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# Profile of the Environmental Business Sector In Jordan

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**Profile of the  
Environmental Business Sector  
in Jordan**

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# *Executive Summary*

This profile is one in a series supported by the Project in Development and the Environment (PRIDE) on environmental markets in Near East countries, including Jordan, Egypt, Morocco, and Tunisia. Designed to help the local and U.S. private sectors participate in environmental business development, each profile defines the country's environmental business sector, describes products and services that the country needs, identifies opportunities, and offers other useful business information. The findings for this profile were developed through field and survey research conducted in Jordan in late 1992.

The most significant environmental problems in Jordan are water related. Water scarcity, combined with rapid development and population growth, are associated with the following chronic environmental maladies:

- ▶ Overexploitation of aquifers as a result of increasing demand and limited water resources.
- ▶ Inadequate industrial and municipal wastewater treatment capacities.
- ▶ Location of industrial plants near or immediately upstream from major water supplies.
- ▶ Overuse and misuse of pesticides, insecticides, fungicides, and fertilizers, leading to irrigation drainage that pollutes surface and groundwater resources.

Other major environmental problems facing the country stem from unmanaged disposal of solid, hazardous, and mining waste (primarily from phosphate mines), and industrial air pollution in Amman.

Currently, these problems are addressed by a medley of uncoordinated rules and regulations falling under the jurisdiction of various government agencies, many of which lack clear statutory directives for their actions. Standards are strict for some sources of water pollution and nonexistent for others. The problem of industrial hazardous waste is largely unaddressed, and no formal air pollution program exists. Finally, there is no statutory basis for coastal zone management, although several related statutes provide authority to regulate coastal areas. The need for a comprehensive legal framework is clear.

Although a national environmental law has not yet been enacted in Jordan, a Draft Environment Act prepared in October 1992 is being revised and is expected to be passed in 1993. The 17-page draft act indicates the Government of Jordan (GOJ) is pressing for improvements in environmental policy. Development of the Environment Act was prompted by the National Environment Strategy for Jordan, a document completed in May 1991 by the Ministry of Municipal and Rural Affairs and the Environment. The strategy describes Jordan's environmental problems and makes recommendations to address water shortages;

overpumping of aquifers; population growth; desertification; agricultural land loss; pollution of air, surface water, marine and groundwater; and loss of critical cultural resources.

This profile concludes that the overall market for environmental goods and services in Jordan in the next five years will be small and thus best suited for Jordanian firms, in some cases with U.S./foreign partners. This is largely due to the fact that the country's population and geographic area are relatively small, and its industrial sector, compact. This compactness will, however, facilitate execution of comprehensive pollution prevention and abatement programs.

Several other factors contribute to a positive outlook for Jordan's environmental private sector. First, public awareness of the need for rapid government action to address environmental problems appears to be growing in the country. In addition, a strong community of nongovernmental organizations is playing a key role in facilitating government action. Finally, the international donor and lending community will contribute more to environmental programs in the coming decade (approximately \$50 million annually for municipal water supply and wastewater treatment projects alone). Thus, opportunities are promising in several areas for firms providing environmental products or services, despite the relatively small size of the country and its industrial sector.

Statistics on the size of current markets for environmental goods and services in Jordan are virtually nonexistent. The table on the next page offers estimates of 1992 and projected 1997 market size based on general market statistics in Jordan and research conducted for this profile on nine environmental business sectors.

The total market for environmental goods and services was estimated at less than \$54 million in 1992, 80 percent of which stems from wastewater projects that are largely donor-funded. To put these estimates in perspective, the International Finance Corporation has estimated average per capita expenditure of non-OECD countries on environmental goods and services at about \$8. This would place the current Jordanian market at \$32 million. The substantial donor aid that Jordan receives in the environmental sector accounts for the discrepancy between that figure and the one on the table. The estimates do not include services that Jordanian government agencies provide to each other.

The estimates for municipal water supply and wastewater treatment are based on the cumulative foreign donor and Jordanian commitments, which amount to approximately \$250 million over the next five years, or \$50 million annually (see section on Municipal Water Supply and Wastewater Treatment and Appendix D). It is also assumed that project investments will increase toward the end of the five-year period.

**Environmental Business Sector: Market Size Estimates by Market Segment**

| <b>Market Segment</b>                                       | <b>1992 Estimate<br/>(in US\$ millions/year)</b> | <b>1997 Estimate<br/>(in US\$ millions/year)</b> |
|---|--|--|
| Municipal water and wastewater                              | 40   | 70   |
| Industrial wastewater treatment and prevention              | 2  | 20   |
| Water purification and conservation                         | 2  | <20  |
| Environmental monitoring and testing equipment and services | <1   | 3  |
| Municipal solid and hazardous waste                         | <5   | 20   |
| Waste recycling   | <1   | ≥5   |
| Agricultural waste recycling                                | <1   | No information available                         |
| Mobile and stationary source air pollution                  | <1   | 5  |
| Renewable energy and conservation                           | <1   | 3*   |
| <b>Total estimated market</b>                               | <b>&lt;54</b>                                    | <b>147</b>                                       |

\*In terms of technical potential, combined industrial and residential savings from energy efficiency measures is estimated at about \$31 million for measures having a payback period of three years or less. Spread over 10 years, a realized market would be roughly \$3 million annually. (Based on a model developed by RCG/Hagler, Bailly, Inc. using energy balance data for Jordan from International Energy Agency; World Energy Balances 1985-1989, OECD, Paris 1990.)

The current estimate of \$2 million for industrial wastewater pollution prevention and abatement is based on interviews and research in Jordan and is probably conservative. The projected growth to \$20 million by 1997 reflects two anticipated developments: stricter government regulation of industries emitting liquid waste streams, and more emphasis on industrial pollution by the donor community.

The GOJ has already initiated efforts to modernize and upgrade water supply systems. Estimates of market size for water conservation and purification systems are based on current GOJ spending in this area. The projected figure reflects an expected increase in GOJ interest in facilitating activities to stem leaks and stop illegal connections. Much of the expenditure is expected to be recovered in saved water. It also reflects greater domestic interest in water saving equipment and services as a result of water scarcity and rising water prices.

Two forces will drive business opportunities in Jordan: the ability of the GOJ to sharpen its regulatory and enforcement efforts, and the scarcity of water of sufficient quality to meet urban, industrial, and agricultural demands.

## Most Attractive Features of Environmental Business Segments

| TYPE OF BUSINESS                         | Opportunity for               |               |                          |                  |                  |
|--|-------------------------------|---------------|--------------------------|------------------|------------------|
|  | Joint Jordanian/U.S. Business | U.S. Business | Jordanian Private Sector | Near-Term Market | Long-Term Market |
| Municipal water and wastewater           | ●                             | ●             | ●                        | ●                | ●                |
| Industrial wastewater                    | ●                             | ●             | ●                        | ●                | ●                |
| Water purification and conservation      | ●                             | ●             | ●                        | ●                | ●                |
| Environmental monitoring and testing     | ●                             | ●             | ●                        | ○                | ●                |
| Municipal solid and hazardous waste      | ●                             | ○             | ●                        | ●                | ●                |
| Waste recycling                          | ○                             | ○             | ●                        | ●                | ●                |
| Agricultural waste recycling             | ○                             | ○             | ●                        | ●                | ●                |
| Mobile & stationary source air pollution | ●                             | ●             | ●                        | ○                | ●                |
| Renewable energy and energy conservation | ●                             | ●             | ●                        | ●                | ●                |

**KEY**

○ = Low

◐ = Medium

● = High

# *Introduction and Overview*

## **Purpose of the Profile**

PRIDE (Project in Development and the Environment) has targeted the private sector as an important player in delivering solutions to environmental problems in Jordan. The purpose of this profile is to describe Jordan's private sector environmental market, and opportunities and strategies for taking advantage of the growing demand for environmental goods and services. This profile is designed to be useful to

both Jordanian and U.S. private sector suppliers of environmental goods and services.

The profile also seeks to provide PRIDE and development agencies with information to develop a strategy for private sector participation in environmental activities, and facilitate the transfer of technology and expertise to Jordan's private sector to help it develop services and capabilities.

## **Definition of Environmental Business Sector**

The environmental business sector includes companies that produce or sell products or services that help conserve natural resources or industrial materials; prevent, reduce and control pollution; dispose of or recycle wastes and hazardous materials; protect water supplies; conserve energy; provide energy from alternative sources; restore the environment and its resources; and produce "environmentally safe" products.

Numerous firms that provide support services in the environmental area are also part of the sector, including management consultants, advertising and public relations firms, lawyers, financial institutions, and accounting firms.<sup>1</sup>

This profile focuses on nine types of environmental goods and services that reflect Jordan's specific environmental problems relating to the deterioration of water, air, or land resources. Together, they comprise Jordan's environmental business sector.

- ▶ Municipal water supply and wastewater treatment equipment and design, construction and operation
- ▶ Industrial wastewater treatment and prevention, and process materials reuse (includes equipment, design and operation)
- ▶ Water purification and conservation equipment and services for industrial, commercial and domestic use
- ▶ Environmental monitoring and testing
- ▶ Municipal solid and hazardous waste collection and disposal
- ▶ Waste recycling services and equipment
- ▶ Agriculturally related recycling and processes

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<sup>1</sup> *Massachusetts Environmental Industry/Education Resource Directory, 1992.*

- ▶ Mobile and stationary source air pollution control equipment and services
- ▶ Energy conservation and renewable energy

## **Organization of Profile**

The profile is divided into five parts. The first is an executive summary. This part, "Introduction and Overview," summarizes Jordan's environmental problems and highlights the most promising opportunities in the environmental business sector.

The third part, "Business Activities and Opportunities in the Environment," describes each environmental market segment. Included are an overview and information on products and services, potential clients, market demand, supply, competition, ownership, and market entry barriers and strategies. A table illustrates the appeal of each market segment.

The fourth, "What is Needed to Take Advantage of the Opportunities," briefly delineates the needs: market awareness and information, increased regulation, participation by foreign environmental companies, financing, removal of barriers to market entry, privatization, training, and access to new technologies and approaches.

Finally, the appendices give more details on Jordan's environmental problems, environmental regulatory framework, and donor programs in the environment. The appendices also contain lists of resources and persons interviewed for the profile survey, and an explanation of the study methodology.

## **Overview of Jordan's Environmental Situation**

Improved health care and waves of refugee migration have increased Jordan's population tenfold since 1948. This growth has put tremendous pressure on the country's scarce water resources and its sanitation sector.

The population of Jordan in 1991 was estimated to be 3.5 million; growth has averaged over 3.8 percent per year in the last decade. A full 75 percent of the population is under 30 years of age. Amman, the capital and largest city, contains nearly 35 percent of the population and is growing rapidly. The government is attempting to slow further migration to Amman by promoting infrastructure development outside the city and providing financial incentives to encourage industries to move to other locations.

Jordan has an area of approximately 90,000 km<sup>2</sup>, 90 percent of which is considered arid and semi-arid. The mountainous area east of the Jordan Rift Valley functions as a precipitation trap for the cold air fronts traversing the country from west and northwest to east and southeast.

Only 3 percent of Jordan's land receives average annual precipitation of more than 300 mm (the minimum required for wheat production in dry farming areas). Around 90 percent receives average precipitation of less than 100 mm/yr which generally classifies it as arid. The scarcity and uneven distribution of precipitation result in meager surface and groundwater resources, comparable to the average flow of the Euphrates River in just one week or that of the Nile in only three days.

The government has tried to alleviate water supply problems and pollution by developing resources and infrastructure in semi-arid areas. Dams and irrigation canals were constructed; water pipes were laid to transport drinking water; and wastewater projects were undertaken in all large towns.

The main polluted surface water resources lie within or downstream from urban and industrial areas, and near irrigated land. Pollution from domestic and industrial sources adversely affects the quality of surface waters. Other surface waters affected are wadis, creeks, rivers and dams downstream from wastewater treatment plants, and solid waste disposal sites like Wadi al Arab, Ukeider, Wadi Shueib, and Wadi Sir.

Pollution from waste disposal has also affected major groundwater resources, rendering some of them unsuitable for domestic purposes and/or irrigation. Amman-Zarqa, the main groundwater area affected, has half of Jordan's population and 70 percent of its light and medium-sized industries.

Groundwater resources are also polluted from solid and liquid waste disposal. Groundwater quality in Karak, Irbid, Ramtha, Aqaba, Mafraq, and elsewhere is deteriorating due to semi-treated wastewater from wastewater treatment plants. In Jordan Valley, Dhuleil, Sama Sdud, and al Agib, overuse of pesticides and insecticides including DDT (now banned, except to eradicate malaria) has significantly increased their concentration in surface and groundwater resources. The flow of irrigation water to rivers increases salinity and the concentration of biocides, nitrates, phosphates, and other damaging substances.

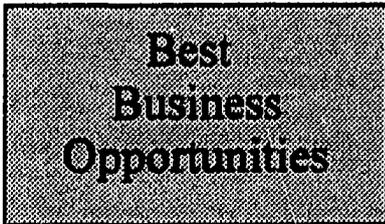
Jordan depends almost exclusively on imported oil for its energy needs, except for modest amounts of natural gas from a recently discovered field. Energy demand rose sharply between 1974 and 1984 at an average annual rate of 14 percent, though the rate of increase has decelerated in the last five years. The total national consumption of primary energy in 1991 reached 3.28 million tons of oil equivalent (TOE) compared with 3.33 million TOE in 1990, a decrease of 1.6 percent. Causes of the decrease included the economic recession and the GOJ's adoption of additional rationing and conservation measures early in 1991 when neighboring countries cut off oil supplies. Electricity ranked second after the transport sector in energy consumption.

The air is considered relatively clean in most of the country except for some polluted areas such as the industrial zones. The main industries are phosphates, potash, cement, glass, iron, petroleum refining, fertilizers, electrical power stations, and ceramics. The vast

majority of industry consists of small workshops, except for about 550 medium-sized food, chemical, furniture, and construction firms, located mostly in the Amman region, Marka, Sahab, Bak'a basin, and Zarqa in the northeast.

Until recently, open dumps were the only way to dispose of solid waste. In recent years several have closed, but many are still used. The waste is dumped, ignited, and allowed to burn, polluting air and water (through leaching), and leaving organic residues which serve as a haven for disease and vermin.

Mining waste is also a significant environmental problem in Jordan. It destroys agricultural soil and vegetation cover, causing dust to collect in public sewage and irrigation tunnels, and trace elements to leach into the soil or blow in the air and land on plants.



Because Jordan is relatively small, a good business opportunity must demonstrate promise for significant growth. Business opportunities in Jordan will be largely driven by two forces: the GOJ's ability to sharpen its regulatory and enforcement efforts, and the increasing scarcity of water of sufficient quality to meet urban, industrial, and agricultural demands. The best opportunities lie in the areas summarized in the table on the next page.

**Overview of Opportunity in Five Environmental Subsectors**

***Municipal Wastewater Treatment***

- ▶ Current systems desperately need upgrades in capacity.
- ▶ Donor spending in this area dominates environmental spending in Jordan.
- ▶ Demand will increase as Jordan's population grows and clean water becomes scarce.

***Industrial Wastewater Treatment and Pollution Prevention***

- ▶ Water scarcity and impending stricter GOJ regulation will drive market.
- ▶ Potential for low-cost pollution prevention, materials recovery, and recycling can be associated with cost recovery and savings.
- ▶ There are excellent opportunities for foreign/local joint initiatives.
- ▶ Donors are expected to emphasize this area more in the future.

***Water Purification and Conservation***

- ▶ Potential is strong for upgrading water supply systems since this effort is often associated with cost recovery or increased income.
- ▶ GOJ is already committed to programs to stem water losses.
- ▶ There is potential for foreign/joint initiatives.

***Municipal Solid and Hazardous Waste Collection and Disposal***

- ▶ The booming urban population will lead to a steady growing demand for these services.
- ▶ Collection services are likely to be privatized, opening new opportunities for local contractors.
- ▶ Enactment of regulations on hazardous waste disposal is expected, given the increasing threat of aquifer contamination coupled with Jordan's limited water supplies.

***Waste Recycling***

- ▶ Waste glass and metal recycling has proven profitable, but collection and separation efficiency could be improved.
- ▶ Plastic waste production is increasing, providing new opportunities for recyclers.
- ▶ The collection and recycling of motor oil has a large unrealized potential especially considering current threats to water supplies from discarded motor oil.

# *Business Activities and Opportunities in the Environment*

## **Municipal Water and Wastewater Treatment**

Due to Jordan's rapid population growth and continuous waves of immigrants and returnees, wastewater treatment plants that were designed to handle wastewater for decades are reaching maximum capacity in under 10 years. Demand is growing for municipal wastewater treatment facilities. Recent legislation and enforcement are also stimulating the growth of the municipal wastewater treatment market. Expanding public awareness and access to donor-agency funding are expected to further drive market growth.

Problems with wastewater management exist throughout the kingdom, but are concentrated in the Amman-Zarqa region. Many systems are overloaded and need capacity upgrades or supplementary systems. For example, the ponds at As-Samra were designed for an average flow of 68,000 cm/day, but now must accommodate 97,471 cm/day. About 90 percent of the urban population has access to piped water, and tankers serve the rest. Piped wastewater systems serve nearly 45 percent of the urban population and 31 percent of the total population.

Fifty-five of the 108 major effluent-producing industrial operations are connected to Amman-Zarqa sanitary sewers, while the remaining 53 discharge to surface waters, mostly wadis. Jordan's 14 major wastewater treatment plants receive strong sewage similar to industrial discharges. No central facilities exist to handle and dispose of toxic and hazardous waste.

In recent years, the Water Authority of Jordan, responsible for municipal water supply and wastewater treatment (see Annex C, Regulatory Framework), has had a mounting deficit. Water and sewerage charges to customers have not been sufficient to cover existing services, let alone to fund additional construction. The GOJ has had to rely on other internal and donor funding sources to finance construction and operation of municipal wastewater treatment facilities.

The construction of municipal water supply and wastewater treatment plants will receive the greatest emphasis in environmental spending over the next decade, in response to growing demand. The funding driving the market will be supplied by the GOJ and by international donor agencies, which are expected to spend US \$250 million on water supply and wastewater treatment in the next five years. While primary and secondary treatment methods are in greatest demand, tertiary treatment methods are being considered for some areas.

**Water Authority of Jordan Revenue and Expenses, 1988-1991  
(in millions JD)**

| <b>Item</b>              | <b>1988</b> | <b>1989</b> | <b>1990</b> | <b>1991</b> |
|--------------------------|-------------|-------------|-------------|-------------|
| Water and Sewer Revenues | 24          | 24          | 22          | 24          |
| Current Expenses         | 37          | 51          | 58          | 61          |
| Annual Deficit           | 13          | 27          | 36          | 43          |
| Accumulated Deficit      | 48          | 75          | 111         | 147         |

Source: A Water Management Study for Jordan, PRIDE, 1992

Jordanian firms will be in a position to take advantage of key markets including pipe manufacture, (local pipe fabrication is already developed), plant and distribution system construction, small- and medium-scale project design and engineering (joint ventures with foreign engineering firms will be the best approach for large-scale projects), and some structural and mechanical equipment and supplies such as storage tanks, valves, water meters, and filters. In addition, local firms will be in a much better position than foreign firms to pioneer and fine-tune low-cost alternative wastewater treatment methods suited to the Jordanian context, such as aquatic plant lagoons in place of high-tech, tertiary treatment technologies. Local production of chemicals for water and wastewater treatment is limited but will dominate supply of this market by the end of the decade.

Foreign firms will continue to be best poised to lead large-scale design and engineering projects, and through this decade, will be the sole suppliers of highly sophisticated technology and equipment. Many opportunities will also emerge for joint manufacture of water treatment and supply equipment. Much of the equipment and services bought with donor funding will be earmarked, depending on the donor. Nevertheless, competitive firms offering superior products will be able to enter the market.

**Type of Sewerage System Available in Houses  
(percent of total houses)**

|                | Greater Amman | Other urban areas | Rural areas | East Bank |
|----------------|---------------|-------------------|-------------|-----------|
| Public network | 79.6          | 4.5               | 1.7         | 29.6      |
| Cesspools      | 19.0          | 92.1              | 85.2        | 64.8      |
| Others         | 0.7           | 1.7               | 0.8         | 1.1       |
| Nothing        | 0.7           | 1.7               | 12.3        | 4.5       |

Source: *National Environmental Strategy for Jordan, 1991.*

*Products and Services*

Technologies used for wastewater treatment include conventional secondary treatment, stabilization ponds and aerated lagoons, land treatment, phosphorous removal by chemical addition, nitrification, and granular media filtration.

