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Environmental Assessment for
the Gaza Industrial Estate Project

December 1996

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PREFACE

Between the time that this draft environmental assessment was prepared in early November and its revision in mid-December, several developments occurred that the reader should be aware of. First, a proposed "industrial estate authority" is being discussed by the donors and the Palestinian Authority. It would provide for the internal environmental controls recommended in this report. These include controlling the numbers and kinds of industries and regulation of wastewater and solid waste streams. Also, some variations on the alternatives delineated in this report are briefly addressed in this revised environmental assessment. These include disposal of the reverse osmosis reject waters in the Wadi Gaza to avoid ocean disposal and to augment flows that contribute to a wetland in the mouth of the Wadi Gaza (see Section 6.2.2).

In addition, discussion among the donor agencies has resulted in some developments that bear upon the funding, and ultimage mitigation responsibilities, of various aspects of the off-site infrastructure. As of early December 1996, USAID has agreed to fund major improvements to the Gaza Municipal Wastewater Treatment plant, which opens up the possibility of having the plant serve as a backup, or possibly a complete replacement for, the proposed wastewater treatment plant at the Gaza Industrial Estate (see Appendix J).

Tentatively, it appears that the wastewater and stormwater discharge controls will be the funding responsibility of the World Bank, which means that the World Bank may be undertaking additional analysis and developing additional mitigation measures beyond those proposed in this USAID-funded environmental assessment. In addition, the World Bank would be responsible for funding the proposed roadway improvements. USAID would focus on the water supply and power supply infrastructure elements, with communications infrastructure supported by funding from the Israelis.

—Bob Davis
December 19, 1996

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ACRONYMS

BOD	Biochemical Oxygen Demand
dBA	A-weighted decibels
EA	Environmental Assessment
EIF	European Investment Bank
EPD	Environmental Planning Directorate
EU	European Union
GCE	Gaza Central Exchange
GDP	gross domestic product
GIE	Gaza Industrial Estate
IEC	Israeli Electric Company
IFC	International Finance Corporation
KV	kilovolt
m^3	cubic meters
MOH	Ministry of Housing
MOI	Ministry of Industry
MOPIC	Ministry of Planning and International Cooperation
MPT	Ministry of Post and Telecommunications
MPW	Ministry of Public Works
MW	megawatt
PA	Palestinian Authority

PADICO	Palestinian Development & Investment Corporation
PEA	Palestinian Electric Authority
PIESZA	Palestinian Industrial Estate and Service Zone Authority
PWA	Palestinian Water Authority
RBC	rotating biological contractors
RO	reverse osmosis
RUPD	Rural and Urban Planning Directorate
SAR	sodium absorption ratio
SBR	sequencing batch reactors
SFB	standard factory buildings
TDS	total dissolved solids
UNDP	United Nations Development Program
USAID	U.S. Agency for International Development
WHO	World Health Organization

EXECUTIVE SUMMARY

Introduction and Purpose

In an effort to support the Middle East peace process, the U.S. Agency for International Development (USAID), the World Bank, and possibly other donors are proposing to financially support the development of off-site infrastructure for the proposed Gaza Industrial Estate (GIE) in the Gaza Strip. Because of the urgency of this project, this Environmental Assessment (EA) has been conducted on a "fast-track" basis. A five-person EA team prepared this draft on-site over a three-week period in late October and early November. An EA is required before USAID and the World Bank can commit funds to an industrial project under their respective project funding guidelines (22 CFR 216 for USAID, and Operational Direction 4.00 for the World Bank). A scoping meeting, attended by some 50 persons in Gaza, was held to identify perceived impacts and concerns by various individuals that might be affected or have expertise related to the proposed project.

As discussed in Chapter 1, the general purpose of the project is to promote economic development in the Gaza Strip through the development of an industrial estate (industrial park) that would promote labor-intensive industries. The unemployment rate has been estimated at greater than 50% for the Gaza Strip. The proposed GIE would result in the employment of up to 22,000 persons in some 250 industrial firms at a site on the border with Israel (about 5 km south of the center of Gaza City). The GIE is proposed as the first of nine industrial estates in Gaza and the West Bank.

Legal, Regulatory, and Institutional Framework

As described in Chapter 2, the peace accords between Israel and the Palestinians have resulted in a Palestinian Authority (PA) that has limited self-government over the Gaza Strip. During the past three years, the PA has begun to organize with the establishment of various ministries. The Ministry of Industry (MOI) plays a key role in the development of the GIE, although the site will be developed and operated by a private firm, the Palestinian Development & Investment Corporation (PADICO).

Under a written agreement between MOI and PADICO, PADICO will provide certain on-site infrastructure to serve the future tenants at the GIE while MOI, through funding from USAID and the World Bank, will construct certain off-site infrastructure components: roads, water supply, wastewater and stormwater treatment and management, telecommunications, and electricity. MOI heads up an Interministerial Committee (the Off-Site Infrastructure Unit) to coordinate the PA's efforts to establish the GIE. Draft legislation before the Palestinian Council, (the elected legislative body for Gaza and the West Bank), would create the Palestinian Industrial Estate and Service Zone Authority (PIESZA), which would ultimately promote and regulate industrial estates, including the GIE.

A major factor affecting environmental impacts and mitigation related to the GIE is the fact that there are currently no statutes and regulations that mandate environmental controls for new

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and existing industries. The Environmental Planning Directorate (EPD) within the Ministry of Planning and International Cooperation is staffed with environmental professionals and is beginning to consider draft regulations that would be considered once the Palestinian Council has passed the environmental framework law, which was proposed in early 1995.

Chapter 2 describes the many PA entities and city of Gaza agencies that could have some involvement with the GIE. Although representatives from the Israeli government did not attend the scoping meeting, they have communicated concerns related to transboundary effects (stormwater runoff, odors, chlorine gas handling, and groundwater withdrawals).

The Proposed Action and Its Alternatives

Technically, the proposed action is for USAID to provide up to approximately US $6 million in grants and for the World Bank to provide a yet-to-be determined loan for funding the off-site infrastructure components. From an EA analytical perspective, the proposed action is the construction and operation of each of the proposed infrastructure components (based on consultant reports provided to the EA team). GIE on-site activities are addressed but are not the focus of this assessment. Alternatives exist for each off-site infrastructure component. These include optional approaches, conceptual designs, or routing. The scope of this EA is restricted to off-site infrastructure only; on-site activities are *not* part of the proposed action.

Chapter 3 describes the GIE project plans, in general, and each individual infrastructure component and its alternatives specifically. PADICO plans to develop the GIE in three phases. Approximately 60% of the total required infrastructure and approximately 25% of the tenant buildings would be in place by the end of the first phase.

Recently PADICO proposed an accelerated construction schedule that would begin in December 1996 and would proceed without outside donor funding. As this emergency or interim phase would not be funded by USAID or the World Bank, these plans were not the focus of the EA. However, because activities conducted under this phase would affect the environment and are integrally connected to the overall GIE, the EA team has prepared a brief analysis of this plan as it existed the first week of November 1996 (see Appendix H). A short description of the proposed action for each infrastructure component is included later in this executive summary along with any significant impacts and major uncertainties that are associated with it.

Description of Existing Environment

Chapter 4 describes the existing environment in the region and at the site that would potentially be affected by the proposed action. Some key points related to the assessment from this section are as follows:

Water Availability and Quality

By far the most salient feature regarding the environment of the Gaza Strip is its increasingly scarce and threatened water supply. Gaza relies almost entirely on groundwater drawn from the shallow aquifer; there are no freshwater perennial streams, lakes, or other surface waters. The shallow aquifer ranges in thickness from 120 meters near the coast to 10 meters in the east and is

often only a few meters below the surface (although at the site it is approximately 50 or more meters below the surface). Because it is near the surface, is near the Mediterranean, is underlain by a saline aquifer (often existing in lenses floating on brackish waters), and is not protected from environmental degradation, the shallow aquifer is vulnerable to declining water levels, salt water intrusion, and contamination from agricultural and industrial activity.

The estimates of the aquifer's renewable yield range from 25 to 80 million cubic meters per year. With annual withdrawals estimated (several years ago) at 110 million cubic meters per year, it is clear that the aquifer is being overexploited, impacting availability and quality (salt water displacement).

The quality of more than half of the water that replenishes the aquifer is poor—mainly as a result of irrigation return flows (excess nitrogen) and domestic wastewater infiltration. Existing wastewater treatment in the study area consists of the Gaza Municipal Wastewater Treatment Plant, which is overloaded and only marginally effective.

The major source of groundwater is rainfall. On average, approximately 40% of the total rainfall replenishes the groundwater with the remaining 60% lost to evaporation. This suggests that strategies that would recharge the aquifer with fresh water could be as important as demand reduction.

Other Elements of the Existing Environment

The site is cleared with bare ground and some scrubby shrubs and groundcover. Only one tree is on-site. Some vegetation grows along two of the site boundaries. There are no sensitive biological habitats or rare and threatened species known to be on-site or nearby. Biological resources were not considered to be an issue by the EA team, the scoping meeting attendees, or the donors.

The site is a former airstrip built by the British during the 1940s when they controlled Palestine. Although it is publicly owned by the PA, nearby residents have used it for subsistence gardens and grazing. The land use surrounding the site is mainly agricultural: olive groves, row crops, and pasture. There are some structures, owned by the PA, on the northwest side of the site that were formerly hangars associated with the airstrip. The airstrip itself has been converted into the back-to-back goods exchange where goods being shipped from the Gaza Strip into or through Israel are inspected.

The site, and indeed most of Gaza, is underlain by deep sandy soils. Where water is available, Gaza soils and climate are well-suited for agriculture. Citrus fruits have long been a mainstay of its economy.

