. Such a plan must be developed with full public participation, thus preventing or minimizing future protests against development projects. As part of the plan, Haifa’s municipality may want to consider establishing environmental management and planning procedures consistent with the ISO 14000 environmental standards. Developing such a plan will not be done overnight. The strategy will help Haifa prepare this plan.

The following paragraphs provide more detailed information on the strategy’s eight objectives:

1. Improve waste management;
2. Reduce effluent discharges;
3. Clean up the Kishon;
4. Improve air quality;
5. Preserve green areas;
6. Improve water management;
7. Improve public transportation; and
8. Shift to urban renewal.

Table 48 summarizes these objectives.

9.2.1 Improve Waste Management

Objective: complete two master plans (one for municipal waste and one for industrial and medical waste) within two years and complete implementation within five years.

Haifa’s first step is to prepare a “solid waste management master plan” based on the technical and economic feasibility study of a new integrated waste management system including source reduction, recycling and composting, treatment, and a new controlled landfill. Such a plan will be developed with full public participation and coordinated with national authorities such as the Ministry of the Environment. Haifa’s population is among the world’s largest solid waste generators (on a per capita basis); it needs to be aware of the need to modify its consumption habits and reduce solid waste production. Haifa’s plan will:
<table>
<thead>
<tr>
<th>Issue</th>
<th>Objective(s)</th>
<th>Time frame (years)</th>
</tr>
</thead>
</table>
| Strategy implementation                    | Establish a Municipal Steering Committee  
Strengthen cooperation between Haifa's decision makers and the public  
Organize a symposium to present the audit results and strengthen public participation | One   
One   
One |
| Inadequate waste management                | Prepare a solid waste management master plan  
Prepare a management plan for industrial (hazardous and non-hazardous) and medical waste  
Implement the plan | Two   
Two   
Five |
| Inadequate treatment of industrial effluents| Issue Permit Orders specifying effluent discharge standards for each plant  
Reinforce the polluter pays principle for industrial effluents, thus encouraging waste minimization and clean technologies | Five   
Five   |
| Pollution of the Kishon                    | Prepare the Kishon watershed plan  
Develop recreation areas along the Kishon’s banks  
Implement the plan | Two   
Five   
Seven |
| Ambient concentrations of air pollutants above standards | Avoid adding new stationary sources of SO₂ (unless reducing existing ones) and further reduce the emissions of particulate, SO₂, NOₓ, VOC, and odors  
Improve monitoring  
Strengthen enforcement of car emission testing  
Encourage the use of non-polluting vehicles (e.g., electric buses) | Two   
Two   
Three   
Ten |
| Lack of accessible green areas             | Increase the accessibility of green areas to the public  
Preserve Haifa’s green valleys by restricting future construction  
Create the Mount Carmel Biosphere Reserve | Five   
Five   
Ten |
| High water losses and water breaks         | Prepare a plan to upgrade the distribution network  
Implement the plan  
Reduce water consumption through awareness and education | Two   
Five   
Five |
| Inconvenience of public transportation     | Increase train frequency, promote intermodal exchange, and integrate, programs, fares, and schedule  
Add new bus routes and increase bus frequency  
Reduce fees through all-day bus tickets and free transfer between lines and for connections with the Carmelit subway and the suburban trains | Three   
Two   
One |
| Inadequate urban maintenance in lower Haifa| Shift to urban renewal of old residential neighborhoods  
Improve the conservation and renovation of residential units | Five   
Five   |
• Study various treatment and disposal alternatives (recovery/recycling, compost, incineration, and sanitary landfill). Like neighboring municipalities, Haifa should recycle and recover valuable materials from its municipal solid waste in an economically and environmentally safe manner. Haifa must commit to a realistic schedule that will bring the city to MOE’s recycling targets.

• Analyze how to integrate, pay, and manage various treatment and disposal alternatives (investments and loans required, operating costs, subsidies, tipping fees, public/private partnerships).

• Assess whether Haifa’s municipality could agree with the municipalities of the “Western Galilee and Haifa Bay Compost” plant to send part of Haifa’s municipal solid waste to the plant (in which case the plant will have to expand). The sludge from the wastewater treatment plant could be co-composted with the municipal waste. Because of Haifa’s scarce land resources, a metropolitan treatment/disposal system may be the most appropriate.