A typical conventional secondary treatment system might employ the following technologies: preliminary treatment such as skimming and screening to remove debris and large suspended solids, influent pumping, primary clarification and coagulation, activated sludge treatment, secondary clarification, effluent disinfection by chlorination, and sludge treatment. Typical equipment includes clarifiers, pumps, piping, aeration and settling tanks, aerators, digestors, flow meters and regulators, control instrumentation, and analytical sampling and testing equipment.

Services for this market are provided by firms that design, construct, and supply materials and equipment for conventional as well as non-conventional municipal wastewater treatment systems. This market also encompasses the operation and maintenance involved in managing wastewater treatment systems.

The opportunities in municipal water and wastewater treatment are rated in the table on the next page.

*Clients*

The clients for the design and construction of wastewater treatment plants will be the Ministry of Water and Irrigation and other municipalities that are under the Ministry of Municipal and Rural Affairs and the Environment. A significant portion of the funding will come from donor agencies and multilateral banks.

**Municipal Water and Wastewater Treatment**

| TYPE OF BUSINESS           | Opportunity for U.S. Business | Opportunity for Jordanian Private Sector | Potential for U.S./Jordanian Alliances | Near-Term Market | Long-Term Market | <p style="text-align: center;"><b>KEY</b></p> <p style="text-align: center;">○ = Low</p> <p style="text-align: center;">◐ = Medium</p> <p style="text-align: center;">● = High</p> |
|----------------------------|-------------------------------|--|--|------------------|------------------|--|
| ENGINEERING AND DESIGN     | ●                             | ◐  | ●                                      | ●                | ●                |  |
| CONSTRUCTION               | ○                             | ●  | ◐                                      | ◐                | ●                |  |
| EQUIPMENT AND SUPPLIES     | ●                             | ◐  | ◐                                      | ●                | ●                |  |
| OPERATIONS AND MAINTENANCE | ○                             | ◐  | ○                                      | ◐                | ●                |  |

As aspects of the operations and maintenance are privatized, the clients for the plant operations will be the population served by the plants. The contracting company that runs the plant is likely to purchase replacement and upgrade parts as well as treatment chemicals.

*Demand and Market Size*

Donors will spend an estimated \$250 million on water supply and wastewater treatment over the next five years or \$50 million annually (donor-funded projects are listed in Appendix D). Of the \$250 million, \$65 million will go directly to wastewater treatment. In addition, another \$585 million worth of projects has been proposed, for which donors have not yet been identified.

The demand for conventional secondary municipal wastewater treatment systems can also be roughly estimated for the next 20 years, based on population projections. Over that period, municipal wastewater treatment plants will need to be constructed to serve 4 million people.<sup>2</sup> The cost of constructing secondary municipal wastewater treatment systems to serve

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<sup>2</sup> Jordan's population can be projected conservatively at 6.5 million in 20 years, 80 percent of which will probably be urban (compared to 70 percent today). Assuming 95 percent of the urban population will be served by secondary municipal wastewater treatment systems, systems must be constructed to accommodate 3.7 million more urban residents. Assuming 50 percent of the rural population will be served, plants must be built to accommodate an additional .25 million people.

*Business Activities  
and Opportunities in the Environment*

4 million people is estimated at roughly \$1.1 billion, or \$55 million annually (using cost curves from EPA document no. 600/8-84-010, adjusted to 1990 dollars). Most likely, more of the total will be spent in the second decade than in the first decade. Furthermore, this figure does not include money spent to maintain existing systems or to operate and maintain new ones.

Non-conventional treatment methods will likely also be employed, particularly tertiary treatment in plants that receive complaints about odor emissions when water is to be used for agricultural purposes. One method considered is to cultivate aquatic plant colonies, which consume the remaining organic content of the treated wastewater, clarifying it and producing potential animal feed.

**Summary of Sewerage and Water Treatment Projects**

| <b>Project</b>                    | <b>Status</b> | <b>Amount (millions JD)</b> |
|-----------------------------------|---------------|-----------------------------|
| Aqaba sewerage project            | 18 months     | 1.8                         |
| EIB: Zarqa sewerage collection    | 92/94         | 9.6                         |
| USAID: Industrial waste discharge | 93/98         | 1.1                         |
| Salt water expansion              | 24 months     | 2.6                         |
| Fuhais/Mahis sewerage project     | 24 months     | 2.8                         |
| KFW: Irbid sewerage               | 93/96         | 26.9                        |
| USAID: Al-Samra upgrade           | 93/98         | 6.6                         |
| USAID: Al-Samra feasibility study | 91/92         | 0.3                         |
| Wadi Musa sewerage                | 24 months     | 2.9                         |
| Mudawara sewerage                 | 12 months     | 0.3                         |
| Jarash sewerage expansion         | 24 months     | 2.7                         |
| Souf and refugees sewerage        | 24 months     | 2.8                         |
| Other sewerage projects           | 24 months     | 5.5                         |
| <b>Total</b>                      |               | <b>65.9</b>                 |

Source: A Water Management Study for Jordan, PRIDE, 1992.

### *Supply and Competition*

Jordan has municipal wastewater treatment plants to meet the needs of around 70 percent of the population, in addition to numerous wastewater treatment plants belonging to public and private sector organizations such as airports, hospitals, universities, industries, and army camps. The municipal wastewater in Jordan is relatively thick with a BOD<sub>5</sub> of 700 to 1,000 mg/l, reflecting the modest use of water in homes due to water scarcity.

#### **Municipal Wastewater Treatment Plants Owned by the Water Authority of Jordan**

| <b>Plant</b> | <b>Year of Start-up</b> | <b>Design capacity m<sup>3</sup>/day</b> | <b>Type of Treatment</b>            | <b>Receiving water</b>              |
|--------------|-------------------------|--|-------------------------------------|-------------------------------------|
| As Samra     | 1985                    | 68,000                                   | Waste stabilization ponds           | KTR                                 |
| Mafraq       | 1988                    | 1,800                                    | Waste stabilization ponds           | Irrigation                          |
| Aqaba        | 1987                    | 9,000                                    | Waste stabilization ponds           | Irrigation                          |
| Ramtha       | 1988                    | 2,335                                    | Waste stabilization ponds           | Irrigation                          |
| Abu Nuseir   | 1988                    | 4,000                                    | Activated sludge                    | KTR                                 |
| Baqa'a       | 1988                    | 6,000                                    | Trickling filters, Solid contact    | KTR                                 |
| Salt         | 1981                    | 2,442                                    | Extended aeration                   | Shua'yd Res., Ground water recharge |
| Irbid        | 1987                    | 11,023                                   | Trickling filters, Activated sludge | Wadi Arab                           |
| Jarash       | 1983                    | 1,155                                    | Oxidation ditch                     | KTR                                 |
| Karak        | 1988                    | 786                                      | Imhoff tank, Trickling filter       | Wadi Karak, Irrigation              |
| Tafila       | 1989                    | 800                                      | Imhoff tank, Trickling filter       | Le-Ghoweir                          |
| Madaba       | 1989                    | 2,000                                    | Waste stabilization ponds           | Irrigation                          |
| Ma'an        | 1989                    | 1,335                                    | Waste stabilization ponds           | Landscaping, revegetation           |
| Koufranja    | 1989                    | 1,800                                    | Imhoff tank, trickling filter       | Wadi Koufranja                      |

Source: WAJ Central Operation Department

The majority of the equipment and materials used to construct water and wastewater treatment facilities comes from foreign manufacturers, either directly or through local agents. British companies seem to be the most competitive equipment suppliers. Some British

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companies are part of an American company and/or have a license agreement to manufacture American-designed equipment.

Several Jordanian firms are ready to plan, design, and construct wastewater treatment facilities, but the greatest chance for success in large-scale projects would come through partnerships between Jordanian and American firms. Jordanian engineering consultants and construction contractors have demonstrated they are capable of designing and constructing small- and medium-scale water and wastewater treatment facilities. Some Jordanian firms have even competed in this area internationally.

Concrete reinforcing iron bars and pipes are manufactured locally. Local production includes reinforced concrete pipes for wastewater collection systems, small quantities of PVC pressure pipes and glass-reinforced plastic pipes, and galvanized steel pipes. Opportunities exist for local production of other types of equipment, including water meters, storage tanks, valves, and chemicals for water and wastewater treatment. So far, local production of these items has been limited, due in part to the small size of the total Jordanian market.

### *Strategies for Market Entry*

The cost of starting production of large-scale or sophisticated wastewater treatment equipment is relatively high, given the small Jordanian market. To make a venture profitable in the long run, local manufacturers would need to feel confident that they would have consistent access to donor agency funded projects, or be able to tap international markets.

Weak legislation and enforcement, bureaucratic barriers, and lack of low-interest rate financing are all major barriers to expansion of this market.

GOJ is seeking to manage its water and wastewater works more efficiently. Privatization could provide an opportunity for private companies to take over operation and management of selected wastewater treatment plants and water supply systems. Jordan's electricity distribution network has been a private sector venture since its inception 46 years ago, and could be a model for efforts to privatize wastewater treatment. Privatization would also provide an opportunity for consultants to facilitate the transfer of ownership. U.S. companies and consultants could help evaluate and manage large corporations.

To pave the way for privatization, several barriers must be addressed, such as the lack of legislation and enforcement of wastewater standards, limited awareness and expertise in privatizing corporations as large as wastewater treatment plants, and inadequate financing.

## **Industrial Wastewater Treatment and Prevention**

Industry consumes approximately 6 percent of the water used in Jordan. Only about 100 industrial installations have wastewater that requires treatment before being discharged to a municipal treatment plant. The GOJ identified a number of industries discharging wastewaters to the Zarqa River and in June 1991, ordered several to close. The temporary closures initiated a series of agreements between the GOJ and the industries that has begun to change industry wastewater management. A few industries recycle water, especially for cooling. Most major industries draw their supply partly from wells. At present, little is being done to conserve industrial water or control pollution.

The government must take the following actions to pave the way for progress in industrial waste prevention and control:

- ▶ Promote water and waste management education
- ▶ Aggressively and comprehensively monitor and enforce
- ▶ Adequately price water for agriculture and industry
- ▶ Control industrial waste discharges through emphasis on pollution prevention and discharge charges
- ▶ Create financial mechanisms to help supply and purchase clean technologies and pollution prevention technologies

Many of Jordan's existing industrial wastewater treatment plants do not function properly; therefore, the direct use of their effluent is highly risky for workers in direct contact with the water, and for crop consumers. Many plants are not designed specifically for the pollutants they treat. The industrial sector has little knowledge of pollution prevention and waste minimization technology and practices. The Amman Chamber of Industries is addressing this disparity.

Industries are concentrated in Amman and the Zarqa Basin. In Amman one major industrial park houses many industries. Although most industries in the park are small, they generate highly toxic and dangerous pollutants. Paint fabricators, metal plating, and cloth dyeing are a few activities that take place there. The park lacks a wastewater treatment facility designed to handle the industries' wastewaters and make them acceptable for discharge directly to the Zarqa River or the municipal sewer system.

### ***Products and Services***

This category includes the design and construction of end-of-pipe treatment methods as well as clean technologies and changes in pollution prevention processes to reduce the volume, concentration, or toxicity of industrial wastewater. End-of-pipe treatment methods fall under biological, chemical, or physical treatment technologies. The equipment used for biological processes includes tanks, biological digestors, piping, pumps, clarifiers, filter media, and gauges. Lagooning requires construction and lining materials and effluent delivery to and from the lagoon.

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Physical processes include methods that physically extract or separate pollutants from effluent waste streams. Technologies include activated carbon adsorption, air stripping, clarification, equalization, evaporation, filtration and separation, screening and cooling, and incineration. A wide variety of equipment is associated with these processes.

Chemical treatment technologies make pollutants less harmful or decompose them altogether. The chemical processes used to treat industrial wastewater include oxidation and reduction, coagulation and precipitation, neutralization, ozonation, and sulfide precipitation. The equipment used for these processes tends to be less complex than that for physical or biological methods, and involves effluent delivery systems, chemicals, control equipment, and tanks.

The volume and concentration of effluent from most industrial plants can be reduced through process changes or materials recycling and recovery, which almost always requires expertise in process engineering. Often, equipment is employed as part of the process change or to recover or recycle lost raw materials, intermediates, or products. High priority industries for pollution prevention and clean technologies include those that use organic solvents and other raw materials, process metals, and large quantities of water.

Investments in pollution prevention and clean technologies pay for themselves through reduced costs for raw materials, and savings from less raw material use and/or product loss. End-of-pipe treatment is a cost that can usually be justified only in terms of savings in fines or the indirect benefits of a cleaner environment.

Equipment and services are supplied by quasi-government organizations, universities, the Royal Scientific Society, the Amman Chamber of Industries, NGOs, or the private sector. Much of the equipment would have to be imported, especially pumps, aerators, chemical feeders, and pollution prevention and clean technologies. Both Jordanian and foreign personnel and companies could supply services.

The opportunities in industrial wastewater treatment are summarized on the table that appears on the next page.

### *Clients*

Industry is the largest client for equipment and services. The private sector owns most industries including polluting businesses such as gas stations, garages, laundries and cleaners, and large institutions such as hospitals and industrial parks, except for a few large, strategic industries in which the government owns 51 percent or more of shares. A factory that handles toxic, hazardous, or polluting materials and produces wastewater with pollutants in excess of levels in the National Standard Specifications must invest in pollution prevention and/or control technologies and services to meet standards. They should invest first in clean

technologies, reuse, and recycling and should handle the remaining pollution with end-of-pipe technologies.

**Industrial Wastewater Treatment**

| TYPE OF BUSINESS          | Opportunity for U.S. Business |  |  |                  |                  | KEY                               |
|---------------------------|-------------------------------|--|--|------------------|------------------|-----------------------------------|
|                           | Opportunity for U.S. Business | Opportunity for Jordanian Private Sector | Potential for U.S./Jordanian Alliances | Near-Term Market | Long-Term Market |                                   |
| DESIGN AND CONSULTING     | ◐                             | ◐  | ●                                      | ◐                | ●                | ○ = Low<br>◐ = Medium<br>● = High |
| EQUIPMENT AND SUPPLIES    | ◐                             | ◐  | ●                                      | ◐                | ●                |                                   |
| OPERATION AND MAINTENANCE | ○                             | ◐  | ○                                      | ○                | ◐                |                                   |

*Demand and Market Size*

Many of the 2,300 registered factories in Jordan need to install pollution prevention or wastewater treatment equipment. Many, however, are too small to install a treatment plant. The smaller manufacturers are ideal candidates for pollution prevention, waste minimization, and clean technology applications. The type of pollutants found in wastewaters from Zarqa Basin industries are shown in the table on the following page:

**Estimated Pollutant Loads from Zarqa Basin Factories, 1990**

| TYPE OF INDUSTRY   | FLOW m <sup>3</sup> /d | BOD kg/d | COD * | TDS * | NH <sub>4</sub> * | PO <sub>4</sub> * | POP. Equl | Mn * | Ni * | Pb * | Cu * | Cd * | Cr * |
|--------------------|------------------------|----------|-------|-------|-------------------|-------------------|-----------|------|------|------|------|------|------|
| CHEMICAL           | 3374                   | 196      | 1135  | 7528  | 122               | 8                 | 3570      | .2   | 1.3  | 1.1  | .2   | .09  | .3   |
| PULP-PAPER         | 2300                   | 461      | 1122  | 3135  | 4                 | 5                 | 8382      | .8   | .3   | 1.0  |      |      |      |
| METALS             | 630                    | 8        | 29    | 1846  | 4                 | -                 | 145       | 1.1  | .2   | .9   | .1   |      | .5   |
| FOOD               | 883                    | 5263     | 13287 | 10613 | 377               | 91                | 95693     | .2   | .2   | 1.5  | .1   |      | -    |
| SLAUGHTER HOUSE    | 1200                   | 15124    | 21735 | 13670 | 17                | 15                | 274973    |      |      | .3   |      |      |      |
| TEXTILES & CLOTHES | 654                    | 162      | 443   | 835   | 11                | 33                | 2936      | -    | .1   | .1   |      | .01  | .1   |
| TANNING            | 200                    | 38       | 102   | 2638  | 36                | 1                 | 691       | -    |      | .2   |      |      | .2   |
| CANDY              | 75                     | 294      | 706   | 235   | 1                 | -                 | 5346      |      |      |      |      |      |      |
| BEVERAGE           | 460                    | 288      | 641   | 941   | 4                 | 2                 | 5236      | .1   |      | .4   |      |      | -    |
| TOTALS             | 9776                   | 21834    | 39200 | 41441 | 576               | 155               | 396972    | 2.4  | 2.1  | 5.5  | .4   | .1   | 1.1  |

\* Kilograms per day (Kg/d)

- indicates trace amounts were found and a blank indicates that no data were reported

The types of wastewater treatment plants in Jordan include stabilization ponds, activated sludge, and trickling filters. Some function properly and produce a satisfactory effluent quality, while others produce effluent that damages the environment. Stabilization ponds in Jordan such as Khirbet es Samra, Aqaba, Mafraq and Ramtha are known to be creating problems. Major changes are required to improve their efficiency as the volume of incoming effluent is more than twice what they were designed to handle. A key problem is often the amount and type of industrial discharges they are receiving.

Many institutions, such as universities, hospitals, airports, and army camps, have treatment plants for their wastewaters. Some are functioning well, but most have serious operation and maintenance problems.

A few plants recycle industrial water for use within the plant. An example of successful in-plant recycling is the Hussein Thermal Generating Plant. In general, reuse in industry involves mixing effluents with other water resources and reusing them in irrigation, as is done with the phosphate mining effluent in Ruseifa, Hasa, and Shidiya, and the cement factories.

### *Supply and Competition*

British companies are the most competitive industrial wastewater equipment suppliers. Some of them have a license to manufacture American-designed equipment. There are few package plant suppliers; most industrial wastewater treatment plants consist of pipes, pumps, tanks, mixers, etc., assembled according to the design specifications of consultants.

The private sector works closely with equipment suppliers to choose and design industrial treatment installations. The volume of treated wastewater in Jordan was estimated at 50 MCM/yr in 1991. Evaporation, infiltration, and other losses reduced the volume used to around 30 MCM/yr.

### *Strategies for Market Entry*

Highly qualified engineers and scientists with knowledge and experience in pollution prevention, waste minimization, or clean technology are in short supply, as are end-of-pipe treatment plant design and construction professionals. Businesses have some qualified staff with experience in industrial end-of-pipe treatment, especially civil and construction engineering. Few companies manufacture equipment and even fewer could operate or maintain pollution prevention or waste treatment equipment. Companies do not stock equipment; plant design and equipment is imported on a case-by-case basis.

The best strategy for local companies, either consultants or equipment sales and service businesses, who want to enter the market would be to combine pollution prevention and control with services and sales. A second strategy would be for a local firm to associate with a leading international firm in the chosen business segment. The association would allow the local firm to gain the training, support, and expertise to be competitive and to supply high-quality consulting, design, or operation and maintenance services. It could also lead to a closer relationship in which the foreign company could continue to draw on less expensive local labor for work outside Jordan and, when doing business in other Arab countries, the foreign firm could take advantage of language skills of the Jordanian staff. Entry strategies for a foreign company could include association with or purchase of a local firm.

## Water Purification and Conservation

Water scarcity and frequent rationing have reduced Jordanian water consumption to among the lowest in the world on a per capita basis. The growing demand on Jordan's limited water supply will cause water conservation to continue to be the key approach to dealing with scarcity. Already, municipal water demands outstrip supply, a discrepancy that is expected to grow (see table below), opening a wide range of markets for

related businesses. As more water management techniques are employed to stay abreast of increasing demand, attractive opportunities will emerge for private sector firms. Many niches, including service supply or equipment manufacture, would be best filled by foreign/local cooperative efforts. These opportunities for foreign and local businesses are discussed in the section on demand and market size in this chapter.

### Current and Projected Water Supply and Demand

| Year | Population (millions) | Combined domestic and light industrial demand (million cubic meters) | Supply (million cubic meters) |
|------|-----------------------|--|-------------------------------|
| 1990 | 3,453                 | 157.9  | 125.0                         |
| 2000 | 5,249                 | 309.8  | 190.0                         |
| 2015 | 8,684                 | 573.5  | 314.4                         |

Source: Water Authority of Jordan, 1992

### *Products and Services*

This section covers equipment or services that conserve, recycle, treat, or purify water for an industrial, urban, or commercial use, as opposed to treating wastewater before expunging it (a topic covered in chapters on municipal and industrial wastewater). The actual recovery of used water in industrial processes is covered in the chapter on industrial pollution treatment, and materials recovery.