Compared to other environmental issues, air quality is not a priority. No ambient data were available. The EA team observed, and EPD staff confirmed, that particulate matter from disturbed surfaces is the pollutant of most concern. Not much heavy industry exists in the Gaza Strip, and the region is well-ventilated by breezes from the Mediterranean. The climate is semi-arid and temperate with a distinct rainy season. Almost half of the rainfall (estimated at approximately 300 to 400 mm at the site) occurs in December and January.

There are no indigenous sources of energy in the Gaza Strip. All of the electricity is imported from Israel. A large combined cycle power plant has been proposed for Gaza that would

ultimately provide power for much of the area including the GIE. However, this power would not be available over the short term.

There are no known archaeological resources at the site. Since it has not been surveyed, it is possible that some may be present given the many millennia of human habitation in this region.

The population of the Gaza Strip is approaching one million persons. More than half of the inhabitants are descendants of refugees from the 1948 Arab-Israeli War and subsequent wars. Many of the workers have been historically employed in Israel in low-paying jobs in the construction and service sector. With frequent and long border closings in the last several years, the unemployment rate is estimated to be above 50%.

Assessment of Impacts

The EA team evaluated each of the proposed infrastructure components and the alternatives identified by the consultants. As described in Chapter 5, 14 potential impacts and areas of concern (identified primarily at the scoping meeting) were the basis for the evaluation. Impacts associated with construction or operation of specific infrastructure components, or the GIE in general, that were considered to be significant or uncertain are discussed below. As required by USAID and World Bank guidelines, the team also compared the proposed action against a no-action alternative. The no-action alternative was defined as the ultimate use of the site as an industrial area (so designated by the PA) but without adequate off-site infrastructure or environmental controls.

Vehicular Access, Telecommunications, and Electric Power Supply Options

None of the proposed options for vehicular access, telecommunications, or electric power supply appear to result in significant impacts. As with all of the options that involve disturbance and covering of the surface, there are uncertainties regarding damage or irretrievable loss of archaeological resources. Also, several mitigation measures and standard precautions are identified to ensure that the construction and operation proceed without significant impact.

Water Supply

The proposed option for providing water to the site is to drill four 120 meter-deep wells into the brackish water aquifer (beginning in Phase I at 1,100 m^3 per day). This would meet all of the site's water demands. Potable water supplies would be provided through the use of reverse osmosis to supply 400 m^3 per day in Phase I and ultimately 800 m^3 per day. Reject waters (or brine), which would amount to 100 m^3 per day (Phase I) and 200 m^3 (Phase III), would be trucked initially and piped eventually for disposal in the Mediterranean through a dedicated ocean outfall. Another option would be creation or enhancement of a wetland at the mouth of the Wadi Gaza. Other alternatives considered included recycle of wastewater and use of water from the Israelis (Mekerot) for all or some of the supply. The proposed action poses the potential for long-term adverse impacts to the brackish aquifer water availability from possible overdrafts and reduced water quality from increasing salinization due to saltwater intrusion. The potential for cross contamination of the less saline upper aquifer and the deeper more saline brackish water also exists. All of the other alternatives had similar drawbacks. The use of Mekerot water appears

to offer the benefit of reducing the need for withdrawals. However, questions over the origin, quality, and alternative uses of the Israelis' water make the benefits of this alternative more uncertain.

Wastewater Treatment and Stormwater Management

All of the wastewater treatment options are based on the concept of individual pretreatment of wastewaters from industrial tenants to proposed specified effluent quality limits (discussed in more detail in Appendix F). Firms with effluents composed of or similar to domestic (sanitary) wastewater would not have to pretreat their effluents. Following pretreatment, the streams from each tenant would be combined and sent to end-of-pipe treatment consisting of a combination of wastewater screening, equalization, biological treatment, post-equalization, tertiary filtration, and chlorination. For all options, stormwater would be collected and combined with the treated wastewater effluent for conveyance to application at an agricultural reuse and groundwater recharge site.

Provided that the pretreatment limits are observed, this approach would be largely beneficial in that the wastewater and stormwater could substitute for water currently being withdrawn from the aquifer by farmers and would also result in some direct recharge. No adverse impacts were identified.

Solid Waste

Assuming that current plans for a separate cell for hazardous waste disposal is developed at the Gaza Municipal Landfill, the EA team determined that there would be no significant adverse impacts from the collection and disposal of solid wastes at the GIE.

On-Site Activities and Overall GIE Effects

In addition to evaluating each infrastructure element proposed for USAID and World Bank funding, the EA team broadly considered the GIE as a whole to include on-site activities. As noted earlier, the water demands from the 250 firms will most likely cause significant adverse impacts on the aquifer resulting in increased saltwater intrusion. Conversely, employment during the construction and, especially, the operation of the GIE will have significant socioeconomic benefits. There is some uncertainty regarding the air quality implications from the mix of industries and the health and safety of the workers given that no occupational standards are in place.

Recommended Mitigation Measures

Mitigation measures that apply to all infrastructure items or to the GIE as a whole are discussed briefly in the next section, while mitigation measures that relate to specific infrastructure items are discussed in the following section. Chapter 5 identifies many other mitigation measures for minor impacts.

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Mitigation Measures that Apply to GIE as a Whole

Given the lack of a regulatory system that would set and enforce environmental standards and discharge limits, the EA team recommends that there be a full-time, on-site, environmental coordinator at the GIE. The environmental coordinator would be a degreed environmental professional who would be able to balance the need for a viable and profitable GIE with the need for environmental controls and protection. Consequently, the selection of this individual should involve both PADICO and the EPD and possibly other ministries. It is recommended that the environmental coordinator position, and his or her support staff, be funded by the World Bank or another donor organization partly to ensure that the function is adequately funded and partly to avoid possible conflicts of interest. The environmental coordinator would be responsible for conducting and submitting reports on the environmental monitoring results and the progress toward attaining the mitigation measures.

In addition to an environmental coordinator, some form of predicting and tracking the environmental discharges from each of the tenant firms is needed. This could be a simple questionnaire that is completed by the owner or the operator as a part of a pre-leasing review and/or it could serve as a form of internal permitting, which could become the basis of monitoring compliance and auditing. At a minimum, strict adherence and monitoring to ensure proper wastewater pretreatment would be required. The questionnaire would include estimates of the number of employees, process description, raw materials and chemicals used and stored, pretreatment process to be employed, estimates of solid and hazardous wastes, and other residuals.

Given the potential for archaeological finds in this region of the world, an archaeological survey should be conducted prior to any further disturbance of the site.

Mitigation Measures that Apply to Specific Infrastructure Items

Although there were no impacts predicted as a result of the construction and operation of roads, eventually transportation could be an issue as more than 20,000 persons attempt to commute to the GIE. The lack of parking spaces on site will force the great majority of the workers to use mass transit. PADICO and the environmental coordinator should plan to ensure that the mass transit is efficient, orderly, and inexpensive. It is recommended that the environmental coordinator develop a transportation plan that would utilize private mass transit companies to transport workers to the site. The plan should consider working with government officials to make dedicated and protected bus stops, staggering work hours, and avoiding product shipments and material deliveries during commuting times.

Long-term monitoring of the brackish water aquifer level and quality is recommended to ensure that the supply of water to the GIE not result in overdraft of the aquifer. To moderate the effects of brackish water overdraft and increased aquifer salinization, a program to reduce industrial water use should be implemented at each industrial facility at the GIE. A combination of wastewater reuse and the implementation of treatment in-place water conservation technologies is recommended. Other water-conserving measures include the use of captured stormwater runoff and economic incentives to increase water conservation.

The establishment of specific industrial wastewater pretreatment requirements is essential to the wastewater treatment strategy at the GIE. Each tenant industry at the GIE should establish a

waste minimization program to reduce the pollutant loadings from the industrial site. This could be accomplished through the creation of a pollution prevention program to also limit water use. Hazardous waste handling and disposal requirements for the pretreatment process should be established at each tenant industry. Monitoring of pretreatment effluents and residues is recommended together with monitoring of stormwater. Finally, there should be effluent quality criteria for sequencing batch reactor treatment to allow unencumbered use of this water for agricultural irrigation and/or specific recharge.

Long-term monitoring of the chemistry of the freshwater (upper) aquifer should be established in the area of agricultural use. Specific water quality criteria for groundwater recharge need to be established to guarantee that pollutants in the water not exceed water quality levels for public acceptance. The agricultural lands where effluent irrigation is practiced should be managed to moderate the sodium adsorption ratio so that soil permeability not be reduced. It is recommended that there be monitoring of soil characteristics and plant yields in areas where treated effluents are used for irrigation.

The establishment of a system of solid and hazardous waste collection and segregation at the GIE is recommended to ensure that hazardous materials be kept separate from normal refuse and nonhazardous solid wastes. A monitoring program is recommended to identify hazardous constituents in the industrial wastes and sludges from the GIE. Finally, water quality criteria for discharge of leachate from the Gaza Municipal Landfill should be established along with the monitoring of the underlying groundwater and surface water runoff quality.

The use of the proposed 2.2 MW diesel electric power generator during the short term to augment power supplies from Israel poses readily mitigated noise and air quality impacts. To avoid additional contamination to the groundwater, the diesel fuel storage tank should be an above-ground structure on a concrete pad with secondary containment. To reduce electric power demands, solar water heating for individual tenant domestic supplies should be encouraged along with natural lighting. Photovoltaics may be cost-effective for exterior street lighting.

1 INTRODUCTION AND PURPOSE

1.1 Introduction

This Environmental Assessment (EA) has been prepared to fulfill U.S. Agency for International Development (USAID) and World Bank requirements for evaluating environmental impacts from projects that have been proposed for USAID and World Bank financial support. In an effort to support the Middle East peace process, USAID, the World Bank, and possibly other international donors propose to fund off-site infrastructure associated with the planned Gaza Industrial Estate (GIE).