• Study how to close and reclaim the old dump, and develop a complete system for monitoring and treating gases and leachate.

• Study how to better control building licenses and the disposal of construction debris.

Haifa also needs to prepare a management plan for industrial (hazardous and non-hazardous) and medical waste. Such a plan should identify options to manage industrial non-hazardous waste; for hazardous waste, the plan should assess alternatives to Ramat Hovav (e.g., land farming, thermal treatment). The plan should also reinforce legally and technically HDEAM’s industrial group.

9.2.2 Reduce Effluent Discharges

Objective: within five years, issue Permit Orders (under the Water Law) specifying effluent standards for each plant and reinforce the polluter pays principle for industrial effluents.

Haifa faces the challenge of treating municipal and industrial discharges. The wastewater treatment plant’s extension should lower the plant’s organic discharge to the Kishon and improve the Kishon’s rehabilitation, since the plant’s discharge to the Kishon represents more than 95 percent of the total organic load discharged by point sources to the Kishon. Most industrial effluents are discharged to the Kishon without any treatment. To reduce effluent discharges, Haifa will:

1. Coordinate with MOE to issue Permit Orders (under the Water Law) specifying effluent discharge standards for each plant. These standards should be consistent with the Kishon’s water quality targets and the protection of the
Kishon’s ecosystem. Industries could decide whether they want to have a common industrial wastewater treatment plant. There should be a similar process for effluents discharged into Haifa Bay (e.g., discharge of mercury from the PVC plant near Acre).

2. Strengthen the control of industrial discharges to the sewage network through inspections, progressive cleanup programs, etc. Current human and financial resources of the organizations in charge (i.e., Haifa municipality and wastewater treatment plant) are very limited.

3. Reinforce the "polluter pays" principle for liquid effluents from industry --through municipal sewage or effluent discharge fees, thus encouraging companies to minimize waste and use clean technologies --the Kishon River Authority (KRA) could use these revenues to implement its program.

9.2.3 Clean Up the Kishon

Objective: complete the Kishon watershed plan within two years, develop recreation areas along the Kishon’s banks within five years, and complete implementation of the watershed plan within seven years.

KRA is responsible for rehabilitating the river ecosystem, the water quality, and the river banks. KRA is preparing a master plan whose goals are to (1) achieve an undisturbed aquatic life habitat along the river from the Baruch reservoir to Haifa Bay and (2) restore the riparian ecosystem. KRA’s strategy is based on two steps:

1. Allow recreation along the Kishon’s banks and avoid scum and odors; and

2. Remove pollutants from the Kishon to achieve an undisturbed aquatic life habitat.

The Kishon Drainage Authority (KDA) is responsible for preventing floods. KRA and KDA are working together on a flood prevention strategy that will be coordinated with the Kishon’s rehabilitation project. The strategy will assess:

- Sources of pollution at a watershed scale (point and non point);

- Self regenerating potential of the river and how to improve it (restoration of the water channel and buffering vegetation, artificial wetland);

- Positive interactions among measures to increase the self regenerating potential, reduce flooding, and restore the river habitat;

- Possibility of using the Nesher ponds and part of the river corridor for regulating small floods (once in 3-10 years);

- Possibility of using farm lands for regulating heavy floods (once in 50 years), reducing the speed of runoff, and increasing aquifer recharge; and
Connections with the National Outline Scheme for Afforestation.

9.2.4 Improve Air Quality

Objective: avoid adding new stationary sources of SO\(_2\) (unless reducing existing ones) and further reduce the emissions of particulate, SO\(_2\), NO\(_x\), VOC, and odors within two years, strengthen enforcement of car emission testing within three years, and encourage the use of non-polluting vehicles (e.g., electric buses) within ten years.