Water conservation can be accomplished in several areas, broadly divided into supply management and demand management techniques. Supply management techniques include leak repairs, measure and allocation devices, prevention of illegal connections, pressure reduction, evaporation suppression, watershed management, and small-scale rainfall collection devices. Demand management techniques involve reducing use of water through such measures as water pricing, local reuse and recycling, use of water saving devices, education, regulation, industrial process changes, and crop substitutions.

Water purification systems for industrial, municipal, or commercial use consist primarily of physical and chemical treatment technologies, whereas biological methods are the principal type of treatment for effluent for reuse.

Physical processes include methods that physically extract or separate pollutants from effluent waste streams. Technologies considered in this section include activated carbon adsorption, clarification, evaporation processes, and other filtration and separation processes such as ion exchange and membrane processes.

Chemical treatment technologies make pollutants less harmful or decompose them altogether. The chemical processes used to treat water for a particular use or reuse include chemical oxidation and reduction, coagulation-precipitation processes, neutralization, and ozonation. The equipment used for these processes tends to be less complex than that required for physical or biological methods, involving effluent delivery systems, control equipment and instrumentation, and tanks.

Potable water filters use several kinds of cartridges such as cellulose, paper, activated carbon, and ceramic. Growing public awareness of water pollution has increased demand for such filters (importation of filters increased by 52 percent in 1991 over 1990), and it is expected to continue to grow. The opportunities in water purification systems and conservation are rated on the table below:

### Water Purification Systems and Conservation

| TYPE OF BUSINESS                  |                               |  |  |                  |                  | KEY                               |
|-----------------------------------|-------------------------------|--|--|------------------|------------------|-----------------------------------|
|                                   | Opportunity for U.S. Business | Opportunity for Jordanian Private Sector | Potential for U.S./Jordanian Alliances | Near-Term Market | Long-Term Market |                                   |
| WATER PURIFICATION SYSTEMS        | ◐                             | ●  | ◑                                      | ◐                | ●                | ○ = Low<br>◐ = Medium<br>● = High |
| SUPPLY MGMT. EQUIPMENT & SERVICES | ◐                             | ●  | ◐                                      | ●                | ●                |                                   |
| DEMAND MGMT. EQUIPMENT & SERVICES | ◐                             | ●  | ◐                                      | ◐                | ●                |                                   |

### Summary of Water Supply Distribution Projects

| Project Name                          | Status    | Amount (millions JD) |
|---------------------------------------|-----------|----------------------|
| EEC/KFW/IBRD: Amman water system      | 93/95     | 25                   |
| EIB: Ramtha water supply              | NA        | 4.5                  |
| Saudi Fund: S. Amman water supply     | 87/92     | 12.8                 |
| Rehabilitation of Fuhais water system | 18 months | 1.7                  |
| Ajlun district water projects         |           | 1.5                  |
| Wadi Musa water project               |           | 1.1                  |
| Al-Aaboun (Tafleih) water project     | 12 months | 0.7                  |
| Salt water project                    | 48 months | 5.0                  |
| Mafraq water project                  | 30 months | 3.2                  |
| Other water projects                  | 24 months | 3.5                  |
| <b>Total</b>                          |           | <b>59.0</b>          |

Source: A Water Management Study for Jordan, PRIDE Document, 1992.

### *Demand, Market Size and Opportunities*

#### *Supply Management*

The time is right for municipalities to look to the private sector to repair distribution system leaks, block illegal connections, and install measurement and allocation devices. Such measures can recover costs which can pay the contractor and generate income for the municipality. The savings attainable through these measures have been estimated at 30 MCM/yr by 2015. Over half (56 percent) of the municipal water supply is unaccounted for, meaning it is lost through leaks or illegal connections. The current municipal water supply could be increased by 14 percent simply by fixing leaks. The total cost of repairing leaks and stopping illegal connections has been estimated at JD 75 million. Black, Veatch and Associates (1987) projected cost savings and revenues of approximately JD 7 million in 1991 by reducing municipal leaks to 15 percent. During low flows, water goes unrecorded because many meters do not function properly. In Mafraq water district, an estimated 10,000 of 18,000 water meters are broken or not in use. With the private sector water meter installation firms working on an incentive-based contract, municipal water authority revenues

could probably be nearly doubled by repairing and installing meters (combined water supply and sewerage revenues were JD 24 million in 1991).

The WAJ has called for actions to deal with meters, billing, illegal connections, and leakage at an estimated cost of JD 2.4 million (WAJ 1988). The savings in reduced expenses and the water itself from these actions is estimated to exceed JD 15 million. In addition, nearly JD 60 million are to be spent on water supply projects over the next several years, largely financed by donor funding (see table on previous page).

There are also opportunities to conduct feasibility studies to employ pressure reduction where long water lines lead down steep slopes, and to use evaporation suppression techniques in vulnerable areas. Candidates for evaporative closures include pipe connections from King Talal Reservoir with both As-Samra and the Jordan Valley facilities.

The private sector (primarily consulting firms) can also offer water conservation services in watershed management. This typically involves planning and administrative functions such as zoning, building regulations, land use planning and sitings of waste management facilities, but also pertains to such activities as land purchases for direct control of access to water courses, and afforestation or revegetation around waterways.

Finally, with the price and demand for freshwater expected to continue to rise, a potentially lucrative opportunity for local manufacturers and suppliers of rainfall capturing systems will be rooftop collection devices and storage tanks.

### *Demand Management*

One way to reduce water demand is through reuse, usually for an application requiring a lower quality of water than did the original. In most cases, reuse requires some treatment or preparation.

The total effluent from treatment plants is expected to increase to 66 MCM/yr annually by the year 2000 and twice that level by 2015, making large volumes of water available for reuse, given sufficient treatment. The current end use of most of this treated wastewater is farming in the Jordan Valley. However, the high fecal coliform concentration (25,000/100ml) prevents the direct reuse of wastewater for most food crops. Treatment plants must be upgraded if the effluent is to be reused. Most wastewater reuse by agriculture involves either direct application, or groundwater recharge and extraction from wells.

In Zai, a water purification plant treats the water pumped from the King Abdullah canal which supplies greater Amman. The plant employs filtration, sedimentation, coagulation, chlorination, and activated carbon techniques. The capacity of the plant is around 125 MCM/yr, but it uses an average of only about one-tenth of that. Costs could easily be saved by improving overall water management. The Zai system can deliver water at a rate of 169 fils per cubic meter (operation and

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maintenance costs), compared to domestic groundwater delivered to Amman at 229 fils per cubic meter. A study by CH2M-Hill (1989) attributed inadequate meter reading, revenue collection, and similar drawbacks to the absence of management information systems. This case represents one of many opportunities for private sector management and information system consulting firms.

Urban reuse is currently limited in the residential and commercial areas. Extensive use of grey water is unlikely among residences unless separate plumbing systems are constructed for septic and non-septic wastewater in homes, which most likely entails prohibitively high construction costs. Water saving devices and equipment have significant potential for reducing water use and increasing water availability. In homes, hospitals, hotels, schools, and other facilities, the main potential for water savings is in bathrooms and kitchens. About half the 553,000 toilets in Jordan are flush units, over 70 percent of which are supplied by the Jordan Ceramics Company. The average toilet currently uses 10 liters per flush. Importers, aware of the market potential of water saving toilets, are promoting toilets that use 5-7 liters per flush. The Ceramics Company is testing a model that uses 5-6 liters per flush. Older models can be outfitted with water-saving devices.

Replacing faucets and shower heads with new models that restrict flow can also save water and open opportunities for private manufacturers and faucet suppliers. Jordan has an estimated 500,000 bathtubs or showers, and over 2 million faucets. The public cost of replacing all units has been estimated at JD 45 million.

Irrigation water represents about 73 percent of total water consumption, which is mainly used to irrigate Jordan Valley agricultural lands, in addition to farms with their own wells. Simple water filtration is employed here. Significant water savings are also possible in agriculture through devices that deliver water more efficiently and avoid evaporation, such as drip irrigation, which is currently used on nearly 60 percent of Jordan's farmland. Substitutions of less water-intensive crops also can save considerable water. In short, there is potential for private sector suppliers of non-water intensive seeds as well as water conserving irrigation systems.

Some households also require filtration units to filter municipal supplies, or local well and surface extraction. The total expected market size of household water filter units has been estimated at about 55,000 units. The market size for replacement cartridges is three times this figure (165,000 units/year).

Finally, water savings are possible in the industrial sector. In terms of equivalent production units, Jordanian operations require 2.76 times more water than U.S. firms—1.71 times more to tan leather, and 1.26 times more to produce beer. In many cases water use could be reduced to below U.S. levels by employing water conservation and recycling techniques and equipment. This market is discussed in the section on industrial wastewater treatment and prevention and process materials reuse.

### *Clients and Ownership*

Municipalities and various GOJ agencies, particularly the Water Authority of Jordan, would be the most likely clients for water supply management services and equipment.

Not all people who are aware of water quality can afford water treatment, but with government subsidies and/or higher water charges, small industry, hospitals, medical labs, commercial firms, and domestic dwellings are potential clients for water demand management services and equipment.

Jordan has about 2,300 manufacturing plants, of which an estimated 500 are candidates for water reuse and conservation equipment and services. Most of these are in the private sector.

A large percentage of the agricultural enterprises in the Jordan Valley and the uplands have yet to convert from basin, furrow, and sprinkler irrigation to drip irrigation.

### *Supply and Competition*

As industry becomes more aware of the benefits of water conservation techniques, new businesses have been emerging. However, competition among Jordanian businesses is still only moderate.

The number of new businesses entering the water filter market has increased with demand in recent years. Prices of water filters have fallen by one-third compared with the prices two years ago, and imports of household water filters increased by more than 50 percent in 1991 over 1990; a similar increase was expected for 1992.

The United States has the most competitive suppliers of household water filter systems, followed by Italy. The most competitive suppliers of water purification equipment for agricultural use are Germany, the United States, and Italy.

Several private sector companies are supplying water treatment equipment and systems. Most of them are 20 to 30 years old. German suppliers tend to be the most aggressive in marketing.

In Wadi el Arab, which supplies Irbid with drinking water, the produced water is purified by cascading coagulation, sedimentation, and chlorination. All over the country small purification plants for industrial and private use are using reverse osmosis, filtration, coagulation, and ion exchange units. Jordan has several long-established drip irrigation manufacturing plants.

### *Market Entry Strategies and Barriers*

The private sector can be active in marketing and supplying and installing water conservation equipment in the residential, commercial, agricultural, and industrial sectors. Water prices can act as powerful incentives for water conservation, especially where prices are minimally subsidized and market driven. Changes in the present structures of both the Jordan Valley Authority and the Water Authority of Jordan to reduce their high government subsidization and subject them more to market forces would spawn the growth of related private sector businesses. Such a move would also alleviate cost recovery problems and provide incentives for farmers to adopt water-conserving equipment and crop choices.

Local businesses will be able to manufacture items of low to medium technological sophistication such as cartridges, while high technology equipment will have to be imported. Some of the best possibilities for Jordanian firms are assembling filtration equipment, water pumps, and diesel engines, and manufacturing cast iron parts. Opportunities will also emerge for local companies that can maintain and repair water delivery systems. In some cases, foreign technologies such as valves and flow meters could be required. U.S. consultants/manufacturers should consider helping to establish manufacturing centers in Jordan.

Strategies for business development in water conservation include acquiring systems and equipment covering the range of sectors being serviced, launching a comprehensive marketing scheme, and training technicians to install and service the equipment.

The potential is good for local manufacturers to produce filter cartridges to meet the growing market demand currently filled largely by foreign suppliers. The technology employed is relatively simple and the cost of entry, moderate. All the raw materials for such filters are available in Jordan. However, the basic technology of the industry is not available. Foreign/local joint ventures would be preferred.

Barriers to entering the water conservation market include limited public awareness of the seriousness of the water scarcity, high cost of entry, and the lack of water conservation legislation. In addition, subsidies artificially decrease the cost of water to consumers.

## **Environmental Monitoring and Testing**

The current market for environmental monitoring and testing equipment is quite limited. However, as the GOJ becomes more active in pollution prevention and control, a market for basic and sophisticated environmental testing equipment is expected to emerge. The largest market segment in this area will be for equipment and services to test and analyze water and liquids. Smaller markets are expected to develop in the agricultural and food areas, especially in pesticide residues and solid and hazardous wastes. Measurement and continuous monitoring of energy use is an established and growing field. All environmental monitoring and testing markets will be small, however, because the Jordanian economy is relatively small.

The National Environment Strategy for Jordan prepared in August 1991 pays little attention to environmental monitoring and testing. A number of government agencies and other groups have quantity and quality monitoring programs for water, but air and land quality monitoring is limited. Jordan has no national environmental quality monitoring plan, and the market for sampling and measurement equipment and services will not significantly expand until this area receives more attention.

A number of water monitoring programs are ongoing. The Marine Sciences Station has been monitoring marine waters since 1986. In addition, in 1989 and 1990 the Aqaba Region Authority, together with the Royal Scientific Society, implemented an environmental monitoring system. The project monitored water quality of consumable water, sea water, treated wastewater, irrigation run-off, and cooling water, to determine suitability of treatment plant effluent and palm forest irrigation runoff for various agricultural uses. The Ministry of Water and Irrigation, the Jordan Water Authority, and the Jordan Valley Authority have major water quantity and quality monitoring activities.

An emerging area will be for agricultural products shipped to the European Economic Community and other Western markets, which will require pesticide residue certificates. As towns and industries build and maintain wastewater treatment systems, as solid and hazardous waste volumes increase, and as the GOJ becomes more involved in managing and protecting the environment, awareness of the need for testing and monitoring will increase.

### *Products and Services*

Environmental testing equipment and services apply to air, water, and solids including resources, raw materials, food products, and wastes. Sampling equipment is required to extract samples, and testing equipment to determine the nature of the samples. The range of sampling and analysis venues requires analysis both on-site and in a removed laboratory. The equipment for both requirements is widely available and directly related to the much larger field of medical analysis.

Skilled laboratory technicians and properly equipped laboratories are required to do testing and analysis. The medical and university teaching and research fields in Jordan probably already have equipment similar to that required for environmental sampling and

analysis. Thus, there is already an infrastructure to supply and service this market. The equipment and services required for environmental sampling and analysis is, if anything, simpler and mostly less precise than that already available in Jordan. The one criterion which this field does not share with the medical and education-related equipment is the portability and robustness needed for on-site and out-of-doors sampling and analysis.

Many proven general spectrum environmental sampling and analysis systems are for sale that handle water, air, or solid samples. This equipment can be imported from many countries and sales and service should be routine because it is so similar to analytical equipment already used and marketed in the country.

The overall opportunities in environmental monitoring and testing are rated on the table below:

**Environmental Monitoring and Testing**

| TYPE OF BUSINESS               | Opportunity for U.S. Business | Opportunity for Jordanian Private Sector | Potential for U.S./Jordanian Alliances | Near-Term Market | Long-Term Market |   |
|--------------------------------|-------------------------------|--|--|------------------|------------------|---|
| TESTING AND ANALYSIS SERVICES  | ○                             | ◐  | ○                                      | ○                | ◐                | <b>KEY</b><br>○ = Low<br>◐ = Medium<br>● = High |
| TESTING AND ANALYSIS EQUIPMENT | ◐                             | ○  | ◐                                      | ○                | ◐                |   |

*Clients*

As the market for environmental testing and analysis equipment grows, it is likely to include government agencies, industry, educational institutions, existing and new laboratories, and possibly consulting and engineering companies. The three segments of this market which appear most attractive are industries, consulting companies/laboratories, and

the government. Industries are already beginning to develop pollution prevention materials and waste recycling and treatment programs. These developments raise the need for measurement and monitoring equipment. The government is expanding its monitoring and enforcement programs. For industries and others to comply with environmental requirements, consultants will be needed.

### *Demand*

The early clients identified above will require equipment for their own sampling analysis activities; technical assistance and services from others to routinely sample and analyze water, air, and solid samples; and substantial repair and maintenance services for all owners of sampling and analysis equipment. Training of samplers, analytical equipment, and repair and maintenance personnel will also be needed.

Research financed by local or foreign institutions is rare, but has the potential to develop as research institutions in Jordan undertake joint endeavors with foreign institutions. Research areas needing testing and analysis equipment which are expected to expand include water-soil-plant interactions, water use efficiency, advanced irrigation techniques, wastewater treatment and reuse, evaluation of groundwater resources, brackish water use in irrigation, brackish water treatment, desalination by using solar energy, water harvesting and artificial groundwater recharge, recycling of industrial water, and integrated environmental assessment of water projects.

The Government of Jordan represented by the Ministry of Planning and the Higher Council of Science and Technology has financed studies and research in the last decade in the following areas: wastewater treatment, wastewater qualities and reuse, qualities of surface and groundwater curative waters, and groundwater artificial recharge.

The amounts allocated for studies and research are surprisingly low and do not cover the needs, but research is still cheapest at universities, because they pay their own salaries and overheads.

Industries are beginning to require more raw materials analysis capacity. Since water is a major input to industrial processing, the need is growing for more sophisticated water analysis. Wastewater sampling and analysis by industry, municipalities, and the government is also becoming more common.

### *Supply*

The Royal Scientific Society and the Water Authority of Jordan have laboratories for analyses and quality control but have not developed the capability to support extensive sampling, monitoring, and analysis. Even the best equipped laboratories in the government

or at the University of Jordan are not able to analyze certain important pollution parameters in liquid, atmospheric, and solid samples. For example, existing laboratories lack adequate microbiological testing and the ability to handle *in situ* analysis of solid and hazardous wastes. The Ministry of Water and Irrigation does not operate laboratories of sufficient capacity in areas other than Amman. All analyses beyond the simplest tests have to be performed in Amman. Other laboratories, especially in the health field, could provide analysis to satisfy some needs in the water and wastewater fields. However, there is almost no capability to analyze air and solid samples.

Technical staffs in laboratories are adequate to perform the current level of testing. However, additional training is needed. Foreign consulting companies in joint ventures with local consultants generally carry out complex studies on pollutant fate and concentrations.

### *Competition*

Laboratories for environmental quality control and studies have been established in several agencies. The best equipped laboratories are in the Ministry of Water and Irrigation, the Ministry of Health, the University of Jordan, the Royal Scientific Society, and the Ministry of Agriculture. The other laboratories are very limited in capacity. Because most laboratories are government-owned or supported by major public institutions, private laboratories will have difficulty competing with them. Yet, these capabilities have proven inadequate to meet even existing demand in some areas.

Equipment supply is limited to agents and sales operations. No major sampling or analytical equipment is manufactured in Jordan. The agricultural sector has a limited network of irrigation water, crop, and soil analysis equipment suppliers. A more robust network of equipment supply and service also exists for the medical analysis equipment field.

### *Strategies for Market Entry*

Teaming with existing education, and research entities and tracking donor agency funding in this area comprise one approach to the sampling and analysis service market. Another strategy involves offering training and information seminars to potential clients. A third is to build on the existing medical, energy conservation, and agricultural sampling and analysis base. Firms that now supply services or equipment to these markets could begin to sell to environmental clients. A fourth way would be to specialize in an area such as solids (wastes, soil, raw materials and products). Because the market in Jordan is small, only a few new ventures are needed. The analytical equipment manufacturing capability is limited, so, a broad-based foreign service provider and an equipment manufacturer could each establish a local presence to exploit the growing demand for services and products. The market might support more than one such venture. In both cases it would be useful to utilize or joint venture with existing Jordanian private sector capability.

## **Municipal Solid and Hazardous Waste Collection and Disposal**

Growing needs for municipal solid waste collection and disposal coupled with GOJ moves to privatize some government services will create opportunities for Jordanian waste collection businesses. The best opportunities for U.S. firms will lie in the sale of heavy equipment, such as collection trucks and bulldozers, while local firms will have a competitive advantage in the supply of small, unsophisticated equipment and all services related to the collection and disposal of municipal solid waste.

U.S. expertise may also be consulted in landfill management. Jordan's large arid areas are poorly suited for agriculture or habitation. Landfilling is therefore considered the most appropriate means of municipal solid waste disposal. However, it must be emphasized that sanitary landfill technologies do not seem to be employed at present.

Markets for firms that provide services or equipment to collect and dispose of hazardous wastes are expected to emerge in the next few years. However, laws pertaining to the handling and disposal of hazardous waste have yet to be developed. At present, water and health laws partially cover some aspects of disposal. No hazardous waste disposal facilities exist in Jordan, although a cooperative industry/government venture has been negotiated for which fund raising is under way.

The increasing scarcity of ground and surface water supplies will encourage GOJ action to prevent aquifer contamination resulting from improper disposal of hazardous waste. U.S. companies will have the advantage in supplying highly sophisticated disposal and incineration equipment, although the market for such equipment is expected to be limited as Jordanian industries will prefer low-cost options. An exception might be found in projects financed by the United States or U.S.-backed donor agencies and multilateral lending agencies.