As shown in Figure 1-1, the GIE site is located near the border between Israel and the Gaza Strip. The Gaza Strip is a part of territory that has been occupied by the Israeli government since 1967 but is currently undergoing a transition to self-rule by the Palestinians under the terms of the Oslo Peace Accords.

An essential element of the peace accords is economic development to provide employment for the Palestinian people. As a result, nine industrial estates have been planned for Gaza and the West Bank (three in Gaza and six in the West Bank). The GIE would be the first of these and will serve as a model for the planning and development of the others.

The Palestinian Authority (PA), the U.S. government, and the World Bank agree that there is an urgent need to begin construction on the initial phases of the GIE as soon as possible. The need to bring substantive relief to the more than 50% unemployment levels in Gaza is no less essential than the symbolic importance of providing what various PA spokesmen have described as a "sign of hope" for the Palestinian people. For these reasons, this EA process is being conducted on a "fast-track" basis. This draft EA was prepared over a three-week period in late October and early November 1996.

The GIE will be owned by the Palestinian Development & Investment Corporation (PADICO), a private venture. Given the risks and uncertainties of the political and business climate, analyses by the World Bank have shown that outside funding will be necessary for this initial industrial estate to succeed (Ref. 3). The description and analyses in this EA are based on several conceptual plans prepared by consultants to USAID and the World Bank (Refs. 9, 10, and 11) and on on-site observations, meetings, and discussions conducted by the EA team while in the Gaza Strip between October 21 and November 7.

Following this introduction, Chapter 2 of this EA describes the legal, regulatory, and institutional framework associated with this project including the roles and relationships of the various agencies within the newly formed PA.

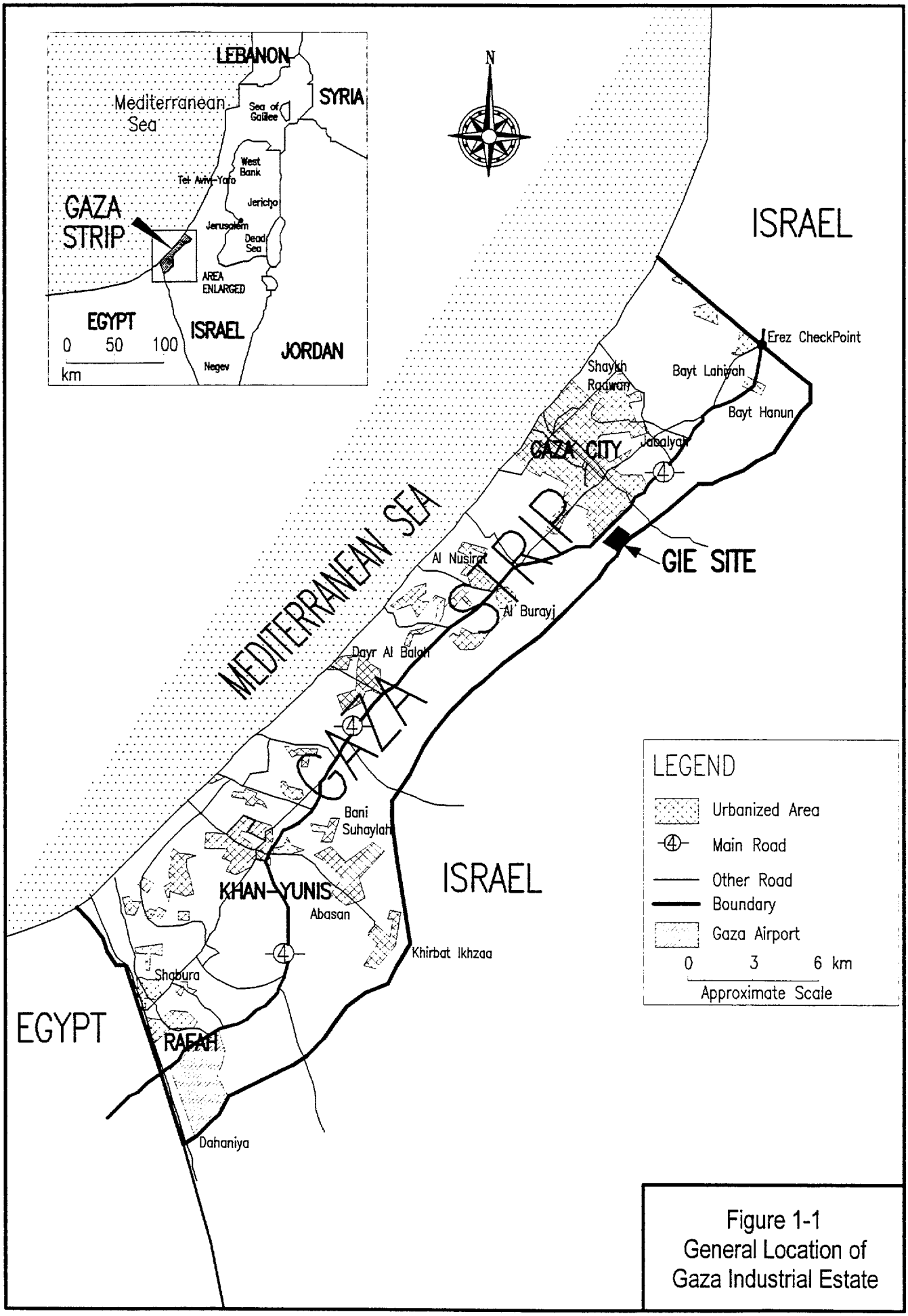

Figure 1-1
General Location of
Gaza Industrial Estate

Chapter 3 describes in general the site location and the proposed project followed by specific discussions on the various components of the off-site infrastructure that would be funded under the proposed action.

The existing environment—regionally and at the site—is described in Chapter 4. The following environmental areas are included: climate, ecology, land use, air quality, noise, energy supplies, hydrology and water availability, water quality, solid and hazardous waste management, archaeological and historical resources, and socioeconomic conditions.

Chapter 5 describes how these environmental areas and the environmental issues raised during the scoping process would be affected by the proposed action and the various alternatives to the proposed action. This section is the core of the analysis. It describes impacts, distinguishing between short-term and long-term, positive and negative, and significant and minor. It identifies and compares the impacts of the various alternatives associated with the infrastructural components. Mitigation measures are identified. (A mitigation measure is a means of reducing, avoiding, or compensating for the identified impact.) This section also identifies unresolved issues associated with the project and suggests environmentally preferable means of resolving them.

Chapter 6 consolidates the recommended mitigation measures associated with the various project alternatives and provides a general monitoring plan for ensuring that the mitigation is accomplished and the unresolved issues are resolved.

Appendices are included to present the references used, scoping session results, and other pertinent information.

1.2 Purpose and Need for the Proposed Action

The proposed action is for USAID, the World Bank, and possibly other donors to provide funding for the construction and possible initial operation of various off-site infrastructural elements. It is important to note that the term "off-site infrastructure" is defined as a specific set of ancillary facilities that would be outside the funding scope of the private developers, PADICO. The off-site infrastructure elements may or may not be outside the GIE property (some will be both). These off-site elements include roads, electric power supply, storm water management, wastewater treatment facilities, water supply facilities, solid waste disposal facilities, and telecommunications facilities.

The general purpose of the proposed action is to promote economic development with an emphasis on employment. The GIE will employ more than 20,000 persons when it reaches its full industrial build-out. The GIE will be the first of several such industrial estates that will provide employment and economic growth. As noted earlier, the need is urgent both from the perspective of providing economic relief and as a tangible sign that there will be benefits emerging from the peace process that will affect the everyday lives of the Palestinian people.

The Gaza Strip has a rapidly growing population approaching one million persons. More than two-thirds of these residents are refugees (and their descendants) from the first Arab-Israeli war in 1948 (Ref. 36, p.34). The Ministry of Industry (MOI) estimates unemployment in excess of 50% (Ref. 44). Many of those who do have work must travel to Israel for low-wage jobs in the construction, service, and other sectors. When the Gaza-Israel border (referred to as the Green

Line) is closed, as a result of threatened or actual disturbances, these jobs can be interrupted for long periods of time.

The peace process has been threatened by elements on both sides that are opposed to accords. Construction of the GIE will support the PA's efforts to reduce unrest among the people. This unrest is attributed, in large part, to frustrations by the people regarding the pace of economic progress that has been promised as an outgrowth of the peace process.

2 LEGAL, REGULATORY, AND INSTITUTIONAL FRAMEWORK

This section on the legal, regulatory, and institutional framework discusses the establishment, operation, and management of industrial estates in Gaza and the West Bank; the framework for environmental policy, regulation, monitoring, and enforcement; and the framework for provision and management of off-site infrastructure services for the GIE.

2.1 Legal Framework

In accordance with the Declaration of Principles signed in September 1993, the PA has limited self-government over the Gaza Strip. The PA was established as a working entity in 1994. The first elections leading to a functioning Palestinian Council took place in February 1996. The process of establishing a set of laws for Palestinian governance of the Gaza Strip and the West Bank has barely begun. The most important laws relating to industrial estates and environmental protection have not yet been enacted.

2.1.1 Laws Regarding Industrial Estates

The current industrial estate is being developed by PADICO under an agreement with the PA referred to as the lease agreement. By this agreement, the PA set aside 485,000 dunums to be leased and developed by PADICO for the establishment of an industrial estate. PADICO agreed to construct and operate the estate including provision of all on-site services for the firms locating in the estate. According to the agreement, MOI is responsible for providing certain infrastructure services to the site (off-site infrastructure) including water, wastewater disposal, electrical power, external roads, and telecommunications lines (Ref. 36). This lease agreement document was signed with a good faith understanding that many of the legal, regulatory, and technical details would be resolved as the developer began developing the GIE site. As of November 1, 1996, this was the only legally binding document between the PA and the developer.