Although annual sulfur dioxide (SO\(_2\)) concentrations in the Haifa area remain below the standard, some half hour SO\(_2\) readings still exceed the standard (three in both 1994 and 1995). Currently, the Haifa area maintains a "delicate balance" to stay below the SO\(_2\) standard. Adding new SO\(_2\) sources or switching to fuels with higher sulfur content could result in recurrent violations of the standard. Much remains to be done to better monitor and control other air pollutants, such as particulate matter (PM), nitrogen oxides (NO\(_x\)), Volatile Organic Compounds (VOC), and ozone (O\(_3\)). Haifa’s strategy to improve air quality is based on six steps:

1. Avoid adding new SO\(_2\) sources to the area, unless existing ones reduce their emissions or adopt additional abatement devices (i.e., install FGD units or switch to natural gas when available);

2. Increase efforts to reduce emissions of particulate, NO\(_x\), VOC, and odors from industry by introducing more stringent requirements into the Personal Orders;

3. Improve monitoring:
   - Measure PM2.5 (particulate with a diameter below 2.5 microns) continuously with monitors;
   - Install continuous monitoring stations at major traffic intersections to assess air pollution from transportation and in the future Carmel Tunnel;
   - Add O\(_3\) monitors to the network, mainly in Haifa’s periphery: Tivon, Kfar Hassidim, and Kiriat Shprinzak and measure NO\(_x\), a parameter including all nitrogen oxides, and not only NO and NO\(_2\) (NO\(_x\)); and
   - Improve VOC monitoring methods.

4. Conduct studies:
   - Study O\(_3\) precursor interactions to establish the strategy needed to reduce O\(_3\) levels in the Haifa area (i.e., reduce NO\(_x\), VOC or both);
• Study odor dispersion in the area and develop methods to reduce odor intensities at the source by strengthening enforcement of Personal Orders and permit requirements; and

• Estimate the impacts of air pollution on health, identify substances with a damaging effect, and study the costs and benefits of reducing air pollution emissions in the area.

5. Enforce testing of air pollutant emissions during the annual tests of cars (CO, NO\textsubscript{x}); and

6. Encourage projects (e.g., Carmel Tunnel) for reducing transportation through the city center and surroundings and encourage the use of non-polluting vehicles (e.g., electric buses).

9.2.5 Preserve Green Areas

Objective: increase the accessibility of green areas to the public within five years, preserve Haifa’s green valleys by restricting future construction within five years, and create the Mount Carmel Biosphere Reserve within ten years.

The 6 km\textsuperscript{2} of parks are well preserved and guarantee the ecological functions of the urban green areas. Though not very large compared to the total area of the municipality, Haifa’s green areas form a system interconnected with the Carmel National Park and the continuous farmland in the Kishon floodplain. Haifa’s large green areas (25 km\textsuperscript{2} per person) do not completely fulfill their social function; children and old people cannot access many of them because they are too steep.

Rehabilitating the floodplain and the mouth of the Kishon provides an opportunity to solve this problem. Currently, the area is degraded by the dump, the random development of the commercial area around the Checkpost, and the pollution of the Kishon. This empty space in the floodplain of the Kishon is currently reserved for commercial and residential uses. Consideration will be given to the creation of green areas and parks for public use. There is already an agreement between KRA, the Municipality, and the Port Authority to create a park on the banks of the Kishon.

Another green area will be created along the Sahadia Canal and the winter pond just between the main road to Tivon and the railway. This area is quite degraded. Part of the winter pond (between the road to Tivon and the railway, just southeast of the Checkpost) is already under construction; another part is unused and can be preserved. A small channel will be preserved to allow water runoff to reach the Kishon, after receiving the water from the Sahadia Spring. Instead of building a concrete channel for urban runoff, some small ponds will be preserved and linked by a channel to operate as a stormwater control, a natural ecosystem, and a recreational area.

Current regulations may not protect open areas adequately. Population growth due to immigration and demand for high-quality housing will increase pressure for
building in open areas. The lack of strong regulations and of a global urban plan may lead to building in open areas. Future construction will be restricted to preserve Haifa’s green valleys—in some critical cases, road construction will be allowed provided there is minimum damage to nature. Adequate planning instruments will be included in a Global Urban Plan. For example, the owners of green areas could give their land to the Local Authority in exchange for the right to build in other areas with a lower environmental value. Another example would be to provide private companies with incentives for the economic management of green areas.