The Prime Minister of Jordan established a clearing committee in 1987 to develop a comprehensive waste management policy. This committee recommended creating a central department responsible for solid waste management, construction of recycling facilities, and use of biodegradable materials, along with the passage of solid waste legislation. In addition, a committee has been formed representing the municipalities, the Health Ministry, the Water Authority, the Royal Scientific Society, and the Natural Resources Authority to address hazardous waste problems. The committee chose a location east of Amman for dumping hazardous chemical waste.

In 1989 the GOJ joined the Basel Convention which controls the trans-boundary introduction of hazardous waste. The Gulf of Aqaba lacks the necessary installations to treat ballast water of ships, particularly oil tankers, but such treatment is especially important in the ecologically sensitive gulf.

**Products and Services**

Transport vehicles, waste movement equipment, collection services, and disposal services and equipment constitute the major products and services market for municipal solid waste. The waste may also be burned (sometimes as a fuel source) in incinerating units. Organic waste may be composted in containers that control drainage and aeration, and may have mechanically turned decomposition. Maulers are sometimes used to reduce the volume of non-compactable waste. Landfill covers can be used to increase landfill capacity by replacing dirt, in addition to suppressing vapors, odors, and disease vectors.

The forms of hazardous waste treatment include incineration in kilns, engineered landfills (a variety of lining methods can be used to prevent seepage), chemical fixation, the reuse of high-energy potential wastes (oils, solvents, paint sludge, organic compounds, pesticides, etc.) as a fuel source as in cement or lime kilns, and bioremediation, which can be used for wastes containing low and medium concentrations of hazardous organic matter. The transport of hazardous waste can require vehicles especially designed for hazardous waste transport when safety is a concern.

The opportunities in municipal solid and hazardous waste collection and disposal are rated on the table below.

**Municipal Solid and Hazardous Waste Collection and Disposal**

| TYPE OF BUSINESS                  | Opportunity for U.S. Business |  |  |                  |                  | KEY<br>○ = Low<br>◐ = Medium<br>● = High |
|-----------------------------------|-------------------------------|--|--|------------------|------------------|--|
|                                   | Opportunity for U.S. Business | Opportunity for Jordanian Private Sector | Potential for U.S./Jordanian Alliances | Near-Term Market | Long-Term Market |  |
| COLLECTION EQUIPMENT AND DISPOSAL | ◐                             | ○  | ◐                                      | ◐                | ●                |  |
| COLLECTION SERVICES AND DISPOSAL  | ○                             | ●  | ○                                      | ◐                | ●                |  |
| HAZARDOUS WASTE                   | ○                             | ◐  | ◐                                      | ○                | ◐                |  |

### *Clients and Ownership*

Even if municipal waste collection and operation of disposal facilities are handed over to the private sector, the main purchasers of composters and landfilling equipment will likely be government agencies and municipalities.

Environmental regulations for industrial solid and hazardous waste disposal are expected to become more stringent over the next several years, but to what degree is uncertain. Ultimately both private and public sector industries will require disposal and treatment equipment and services. Hospitals could also become buyers of waste incineration equipment, once such regulations are implemented.

### *Demand and Market Size*

Jordan has approximately 140 municipalities, cities, and villages. Twelve currently operate landfills, seven of which serve more than one city. Municipalities not served by landfills allow open dumping or burning. Over 90 percent of the population has access to sanitation services in both rural and urban areas. Jordan's growing population coupled with steady migration to urban areas will assure the demand for municipal solid waste removal equipment and services. (Currently, 97 percent of the population is concentrated in a 31-mile corridor east of the Jordan River.) An estimated 1,200 tons of solid waste is generated daily in Greater Amman. The average individual production of domestic waste in Amman was 0.46 kg/day in 1979, 0.72 kg/day in 1984, and to 0.84 kg/day in 1986.

Although the Municipality of Greater Amman pays about JD 4 million for collection services in Amman, it cannot meet the full demand for the collection and disposal of municipal solid waste. Privatization of collection services is probable in the near future, and will open opportunities for local contractors. As solid waste collection represents a new type of business for the private sector, contractors are expected to be conservative in pricing policies at the beginning but more competitive over time.

With no adequate regulations, hazardous waste is dumped in unappraised sites, with little regard for potential contamination. The main sources of industrial solid and hazardous waste in Jordan are as follows:

- ▶ Hospitals
- ▶ Thermal industrial treatments
- ▶ Pharmaceutical industry
- ▶ Used mineral oils
- ▶ Paint residuals
- ▶ Metal waste containing copper compounds, zinc, cadmium, mercury, and lead

The following table shows disposal measures currently employed for some typical wastes.

**Major Industrial Solid Wastes and Present Disposal Measures**

| Type of Industry       | Solid Waste Generated                                   | Disposal Measure Employed  |
|------------------------|---|--|
| Industrial engineering | Metal, electrical                                       | Metals are collected in containers and sent to be recycled; plastic and electrical waste is collected in plastic bags and burned |
| Construction           | Concrete and other building materials                   | Dumping at various sites   |
| Wood and furniture     | Fibers and sawdust                                      | Sawdust is collected and sold; fibers and textiles are collected and burned or sold  |
| Tanning industry       | Solvents and other chemical residuals                   | Treated in waste treatment plant   |
| Shoes                  | Natural and other leather, threads, paper and cardboard | Collected and burned or dumped   |
| Food                   | Food waste, plastic, paper and metal                    | Collected in bags and burned or dumped   |
| Chemical and medical   | Chemical and organic waste, paper, plastic, glass       | Solid wastes are burned, dumped or sold  |
| Paper                  | Paper and plastic waste                                 | Burned or recycled   |

### *Supply and Competition*

At present, municipalities collect and dispose of municipal solid waste. In recent years, several sites have been closed. They generally dump wastes in an open site outside municipal boundaries and allow them to burn. With the humidity ratio reaching 70 percent in the domestic refuse, the burning process is incomplete, especially during winter.

The table on the next page gives the typical composition of domestic waste in 1986.

| Type of waste       | Content |
|---------------------|---------|
| Organic matter      | 49%     |
| Paper and cardboard | 26%     |
| Glass               | 3%      |
| Metals              | 3%      |
| Plastic             | 12%     |
| Other               | 7%      |

Source: Energy Management Services, Jordan, 1992.

Few if any companies provide safe disposal and treatment of hazardous waste. The potential for joint ventures between U.S. and Jordanian firms in treatment plants could be significant once comprehensive regulations for disposing of hazardous waste are established and enforced.

### *Market Entry Strategies and Barriers*

Legislative and bureaucratic barriers prevent the private sector from entering the business of municipal waste collection and disposal. In addition, regulation and enforcement is often relaxed for government-owned facilities. To contract collection services to the private sector, GOJ regulations will need to be revised to ensure a clear billing and payment structure, giving private collection services confidence in their returns. A scheme has been suggested involving the GOJ by which the contractor could use available machinery and receive free consulting services and TV and radio time to educate the public about solid waste collection. Costs of entry in the municipal waste collection and disposal market are relatively low; transport vehicles and labor are the primary needs.

Businesses wishing to enter the market for incineration and engineered landfills to dispose of hazardous waste will encounter relatively high costs since both require sophisticated technology. To operate and manage hazardous waste facilities also requires significant training.

U.S. equipment and machinery could be used to collect and dispose of municipal waste, as well as to handle, incinerate, or dispose of hazardous waste. U.S. firms could increase their competitiveness by offering financing at low interest rates.

**Waste Recycling  
Services and  
Equipment**

Huge amounts of motor oils are spilled daily over Jordan, contaminating the soil, surface water, and groundwater. Even when this oil is discharged into the sewage system, treatment plants in Jordan do little to diminish the toxicity or environmental degradation. Major users and collectors of these oils include large fleet operators such as the government institutions, the military, police, municipal transportation, airports and the Royal Jordanian Airline, service stations, and garages.

Collecting and re-refining mineral oil is a feasible business which is practiced in many developed and developing countries. The residue from the refining process could be used as a soil stabilizer in road construction.

Many domestic solid wastes are recycled in different stages of management. For example, soft drink bottles are reused after consumption (98 percent of bottles are returned). Old newspapers are returned and recycled, and cans are used for several purposes. Almost half the 150-160 million cans that Jordanians use annually are used in Amman.

Recently some industries have started to recycle solid waste such as paper, cardboard, plastic, and glass. As a pilot case, the Jordan Paper and Cardboard Manufacturing Company collects and recycles paper and cardboard. Approximately 8,000 tons of paper is recycled each year. In the last two years the company has distributed containers to several collection sites; a contractor and some individuals have collected and transported paper to the company.

Jordan has made tremendous efforts and achieved progress in agricultural development. This is due to farmers' awareness of the role of agriculture in supporting and strengthening the national economy, which has led to the introduction of new technologies in agriculture. Some of these methods present problems which will be reviewed in detail below.

Plastic is used in agriculture in many ways (e.g., plastic greenhouses and agriculture irrigation systems). Jordan consumes around 50,000 tons of plastic annually, of which 20,000 tons are for plastic houses. The Five Year Plan for 1986-1990 estimated that 60,000 dunums will be served by water irrigation systems in the early 1990s.

Accurate figures about the present situation are not available but indications point to increased demand for plastic products, which means that plastic waste will accumulate and hurt the environment.

The main types of plastic used in agriculture are:

- Low density polyethylene, mainly used in "protected" agriculture and plastic greenhouses. (The most common type of plastic waste in Jordan, around 8,000 tons of it accumulate yearly).
- Polystyrene, used to wrap vegetable and fruit. Annual demand for this plastic is around 3,000 tons/year.
- PE and PVC irrigation pipes.

These plastics have certain impacts on the environment, mainly as follows:

- They are aesthetically displeasing.
- They directly threaten animal life because animals cannot utilize them (and they can cause suffocation and death).
- When buried, they prevent soil from aerating and water from percolating into the soil.
- They clog irrigation tunnels and shut down systems.

Plastic and oil pollution is a serious problem; a key solution is recycling and increasing awareness of the environmental impact of present practices and the value of oil and plastics recycling.

### *Products and Services*

The main types of solid waste in urban areas are household, commercial, industrial, street, and construction wastes. Of potential value in this waste stream are organic wastes, plastics, rubber, motor oil, cooking oil, household batteries, metals, and any item that can have value added for resale to consumers, such as used shoes, or to industries, such as plastic and glass.

Separation, the first step in the extraction of recycled materials from municipal waste, can be accomplished manually or by automation. Most of the limited separation of municipal solid refuse in Jordan is done by hand. The following table lists needs for technology and equipment to recycle various wastes.

*Business Activities  
and Opportunities in the Environment*

| <b>Recyclable Product</b> | <b>Technology or Equipment Employed</b>  |
|---------------------------|--|
| Plastic                   | Sorting, cutting, washing, granulating, and molding  |
| Cooking and motor oil     | Sieving and dehydrating devices  |
| Metal                     | Hammer mills and ball mills for shredding and grinding   |
| Glass                     | Separators, washing tubs, batching equipment, furnaces, annealing equipment, molding and shaping machinery |
| Rubber                    | Tire resurfacing and retreading, pressing, shredding, firing, cracking, injection and extrusion molding    |
| Paper and wood            | Shredders, pulpers, wood hoppers, repulping tubs, dewatering presses, and fiber balers                     |

To collect and recycle oils requires investment in collection tankers; storage tanks; filtration, re-refining and repackaging equipment, and redistribution tankers. Also needed is the ultimate disposal of the residues from filtration and re-refining. The re-refined oil could be used as a lubricant or as a fuel. The first reuse has the highest value, but only a portion of the lubrication oil collected can be re-refined and upgraded to meet the quality standards necessary for it to again serve as a lubricant. Motor and lubrication oil in Jordan is often used longer than recommended and by the time it is changed or replaced, it has deteriorated significantly. This common overuse makes the re-refining and upgrading process very costly. Thus, the main use for waste oil would be as a high BTU fuel additive in industrial and commercial boilers. It can also be used in incinerators and other combustion processes. Supply segments such as aviation oil, motor oil from well maintained fleets, and lubricating oil from selected industrial processes can be re-refined and recycled economically as lubricating oil.

The opportunities in waste recycling and associated businesses are rated on the table on the next page.

*Clients*

Glass collectors sell their waste glass to recyclers and processors, who clean, recycle, and reprocess glass into new products. At present Jordan has no major glass recycler. The only flat glass factory is in Ma'an. The only clients for waste and recycled glass are bottlers who have the capacity to clean and handle recycled glass containers, and small specialty glass makers. Until there is a major glass products maker or a major flat glass manufacturer, the market for recycled glass will not be large. To stimulate the use of waste and recycled glass, the military could undertake some of these manufacturing ventures. It has both the personnel

action by the government or a major, unprecedented private investment to significantly accelerate glass or plastic recycling.

**Waste Recycling and Associated Businesses**

| TYPE OF BUSINESS                 | Opportunity for U.S. Business |  |  |                  |                  | KEY                               |
|----------------------------------|-------------------------------|--|--|------------------|------------------|-----------------------------------|
|                                  | Opportunity for U.S. Business | Opportunity for Jordanian Private Sector | Potential for U.S./Jordanian Alliances | Near-Term Market | Long-Term Market |                                   |
| PLASTIC AND OIL                  | ○                             | ◐  | ◑                                      | ◐                | ◐                | ○ = Low<br>◐ = Medium<br>● = High |
| PAPER, GLASS and METAL RECYCLING | ○                             | ◐  | ○                                      | ◐                | ◐                |                                   |

*Demand and Market Size*

Glass recyclers are ready to buy many times more than what is offered. At current prices for finished metal, metal recyclers and traders are ready to buy many times more scrap than is offered. There is already a small but reportedly profitable scrap metals market.

Demand for waste glass is increasing, but still limited. Collectors' profits are limited but apparently reasonable. In-house recyclers in business report it is very profitable.

Recyclers, especially the large National Paperboard Company, would buy many times more than they receive, because it is more economical than importing paper pulp. At current prices, demand is many times higher than supply, however. Recyclers should increase their buying prices to increase supply.

Some waste oil is recycled, especially in selected industries and by independent collectors who buy it for resale as a combustion fuel supplement. Since this industry is not highly organized, it appears that new and more efficient businesses could enter the market.

### *Supply and Competition*

Metal recycling and processing are mature technologies that have been employed successfully in Jordan for many years. Collectors of metals like iron, aluminum, copper, brass, and lead sell them to recyclers and scrap traders. Iron and aluminum are recycled and remanufactured, while the rest of the metals are sold to scrap traders who export them.

Plastics collectors sell their plastic wastes to processors, who in turn clean and recycle them into packing products for non-food goods. The supply of plastics is limited, so plastics recyclers should raise the buying price to encourage more collection and to increase the number of collectors. The quantity collected is very small compared with the potential.

To expand the markets described above will require extensive publicity and public education about the value of recycling and reuse, and a substantial investment by the government or the private sector in an industry that uses major amounts of waste and recycled products.

Paper and cardboard are the only major recycled or reused products in Jordan. The industry is considering expanding its paper board manufacturing but may have to go to Europe to get sufficient stock. Europe has an oversupply of recycled paper, and the plant in Jordan could obtain free, bailed recycled paper and cardboard at ports in Italy and Germany if it paid for loading and shipping.

### *Market Entry Strategies and Barriers*

For collectors, the costs of market entry are limited to collection equipment. For recyclers, the costs are greater and include recycling equipment and process materials.

Consulting firms could perform technical and feasibility studies for small oil re-refining plants, while joint local and U.S. consultants could do the studies for medium and large plants.

Currently there is no enforcement of legislation to drive the market for waste oil recycling. Small-scale re-refining of used oils could become widespread, first in Amman, and then throughout Jordan. American equipment suppliers could have good opportunities, particularly in small portable re-refining units. U.S. companies are advised to join local partners for consulting and/or supply of equipment and plants, because the business will continuously expand, especially for small units.

**Agricultural  
Waste  
Recycling**

Several agriculturally related small-scale businesses are particularly suited for the Jordanian context. These are primarily opportunities for small, locally owned businesses, although in some cases U.S. expertise might be needed.

One such opportunity is the treatment of manure to produce fertilizer. Small specialized contracting businesses could design and construct digesters. U.S. companies could supply a few high-tech digesters suitable for large animal farms.

Blood from slaughterhouses can be separated from other animal waste and sold to animal feed producers.

The use of animal bones to produce gelatin products ranging from pharmaceuticals to explosives would not only create small businesses, but would reduce the amount of waste from livestock cultivation.

Two additional opportunities relate to Jordan's large phosphate mining industry. Phosphates from the Jordan Phosphate Mines Company in Shidiya are transported to its fertilizer manufacturing plant in Aqaba by truck, which is costly and damaging to the environment. A pipeline has been considered to transport slurry phosphate (a phosphate and water mix), as is common in the United States and other countries. Another possibility is to use the phospho-gypsum by-product of the fertilizer-producing plants as a material to manufacture blocks for construction.

### *Products and Services*

Livestock farms produce a continuous supply of manure, which is considered a concentrated solid pollutant and a potential source of disease and odor. Disposal of animal manure can be a problem for farm owners. Low-tech, low-cost digesters (fermenters) can be employed to treat dung, producing a hygienic all-purpose fertilizer. The cost of such a fermenter in Jordan has been estimated at about JD 1,500 for a small poultry farm of about 6,000 chickens. In some cases it may even be cost effective to capture methane gas produced in the fermentation chamber.

Slaughterhouses generate a steady supply of large volumes of blood. Blood is separated from other slaughterhouse waste and prepared for resale to animal feed producers.

Animal bones are another potentially valuable animal by-product. They can be processed to produce gelatin for use in several industries, including pharmaceuticals and explosives.

*Business Activities  
and Opportunities in the Environment*

Equipment, engineering, and construction expertise would be required to install a pipeline to transport phosphorous slurry.

Phospho-gypsum, a by-product of fertilizer production from phosphate, can be used to manufacture building blocks and to make the desert soil in southern Jordan more suitable for agriculture.

The opportunities in agricultural waste recycling are rated in the table below.

**Agricultural Waste Recycling**

| TYPE OF BUSINESS                                     | Opportunity for U.S. Business | Opportunity for Jordanian Private Sector | Potential for U.S./Jordanian Alliances | Near-Term Market | Long-Term Market |
|--|-------------------------------|--|--|------------------|------------------|
| ORGANIC FERTILIZER PRODUCTION FROM MANURE            | ○                             | ●  | ○                                      | ◐                | ●                |
| PROCESSING ANIMAL BONES TO MAKE GELATIN              | ○                             | ◐  | ○                                      | ◐                | ◐                |
| CONSTRUCTION OF PIPELINE TO CARRY PHOSPHOROUS SLURRY | ◐                             | ◐  | ●                                      | ◐                | ◐                |
| MANUFACTURING PHOSPHO-GYPSUM BLOCKS                  | ○                             | ●  | ○                                      | ◐                | ●                |

**KEY**

○ = Low

◐ = Medium

● = High

*Clients and Ownership*

Hundreds of livestock farms in Jordan would buy small manure-digester units. Large-scale farms need larger, more sophisticated equipment. The farming industry is part of the private sector.

Animal feed production plants would buy blood from slaughterhouses.

## *Business Activities and Opportunities in the Environment*

Private sector explosives, pharmaceutical, food, and other industries that import gelatin supplies would be clients for new local gelatin producers.

The client base for phosphate blocks consists of domestic and possibly neighboring country construction industries and developers.

Although the Jordanian Phosphate Mines Company is more than 50 percent government owned, it is expected to be completely privatized within the next five years.

### *Demand and Market Size*

The hundreds of animal farms in Jordan could contribute to a substantial demand for manure digesters. The fertilizer produced would find a good market.

Small quantities of blood and organic-laden water are given to local blood meal makers. By better separating blood during chicken, sheep, and cattle processing, the slaughterhouse could market blood to animal feed makers. In addition, all the sheep and cattle hides which can be recycled are sold to the leather tanning plant in Amman. Many are not in good enough shape to be used, but represent a raw material for local use.

The market size for gelatin produced from animal waste is significant in Jordan. Gelatin should be competitive as it is produced from raw material that is available free.

Jordan Phosphate Mines Company trucks 1 million tons of phosphates yearly from Shidiya to its fertilizer manufacturing plant in Aqaba. (This figure will be 1.7 MCM/year by 1994.) This is costly and detrimental to the environment and too few transporters are available. In the United States, phosphates are transported by pipe in the form of slurry.

The market for building blocks is growing along with Jordan's population boom. Aqaba is expanding port activities and establishing a new industrial free zone. Demand for building blocks and arable lands will continue, as Aqaba expands and its population grows.