However, the legal framework for the creation of industrial estates and service zones is currently being developed by the Interministerial Committee on Industrial Estates with the help of consultants. When this law is enacted, it will establish the legal framework for management and operation of industrial estates. The member organizations and advisors for the Interministerial Committee are as follows:

- Ministry of Industry (MOI)
  - Ministry of Planning and International Cooperation (MOPIC)
  - Ministry of Public Works (MPW)
  - Ministry of Housing (MOH)
  - Palestinian Water Authority (PWA)
  - Palestinian Electric Authority (PEA)
  - Invited consultants
  - Dr. Amin Haddad - PADICO
  - Alla' Showa - Development Resource Center
  - Dr. Akram Karmoul

Draft legislation (Ref. 39) has been prepared (draft 4, 10/8/96) and is being reviewed. The legislation will formally create the Palestinian Industrial Estate and Service Zone Authority (PIESZA) as an autonomous agency. As currently proposed, PIESZA will have 12 members, one of whom will represent the appropriate environmental authority. One member will represent the unions; another the Palestinian Chamber of Commerce; two the developers of industrial estates; and two others the tenant firms within the estates.

The draft legislation setting up PIESZA addresses issues such as types and location of zones; companies and exporters allowed to operate within these zones; permitting procedures; tax status and incentives for companies within these zones; and developer and PIESZA responsibilities for on- and off-site infrastructure, as well as PIESZA board composition and the administrative and legal responsibilities of PIESZA. The current draft is largely silent on issues related to the environment. The permitting process does require companies to describe the industrial processes that will be used and all types and quantities of waste that will be generated. It also stipulates that industrial wastes must comply with local mandates, rulings, and criteria. However, it does not require any description of hazardous or toxic materials to be used as raw materials; how they will be used and stored; or how worker safety will be assured. It does not require any estimate of the volume of water that will be needed by the company for industrial purposes, the energy requirements, or vehicle traffic. Although the draft legislation indicates that no existing laws should be violated, no national or local environmental legislation has yet been enacted.

2.1.2 Environmental Control in the Gaza Strip

To date, no environmental laws have been formally approved by the Palestinian Council and adopted by the PA. However, the Environmental Planning Directorate (EPD) of MOPIC has taken the lead in planning environmental safeguards. An emergency environmental protection plan was developed in July 1995. Emergency structural plans were developed for water, wastewater, and stormwater management in that same period also. These plans have not been formally approved, but most development projects, including the GIE project, are referring to these plans for environmental issues. Although no statute for environmental protection has been enacted, there is a proposed Palestinian law for the "Protection of the Environment." The proposed law covers such items as the following:

- Environmental impact assessment
- Environmental auditing
- Facilities licensing, monitoring, inspection, and enforcement
- Water and air quality protection
- Prevention and abatement of noise pollution
- Management of hazardous waste and hazardous substances
- Emergency preparedness and response
- Management of solid waste
- Management of domestic and municipal sewage
- Protection of the marine environment
- Public participation in the regulatory process, information access
- Redress of environmental nuisances
- Research, training, and public education

Until this or other legislation has been passed, there is no legal authority needed to draft environmental regulations, or monitor and enforce any environmental standards. At present, the only legislation regarding the environment that can be enforced is that which has been written into international agreements with the PA. The Agreement on the Gaza Strip and the Jericho Area (Cairo, May 4, 1994) known as the "Cairo Agreements" contains an annex (Annex II, Article 1) that requires the adoption of laws and regulations related to environmental issues such as air, water, and sea pollution; treatment of solid and liquid wastes; and use and handling of hazardous substances including pesticides and insecticides, which could have transboundary effects. The "Washington Agreements" signed in September 1995 as part of the peace process provide more details regarding the obligations of both the PA and the Israeli Government. However, these agreements provide only policy and broad guidelines regarding the handling of environmental matters.

On a more limited scope, other PA agreements may also contain environmental provisions. For example, international lending agencies may stipulate certain conditions for loan approval and disbursement. Once the PA signs these agreements, they should have the force of law (Ref. 42). These conditions may include adherence to specifically recommended international standards for water quality, sewage effluent, and management of hazardous substances for project activities. To date, no known agreements directly address environmental issues related to the GIE.

In the absence of a legal basis for creating, monitoring, and enforcing environmental standards, no standards have been formally approved and adopted. In addition, no agency within the PA has been formally given the responsibility to develop, monitor, or enforce any standards that may exist as part of international agreements. Discussions with EPD suggest that until regulations are in place, activities should abide by international standards such as World Health Organization (WHO) standards.

2.2 Institutional Arrangements Related to the GIE

The GIE is to be a privately financed and developed industrial estate. It will provide factory locations and site services for a variety of private sector tenants. Off-site services including roads, electrical power, telecommunications service, water supply, wastewater treatment, and stormwater control will be provided or coordinated by the PA through its ministries and agencies. At present, the Off-Site Infrastructure Group is coordinating the provision of off-site services. The group is chaired by MOI, and members represent interested ministries and agencies as well as the private site developer, PADICO. Although eventually PIESZA would regulate the industrial estate, the GIE is being developed in the absence of regulations and will serve as a model for as many as eight future industrial estates in the West Bank and Gaza Strip. The details of management of off-site infrastructure services for the industrial estates is not clearly stated in the draft PIESZA legislation. Discussions on how and who will operate and maintain off-site service equipment remains uncertain. A brief discussion of the current role of each agency is provided in the following paragraphs. Given that the PA is in the first stages of fully defining the roles of each of its ministries and agencies, changes of responsibility, jurisdiction, and authority are likely to take place as the GIE project is implemented.

2.2.1 Ministry of Industry (MOI)

MOI has taken the lead role for the PA in developing plans for the GIE. It currently chairs the Off-Site Infrastructure Group and the Interministerial Committee, which has focused its efforts on establishing the GIE and developing a legal framework for managing and operating industrial estates and service zones in Gaza and the West Bank. The committee's primary focus is employment creation.

2.2.2 Palestine Development & Investment Corporation (PADICO)

PADICO is a private business that was established in 1993 to create investment opportunities and channel these investments into the Gaza Strip and the West Bank. PADICO and its affiliates provide services in areas such as tourism, real estate, housing, and industrial investments. The company is the developer of the GIE and will construct all on-site infrastructure that will interface with the off-site infrastructure. PADICO also participates as a member of the Off-Site Infrastructure Group and as an advisor on the Interministerial Committee that is working on the draft legal framework for establishing PIESZA.

2.2.3 Ministry of Planning and International Cooperation (MOPIC)

MOPIC is composed of two divisions. Only the planning division has any role in the planning and management of the GIE. Both EPD and the Rural and Urban Planning Directorate (RUPD) within the Planning Division have roles related to the GIE. The Director General of the Planning Division is a member of the Interministerial Committee reviewing nontechnical issues related to the GIE.

EPD has been tasked with environmental planning within the Gaza Strip. Much of the work of the past several years has been in completing baseline studies of environmental conditions within Gaza. EPD works closely with other ministries and agencies and with the donor community in coordinating a number of important environmental initiatives. It now appears that EPD will act in the future as a monitoring, regulatory, and enforcement body, but as indicated above, the legislation clearly defining these roles and the resources necessary to carry them out is lacking. Specific issues regarding jurisdiction, monitoring of environmental laws and regulations, and enforcement have yet to be resolved. EPD coordinates with other ministries and agencies on environmental issues. Most notably, EPD works with the Environmental Department of the Ministry of Agriculture; the Environmental Health Department of the Ministry of Health and several municipalities within the Gaza Strip; and appropriate departments within PWA, MOH, and MOI.

RUPD is responsible for broad physical planning within the Gaza Strip. RUPD was consulted in the GIE site selection process.

2.2.4 Other Agencies with Responsibilities Related to Off-Site Infrastructure

A number of other PA agencies have participated in the development of the GIE. Several of these have key roles related to planning, construction, and/or operation and maintenance of off-site infrastructure. These agencies and their roles are described in the following subsections.

- *Ministry of Public Works (MPW)*
  MPW is responsible for all public works within the Gaza Strip. Its major role in the GIE project relates to roads and traffic planning. MPW will be responsible for planning and building new roads and upgrading existing roads related to the GIE off-site infrastructure. MPW has the equipment and expertise for planning, building, and maintaining roads. It also oversees roads-related projects that are financed and constructed by other agencies and international donors. It appears that once off-site road construction is complete, MPW will be responsible for maintaining these roads and their rights-of-way.

- *Palestinian Water Authority (PWA)*
  PWA has been created as a planning and regulatory body for managing the water resources and wastewater treatment within the West Bank and Gaza Strip. It is not now, nor will it be, an implementing agency. Currently water supply systems and wastewater treatment facilities (to the degree that they exist) within the Gaza Strip are managed by technical departments within the local councils. Future plans call for the creation of autonomous private sector water supply and sewerage agencies to take on these roles on a fee-for-service basis. PWA has been integrally involved with the planning of the GIE as it relates to water pumping and use. Once the off-site infrastructure is complete, PWA plans to monitor water pumping rates to ensure that the limits agreed upon are adhered to. PWA will not operate and maintain the water and wastewater systems supplying these services to the GIE, but it is not yet clear who will.

- *Palestinian Electric Authority (PEA)*
  PEA has responsibility for managing electrical power distribution and use within the Gaza Strip. It is the lead agency focusing on provision of electrical power for the GIE. At this stage, PEA has agreed to provide power to the site and will, if asked, construct all electrical lines and appurtenances related to the electrical off-site infrastructure. If contractors are employed to construct these lines, PEA will have inspection and approval responsibility to ensure that work is properly completed. PEA also appears to be ready to install, operate, and maintain any electrical power generation facilities associated with the GIE.