The Carmel National Park will be enlarged and transformed into a biosphere reserve, as suggested by the expert Committee specially appointed for the Carmel National Park after the fire of 1989. Biosphere reserves constitute a network of areas of international ecological importance, acknowledged by UNESCO and other international organizations (IUCN, UNEP); a biosphere reserve is recognized at the international level and an international consensus is needed to modify its land. In addition, the management of the biosphere reserve (division in core, buffer, and transition zones) is undoubtedly the most innovative and efficient approach to reconcile biodiversity conservation and economic development.

9.2.6 Improve Water Management

**Objective:** complete a plan to upgrade the distribution network within two years and within five years, complete plan implementation, reduce water consumption through education and awareness, a progressive fee schedule, and loss reduction in the distribution network.

Haifa’s old distribution network, mainly made of iron, results in relatively high losses (20 percent) and water breaks (600 per year). Given the scarcity of water resources in Israel and in Haifa, Haifa must improve its management of water. Haifa’s strategy to improve water management is based on four steps:

1. Perform a comprehensive water survey to identify major leaks and set priorities for upgrading;

2. Prepare a plan to upgrade the water distribution network to reduce water losses due to breaks and leaks. Such a plan will include recommendations on budget and schedule;

3. Implement actions to reduce water consumption through education and awareness, and a progressive fee schedule; and

4. Upgrade the central distribution of municipal water by improving its control of pressure and flows to provide better services.

9.2.7 Improve Public Transportation
Objective: promote public transportation by increasing bus and train frequency and national subsidies to reduce fares and by enabling intermodal exchange within three years, and, within ten years, develop infrastructure (e.g., Carmel Tunnel) for reducing traffic through the city.

The urban sprawl and the growth of a metropolitan area around Haifa are increasing traffic. Although the central bus station is connected by a short gallery to the train station, there is no ticket integration among various means of transportation on an urban or metropolitan scale. There is no intermodal exchange between the Carmelit subway and private transportation and no integration with bus tickets. To improve public transportation, Haifa will take the following four steps:

1. Improve the use of trains and buses by increasing frequency, adding new routes (between residential areas and railway lines and stations and between downtown and the Carmel ridge), promoting intermodal exchange, and integrating programs, fares, and timetable;

2. Extend the Carmelit subway to the Central Bus station and the Ahuza area;

3. Increase national subsidies to reduce fares for public transportation through all-day bus tickets and free transfer between lines and for connections with the Carmelit subway and suburban trains; and

4. Develop infrastructure (e.g., Carmel Tunnel) for reducing traffic through the city.

9.2.8 Shift to Urban Renewal

Objective: Within five years, shift to urban renewal of old residential neighborhoods and improve the conservation and renovation of residential units.

The housing problem depends on the area of the city and the social level. While the middle and higher classes have moved to the new residential areas between the green valleys up on the Carmel, some of Haifa’s lower parts suffer from inadequate urban maintenance and the population decreases or moves away. This process leads to degradation and loss of dwelling units. To resolve this housing problem, Haifa will:

- Promote public programs and incentives to add new dwelling units to the old neighborhood, after improving services;

- Improve the urban quality in the old quarters to keep residents;

- Extend regulations on building materials, external areas, and public space from single historical buildings to urban areas;

- Improve the conservation and renovation of residential units;

- Shift to urban renewal of old residential neighborhoods; and
Improve landscape and historical sites preservation.

9.3 Funding

To reach the strategy’s objectives, Haifa will have to implement seven priority environmental projects:

I. Solid waste management master plan;
II. Closure and reclamation of the Haifa landfill;
III. Rehabilitation of the Kishon river and development of recreation areas along the Kishon’s banks;
IV. Construction of the Carmel tunnel;
V. Development of railway infrastructure;
VI. Increased monitoring network to track air pollution from vehicles; and
VII. Urban renewal of old residential areas (e.g., Hadar Hacarmel and Lower Haifa).

Funds to implement these projects could come from three sources:

1. National budget and matching contributions from the municipality, particularly for Projects A, B, C, and E;
2. Private entrepreneurs, particularly for Projects D and G; and
3. European Commission, particularly for Projects A, C, and F.