Phospho-gypsum could also be used to increase the cohesiveness of the desert soil and decrease salinity in the south and southeast of Jordan to improve land for agriculture. This would require a government awareness program at the very least, and preferably an appropriate incentive program.

### *Supply and Competition*

Currently, organic fertilizer must be imported to Jordan. The proposed manure digesters will produce a hygienic organic fertilizer which will reduce the need for some of the imported organic fertilizers.

**Mobile and  
Stationary Source  
Air Pollution  
Control**

The Amman slaughterhouse is the largest of approximately 15 in the kingdom. Except for the ones in Zarqa, Salt, and Aqaba, they are small. The Amman slaughterhouse on an average day handles 100-150 cattle, 1,000-2,000 sheep, and 20,000-30,000 chickens. It also handles 20-30 camels during the year.

Gelatin is not currently manufactured in significant quantities in Jordan (if at all) and must be imported to satisfy demand.

While a handful of Jordanian firms could supply the required engineering and design of a phosphate slurry pipeline, much of the technology and equipment will have to come from the United States or other countries experienced in this area.

The fertilizer manufacturing plants in Aqaba (owned by Jordan Phosphate Mines Co.) produce 1 million tons/year of phospho-gypsum as a by-product of fertilizer manufacture, which has been accumulating in large piles and could be used to manufacture building bricks.

### *Market Entry Strategies and Barriers*

Farms usually lack the financial capability to buy even a low-cost digester, so low-cost, long-term interest rate financing is required. Later, the farmer might benefit from a reduced use of veterinary medicines and savings on soil fertilizers. Another barrier to entry is the lack of proper legislation and enforcement addressing disposal of manure.

Gelatin production has the potential to be profitable as the raw materials are found locally and manufacturing costs in Jordan are competitive. Entry costs are high, as moderately sophisticated technology is required, particularly for high-grade gelatin for the pharmaceutical industry.

Engineering companies interested in working on a pipeline for the Jordan Phosphate Mines Company might consider undertaking a pro-bono feasibility study to determine its feasibility and cost-effectiveness.

Cost of entry for producing phosphogypsum blocks is moderate and the technologies are relatively unsophisticated. Low-interest-rate, long-term loans could be an excellent incentive for such a big project. Uncertainty and unawareness of the possibilities are major barriers to market entry. However, suggestions could be addressed to Jordan Phosphate Mines Co. Financing a study would encourage the company to engage in these projects. Current regulations do not encourage the development of this market. U.S. and local consultants could jointly supply consulting services.

Mobile source air pollution originates in the transportation sector. Stationary air pollution stems primarily from industrial activities and thermal power plants. Public awareness of air pollution is not strong in Jordan, and the market is limited to a few activities that have the potential to be expanded and supplemented. Jordan lacks comprehensive laws on air pollution, so interest in stemming air pollution is limited.

Transportation is the largest single sector energy consumer of at 1.10 million TOE, accounting for 43.9 percent of the kingdom's total energy consumption. Most means of transportation in Jordan use refined petroleum products as a source of energy. Registered vehicles in Jordan numbered 24,000 in 1970, a figure that has increased 10.5 times in the last two decades, reaching 254,000 in 1990. About 60,500 of those vehicles use diesel oil and the rest, leaded gasoline. In 1987, 435 million liters of gasoline, 888 million liters of diesel oil, and 176 million liters of kerosene were consumed. It is estimated that the quantity of transportation emissions was about 19 million tons in 1990.

About 70 percent of commuters in Greater Amman use "service" cars (taxis); 20 percent use public buses; and only 10 percent use their own cars. More fuel-efficient forms of transportation would reduce fuel used per passenger mile, and decrease the amount of exhaust produced.

The best opportunities for suppliers of products and services related to stemming mobile source air pollution lie with local Jordanian businesses. Potential areas for growth include engine tune-up programs and manufacture of mufflers to supply domestic as well as other Near Eastern markets. U.S. manufacturers could supply sophisticated analyzing equipment. In the long run, opportunities could arise for U.S. engineering firms and equipment suppliers to construct public transportation systems. An opportunity for small local businesses lies in manufacturing canopies to cover trucks that transport potash, which pollutes the air.

Point source air pollution in Jordan stems from industrial and commercial activities as well as thermal power plants. The best prospects for U.S. air pollution control equipment and consulting firms lie in large-scale industries (see table in clients and ownership section). The local firms will be better equipped to provide services to small and medium-sized industries, but the GOJ must first make a commitment to increase enforcement of regulations for small polluters.

### *Products and Services*

The equipment associated with stemming vehicle air pollution includes vehicle tune-up equipment, exhaust analyzers, and catalytic converters. Alternative fuels can also reduce vehicle pollutant emissions. Technical consulting services can be useful in determining optimal traffic flows and modeling air quality. Finally, the construction of low-polluting

*Business Activities  
and Opportunities in the Environment*

public transportation systems such as light rails requires both specialized equipment and engineering services.

Equipping an industrial plant with air emission control equipment requires a high level of technical expertise to obtain good performance. Engineering consulting services from specialized firms are often required before equipment can be purchased and installed. Converting to natural gas requires investments in new burners and boilers, as well as investments to increase the production and delivery of natural gas to industrial sites.

Particulate pollutants are commonly removed by mechanical collectors, fabric filters (baghouses), electrostatic precipitators, and wet scrubbing devices. Gaseous pollutants can be removed by several types of processes, depending on the type of pollutant. Sulfur dioxide can be removed from coal burning power boilers by using flue gas desulfurization processes. Molecular sieves are used to remove sulfur dioxide in sulfuric plants and  $\text{NO}_x$  in nitric plants. Methods for controlling odors and toxic pollutants include thermal incineration (after burners), catalytic oxidation, activated carbon adsorption, and condensation.

### *Clients and Ownership*

If Jordanian air quality standards for adequate vehicle maintenance and servicing are developed and enforced, or if the GOJ raises fuel prices to encourage optimal engine maintenance, an opportunity will emerge for the private sector to provide vehicle tune-ups. Most of vehicles in Jordan are owned by the private sector and serviced at private service stations. Government institutions, however, do have repair and maintenance centers for army and government vehicles.

The GOJ and the municipalities would comprise the primary clients for construction of public transportation systems. Donor funding will largely define this market.

# *What Is Needed to Take Advantage of the Opportunities*

## **Market Awareness and Information**

The success of environmental businesses in Jordan depends on public and industry awareness of environmental problems. The GOJ and the private sector should plan a comprehensive public awareness program to supply the market with facts and figures on the environment. The survey conducted for this profile showed that a large percentage of the public lacks access to environmental information. The media can play an important role on behalf of the GOJ by presenting environmental education programs. GOJ plans for expenditures on pollution control enforcement are unclear. This information is needed, however, to give the private sector the confidence it needs to enter environmental markets.

## **Increased Regulation**

The GOJ must develop a more focused regulatory agenda. Market demand must be established through sharpened regulation before many environmental businesses can be expected to fully take root. The private sector must be convinced that enforcement will be consistent. Economic incentives should be established wherever possible to justify implementation of pollution control measures in industry.

## **Participation of Foreign Companies**

Environmental business is a relatively new concept in Jordan, often involving new technologies. The future of environmental business depends largely on the availability of a qualified authority to give advice and assistance for establishing businesses. Agents/distributors of imported environmental equipment need to know how to find the most appropriate equipment to import. Foreign equipment suppliers must adapt their products to Jordanian specifications. Generally this means offering technologies that rely less on consistent operation and maintenance and that minimize the need for expensive replacements or spare parts. Where spare parts are required, the foreign supplier should establish and guarantee a mechanism for obtaining them. Foreign companies also need to consider how to lower the costs of their products and services to make them competitive in the Jordanian market. One option for lowering costs is to begin local assembly and manufacturing for certain technologies.

## **Financing**

Emerging environmental businesses often require feasibility studies and financing for capital investments. Because environmental awareness and the market are still limited, environmental goods and services may seem like a risky business. The GOJ and donor organizations can help the private sector overcome fears by financing the cost of entry through grants or low-interest long-term loans. Several environmental sectors described in this report require feasibility studies before companies will consider entering the business.

## **Removal of Barriers**

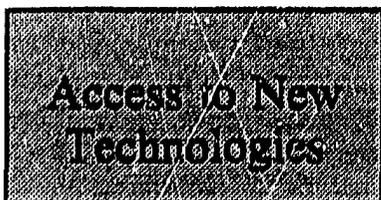
The GOJ should help the private sector explore environmental businesses by removing all barriers, such as customs duties on environmental equipment, and by enforcing laws to encourage using environmental equipment and systems. High import duties discourage the import of much equipment important to the sector. The custom duties on wastewater treatment systems, for example, are about 40 percent. In addition, environmental equipment is often lumped with other kinds of equipment when customs duties are applied.

## **Privatization**

Undoubtedly, the privatization of environmentally related municipal services will open opportunities for the private sector (see section on water purification and conservation). If state-run industries also privatize, government regulatory agencies will be more likely to enforce environmental standards. As it stands, conflicts of interest may arise if one government agency regulates another. Privatization may also reduce the state financial burden of maintaining unprofitable enterprises. The electricity distribution industry, which has been private since its inception, demonstrates what is possible.

## **Training**

The lack of local experience in environmental projects could be a significant barrier to successful project implementation. The private sector will need additional education and training to develop the specializations required to address Jordan's air and water pollution problems. While few experts can be found in environmental consulting, there are experts in related technical fields. Those with advanced training in chemical and mechanical engineering areas pertaining to environmental technologies are needed.



The private sector's lack of technical capability to address many of the country's environmental problems constrains development of an environmental business sector. Many solutions to environmental problems involve a combination of scientific analysis and testing, designed and engineered systems, equipment procurement and installation, and ongoing operations and maintenance. Few private companies in

Jordan possess the capabilities to provide such an integrated solution, and few have cooperated to combine their capabilities. Thus, environmental solutions provided by these companies are often inadequate. Few engineers have experience in industrial waste minimization and materials recovery.

Access to new technologies can be facilitated by organizing environmental businesses and workshops, establishing technology databases, setting up environmental professional and trade associations, distributing buyer's guides, and linking foreign technology suppliers with the Jordanian business community through catalog exhibits, and trade and investment missions.

## Jordan's Environmental Problems and Trends

Jordan has an area of approximately 90,000 km<sup>2</sup>, 90 percent of which is arid or semi-arid. The mountainous area to the east of the Jordan Rift Valley functions as a precipitation trap for the cold fronts traversing the country from west and northwest to east and southeast. These fronts result in average annual precipitation ranging from 300 mm in the southern highlands of Shoubak and Karak to more than 600 mm in the northern highlands of Salt and Ajlon. To the east of the highlands, the topography flattens rapidly and the area lies in a precipitation shadow receiving average of precipitation with a maximum value of 300 mm, decreasing rapidly to 50 mm in the east and south.

The kingdom has three major rivers: the Jordan, the Zarqa, and the Yarmouk. The Jordan River is saline, and thus not suitable for drinking or irrigation. The Zarqa receives substantial municipal, industrial, and agricultural pollution loads. Though Yarmouk is reportedly less stressed, it also receives municipal wastewater.

Only 3 percent of Jordan's land area receives average annual precipitation of more than 300 mm (the minimum required for wheat production in dry farming areas). Around 90 percent of the country receives average precipitation of less than 100 mm/yr and is generally classified as arid. The scarcity and uneven distribution of precipitation over Jordan result in meager surface and groundwater resources with a total annual flow comparable to the average flow of the Euphrates River in one week or that of the Nile in about three days.

### Current and Projected Water Sources and Consumption

| Source                    | 1989   |                                 | 1995   |                                 |
|---------------------------|--|---------------------------------|--|---------------------------------|
|                           | Available water extractions (Mill m <sup>3</sup> ) | Consumed (Mill m <sup>3</sup> ) | Available water extractions (Mill m <sup>3</sup> ) | Consumed (Mill m <sup>3</sup> ) |
| Renewable groundwater     | 280  | 375                             | 280  | 359                             |
| Non-renewable groundwater | 118  | 56                              | 118  | 118                             |
| Surface water             | 500  | 500                             | 594  | 594                             |
| Treated water             | 32   | 32                              | 60   | 60                              |
| Total                     | 930  | 963                             | 1052   | 1131                            |

Source: *National Environment Strategy for Jordan*, 1991.

Jordan is divided into four different climatic regions: (i) the western heights which enjoy a Mediterranean climate; (ii) the desert in the east; (iii) the Gulf of Aqaba which is hot and humid; and (iv) the Jordan Valley which has a semitropical climate. Rain normally falls in winter (i.e. December to March) with the maximum amount usually during January. In general, the amount of rainfall decreases from west to east and from north to south.

The most significant environmental problems in Jordan are water related. Water scarcity, rapid development, and population growth are all associated with the following chronic environmental maladies:

- ▶ Overexploitation of aquifers as a result of increasing demand coupled with limited water resources,
- ▶ Inadequate industrial and municipal wastewater treatment capacities,
- ▶ Siting of industrial plants near or immediately upstream from major water supplies,
- ▶ Overuse and misuse of pesticides, insecticides, fungicides, and fertilizers leading to pollution of surface and groundwater resources by irrigation drainage.

Other major environmental problems facing the country stem from unmanaged disposal of solid and hazardous waste, mining waste (primarily from phosphate mines), and some sources of air pollution in industrial sections of Amman.

The population of Jordan, estimated at over 4 million in 1991, has grown at an average rate of 3.8 percent in the past 11 years. The capital city, Amman, contains nearly 35 percent of the country's population. The large size of this 'city state' causes many problems for the economic infrastructure and planning. Therefore, measures are being taken to halt further migration to this city ( e.g. service infrastructure is being developed outside Amman and the government is giving financial incentives to encourage industries to move there).

In the early 1960s, the Jafr groundwater basin was developed to provide water for both domestic and irrigation uses. After a few years of extraction, water levels started to drop rapidly and the water quality deteriorated. The investments in that area were lost because the water became unsuitable even for irrigation, and groundwater levels and quality dropped to unacceptable levels. In Dhuleil area, water levels dropped and irrigation water infiltrated to the

groundwater. A similar pattern has been observed at many other locations, including Azraq and Disi-Sahel es Sawan-Mudawara.

It is now feared that water will start moving from these marshes to the well field area. The signs of a salinity increase have already been registered. If pumping continues at present rates, salt water will start moving toward the water producing areas, leading to salinization of all groundwater.

Pollution resulting from waste disposal has also affected major groundwater resources, which rendered some of them unsuitable for domestic purposes and others even less suitable for irrigation. The main groundwater area affected by wastes is the Amman-Zarqa area, where around half of Jordan's population live and around 70 percent of its light and medium industries are located. The major pollutants which reach the groundwater resources (other than early domestic wastewater from Zarqa cesspools) come from the different industrial plants spread over the area (e.g., chemicals, steel, petroleum, paper, detergents, batteries, polymers, textiles, chlorine filling, soft and alcoholic drinks).

From water analyses performed on wells in the area, it can be shown that trace element concentrations such as iron, arsenic, aluminum, cadmium, chromium, lead, zinc, mercury, and manganese are increasing to unacceptable levels. Some other wells have increasing concentrations of nitrates, phosphates, TDS, bacteria, etc. indicating pollution by domestic wastes.

The solid waste disposal site of greater Amman is at the southeastern edge of the aquifer underlying the Amman-Zarqa area. Leakage easily reaches the aquifer and contaminates its water. In addition, only slightly over 50 percent of houses in the area are connected to a wastewater treatment plant. The rest possess cesspools which leak into the surface and groundwater bodies or discharge into wadis.

The wastewater treatment plant of the Amman-Zarqa area, Khirbet al Samra, discharges an effluent of semi-treated wastewater along the Wadi Dhuleil and Zarqa River courses; this has caused the groundwater quality to severely deteriorate along the effluent portions of the wadi. The damage in that area is so severe that the groundwater is unfit to irrigate even salt-tolerant crops.

Groundwater resources elsewhere in Jordan are also polluted from solid and liquid waste disposals. Groundwater in the areas of Karak, Irbid, Ramtha, Aqaba, and Mafraq, among others, is deteriorating due to semi-treated wastewater from wastewater treatment plants into the groundwater resources.

Fertilizers and biocides used in agriculture in the Jordan Valley area, Dhuleil, Sama Sdu, al Agib, and elsewhere, are also harming the underlying groundwater. Irrigation water infiltration carries these pollutants (with others), decreasing the quality of the groundwater and drastically increasing its salt content.

The other main polluted surface water resources are within or downstream from urbanized and industrialized areas, Domestic and industrial sources severely pollute the surface waters of the Amman-Zarqa area, especially the Zarqa River.

The surface water was rendered unsuitable for domestic and irrigation uses in the dry season, because the flow consists of industrial and domestic effluent. Only during flood periods does the water quality improve. Along Wadi Dhuleil, the effluent quality of Khirbet al Samra has polluted surface and groundwater, affecting human health and the environment.

The water of the Zarqa River collects in the King Talal Dam whose water quality gradually deteriorated from 1977 to 1985 but remained suitable for irrigation. After the operation of the Khirbet al Samra treatment plant in 1985, the water quality at the dam deteriorated rapidly until it was rendered unsuitable for irrigation of most crops.

The other surface waters affected by pollution are wadis, creeks, rivers, and dams lying downstream from wastewater treatment plants and solid waste disposal sites like Wadi al Arab, Ukheider, Wadi Shueib, Wadi Sir, and others. Many wadies are dammed so that their water collects in reservoirs. A study of the water quality at Jordan's dams showed that all reservoirs are eutrophic to highly eutrophic except Ziqlab reservoir which receives only flood and spring water originating from sparsely inhabited areas. Irrigation return flows to river courses are increasingly causing a deterioration of groundwater quality expressed in salinity increases, high contents of biocides, nitrates, phosphates, and other substances.

Seepages from sewerage pipes undermine water supply systems. Water supply pipes in different areas of Jordan are leaking as a result of breakage, corrosion, and erosion. Water shortages prevent pipes from being continuously under pressure or in operation. Water is pumped once or twice each week to consumers especially during the dry season. Upon pressure release, contaminated water leaking from cesspools and sewage systems becomes sucked into the water supply pipes and reaches houses.

The use of biocides and fertilizers is generally restricted to irrigated areas like the Jordan Valley, Dhuleil, Disi, Sama Sdud, Aqib, Azraq and Amman-Zarqa; groundwater underlying these areas has increasing concentrations of biocides, fertilizers, and salinities from the irrigation return flows. Surface water resources in the surrounding irrigated agricultural areas are also affected by pollution and increasing salinities. This is best shown in the side wadis of the Jordan Valley, which serve as drainage for irrigation waters.

To cope with the delicate, environmental conditions of semi-arid areas, the Government of Jordan has tried in recent decades to develop resources and construct wastewater treatment plants and sewage systems. Dams and irrigation canals were constructed, water pipes up to 100km in length per project were laid to carry drinking water, and wastewater projects were developed in all large towns.

If Jordan does not address the issues of water shortage, more water will need to be diverted from agricultural to domestic uses creating more unemployment in the agricultural sector, increase of food imports, and a drain of foreign currencies. These results would lead to poverty, deficient food supplies, and possibly social unrest.

The air is considered relatively clean in most of the country except for some polluted areas such as the industrial zones. Air pollution in Jordan is either natural or industrial. The major natural pollutants are sand and dust storms. Approximately 90 percent of Jordan's area is desert, which is exposed to khamasini winds from the North African Coast during April and May. As a result, air is polluted with dust and sand. It is estimated that about 1.8 million tons of dust reach Jordan annually. In Amman alone, dust quantities are estimated at 360 tons/yr. During khamasini conditions, direct solar radiation decreases from 300 to 220 J/cm<sup>2</sup>/hr, whereas diffused radiation increases from 60 to 114 J/cm<sup>2</sup>/hr.

The high annual averages of total suspended particulates, sulfur dioxide, carbon monoxide, and nitrogen oxides exceeded WHO and U.S. air quality standards. Air pollution observed downtown correlated well with traffic activity, indicating that transportation was and will be the major source of gaseous pollution in Amman.

The industrial sector has developed in Jordan during the last 20 years, and mining activities have also developed and expanded at high rates. Industrial establishments in 1989 totalled 13,488, with approximately 133,000 employees. Industry consumed 498,000 TOE in 1990, which represents 20.2 percent of national energy consumption, including 1,188 GWhr of electricity (i.e., about 38.5 percent of total electrical consumption).

The main industries are phosphates, potash, cement, glass, iron, petroleum refining, fertilizers, electrical power stations, and ceramics. The vast majority of industrial firms are considered as small workshops and the rest (about 550) are medium-sized factories in the food, chemical, furniture, and construction industries.

Most of these factories are located in the Amman region, in Marka, Sahab, Bak'a basin, and Zarqa in the northeast. The sulfur content in the heavy fuel oil which is used in industry is about three times the international standards.