- *Ministry of Post and Telecommunications (MPT)*
  MPT is responsible for operating and maintaining the telecommunications network within Gaza. MPT will be responsible for establishing and maintaining a reliable link from the GIE site to the Gaza Central Exchange. At this stage, MPT has agreed to connect cables to the site.

- *Municipality of Gaza*
  The GIE falls outside the present boundaries of the Municipality of Gaza. However, the municipality may provide certain services related to the GIE, particularly those related to solid waste disposal. The municipality operates a landfill site just south of the GIE site and is now establishing a hazardous waste repository. A verbal agreement exists that the municipality will collect and dispose of solid wastes from the GIE site.

  The Municipality of Gaza may also play a role in facilitating the interim phase of the project, which has been planned to provide water and wastewater services for the first tenants of the GIE prior to the completion of the off-site infrastructure. The municipality has agreed to provide water to the site and to accept untreated wastewater into the municipal system on a temporary basis.

2.3 Management of Off-Site Services

The agreement signed by MOI and PADICO outlines the responsibilities of both parties for the GIE. It stipulates that MOI is committed to provide certain infrastructure services such as water, wastewater disposal, standby electricity generation, external access roads, and telecommunications services to the site and that PADICO, the site developer, will pay for these services. However, it is not clear, in all cases, who will operate and maintain equipment to provide these services. For example, current plans call for brackish water to be pumped to storage for industrial use with some portion treated using a reverse osmosis process for meeting potable water needs. MOI has not made it clear what agency or entity will operate and maintain the pumps or who will operate and maintain the reverse osmosis plant. As indicated above, PWA is not an implementing agency and does not have the capacity to fulfill this function. The GIE lies outside municipal boundaries so the municipality has no obligation to operate the water supply facilities. MOI may choose to develop the capacity to support provision of off-site services within the ministry or contract with the firms in the private sector to provide services, paying for these services through fees collected from PADICO.

The draft legal framework for the establishment of PIESZA is also silent regarding the management of off-site services. However, as constituted, it does not appear that PIESZA will have the capability to manage provision of off-site services. Although there has been discussion of these off-site service management issues, they remain to be fully resolved.

2.4 Israeli Institutions Concerned with the GIE

The GIE is located adjacent to the "green line" or boundary with Israel. For this reason, and because the Israelis provide all of the electrical power and some of the fresh water to Gaza, this section discusses potential Israeli involvement in the GIE related to transboundary concerns and power and water provisions.

2.4.1 Transboundary Concerns

As discussed earlier in this section, the Cairo and Washington peace accords both address environmental obligations for the PA and the Israelis. Generally, the accords stress the importance of minimizing transboundary environmental impacts and the need for consultation between the PA and Israel when these issues arise. USAID has been handling the communication with the Israelis with regard to the GIE. The conduit for communication within the Israeli government has been Mr. Shmoul Kantor of the Mekorot Water Co. Ltd, the chief supplier of water within Israel. USAID staff invited the Israelis to the scoping meeting conducted on October 28. Although they did not attend, Mr.Kantor sent a memorandum (Ref. 41) to John Starnes of USAID on October 27, with the following Israeli comments related to transboundary issues:

- Regarding the use of chlorine for the wastewater treatment plant, chlorine should be handled according to Israeli regulations.
- Whether or not the 100-meter-wide security zone on the Gaza side of the green line can be used for the stormwater or other impoundments has not been resolved. Mr. Kantor has referred the resolution of this issue to Mr. Hillel Adiri of the Ministry of Agriculture.
- The Israeli standards for treated wastewater reuse will be submitted to USAID. The Israelis' concern relates to odors. If odors are likely, this issue needs to be addressed with Israeli environmental institutions.
- The drainage from the GIE site flows toward the green line and Israel. Israel is concerned about stormwater controls at the site to avoid problems on the Israeli side.

2.4.2 Provision of Water and Power

The Israeli Mekorot Water Corporation is committed to providing five million cubic meters of water per year to Gaza under the terms of the peace accords. The Israeli Electric Corporation provides bulk power to Gaza through 11 feeder lines.

2.4.3 Israeli Government Environmental Agencies

The Israeli Ministry of Environment has overall jurisdiction for environmental planning and enforcement.

2.5 Other International Donor Support to the GIE

Other donors have made commitments or have expressed interest in the GIE project. The World Bank is committed to collaborating with USAID to support the provision of off-site services. The International Finance Corporation (IFC) and the European Investment Bank (EIB) have expressed interest in participating as investors in the project. As clearly as can be determined, no firm commitments have been made by the IFC or the EIB. However, the World Bank's commitment is firm, even if the financing requirements are not yet clear (Ref. 42). The World Bank expects to support the later phases of off-site infrastructure development and required supporting activities. This may include technical assistance, training, and equipment to support certain mitigation measures and environmental monitoring, auditing, and compliance to ensure the proper management and operation of the GIE facility (Ref. 42).

3 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

This chapter presents an overview of the proposed GIE project and a site description. It also summarizes the proposed actions and alternatives that have been described in previous studies for the development of the off-site infrastructure (Refs. 7, 8, and 9). Specifically, the off-site infrastructure components discussed include roads, electricity, stormwater management, wastewater treatment, water supply, solid waste disposal, and telecommunications. The environmental evaluation and comparison of alternatives are provided in Chapter 5.

3.1 Project Overview

USAID West Bank and Gaza is proposing to support the generation of new jobs in the Gaza Strip by assisting in the provision of off-site infrastructure to serve the proposed GIE. The GIE will provide technical assistance and design services related to the off-site infrastructure (access roads, water supply, wastewater treatment, storm drainage, electrical service, telecommunications service, and solid waste disposal). It is important to note that the term "off-site infrastructure" is defined as the specific set of ancillary facilities that would be outside the funding scope of the private developer, PADICO. The off-site infrastructure may or may not be outside of the GIE property (some facilities will be both).

A portion of the off-site infrastructure (up to US$6 million) would be constructed under the USAID-financed project with the remainder of the construction to be financed by the World Bank and, possibly, other donors.

The GIE project and other future industrial estate and service zone projects are the result of the PA commitment to induce economic growth and to attract local, regional, and international investors. The development of the GIE is expected to create more than 20,000 jobs in 250 tenant firms by the time the estate is completed. Plans for the development of the estate were initiated in an agreement between the PA, who is represented by MOI, and PADICO.

PADICO was established in 1993 to create investment opportunities and channel these investments into the Gaza Strip and the West Bank. PADICO and its affiliates provide services in areas such as tourism, real estate, housing, and industrial investments.

PADICO's development plans for the site show that 70% of the site will be industrial and 30% will be roads and offices. The built-up area will represent 80% of the site area. A three-phase approach is planned for the implementation of the project. Phase I will provide approximately 60% of the total required infrastructure and 25% of the built-up area. An additional 20% of the infrastructure and 25% of the built-up area are planned for Phase II. The final phase will culminate with the completion of the last 20% of the infrastructure and the remaining 50% of the built-up area. As shown in Table 3-1, a mix of industries is planned for the

GIE. However, the specific type of industry within the broad categories shown in Table 3-1 has not yet been established. Areas on the site have already been allocated to small, medium, and large factories; administration and public service buildings; special functions; utilities connections; and open areas.

As a result of social and political pressures to provide immediate employment, an interim phase (considered to be part of Phase I) has been planned by PADICO for completion by the end of January 1997. This interim phase will include installation of a fence; construction of several standard factory buildings; construction of an administration building; and the development of several infrastructure components. PADICO representatives stated that several tenants have signed letters of intent to move to the site as soon as space is made available. USAID will not fund any of the interim phase activities. Nevertheless, the EA briefly addresses impacts associated with the interim phase and includes a discussion of these impacts in Appendix H.

Table 3-1
PROJECTED INDUSTRY MIX AT THE GAZA INDUSTRIAL ESTATE

Types of Industry	PHASE I		FINAL PHASE	
	% Space	Area	% Space	Area
Garments, Textiles	40	18,200	40	129,000
Consumer Industries	15	7,200	15	48,600
Electric Appliances	13	6,240	13	42,120
Shoes, Leather	10	4,800	10	32,400
Data Processing	5	2,400	5	16,200
Automotive Parts	5	2,400	5	16,200
Agro-Industries	5	2,400	5	16,200
Hardware	3	1,440	3	9,720
Pharmaceuticals	2	960	2	6,480
Jewelry	2	960	2	6,480
Total	**100%**	**48,000**	**100%**	**324,000**

3.2 Site Description

As shown in Figure 3-1, the GIE site is situated approximately 5 km south of the center of Gaza City; 25 km north of the new Gaza airport; and 5 km east of the proposed Gaza seaport. The GIE is located immediately off Highway 4 along the eastern edge of the Gaza Strip. El-Montar road connects with Highway 4 and runs along the southeastern side of the site. A road leading to the town of Netzarim starts at the El-Montar entry point and runs along the west side of the GIE approximately 75 m from the site boundary. The GIE site area is known locally as the Old Matar

(airport) land. The location of the site relative to its immediate surroundings is shown in Figure 3-2.

During the British mandate, the GIE site was the location of a small airport. The existing back-to-back goods exchange area, which is currently covered by a metal roof, was used as a runway. After the end of the British mandate in 1948, the runway and hangars were used by the United Nations Refugee Works Agency. The area was also used by Egypt in the late 1960s. The land is currently used as a back-to-back goods exchange, and it is the only area in Gaza where goods are exchanged at the border.

The surface area of the GIE site is 485 dunums (485,000 m^2). The PA owns the entire GIE site. It is vacant and cleared. The land immediately north and east of the GIE is privately owned. Land on the west and south side of the GIE is public. The GIE is located in a farmland and rural area. The topography of the site area is relatively flat sloping gently from the northwest to the southwest. The average elevation is about 65 m above mean sea level.