The phosphate mining industry, one of the biggest enterprises in Jordan, has a major impact on the environment. Three main phosphate mines, located in southern Jordan, are operating: Hassa, Abyad, and Shidiya. Proven reserves of phosphates are about 2,000 million tons. The production rate was about 4.46 million tons in 1991. This quantity is transported to Aqaba by trains and trucks. About 85 percent of the phosphate is exported and the rest is used as raw material for the fertilizer factory in Aqaba.

The Phosphate Mines Co. and the Ports Corporation are taking measures to reduce dust emissions in Aqaba by installing filtration equipment. It is estimated that 10,000 to 30,000 tons of soft phosphate will be collected annually. This method will be extended to cover

facilities in the main mines in order to limit dust emissions to a minimum; this would help to collect a quantity of 250,000 to 600,000 tons/year, according to the particulate size collected.

The country's one refinery, the Jordan Petroleum Refinery Company, is situated in Al Hashemiya near Zarqa. Its normal production capacity is about 4.5 million tons/yr; however, it is working at half capacity due to economic reasons. In 1991, total output was about 2.31 million tons, including liquified petroleum gas, gasoline, jet fuel, kerosene, diesel, heavy fuel oil and asphalt. Processing crude oil damages the surrounding environment (e.g., combustion gas from boilers and furnaces). It is estimated that about 18 times the amount of fuel consumed (i.e., 200,000 tons/year), is released to the atmosphere. Product leakage and evaporation during processing, storage, loading, and unloading also result from oil refining.

Until recently, open dumps were the only way to dispose of solid waste. In recent years, several have closed, but many are still being used. Disposal is done mainly by dumping and igniting the waste, and allowing it to burn. This pollutes the air and water through leaching, leaving organic residues which act as a haven for disease and vermin.

Mining waste is a significant environmental problem in Jordan. Mining in Jordan is open pit, with the ore deposit, primarily phosphate, close to the surface and the overburden cover, very thin. Mining operations create large piles of sediment and dust. They destroy agricultural soil and vegetation cover, leave dust on public sewage and irrigation tunnels which causes many problems, and cause trace elements to leach or blow into the air and concentrate in soil and plants. Dust produced in quarries, cement works, and phosphate mines in the last few decades increasingly concentrates in the air, endangering the health of the surrounding inhabitants.

The main source of pollution causing disease is wastewater in contact with water supply pipes that leak because of interrupted pumping. Also, wastewater treatment plant effluents contain parasites and bacteria that directly affect workers who come in contact with that water, and/or consume fruits and vegetables irrigated by it.

Both liquid and solid industrial wastes threaten surface and groundwater resources. Using these resources for domestic purposes exposes the population to higher concentrations of heavy and trace elements, which may lead to chronic poisoning. An example cited in this context is the mercury-contaminated soil and water near the chlorine filling plant in the Ruseifa area, a problem that surfaced in 1990 and 1991.

The overuse of pesticides and insecticides including DDT has significantly increased in the concentration of these biocides in surface and groundwater resources. The consumption of vegetables and fruits harvested before degradation of biocides may cause severe illnesses. Little work has been done in this field, but concentrations in crops are definitely higher than they should be to be safe for consumption.

Gases such as SO<sub>2</sub>, H<sub>2</sub>S, CO, and NO<sub>x</sub>, as well as lead, are released into the atmosphere in industrial zones (e.g., along the Zarqa River or from non-point sources like vehicles). In el Hashymiya village and northeast of Zarqa, these emissions are already causing health problems for the surrounding population.

Ruseifa served as a tourist resort in the 1950s and 1960s with water, springs, green fields, gardens, etc. Water pollution and water depletion have terminated tourist activities in the area. In Jordan, forests are increasingly used as disposal sites, water resources are being depleted and surface waters are becoming less suitable for recreation. Examples can be seen in Azraq and Ruseifa with its drying pools, in Aqaba with partly polluted banks, and along the Zarqa River and King Talal Dam where water pollution, bad odors, and mosquitoes are increasingly discouraging tourists. Tourism in the Aqaba region has been growing rapidly with an annual increase in visitors of about 36 percent from 1987 to 1989.

## *Business Climate in Jordan*

From the mid-1970s to the early 1980s, economic activity boomed in Jordan due to increases in expatriate remittances, aid from other Arab countries, public sector infrastructural projects, and exports. Toward the end of the 1980s, economic growth in real terms wavered and inflation rose. Since then, the economy has mostly stagnated with only short periods of growth.

During 1988, the economy suffered major changes, due to an increase in Jordan's foreign debt and insufficient foreign currency revenues. By the end of the year, the government undertook tough economic, monetary, and financial measures to correct this situation. The Jordanian dinar was floated, leading to a decline in its value.

Following an agreement with the IMF in 1989, a new medium-term economic reform program was implemented, calling for gradual economic growth, expansion of exports, and a reduction in the budget deficit. However, the Gulf crisis adversely affected Jordan's economy, and the government strayed from its structural adjustment program. In 1991 the Gross National Product reached JD 2,415 million, a decline of 1.1 percent in real terms against 1990.

Jordan has a modest industrial and manufacturing base of about 7,500 registered establishments. The nation boasts a skilled and highly educated workforce and is well positioned to engage in regional trade. Through the Encouragement of Investment Law of 1987, the government encourages foreign and private investment. Investments meeting the definition of an "economic project" qualify for various tax holidays, exemptions from customs and import duties on fixed assets needed to establish a project, free grants of state-owned land outside Amman and Zarqa, and annual repatriation of dividends. The investor must, however, meet performance requirements to obtain these exemptions.

The government is planning to improve its investment incentive policies, emphasizing development of the country's small-scale and large-scale industrial sector. The government also plans to promote the privatization of some major share holding companies and the expansion of free zones in Zarqa and Aqaba. Currently, capital outflows are restricted under the Foreign Currency Control regulations No. 95 of 1966 and their updates.

## Key Economic Indicators

| <b>DOMESTIC ECONOMY</b>                    | <b>1988</b> | <b>1989</b> | <b>1990</b> | <b>1991</b> |
|--|-------------|-------------|-------------|-------------|
| Population (millions)                      | 3.75        | 3.88        | 4.01        |             |
| GDP (billions Dinars, 1985 prices)         | 2.152       | 1.924       | 1.921       | 1.931       |
| GDP/Capita (Dinars, 1985 prices)           | 547         | 495         | 479         |             |
| Consumer Prices (1985 = 100)               | 106.4       | 133.8       | 155.4       | 168.1       |
| Commercial bank exchange rate (US\$/Dinar) | 2.69        | 1.75        | 1.51        | 1.47        |
| <b>BALANCE OF PAYMENTS</b>                 |             |             |             |             |
| Trade balance                              |             |             |             |             |
| Exports (million of US\$)                  | 865         | 929         | 1123        |             |
| Imports (millions of US\$)                 | 2719        | 2140        | 2447        |             |
| Services balance (millions of US\$)        | 80          | 176         |             |             |
| Receipts (million of US\$)                 | 1,420       | 1,239       |             |             |
| Payments (millions of US\$)                | (1,340)     | (1,063)     |             |             |
| Transfers (millions of US\$)               | 1,351       | 1,178       |             |             |
| Current account balance (millions of US\$) | (293.7)     | 384.9       |             |             |
| Total external debt (millions of Dinars)   | 7982        | 8,244       |             |             |
| U.S. aid to Jordan (millions of US\$)      | 18          | 42          | 35          |             |
| Exports to Jordan (millions US\$)          | 342.9       | 297.2       | 280.0       |             |
| Imports from Jordan (millions US\$)        | 3.5         | 4.9         | 5.0         |             |
| Revenues (millions of Dinars)              | 544.34      | 565.40      | 746.08      |             |
| Expenditures (millions of Dinars)          | 910.87      | 947.92      | 1,001.21    |             |
| Deficit (millions of Dinars)               | (204.57)    | (137.10)    | (95.00)     |             |

Sources: (1) International Financial Statistics Yearbook, IMF, 1992.

(2) U.S. Department of Commerce

## *Regulatory Framework*

Jordan does not yet have a national environmental law, but does have many regulations, instructions, and rules that relate to the environment and acts to protect and regulate its use, (e.g., concerning water, irrigation and municipalities); most important are those related to public health. Although the government adopted a National Environmental Strategy in May 1992, it is not yet implemented. There is no formal coordinating mechanism and little cooperation among agencies involved in the environment. The steps the government and the private sector have taken indicate awareness of the problems and readiness to enact laws and regulations to solve them. Both government agencies and NGOs are pressing for improvements and sounder environmental policies.

Because laws and administrative directives pertaining to the environment have been developed piecemeal, they are often ineffective and far from comprehensive. The new National Environmental Strategy was designed as a single integrated policy leading to the formation of a higher council for environmental protection. The council will monitor compliance with environmental legislation and coordinate all concerned bodies. Also it will set the stage for "environmental management" legislation to empower the Department of the Environment to fulfill its mandate through greater legal and enforcement authority. Finally, it will create a national process to assess the environmental impact of all new development and construction projects before they are initiated.

Water pollution control in Jordan is a cooperative effort by several agencies that lack a complete statutory underpinning or regulatory framework. Some sources have stringent standards, while others have none. Neither the statutory mandate nor the institutional responsibility for promulgating missing standards is clear.<sup>1</sup>

The industrial sector expanded over the last 10 years due to government regulations that favored economic priorities over environmental ones. Environmental violations were and are occurring; these were accepted in the past because the industrial base was small. The natural system had time to recover. These violations are now unacceptable due to the huge number of factories that are dumping hazardous chemical waste. There are no official specifications or maximum allowed levels for such pollutants.

Water pollution regulations in Jordan vary considerably depending on the water source. Direct industrial discharges are regulated by Jordanian Standard Specification Number 202 issued in 1981 by DDS and revised in 1990. The standards cover up to 37 pollutant parameters (conventional and nonconventional pollutants and metals), setting maximum allowable discharges to various water bodies. Industries are required to self-monitor once a week. WAJ guidelines specify compliance monitoring at industries twice a

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<sup>1</sup>An Analysis of Jordanian Environmental Laws and Institutions. Submitted by PRIDE to USAID/Jordan, Government of Jordan, 1992.

month.<sup>2</sup>

Indirect dischargers are subject to a different set of effluent limits imposed by the WAJ under a regulation issued in September 1988. Concentration limits are established for 29 organic and chemical constituents and physical properties. Process changes must be reported to the WAJ, which is allowed to sample twice a month.<sup>3</sup>

Publicly owned treatment works constructed and operated by WAJ are not subject to specific effluent limitations. No detailed standards regulate the disposal of sludge generated in the course of municipal or industrial wastewater treatment, although health policies may be applied. Regulations do not exist to control illicit disposal to storm drains, underground injection, or marine dumping.<sup>4</sup>

While air pollution is not yet a major problem in Jordan, it is growing due to population growth, urbanization, and industrialization. The first air pollution priority is the Zarqa Basin. Jordan has no air pollution laws and no formal regulatory programs. As with water pollution, several government agencies perform activities related to air quality management. DOE participates in industrial licensing/siting undertaken by MIT. Jordan has not promulgated its own air quality criteria but adapts World Health Organization Standards for this purpose. Finally, DOE has a standing request to DDS to jointly develop Jordanian air quality criteria.<sup>5</sup>

Pursuant to the Public Health Law, MOH has the authority to close facilities where air pollution threatens health. The Meteorological Department performs long-term meteorological monitoring and records maintenance. RSS conducts some sampling and analysis on behalf of DOE, as well as research studies on urban air pollution. The Ministry of the Interior enforces traffic laws and through the police may issue tickets to polluting vehicles. Cars must be inspected every year, although no pollution control equipment is required. The DOE has insufficient equipment or resources to monitor, so no comprehensive air quality monitoring is occurring.

Jordan has no hazardous waste disposal facilities, although a cooperative industry/government venture has been negotiated for which fundraising is under way. Individual municipalities control collection and disposal practices. No consolidated laws specifically call for regulation of solid or hazardous waste. The Royal Society for Conservation of Nature has recommended passage of solid waste legislation. No regulatory

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<sup>2</sup>Ibid.

<sup>3</sup>Ibid.

<sup>4</sup>Ibid.

<sup>5</sup>Ibid.

activities are occurring at the national level.

Presently, NRA does not monitor mines or quarries, and the authorized mine inspection is not active. Since the NRA lacks police powers under the mining law, it has often worked with mayors to close quarries and confiscate equipment. Initial licensing of mines and quarries is the most important environmental activity that NRA performs regarding mining. Members of the licensing committee are drawn from MOI, the Ministry of Water Irrigation, and MOA.<sup>6</sup>

The coastal area along the Gulf of Aqaba is extremely rich in marine life, with clear water and coral formations, making Aqaba an outstanding tourist resource. Development has brought a decline in fisheries resources; oil, thermal, and phosphate pollution; and damage to the coral reefs. The Aqaba Regional Authority, which is responsible for coastal zone management in Aqaba, controls construction of coastal installations and prepares plans and environmental studies. DOE consults on licensing activities affecting the coastal zones and responds to citizen complaints. WAJ is responsible for enforcing effluent limits on discharges into the sea, and MOA has jurisdiction over fishing regulations. There appears to be no centralized statutory basis for coastal zone management in Jordan, although several related statutes provide some authority to regulate coastal degradation.<sup>7</sup>

The key government institution working in environmental protection is the Department of Environment, under the Ministry of Municipal and Rural Affairs and the Environment. It regulates and enforces laws which relate to the environment, and responds to citizen complaints or ministry inquiries about water pollution, monitors some water and wastewaters, participates in licensing and regulatory development committees, and performs research and studies on water pollution.

Various other government institutions hold some jurisdiction over environmental matters, including the Ministry of Health, the Ministry of Water and Irrigation, the Ministry of Industry and Trade, and the Department of Forests and Soil Conservation at the Ministry of Agriculture. These agencies are supported by quasi-independent institutions, (e.g., university research centers, the Royal Scientific Society, and the Higher Council of Science and Technology).

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<sup>6</sup>Ibid.

<sup>7</sup>Ibid.

| Title of Law   | Function   |
|--|--|
| Health Law No. 21 of 1971  | Controls and defines uses of wastewater, among other mandates  |
| Agriculture Law No. 20 of 1973                                   | Provides Minister of Agriculture with legal base to develop and protect Jordan's rangeland and forest resources  |
| Water Authority Law No. 18 of 1988                               | Created Water Authority of Jordan and provides full responsibility to MWI for all water and sewage systems and for establishing a water policy, includes penalties and fines |
| Military Ordinance Number 6 of 1980                              | Required all industries to treat their wastewaters by January 1, 1981  |
| Military Ordinance No. 2 of 1982, updated by MOA decree of 1991  | Placed restrictions on the use of wastewaters to irrigate agricultural lands   |
| Public Health Law No. 21 of 1971, sections 31 and 36             | Gives MOH powerful authority to close facilities and order health nuisances eliminated   |
| Traffic Law No. 14   | Prohibits the driving of vehicles that pollute the air   |
| Organization of Natural Resources Affairs Law No. 12, Article 44 | Disallows the appropriation of water without written permission from the vice president and agreement of land owners   |
| Municipalities Organization Law No. 18 of 1988                   |  |
| Regulation No. 61 and No. 67 of 1979                             | Regulates buildings and zoning in Amman  |
| Regulation No. 79 of 1986  | Regulates city and village buildings and zoning  |
| Jordan Standards No. 288 for Drinking Water                      | Lists drinking water standards   |
| Circular No. 31 of 1971  | Pertains to wood and wastes discharged by ships into the Aqaba port  |
| Fisheries Law No. 25 of 1943                                     | Pertains to fisheries  |
| Agreement with the Iraqi Petrol Company of 1931                  | Regulates transport of mineral oil   |
| Standards Specification No. 202                                  | Specifies standards for industrial wastewater discharges.  |

In addition to the government agencies listed above, two NGOs concerned with environmental issues have evolved in the last 12 years: the Royal Society for the Conservation of Nature established in the early 1980s, and the Jordan Association for the Control of Environmental Pollution established in 1988. Both function as pressure groups to protect the environment. The different economic and social development plans of Jordan

which were prepared by the government (1980-1985 and 1985-1990 etc.) dealt with the environmental sector as an important development issue.

The water sector was reorganized in 1987 by the creation of the Ministry of Water and Irrigation. Previously, the water sector had been managed by the Water Authority of Jordan and the Jordan Valley Authority; their responsibilities sometimes conflicted and they suffered inefficiencies and poor personnel management. The Ministry of Water and Irrigation (MOWI) has the Water Authority and the Jordan Valley Authority under its umbrella. The ministry as such is now responsible for water resources studies, planning, development, and allocation all over the country. It is also responsible for wastewater collection, treatment, and allocation for reuse. Irrigation activities are also under the supervision and responsibility of the MOWI. Each of the two authorities under MOWI has several departments to facilitate planning, implementation, control, maintenance, water distribution, and consumer affairs.

Although the water sector is now under a single organization, the two authorities still conflict sometimes. The Jordan Valley Authority tries to save as much water as possible for irrigating the Jordan Valley, whereas the Water Authority tries to allocate as much water as possible to bridge the gap between supply and demand for domestic and industrial uses.

The Water Authority is responsible for managing water resources and for water supply and distribution, as well as sanitary services. Its operating budget in 1991 was approximately 60 million JD, compared with the Department of Environment's total budget of less than 100,000 JD that year. The Jordan Valley Authority is now responsible for developing storage and irrigation systems for agricultural use in the Jordan Valley area.

The Ministry of Water and Irrigation is responsible for water supply, construction and maintenance of wastewater treatment plants, and protection of surface water quality from municipal and industrial wastewater discharge by monitoring effluent and taking compliance actions. The Ministry of Health is responsible for performing analyses for biological contaminants and monitoring water supplies to ensure their safety. MOH also has the authority to close down industries for violating health laws.

Through its Department of Standards and Specifications, the Ministry of Industry and Trade is responsible for developing all standards in Jordan, and promulgating wastewater limits and drinking water standards in Regulations, No. 202 and 286, respectively.

In general, the water sector is now better organized than before, but organizational plans to simplify and clarify authorities and integrate planning and decision-making are still needed.

Most industrial plants in Jordan own wastewater treatment facilities, but few are designed to specifically treat the pollutants produced by a particular industrial plant. This is partly the result of a government policy of the early 1980s, which threatened to close any

*Appendix C*

factory that did not acquire a wastewater treatment plant within six months. To comply, each factory tried to import a treatment plant without regard to specific design or efficiency. Other industries are not complying with the effluent quality guidelines issued by the Department of Standards, due to the relatively high cost of meeting specifications.

07

## *Donor Programs in the Environment*

In Jordan, donors such as USAID, UNDP, the World Bank, CIDA of Canada, GTZ of Germany, and donor agencies of France, Japan, and the United Kingdom operate development programs covering a wide range of areas, including the environment.

Most projects related to the environment are conducted on behalf of the government, mainly through the Ministry of Planning, with little direct private sector involvement. Some donors, such as USAID and CIDA, have special private sector programs, but they have not stressed environmental business. The emphasis will probably shift with increased awareness of the role that the private sector can play in stemming pollution.

USAID has been active in Jordan for over 30 years. In the area of energy and the environment, USAID sponsors training programs for Jordanians, financing programs for the private sector, feasibility studies, reports, and research. In the future, USAID plans to concentrate more on environmental issues, especially in the water and energy sectors; the agency will also emphasize a more active, productive private sector role and private sector development.

Since CIDA initiated its program in Jordan in 1987, it has executed a number of projects, several of which have related to the environment, including designing three desert dams, supplying an aquifer drilling tool for Al Dissi Aquifer, and operating agricultural projects on the southern farms (supply of services and equipment). These projects were either requested explicitly by the Ministry of Planning or suggested by Canadian private sector consultants who are paid by the Canadian government. CIDA plans to focus more on the private sector in its program.

GTZ has operated in Jordan for a long time, helping to carry out numerous development projects. Although most of its projects have been in the agricultural sector, recently GTZ has initiated projects addressing the water problem. GTZ is involved only with governmental projects, and has a representative resident in the Ministry of Planning. Future projects are selected from proposals of the Ministry of Planning and the GTZ team in Jordan. GTZ plans to concentrate future budgets on more environmentally related projects in which the Jordanian private sector will act as the local consultant on the GTZ team.

## JORDAN WATER/WASTE WATER--INTERNATIONAL PROJECTS

**FUNCTIONS:**

PP = Policy, Planning and Management

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2 = WASTE WATER

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| DONORS/PROJECTS  | PP | LL | RD | FI | DT | OM | ME | EN | TE | IC | ES | S/F DATE | EST. COST-FOREIGN           |
|--|----|----|----|----|----|----|----|----|----|----|----|----------|-----------------------------|
| <b>MULTILATERAL DONOR AGENCIES:</b>                    |    |    |    |    |    |    |    |    |    |    |    |          |                             |
| EC/Hammad Sirhan Groundwater Inv.                      |    |    | 1  |    |    |    |    |    |    |    |    | 92/95    | ECU 4 Mil                   |
| EC/Azraq Groundwater Study                             |    |    | 1  |    |    |    |    |    |    |    |    | 90/93    | ECU 3 Mil                   |
| EC/Design Walice & Myib Dams                           |    |    |    |    | 1  |    |    |    |    |    |    | 89/93    | ECU 2 Mil                   |
| EC/KAC Rehabilitation Study                            |    |    |    |    | 1  |    |    |    |    |    |    | 93/96    | ECU 570,000                 |
| EC/Sectoral Policy                                     | 3  |    |    |    |    |    |    |    |    |    |    | 92       | ECU 200,000                 |
| EC/Raising Kafrein Dam Study                           |    |    |    |    | 1  |    |    |    |    |    |    | 91/92    | ECU 450,000                 |
| EC/Aqaba Environment                                   | 1  | 1  | 1  |    |    |    |    |    |    |    | 1  | 92/95    | ECU 350,000                 |
| EC/Various Water Supply Proj.                          |    |    |    |    | 1  |    |    |    |    |    |    | 92/93    | JD 6 Mil                    |
| EC/Wadi Rejel Dam (Const.)                             |    |    |    |    | 1  |    |    |    |    |    |    | 92/93    | JD 1 Mil                    |
| EC/Wadi Jordan Dam (Const.)                            |    |    |    |    | 1  |    |    |    |    |    |    | 92/93    | JD 0.8 Mil                  |
| EIB/KFW/IBRD Rehabilitation Greater Amman Water System | 1  | 1  |    |    | 1  | 1  | 1  |    | 1  |    |    | 93/95    | JD 25 Mil                   |
| EIB/Zarqa Sewage Collection and Processing             |    |    |    |    |    | 2  |    |    |    |    |    | 92/94    | 50% Financing of ECU 12 Mil |
| EIB/Ramtha Water Supply                                |    |    |    |    |    |    |    |    |    |    |    | NA       | JD 4-5 Mil                  |
| EIB/Raise Al Kafrein Dam                               |    |    |    |    | 1  | 1  |    |    |    |    |    | 93/95    | 50% Financing of JD 6 Mil   |
| EIB/Rehabilitation KAC                                 |    |    |    |    | 1  | 1  |    |    |    |    |    | NA       | 50% Financing of JD 10 Mil  |
| IBRD/Pollution control                                 |    |    |    |    | 2  | 2  |    |    |    |    |    | NA       | NA                          |
| IBRD/Regional Water Management Study                   | 1  |    | 1  |    |    |    |    |    |    |    |    | NA       | NA                          |
| IBRD/Zarqa Water Pipeline System                       | 1  |    |    | 1  | 1  |    |    |    |    |    |    | 90/92    | JD 4.654 Mil                |
|  |    |    |    |    |    |    |    |    |    |    |    |          |                             |
|  |    |    |    |    |    |    |    |    |    |    |    |          |                             |

## JORDAN WATER/WASTE WATER--INTERNATIONAL PROJECTS (Continued)

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| DONORS/PROJECTS                              | PP | LL | RD | FI | DT | OM | ME | EN | TE | IC | ES | S/F DATE  | EST. COST--FOREIGN |
|--|----|----|----|----|----|----|----|----|----|----|----|-----------|--------------------|
| NO DONOR IDENTIFIED:                         |    |    |    |    |    |    |    |    |    |    |    |           |                    |
| Convey Disi Water to North                   |    |    |    |    | 1  |    |    |    |    |    |    | 92/96     | JD 240 Mil         |
| Rehab. Fuheis Water System                   |    |    |    |    | 1  |    |    |    |    |    |    | 18 Months | JD 1.65 Mil        |
| Ajlun District Water Projects                |    |    |    |    | 1  |    |    |    |    |    |    | 18 Months | JD 1.5 Mil         |
| Wadi Musa Sewage                             |    |    |    |    | 2  |    |    |    |    |    |    | 24 Months | JD 2.9 Mil         |
| Mudawara Sewage                              |    |    |    |    | 2  |    |    |    |    |    |    | 12 Months | JD 0.285 Mil       |
| Salt Sewage Expansion                        |    |    |    |    | 2  |    |    |    |    |    |    | 24 Months | JD 2.6 Mil         |
| Jarash Sewage Expansion                      |    |    |    |    | 2  |    |    |    |    |    |    | 24 Months | JD 2.7 Mil         |
| Update National Water Plan                   | 3  |    |    |    |    |    |    |    |    |    |    | 12 Months | JD 1.4 Mil         |
| Study Deep Water Systems--Potable & Brackish | 1  |    | 1  |    |    |    |    |    |    |    |    | 24 Months | JD 3.8 Mil         |
| Souf Town & Refugee Camps Sewerage Project   |    |    |    |    | 2  |    |    |    |    |    |    | 24 Months | JD 2.75 Mil        |
| Wadi Musa Water Project                      |    |    |    |    | 1  |    |    |    |    |    |    | 18 Months | JD 1.05 Mil        |
| Al-Aabour (Taffleh) Water Project            |    |    |    |    | 1  |    |    |    |    |    |    | 12 Months | JD 0.66 Mil        |
| Salt Water Project                           |    |    |    |    | 1  |    |    |    |    |    |    | 48 Months | JD 5 Mil           |
| Mafrag Water Project                         |    |    |    |    | 1  |    |    |    |    |    |    | 30 Months | JD 3.2 Mil         |
| Aqaba Sewerage Project                       |    |    |    |    | 2  |    |    |    |    |    |    | 18 Months | JD 1.8 Mil         |
| Fuheis's/Mahis Sewerage Project              |    |    |    |    | 2  |    |    |    |    |    |    | 24 Months | JD 2.75 Mil        |
| Various Water Projects                       |    |    |    |    | 1  |    |    |    |    |    |    | 24 Months | JD 3.5 Mil         |
| Various Sewerage Projects                    |    |    |    |    | 2  |    |    |    |    |    |    | 24 Months | JD 5.5 Mil         |
| Various Water & Sewerage Related Studies     |    | 3  |    |    | 3  |    |    |    |    |    |    | 24 Months | JD 2.3 Mil         |

NOTE: Some of the international projects have not all been confirmed/verified by GOJ or the donors.  
NA=Information Not Available

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| DONORS/PROJECTS                                       | PP | LL | RD | FI | DT | OM | ME | EN | TE | IC | ES | S/F<br>DATE | EST. COST--<br>FOREIGN   |
|---|----|----|----|----|----|----|----|----|----|----|----|-------------|--------------------------|
| <b>BILATERAL DONOR AGENCIES:</b>                      |    |    |    |    |    |    |    |    |    |    |    |             |                          |
| GTZ Ground Water Northern Jordan                      | 1  |    | 1  |    |    |    |    |    |    |    |    | 91/93       | DM 18 Mil                |
| KFW/Renovating Water Meters                           |    |    |    |    |    | 1  |    |    |    |    |    | 93          | DM 5 Mil                 |
| KFW/North East Ghor Carrier Replacement               |    |    |    |    | 1  | 1  |    |    |    |    |    | NA          | JD 5 Mil                 |
| KFW/Irbid Governorate Sewage                          |    |    |    |    | 2  | 2  |    |    |    |    |    | 93/96       | DM 64 Mil                |
| German Gov./Winter Damages                            |    |    |    |    |    | 1  |    |    |    |    |    | 92          | DM 5 Mil                 |
| Italy/Supplies for Ma-an                              |    |    |    |    |    | 1  |    |    |    |    |    | 92          | Lira 10 Bil              |
| Japan/Study & Final Design Al Tannour Dam (Wadi Hass) |    |    |    |    | 1  |    |    |    |    |    |    | 36 Months   | NA                       |
| Japan/Study Raising Wadi Arab Dam                     |    |    |    |    | 1  |    |    |    |    |    |    | NA          | NA                       |
| Japan/Updating Water Master Plan                      | 3  |    |    |    |    |    |    |    |    |    |    | NA          | NA                       |
| Saudi Fund/Southern Amman Water                       | 1  |    |    | 1  | 1  |    |    |    |    |    |    | 87/92       | JD 12.75B                |
| USAID/Water Quality Improvement and Conservation      | 3  | 3  |    | 3  | 3  |    | 3  |    | 3  | 3  | 3  | 92/97       | US \$21 Mil              |
| USAID/National Water Strategy Study                   | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 92          | US \$0.4 Mil             |
| USAID/Es-Samra Feasibility Study                      |    |    |    |    | 2  |    |    |    |    |    |    | 91/92       | US \$0.4 Mil             |
| USAID/PL480/Equipment for Emergency                   |    |    |    |    |    | 3  |    |    |    |    |    | NA          | NA                       |
| <b>NO DONOR IDENTIFIED:</b>                           |    |    |    |    |    |    |    |    |    |    |    |             |                          |
| Al Karameh Dam  | 1  |    |    | 1  | 1  |    |    |    |    |    |    | 92/95       | JD 45 Mil                |
| Construction Al Mujib Dam (Options - 35/35/75)        |    |    |    |    | 1  |    |    |    |    |    |    | 93/96       | Options--JD 62/79/86 MIL |

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 1 = WATER                      2 = WASTE WATER                      3 = BOTH

| DONORS/PROJECTS                                     | PP | LL | RD | FI | DT | OM | ME | EN | TE | IC | ES | S/F<br>DATE | EST. COST--<br>FOREIGN |
|---|----|----|----|----|----|----|----|----|----|----|----|-------------|------------------------|
| <b>MULTILATERAL DONOR AGENCIES:</b>                 |    |    |    |    |    |    |    |    |    |    |    |             |                        |
| UNDP/Strengthening Policy & Planning in MWI         | 3  |    |    |    |    |    |    |    |    | 3  |    | 92/95       | US\$0.5 Mil            |
| UNDP/Wet Lands of Azraq--GEF Project                |    |    | 1  |    | 1  |    |    |    |    |    |    | NA          | US\$3.3 Mil            |
| UNDP/Dana Wild Life--GEF Project                    | 3  |    |    |    |    |    |    |    |    | 3  |    | NA          | US\$3 Mil              |
| UNDP/Emergency Needs Assessment                     |    |    |    |    |    |    | 1  |    |    |    |    | 92          | US\$50,000             |
| <b>BILATERAL DONOR AGENCIES:</b>                    |    |    |    |    |    |    |    |    |    |    |    |             |                        |
| ODA/Administration Systems in MWI                   | 3  |    |    |    |    |    |    |    |    |    |    | NA          | NA                     |
| ODA/Thames Water Authority Twinning                 | 3  |    |    |    |    | 3  |    |    | 3  |    |    | NA          | NA                     |
| ODA/Technical Assistance to MWI                     | 3  |    |    |    | 3  | 3  | 3  |    | 3  | 3  |    | NA          | UK £4.5                |
| ODA/Central Workshop                                |    |    |    |    |    | 3  |    |    |    |    |    | NA          | NA                     |
| CIDA/Long-Term Technical Assistance to Water Sector | 3  | 3  | 3  |    | 3  |    |    |    |    | 3  | 3  | NA          | NA                     |
| CIDA/Environmental Study Zarqa River Basin          | 3  | 3  | 3  |    |    |    |    |    | 3  | 3  |    | 4 yrs       | JD 1.3 Mil             |
| CIDA/Regional Water Conference                      |    |    |    |    |    |    |    |    |    | 3  |    | NA          | NA                     |
| IDRC/Study Water Reservoir Use                      |    |    | 1  |    |    |    |    |    |    |    |    | NA          | NA                     |
| IDRC/Study Plastic Film Production                  |    |    |    |    |    | 1  |    |    |    |    |    | NA          | NA                     |
| IDRC/Study Waste Water Treatment                    |    |    | 2  |    |    |    |    |    |    |    |    | NA          | NA                     |
| IDRC/National Information System                    |    |    |    |    |    |    |    |    |    | 3  |    | NA          | NA                     |
| GTZ/Advisory Services to JVA                        | 1  |    |    |    | 1  | 1  | 1  |    |    | 1  |    | 92/94       | DM 1 Mil               |

## *Resources*

### *In Jordan*

#### **Chamber of Industries**

**Usama Mudallal, Environmental Advisor**

#### **Commission of the European Communities**

**Torben Holtze, Development Counsellor**

#### **European Investment Bank**

**Patrick Walsh, Senior Loan Officer**

#### **Higher Council for Science and Technology**

**A. Abel-Rahman, Director, Agriculture and Water Sector**

#### **Japan Environment Center**

**Tetsuo Hayakawa , Director, Office of Total Pollutant Control**

#### **Jordanian Society for Control of Environmental Pollution**

**Munir Al-Adghan, Project Director**

#### **Jordan University of Science and Technology**

**Abdullah Jararat, Professor of Agriculture**

#### **JVA**

**Abdullah Al-Aziz Weshah, Secretary General**

#### **Ministry of Agriculture**

**Usama Ali Bilbeisi, Chief, Public Relations and International Cooperation**

#### **MMRAE**

**Dr. Saleh Al-Share, Director, Department of Environment**

#### **MWI**

**Adnan Saad Al-Zoubi, Director, Public Relations and Information**

#### **Royal Scientific Society**

**Murad Bino, Director**

#### **Society for the Environmental Pollution Control**

**Ms. Huda Qasim, Executive Secretary**

United Nations ESCWA  
Ahmed Hamza, Regional Advisor on Environment

U.S. Embassy/Amman  
Amit Agarwal, U.S. State Department  
Roger Harrison, Ambassador

USAID/Amman  
Abdullah Ahmed, Environmental Officer

Water Authority of Jordan  
Fawzi N. Abu Niaaf, Director, Development/Planning Directorate

World Bank  
Christopher Ward

*In Washington, D.C.*

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Office of Small and Disadvantaged Business Utilization  
Agency for International Development  
Washington, D.C. 20523-1414  
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**Office of Finance and Contracts  
U.S. Department of Commerce  
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Washington, D.C. 20230  
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Fax: (202) 377-5702**

**Committee on Renewable Energy Commerce and Trade  
Department of Energy  
Office of Conservation and Renewables  
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Fax: (202) 586-1605**

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U.S. Environmental Protection Agency  
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Washington, D.C. 20460  
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Fax: (202) 260-4470**

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Export Import Bank  
Office for Africa and the Middle East  
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Phone: (202) 566-8011  
Fax: (202) 566-7524**

**Investment Development Department  
Overseas Private Investment Corporation  
Information Officer  
1100 New York Avenue, NW  
Washington, D.C. 20527  
Phone: (202) 336-8636  
Fax: (202) 408-5155**

**Office of International Trade  
Small Business Administration  
409 3rd Street, SW  
Washington, D.C. 20416  
Phone: (202) 205-6720  
fax (202) 205-7272**

## JORDAN WATER/WASTE WATER ORGANIZATIONS

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| ORGANIZATIONS  | PP | LL | RD | FI | DT | OM | ME | EN | TE | IC | ES | # STAFF |
|--|----|----|----|----|----|----|----|----|----|----|----|---------|
| <b>PUBLIC SECTOR-MWI</b>                             |    |    |    |    |    |    |    |    |    |    |    |         |
| Ministry of Water and Irrigation (MWI)               | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  |    | 8,646   |
| MWI Water Authority of Jordan (WAJ)                  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  |    | 6,489   |
| WAJ Board of Directors                               | 3  | 3  |    | 3  |    |    |    |    |    |    |    |         |
| Planning & Coordination Committee                    | 3  |    |    |    |    |    |    |    |    |    |    |         |
| Public Relations & Public Service Unit               |    |    |    |    |    |    |    |    |    | 3  |    | 2       |
| Planning, Development & Information                  |    | 3  |    |    | 3  |    | 3  |    |    | 3  |    | 53      |
| Directorate of Planning & Development                | 3  | 3  |    |    | 3  |    | 3  |    |    |    |    |         |
| Directorate of Information                           | 3  |    |    |    |    |    | 3  |    |    | 3  |    |         |
| Directorate of Organizational Development (Training) |    |    |    |    |    |    |    |    | 3  |    |    |         |
| Administration & Finance                             |    |    |    | 3  | 3  |    |    |    |    |    |    | 324     |
| Projects   |    |    |    |    | 3  |    |    |    |    |    |    | 125     |
| Water Resources                                      | 1  | 1  | 1  |    |    |    |    |    |    |    |    | 537     |
| Directorate of Drilling                              |    |    |    |    | 1  |    |    |    |    |    |    |         |
| Directorate of Laboratories                          |    |    |    |    |    |    | 3  |    |    |    |    |         |
| Directorate of Water Resources Studies               | 1  | 1  |    |    |    |    |    |    |    |    |    |         |
| Directorate of Irrigation                            |    |    |    |    |    | 1  |    |    |    |    |    |         |
| Operations & Maintenance                             |    |    |    |    |    | 3  | 3  |    |    |    |    | 581     |
| Governorate Directorates                             |    |    |    |    | 3  | 3  | 3  | 3  |    | 3  |    | 4,869   |
| MWI Jordan Valley Authority (JVA)                    | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |    | 2,152   |

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| ORGANIZATIONS                    | PP | LL | RD | FI | DT | OM | ME | EN | TE | IC | ES | # STAFF |
|----------------------------------|----|----|----|----|----|----|----|----|----|----|----|---------|
| <b>PUBLIC SECTOR—MWI</b>         |    |    |    |    |    |    |    |    |    |    |    |         |
| JVA Board of Directors           |    |    |    |    |    |    |    |    |    |    |    |         |
| Senior Administration            | 1  |    |    |    |    |    |    |    |    |    |    | 6       |
| Planning & Information           | 1  | 1  | 1  |    |    |    | 1  |    | 1  | 1  |    | 9       |
| Planning                         | 1  |    |    |    |    |    |    |    |    |    |    |         |
| Computer                         |    |    |    |    |    |    |    |    |    | 1  |    |         |
| Information                      |    |    |    |    |    |    |    |    |    | 1  |    |         |
| Training                         |    |    |    |    |    |    |    |    | 1  |    |    |         |
| Administration & Finance         |    |    |    | 1  | 1  |    |    |    |    |    |    | 181     |
| O&M (Jordan Valley)              |    |    |    |    |    | 1  | 1  | 1  |    |    |    | 938     |
| O&M (Southern Ghor & Wadi Arabs) |    |    |    |    |    | 1  | 1  | 1  |    |    |    | 351     |
| Studies & Design                 | 1  | 1  | 1  |    | 1  |    | 1  |    |    |    |    |         |
| Drainage Department              |    |    |    |    |    | 1  |    |    |    |    |    | 98      |
| Laboratory Department            |    |    |    |    |    |    | 1  |    |    |    |    | 110     |
| Mechanics Department             |    |    |    |    |    | 1  |    |    |    |    |    | 154     |
| Water Resources                  | 1  | 1  | 1  |    | 1  |    |    |    |    |    |    |         |
| Irrigation Department            |    |    | 1  |    | 1  | 1  |    |    |    |    |    | 44      |
| Dams Department                  |    |    |    |    | 1  | 1  |    |    |    |    |    | 121     |
| Rural Development Department     |    |    |    |    | 1  | 1  |    |    |    |    |    | 107     |
| Lands Department                 |    |    |    |    |    |    |    |    |    |    |    | 33      |
|                                  |    |    |    |    |    |    |    |    |    |    |    |         |
|                                  |    |    |    |    |    |    |    |    |    |    |    |         |