The site was selected by the PA and MOI based on several factors. A study was conducted under the "emergency resource protection plan" to delineate areas within the Gaza Strip that should not be used for industrial activities if sensitive receptors existed nearby or contamination of groundwater could occur. The GIE site was selected to avoid these areas. Further, the site is adjacent to the major border crossing for shipping goods between Israel and the Gaza Strip (the back-to-back exchange). It is therefore accessible to both Gaza and Israeli markets. Finally, since the site is owned by public authorities, ownership issues can be avoided.

3.3 Off-Site Infrastructure Components, Plans, and Alternatives

The PA and MOI, as part of their agreement with PADICO, have agreed to provide the necessary off-site infrastructure to meet the requirements of the industrial estate for the three-phase program (Ref. 37). PADICO will develop all on-site infrastructure such as on-site roads, buildings, water distribution systems, and wastewater collection systems. There is general agreement about the elements of the infrastructure components that will be constructed by PADICO and the responsibilities of the MOI and other PA agencies.

As noted earlier, in some cases, specific siting of the off-site infrastructure and on-site infrastructure has not been made. The MOI has appealed to USAID, the World Bank, and others to assist in the development of the off-site infrastructure in order to move the GIE project forward and provide employment and trade opportunities to the Gaza Strip in the immediate future.

The off-site infrastructure components discussed in the following sections include vehicular access; electrical power; stormwater management; water supply; wastewater treatment and effluent disposal; solid waste disposal; and telecommunications. The proposed action as well as alternatives considered in the conceptual plan for off-site infrastructure are presented. Brief summaries of key elements of each action and the alternatives are also included.

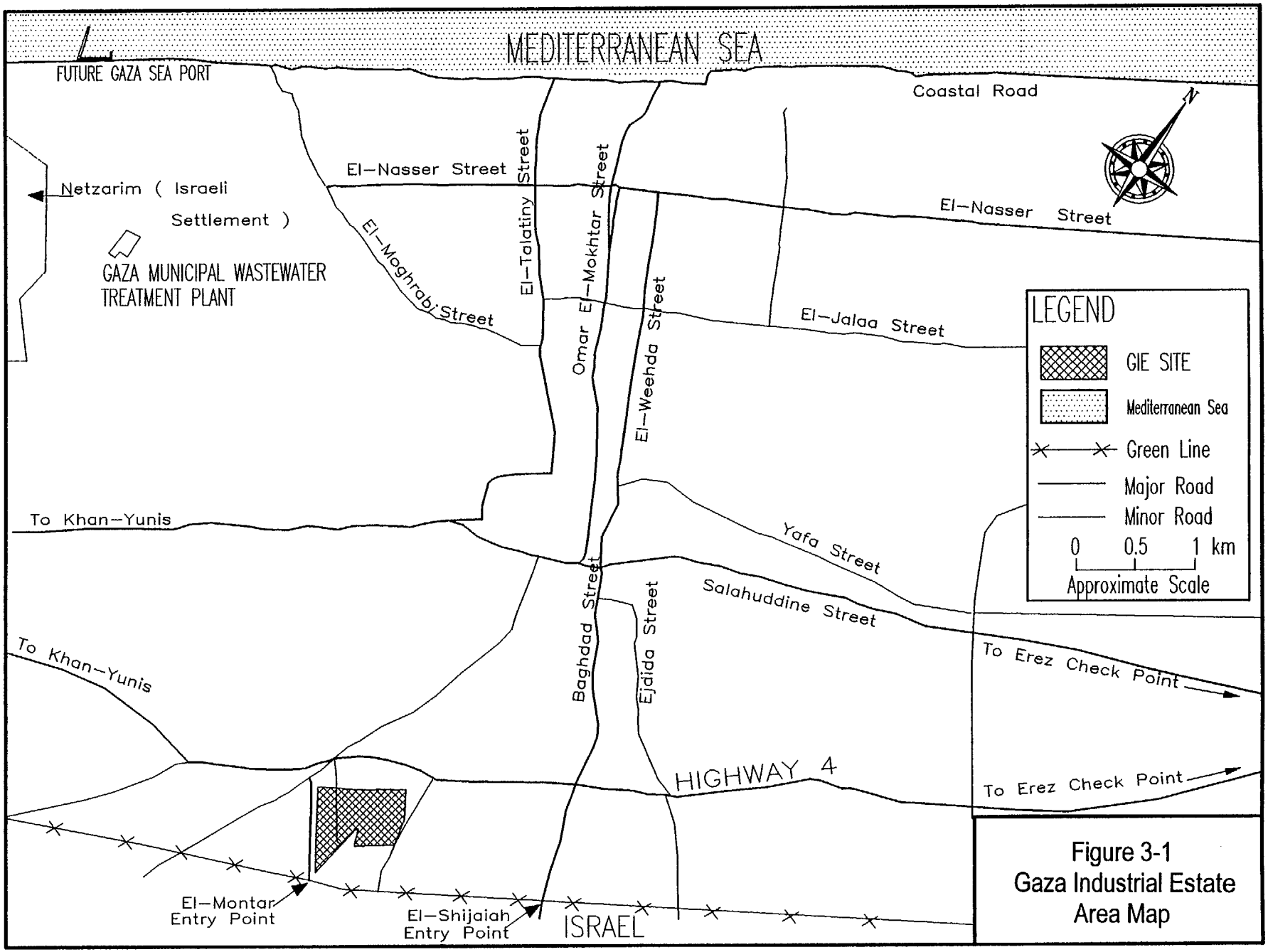

Figure 3-1
Gaza Industrial Estate
Area Map

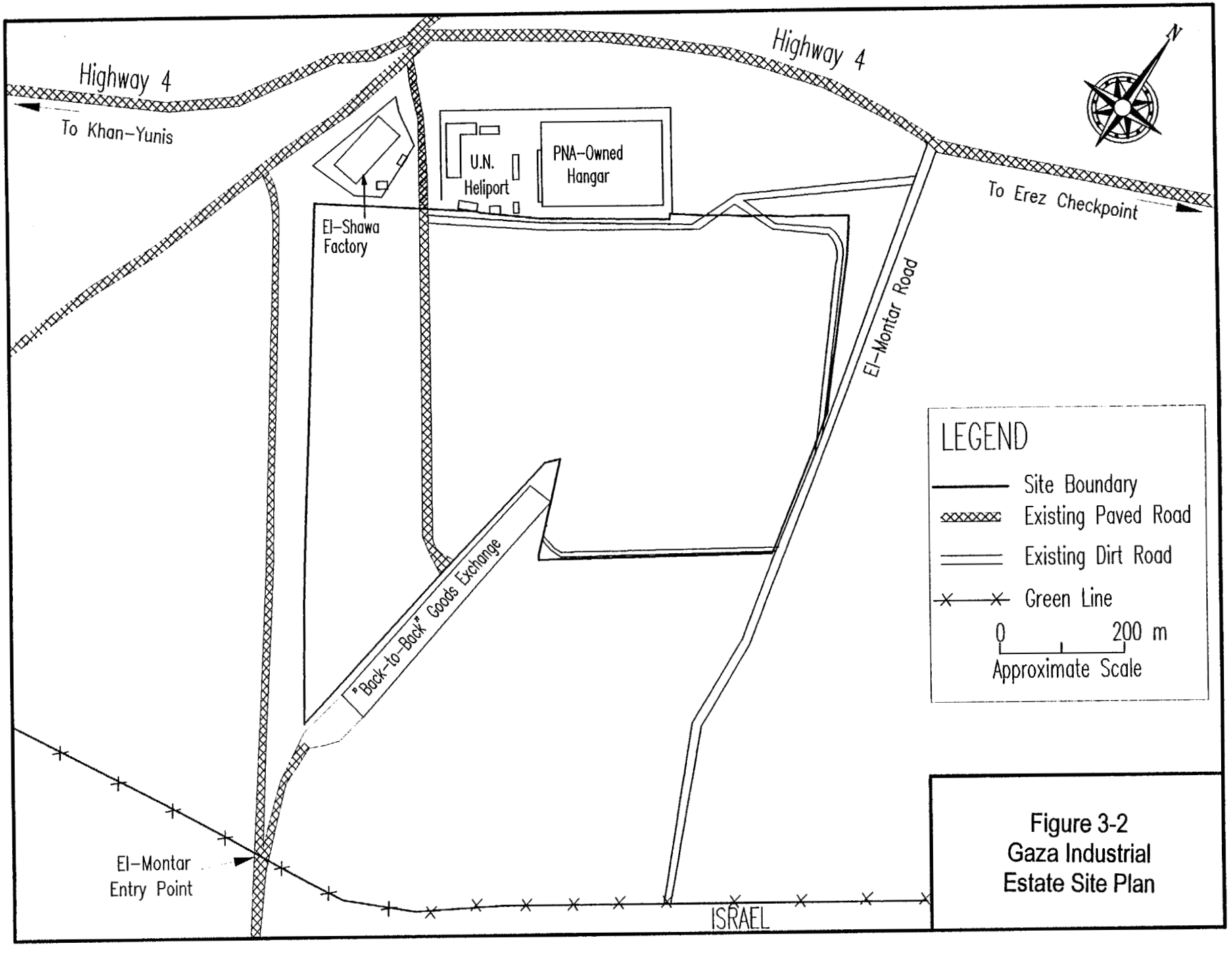

Figure 3-2
Gaza Industrial Estate Site Plan

3.3.1 Proposed Vehicular Access and Alternatives

Highway 4 is currently subjected to high traffic load, primarily because of the location of the current back-to-back goods exchange facility at El-Montar. At present, according to a survey conducted by MOPIC, approximately 3,440 vehicles per day use this highway, which is linked to Gaza City by a number of roads leading to the west side of the city.

Currently, the only access to the GIE area is an existing 6 m-wide paved road that is 500 m long. The access road stretches from Highway 4 to the entrance to the site. The access road connects into an on-site paved road, which crosses the proposed GIE area and terminates at the back-to-back goods exchange facility. At present, because of the closure of the Gaza Strip, it is estimated that only 100 trucks per day use this access road to the facilities. Once the GIE is constructed and fully developed, approximately 7,000 trucks are expected to use Highway 4 and the access road to the GIE (Ref. 11).

The different options described below are to accommodate the expected heavy traffic. These options are shown in Figure 3-3. The construction of on-site internal roads are outside the scope of the EA and are the responsibility of PADICO. However, the assessment will consider points of intersection and connection between on-site and off-site access.

Option 1: Road on the Southern Side of GIE

The existing access road that extends from Highway 4 to the entrance of the GIE will be upgraded with 0.1 m of bituminous overlay. Two sidewalks will be added on the side of the road and will each be 2 m wide. A central median will be provided with street illumination poles. Stormwater drainage will be installed under the sidewalks for rainwater discharge. Cars and buses will enter the site through a gate located at the entrance to the GIE.

The second section of the road is a dirt road. It starts at the access road before the GIE entrance and turns at about a 90-degree angle toward the south for a distance of 171 m along the western boundary. The road then turns at a 90-degree angle in a southeastern direction for 606 m along the south boundary until it reaches the end of the south boundary of the site. The road turns 90 degrees towards the northeast, stretches 204 m, and ends at the back-to-back goods exchange facility. This road will be used by trucks that are going to the exchange facility only. The GIE trucks will be admitted at the main gate.

Option 2: Road on the Eastern Side of GIE

The existing access road extending from Highway 4 to the entrance to the GIE will be used. Trucks will enter at the western entrance then travel on the existing dirt road for 697 m toward the north. The road turns at a 90-degree angle and stretches to the east for about 357 m. It then deviates slightly to the south for 159 m and turns sharply southward for about 411 m to enter the exchange facility.

Option 3: Road on the Northern Side of GIE

The access road follows the northern boundary of the GIE in a southern direction. Trucks for both GIE and the exchange facility would exit Highway 4 about 1 km north of the intersection of the highway with the existing access road. The trucks would then follow an existing road that

stretches about 250 meters between private houses and small industrial plants. The road then follows the same route described in Option 2 above on the northern side of the property until it reaches the back-to-back goods exchange facility. This road is for trucks entering the property from the northern side and for trucks bound for the exchange facility.

Option 4 (Proposed Action): Road on Northern Side of GIE and Extension of El-Montar Street

This option is the proposed action and is the same as option 3 except that the access road starts at the extension of El-Montar Street and continues toward the east in a straight line passing through private property of farm land until it joins the northern side of GIE. It continues east for a distance of 704 m. The road then turns southeast for 411 m and enters the exchange facility. A comparison of the four alternatives is provided in Table 3-2.

Table 3-2
Technical Comparison of Road Alternatives

Item	Option 1	Option 2	Option 3	Option 4 (Proposed Action)
Existing Street Length	215 m	215 m	250 m	250 m
Total Length	974 m	1,532 m	1,198 m	1,096 m
Street Width	16 m	16 m	16 m	16 m
Access Road Width	7 m	7 m	7 m	7 m
Cost of phase I (US$)	372,227	583,795	463,002	591,770
Cost of phase III (US$)	NA	NA	NA	668,493

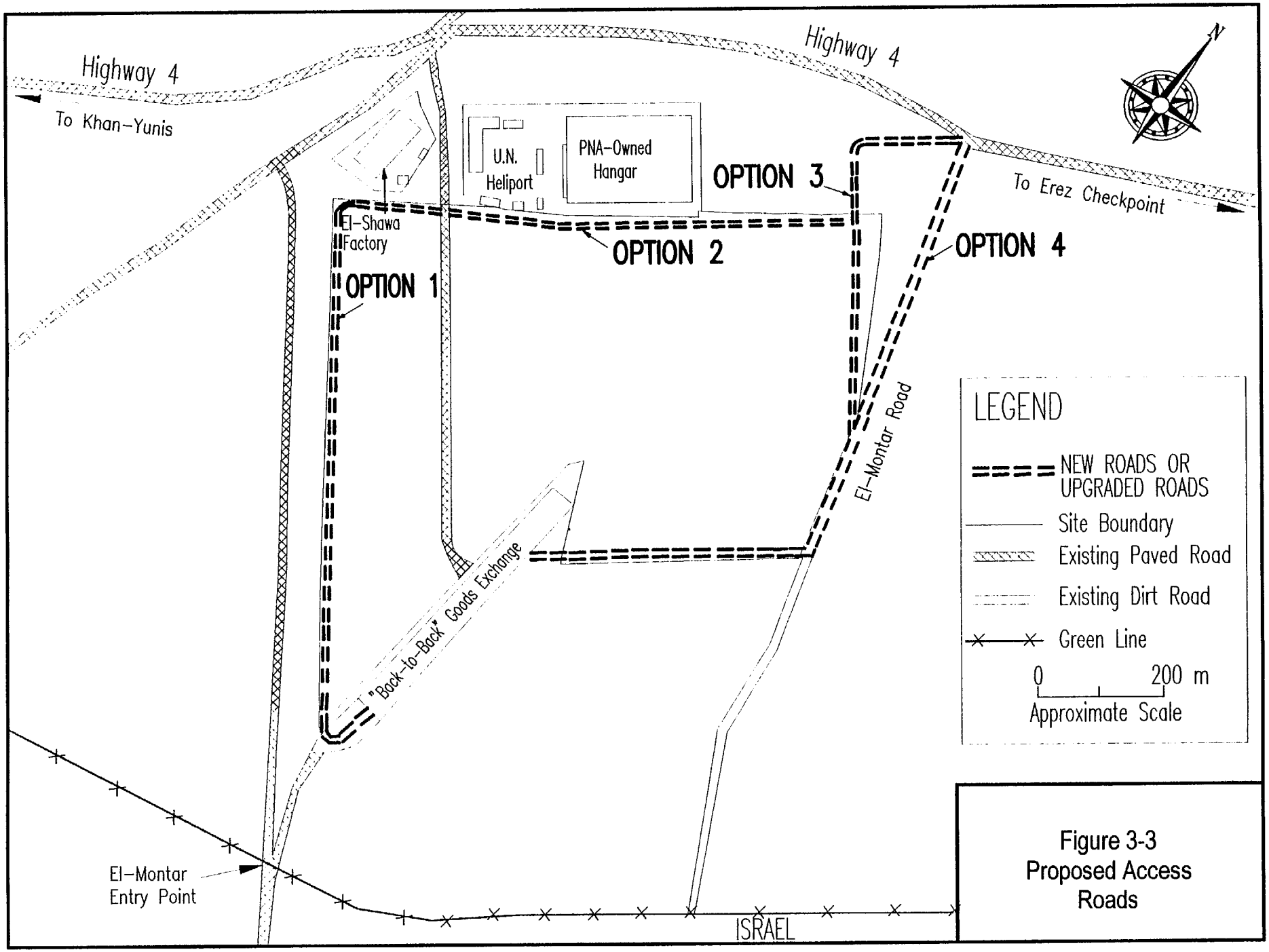

Figure 3-3
Proposed Access
Roads

3.3.2 Proposed Electrical Energy Provision and Alternatives

The power requirements for the GIE have been estimated at 3 megawatts (MW) during Phase I and 21 MW for Phase III, when the site will be fully developed (Ref. 11). These estimates were based on an assumed mix of industrial tenants within the 250-site estate as well as the demands for the provision of services such as the water and wastewater treatment plants and security lighting. The options considered for meeting these requirements take into account the current loading and demand forecasts for the existing power lines in reasonable proximity to the site; the desire for reduced energy dependence on Israeli generating capacity; the likelihood that new generating capacity will be established within the Gaza Strip; and the need for reliable standby power for periods of unpredictable electricity power outage. Although Line 6 passes closest to the GIE site, providing power from this line was not considered as it is already very heavily loaded and the PEA considered alternatives to reduce the load on this line to be unreasonably complicated. Therefore, the options considered include a Phase I element (which includes provision for diesel standby power[1]) and a Phase III element to provide for the ultimate needs of the estate. The options for the off-site electrical power plan are shown in Figure 3-4. The on-site plan is illustrated in Figure 3-5.

Although the EA will not consider the details of on-site power distribution, it will discuss certain measures, such as energy conservation, which may have off-site impacts on the environment. An assessment of the impacts of large-scale off-site power generation are beyond the scope of this assessment and will not be dealt with in this report.

Phase I - Proposed Alternative: Overhead Utility Power with Standby Generation

The PEA would provide 3 MW of power by extending two feeder lines from Israeli Electric Company (IEC) sources (feeder lines 4 and 5) near the intersection of these feeder lines and Highway 4 (see Figure 3-5). Overhead transmission lines (22 kv) would be constructed from these locations along the current road right-of-way to the boundary of the GIE. One line would begin at the intersection of Line 4 with Highway 4 and would be joined by a second line, which would begin at the intersection of Line 5, Highway 4. The distance from the Line 4, Highway 4 intersection to the entry gate of the GIE is approximately 4.5 km. The distance from the Line 5, Route 4 intersection to the GIE entry gate is approximately 2.3 km. From this point, the two lines would be buried as they traverse the GIE property to the switch gear installed within the utility area at the southeast corner of the property.

A line sufficient to carry the load requirements for the full build-out of the site would be buried along with the incoming lines to minimize disruption when Phase III is implemented.