## JORDAN WATER/WASTE WATER ORGANIZATIONS (Continued)

**FUNCTIONS:**

PP = Policy, Planning and Management

LL = Legislation, Licensing &amp; Standards

RD = Research &amp; Development, Exploration

FI = Finance

DT = Design, Tender Documents &amp; Construction

OM = Operations &amp; Maintenance

ME = Monitoring, Evaluation &amp; Interpretation

EN = Enforcement

TE = Training &amp; Formal Education

IC = Information, Communication &amp; Public Awareness

ES = Environmental Services Industry

1 = WATER

2 = WASTE WATER

3 = BOTH

| ORGANIZATIONS   | PP | LL | RD | FI | DT | OM | ME | EN | TE | IC | ES | COMMENTS |
|---|----|----|----|----|----|----|----|----|----|----|----|----------|
| <b>OTHER PUBLIC SECTOR UNITS:</b>                           |    |    |    |    |    |    |    |    |    |    |    |          |
| The Cabinet of Ministers                                    | 3  | 3  |    | 3  |    |    |    |    |    |    |    |          |
| The Parliament  |    | 3  |    | 3  |    |    |    |    |    |    |    |          |
| Ministry of Planning (MOP)                                  | 3  |    | 3  | 3  |    |    |    |    |    |    |    |          |
| Ministry of Municipal & Rural Affairs & Environment (MORAE) | 3  | 3  |    |    |    |    | 3  |    |    | 3  |    |          |
| Dept. of Environment (DE)                                   | 3  | 3  |    |    |    |    | 3  |    |    | 3  |    |          |
| Ministry of Agriculture (MOA)                               | 1  | 1  | 1  |    |    |    | 1  |    |    | 1  |    |          |
| Public Relations & Information                              |    |    |    |    |    |    |    |    |    | 1  |    |          |
| National Center for Research & Technology Transfer          |    |    |    |    |    |    | 1  |    |    | 1  |    |          |
| Ministry of Health (MOH)                                    |    | 1  |    |    | 1  |    | 1  | 1  |    | 1  |    |          |
| Ministry of Public Works & Housing (MPWH)                   |    | 1  |    |    | 1  |    |    |    |    |    |    |          |
| Ministry of Industry & Trade (MIT)                          |    | 3  |    |    |    |    |    | 3  |    |    |    |          |
| Directorate of Standards & Measurements                     |    | 3  |    |    |    |    |    |    |    |    |    |          |
| Ministry of Finance (MOF)                                   | 3  |    |    | 3  |    |    |    |    |    |    |    |          |
| The Budget Dept.  | 3  |    |    | 3  |    |    |    |    |    |    |    |          |
| Ministry of Education (MOE)                                 |    |    |    |    |    |    |    |    | 3  | 3  |    |          |
| Ministry of Energy & Mineral Resources (MEMR)               |    |    | 1  |    |    |    |    |    |    |    |    |          |
| Natural Resources Authority                                 |    |    | 1  |    |    |    |    |    |    |    |    |          |
| Ministry of Interior  |    |    |    |    |    |    |    | 3  |    |    |    |          |
| Public Safety Committee                                     |    |    |    |    |    |    |    | 3  |    |    |    |          |
|   |    |    |    |    |    |    |    |    |    |    |    |          |
|   |    |    |    |    |    |    |    |    |    |    |    |          |



**JORDAN WATER/WASTE WATER ORGANIZATIONS (Continued)**

**FUNCTIONS:**

- PP = Policy, Planning and Management
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- ES = Environmental Services Industry
- 1 = WATER                      2 = WASTE WATER                      3 = BOTH

| ORGANIZATIONS                                       | PP | LL | RD | FI | DT | OM | ME | EN | TE | IC | ES | COMMENTS |
|---|----|----|----|----|----|----|----|----|----|----|----|----------|
| <b>NON-GOVERNMENTAL AGENCIES:</b>                   |    |    |    |    |    |    |    |    |    |    |    |          |
| Royal Scientific Society (RSS)                      |    | 2  |    |    |    |    | 3  |    | 2  | 3  | 3  |          |
| Royal Society for the Conservation of Nature (RSCN) |    |    |    |    |    |    |    |    |    | 3  |    |          |
| Society for the Control of Environmental Pollution  |    |    |    |    |    |    |    |    |    | 3  |    |          |
| University of Jordan (UJO)                          |    |    | 3  |    |    |    | 3  |    | 3  | 3  |    |          |
| Jordan University of Science & Technology (JUST)    |    |    | 3  |    |    |    | 3  |    | 3  | 3  |    |          |
| Industries  | 3  |    |    | 3  | 3  | 3  | 3  |    |    |    | 3  |          |
| Farmers   | 1  |    |    | 1  | 1  | 1  |    |    |    |    | 1  |          |
| Jordanian Engineers Association                     |    |    |    |    | 3  |    |    |    |    |    |    |          |
| Jordanian Contractors Association                   |    |    |    |    | 3  |    |    |    |    |    | 3  |          |
| Manufacturers & Importers                           |    |    |    |    |    |    |    |    |    |    | 3  |          |
|   |    |    |    |    |    |    |    |    |    |    |    |          |
|   |    |    |    |    |    |    |    |    |    |    |    |          |
|   |    |    |    |    |    |    |    |    |    |    |    |          |
|   |    |    |    |    |    |    |    |    |    |    |    |          |

## *Selected Bibliography*

- Ahmad, Abdullah A. *Jordan Environmental Profile Status and Abatement*, 1989.
- Annual Report of the Ministry of Energy and Mineral Resources*, Jordan, 1990.
- Bannayan, H. *The Inadequacy of Stabilization Ponds Treatment as Manifested by the Effects of Khirbat es Samra on the Groundwater Quality in Water Pollution in Jordan—Causes and Effects*, Amman: El Kutba Publishers, 1991.
- Elkarmi, A, and Akeel, N. *The Factors Affecting Air Pollution in Downtown Amman Area*, n.d.
- Environmental Pollution in Jordan - Controls and Management*, n.d.
- Gedeon, R. "The Potential Impact of Industrial Wastes on Water Resources in Amman-Zarqa Basin." *Water Pollution in Jordan—Causes and Effects*. Amman: El Kutba Publishers, 1991.
- Hashwa, F., Jriesat, R., Rimawi, O. Salameh, E., Saliba, E. *The Effects of Khirbet es Samra Effluent on the Water Quality of Wadi Dhuleil and Zerka River*. University of Jordan, Water Research and Study Center Bulletin No. 10, 1987.
- Hijazin, S. *Solid Waste Disposal Sites in Water Pollution in Jordan, Causes and Effects*, Amman: El Kutba Publishers, 1991.
- Hospodarec, R.W. *Environmental Assessment of the Jordan Petroleum Refining Company*, Washington, D.C.: The World Environment Center, 1987.
- International Monetary Fund. *International Financial Statistics*. Washington, D.C., 1992.
- Jaber, J., Hoy, R., and Proberts, S. *Energy Management and Environmental Protection in Jordan: Economic Impact*, n.d.
- Jordan Ministry of Municipal, Rural Affairs and the Environment. *National Environment Strategy for Jordan*, Amman: The Economic Press Co., 1991.
- JSCEP. *Seminar on Protecting Jordan's Water Resources*, n.d.
- Ministry of Planning. *Socio-Economic Developmental Plans 1980 and 1985*. Amman: n.d.

- Ministry of Water and Irrigation. Files. Amman, n.d.*
- Mudallae, O. *Industrial Environmental Legislation in Jordan and the Arab World*, n.d.
- Nilsson, A. *Greenhouse Earth*, n.d.  
*Odor Problems in Wastewater Treatment Plants in Jordan*, n.d.
- Odat, Gh. *Air Pollution in Jordan*, n.d.
- RCG/Hagler Bailly, Inc. *Ministry of Energy and Mineral Resources, the Hashemite Kingdom of Jordan Industrial Energy Efficiency Program*. Prepared for the USAID Bureau of Science and Technology, 1991.
- Recommended Wastewater Treatment Guidelines for the Hashemite Kingdom of Jordan*, WASH Field Report No. 17. Prepared for USAID Mission to Amman by the Water and Sanitation for Health Project, 1981.
- Royal Scientific Society. *Air Pollution Monitoring in Amman-Final Report*, n.d.
- Royal Scientific Society. *The First Regional Seminar on Air Pollution*, Amman: 1990.
- Salameh, E. "Over-exploitation and Salinization of Groundwater," in *Water Pollution in Jordan, Causes and Effects*, Fss-Amman, El Kutba Publishers, 1991.
- Salameh, E. *Water Resources of the Arab Countries, Characteristics, Potential and Future Prospects*, UNCED, Bonn: April, 1992.
- Sara, Y. *Solid Wastes Treatment*, n.d.
- Shureiki, Y. "Effects of Agricultural Activities on Water Pollution," *Conference Proceedings of the Jordanian Society for the Control of Environmental Pollution*, Amman: 1990.
- Tell, S., and Sara, Y. *State of Environment*, n.d.
- Trick, Peter, B. *An Analysis of Jordanian Laws and Institutions*. Prepared for USAID/Jordan and the Government of Jordan by Project in Development and the Environment (PRIDE), 1992.
- Water Authority of Jordan. *Internal Reports on Waste Treatment Plants (Salim, Saqi; and Others)*. Amman: 1987 and 1991.
- Water and Wastewater Sector Assessment in Jordan*. WASH Field Report No. 244. Prepared for the USAID Asia/Near East Bureau, by the Water and Sanitation for

**Health Project, 1989.**

*Water Management Study for Jordan.* Prepared for USAID/Jordan and the Government of Jordan, by Project in Development and the Environment (PRIDE), 1992.

**William, F.** *Strategic Planning for Energy and the Environment*, n.d.

## *Profile Methodology and Survey*

This profile was completed through desk, field, and survey research, and report synthesis and analysis. The desk research consisted of obtaining information on the private sector in Jordan, U.S./Jordanian investment and trade relations, existing environmental projects, and relevant environmental institutions in Jordan. The information collected and used to compile this profile was quantitative and factual in some cases and anecdotal in others, largely because the exploration of environmental market dynamics in Jordan has begun only recently.

The survey research involved a questionnaire that was designed to address a wide spectrum of organizations and companies. It was divided into four main sections, each for a particular group, as follows:

**Section A: General Classification Questions.** This section has seven questions intended to classify the organization as private or governmental ("private sector" or "privately owned" means a business with less than 50 percent ownership and control by the Government of Jordan), discharger or environmental business, and to describe its activity, history in the market (local and regional), size, products, services, and type of discharge.

**Section B: Environmental Needs and Issues.** This section contains 21 questions that identify the environmental problems and needs of the business. This section was designed mainly for environmental businesses, so dischargers were not accounted for in the results.

**Section C: Public Opinion.** This section, has seven questions that ask dischargers and environmental businesses how Jordan's environmental problems should be handled.

**Section D: General Environmental Businesses.** Section D was added early in the survey to obtain more information on the types of problems and barriers facing environmental business.

A wide range of specialties and business activities available in the market was covered. However, time constraints did not allow coverage of a larger number of companies in each activity. Business activities were divided into dischargers and environmental businesses.

Dischargers include governmental and nongovernmental (private) businesses that contribute to pollution in Jordan while producing goods or providing services. Dischargers were subdivided into 10 business activities, covering most major discharging activities (excluding domestic dischargers/citizens) as follows:

*Appendix G*

|                                 |    |                        |   |
|---------------------------------|----|------------------------|---|
| 1. Industry                     | 11 | 6. Commercial          | 2 |
| 2. Military                     | 3  | 7. Construction        | 2 |
| 3. Medical                      | 4  | 8. Municipal Services  | 2 |
| 4. Garages/Airplane Maintenance | 5  | 9. Tourism Development | 2 |
| 5. Chemical Storage/Transport   | 5  | 10. Others             | 2 |

The survey covered (38) businesses of dischargers.

Environmental businesses are governmental and nongovernmental organizations, institutions, and private businesses that participate directly or indirectly or could have potential to participate in minimizing, eliminating, or analyzing environmental problems. Environmental businesses were divided into 12 activities, listed below with the number of interviews conducted for each:

|   |   |                        |   |
|---|---|------------------------|---|
| 1. Consultants                                    | 6 | 7. Treatment           | 0 |
| 2. Engineers                                      | 6 | 8. Recyclers           | 0 |
| 3. Construction                                   | 0 | 9. Publishing          | 2 |
| 4. Equipment Manufacturers                        | 0 | 10. Training/Education | 2 |
| 5. Equipment Supply, Operation<br>and Maintenance | 1 | 11. Financiers/Bankers | 1 |
| 6. Testing Laboratories                           | 3 | 12. Others             | 1 |

Some environmental activities could not be found in the local market, such as the construction of pollution treatment projects, manufacturers of environmental products, and firms specializing in waste treatment and recycling.

The survey was conducted primarily on a person-to-person basis. However, many organizations requested that the questionnaire left with them, which sometimes resulted in a different kind of response. Those answers were not included in the result sheets, but were considered in the evaluation process and taken as public opinion indicators.

## *Individuals and Companies Interviewed*

### *Industries*

1. Arab Hygienic Paper Industries (SOFT)  
Mr. M. Faouri, Financial Manager
2. The Arab Potash Co.  
Mr. Ali Ensour, Managing Director  
Tel: 666165
3. Jordan Petroleum Refineries  
Mr. Sa'ad Al Tell, General Manager  
Tel: 630151
4. Jordan Dairy Co.  
Mr. A. Ghalayini, Financial Manager  
Tel: 953368
5. Elba House Co.  
Mr. A. Shawabkeh, Administrative Manager
6. Jordan Match Co.  
Mr. M. Asa'ad  
Tel: 983418
7. Jordan Ice & Aerated Water Co.  
Mr. A. Farouqi, Maintenance Manager  
Tel: 892014
8. Jordan Ceramic Industries Co.  
Mr. A. Shaheb  
Tel: 981373
9. Jordan Optical Manufacturing Co.  
Mr. A. Yassin
10. Fine Hygienic Paper Co. Ltd.  
Miss Salwa Masri, Personnel Manager  
Tel: 652688

11. Industrial Commercial & Agricultural Co.  
Tel: 951945
12. Al-Maqdesiah Tires Retreading Co.  
Mr. Ahmad Karram  
Tel: 722480

*Military*

1. Blankets & Tents Factory  
(Jordanian Armed Forces)
2. Directorate of Royal Maintenance Corps.  
(Jordanian Armed Forces)
3. King Hussien Workshops (Armour Rebuild Facility)  
(Jordanian Armed Forces)

*Medical*

1. Al Hikmah Pharmaceuticals  
Mr. Faisal Al. Ra'i  
Tel: 811962
2. Ministry of Health  
Mr. Ahmad Iram, Doctor  
Tel: 665131
3. King Hussien Medical Center  
Mr. Ahmad Al Ali, Doctor  
Tel: 813813

*Garages & Transport*

1. Royal Jordanian Airline  
Mr. Hanna Abu-Deia  
Tel: 672872
2. Ministry of Transport  
Mr. Marwan Al Hmood, Transport Engineer  
Tel: 641461

3. **Medico Carwash Station**  
**Mr. Ahmad Khater, Manager**  
**Tel: 671087**
4. **Macca Carwash Station**  
**Mr. Ahmad Hammadien, Manager**  
**Tel: 821445**
5. **Civil Aviation Authority**  
**Mr. Assem Al-Dalgamone**  
**Tel: 52653**

*Chemical Stores*

1. **Spartan Co.**  
**Miss Enass Assaf, Production**  
**Tel: 774992**
2. **Jordan Sulpho-Chemicals Co.**  
**Mr. Hatem Abbas, Technical Manager**  
**Tel: 991434**
3. **Medeca Co.**  
**Mr. Khoury, Director**  
**Tel: 662401**
4. **Vapco**  
**Miss Sawssan A. Fareed, Assistant Manager**  
**Tel: 722801**
5. **Nabilsie Drugstore Co.**  
**Tel: 630824**

*Commercial*

1. **Ata Ali Co.**  
**Mr. Marwan Mahmoud**  
**Tel: 812310**

*Construction*

1. **Jordan Tile Co.**  
**Mr. Hassan Abu-Ashour**  
**Tel: 991560**

2. **Altanqeeb Construction Material Manufacturing Co.**  
**Mr. Dawoud Mustafa, Sales Manager**  
**Tel: 892079**

*Municipal Services*

1. **Dhullel Coop. Society for Cow Herders**  
**Mr. Khaled El Saad, Engineer**  
**Tel: 914095**
2. **Amman Slaughter House**  
**Dr. Othman Al Kilani, Manager**  
**Tel: 891531**

*Tourism*

1. **Dead Sea Hotel Spa Co.**  
**Mr. Wasiem Ziadeh, Executive Secretary**  
**Tel: 802028**
2. **Ma'ain Hot Springs Spa**  
**Mr. Fankhier Al-Zabin**

*Others*

1. **Jordan Electricity Authority**  
**Mr. M. S. Arafa, Director General**  
**Tel: 815615**
2. **Jordan Phosphate Mines Co. Ltd.**  
**Mr. Mustafa Salama, Chief of Chemical & Environmental Studies Section**  
**Tel: 660141**
3. **Private Testing Lab**

*Environmental Businesses*

*Consultancy*

1. **Water Authority**  
**Mr. Hussam Khniem, Engineer**  
**Tel: 680100**

2. **Environmental & Water Research Center**  
Dr. Rand Khawas  
Tel: 776115
3. **Higher Council for Science & Technology**  
Dr. Fawaz Al Karmi  
Tel: 835283
4. **Dept. of the Environment**  
Mr. Esah Abu Hamzeh
5. **Ministry of Trade & Industry**  
Mr. Fawzi Al Momani, Head of Industrial Services Section  
Tel: 663191
6. **Dr. Fouzi Al Rayan, Private Consultant**
7. **Jordan Technical consulting Group**  
Dr. Munif Hijazi  
Tel: 690262

*Engineering*

1. **Sigma Engineering Consultancy Co.**  
Mr. Maged Al Hilou  
Tel: 641241
2. **The Joint Venture Arabtech & MAR Jardaneh**  
Mr. Kassim Abu Hassan, Engineer  
Tel: 827167
3. **Ministry of Energy & Mineral Resources**  
Mr. J. O. Jaber, Head of Energy Conservation Section  
Tel: 815615
4. **Arab Engineering Consulting Firm**  
Mr. Abdel Fattah Toukan, Director  
Tel: 606068
5. **Water Authority**  
Mr. Ameen Belbiesy, Director  
Tel: 679143

6. **Ministry of Energy & Mineral Resources**  
**Mr. H. Taher, Renewable Energy Department**  
**Tel: 815615**

*Equipment & Supply*

1. **Horizon Water Filtration**  
**Mr. Yousef Qutub, General Manager**  
**Tel: 617502**

*Testing Laboratories*

1. **Water Authority/Lab & Water Quality Dept.**  
**Dr. Hamid Ounn, Director**  
**Tel: 680100**
2. **Royal Scientific Society/Environmental Research Center**  
**DR. Ali Elkarmi, Head of Ecology Division**  
**Tel: 844700**
3. **Geotechnical Engineering & Material Testing**  
**Mr. Marwan Sa'adoun, Geologist**  
**Tel: 642806**

*Publishing*

1. **Fridrich Nouwman Foundation**  
**Mr. Walter Rudel**  
**Tel: 689377**
2. **Jordanian Society for the Control of Environmental Pollution**  
**Dr. Saqar Al Salem, Secretary General**  
**Tel: 695857**

***Training & Education***

1. **Ministry of Planning**  
**Mr. Hussien Sha'amri, Chemical Engineer**  
**Tel: 6493341**
2. **Jordan University**  
**College of Engineering & Technology**
3. **Jordan Engineering Association**  
**Mr. Faisal Al Masri**  
**Secretary General, Assistance for Technical Affairs**  
**Tel: 660134**

***Financier/Banker***

1. **Industrial Development Bank**  
**Mr. Zaidan A. Younes, Engineer**  
**Tel: 647821**

***Others***

1. **Energy Management Services**  
**Eng. Khaled Bushnaq, General Manager**  
**Tel: 696464**

## ***Environmental Publications and Public Awareness***

Environmental issues are frequently addressed by the media including television, radio, and newspapers, and by seminars in schools, community colleges, universities, clubs, associations of farmers, engineers and physicians, and syndicates. Jordanian schools educate students to care about the environment through their regular lessons and lectures by specialists and people working in the field. The standard of environmental education in the schools is satisfactory.

The University of Jordan issues two to three bulletins yearly on the findings of the Water Research and Study Center, in addition to numerous reports about their current research projects.

The Royal Scientific Society also issues reports on current research projects. The scientific journals of the Jordanian universities frequently publish articles on environmental issues. The Royal Society for the Conservation of Nature issues a quarterly magazine on environmental issues called *Reem*, which has educational goals.

The Jordanian Society for the Control of Environmental Pollution started publishing a magazine called *Risalat Al Bi'a* one year ago. Like *Reem* it is also an educational magazine at the mass media level. The Ministry of Education developed a program to educate people on environmental issues, environmental repair, and conservation.

The Friedrich Neuman Foundation (FNS), in cooperation with the Jordanian Society for the Control of Environmental Pollution, is supporting environmental awareness and educational programs throughout Jordan.

Environmental education at the university level is distributed among various departments and faculties. Faculties of science, engineering, technology, agriculture, and medicine offer courses in environmental studies and protection. At a B.Sc. level there is no specialization in environmental studies, except at the Department of Earth and Environmental Sciences, Yarmouk University.

Training is offered by various departments and agencies, both governmental and nongovernmental, (e.g. the Ministry of Water and Irrigation has its own training center and universities offer training in water, wastewater treatment and analysis, water resources, and irrigation).

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