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[1] Although all reference to the proposed diesel generator set is as a standby unit, the analysis included in Ref. 11 is based on operation for 10 hours a day. This suggests that the diesel generator set should more appropriately be described as providing for the intermediate and peak power requirements of the GIE. To be consistent, this report will continue to refer to the generator set as a standby unit.

Power from the switch gear in the utility would be conveyed through a network of buried cables to roughly five transformers spread throughout the first phase build-out area of the GIE.

Standby power is to be provided by a 2.2 MW standby diesel generator with lines connected to the switch gear located within the utilities complex. Fuel storage for three days (estimated) of 15 m^3 is also proposed, either underground or in a ground-level tank. A site for this standby generator and its associated fuel storage that would be acceptable to the PEA and PADICO has not yet been identified. A site of about 250 m^2 will be required. Fuel would be either trucked or piped to the site from the fuel distribution point about 4 km north of the GIE site.

Phase I - Option 2: Buried Utility Power with Standby Generation

This option is the same as option 1 except that the overhead lines along Highway 4 and along the site access road would be buried. The connection points and routing for the power lines would remain the same as in option 1. No alternatives for standby power were considered. It should be noted that the burial of power lines is an expensive (in this case nearly a quarter of a million dollars) alternative, and it has adverse environmental impacts and costs. In the United States, this is normally carried out only under the most extraordinary circumstances to mitigate adverse aesthetic impacts where those impacts are of some overriding importance.

Phase III - Option 1: Dedicated GIE Power Plant

The GIE would construct a fully operational 21 MW diesel power plant away from the GIE site. Power would be transmitted to the site either above ground or underground and connected to the underground line as it enters the GIE property. No site for this generating facility has been identified or discussed. Evaluation of this future facility is outside the scope of this EA because the plans for this unit are preliminary. Among the uncertainties for the Phase III power provision is the fuel source of the proposed generating facility. Although the preliminary plans call for diesel-powered generation, gas turbine generation using natural gas from a possible gas pipeline originating in Egypt may result in lower cost and more environmentally benign power production.

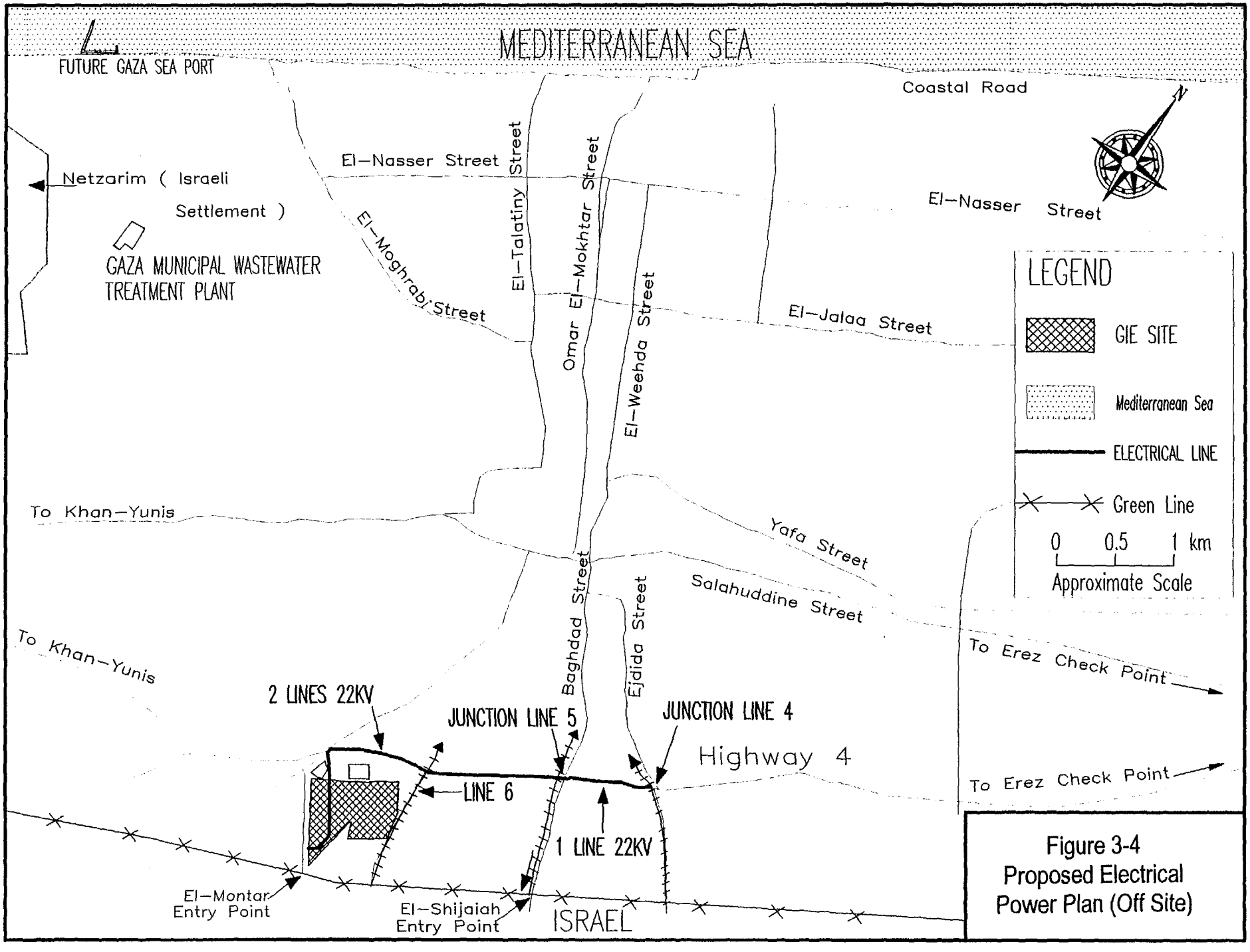


Figure 3-4
Proposed Electrical
Power Plan (Off Site)

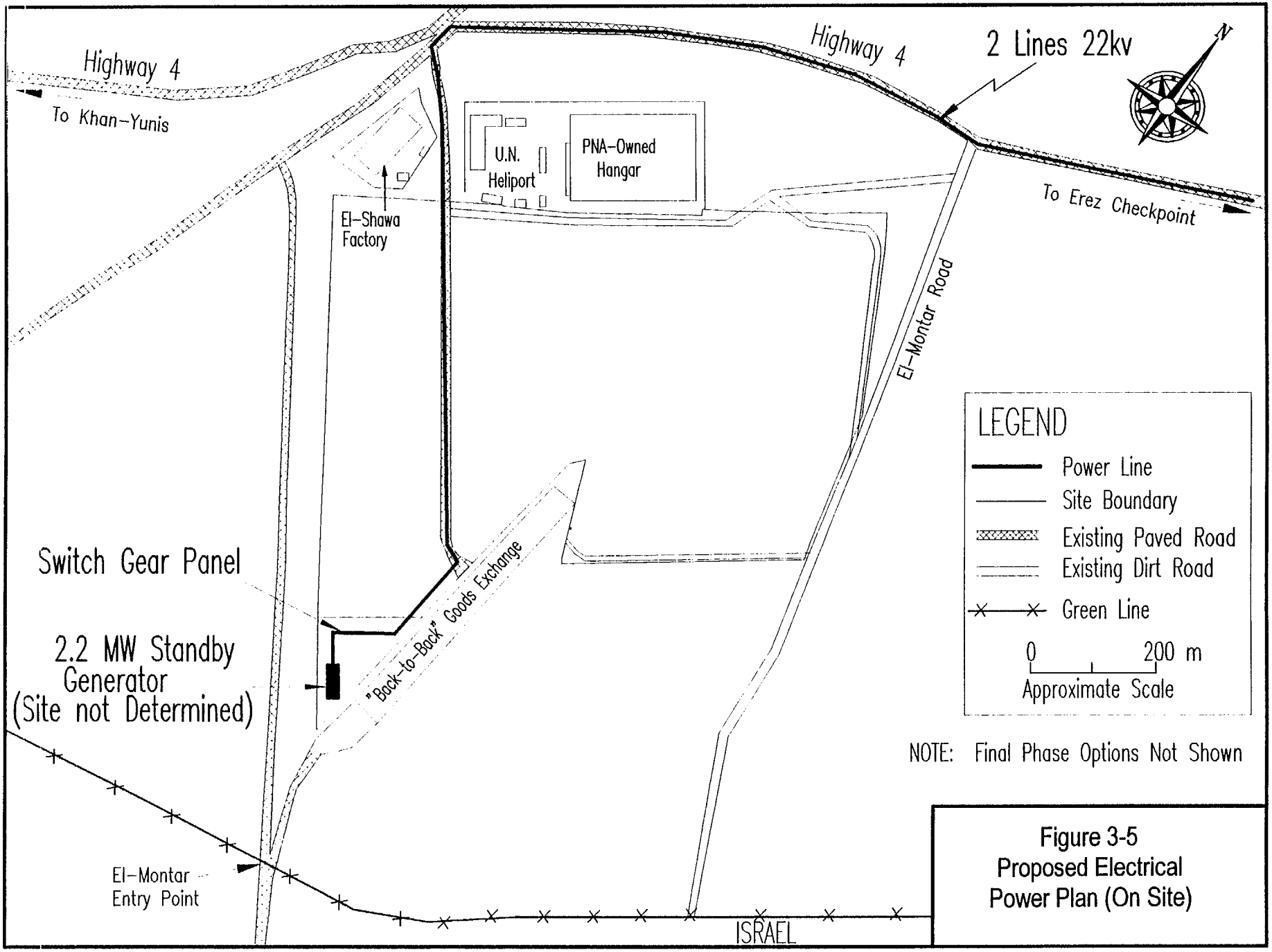


Figure 3-5
Proposed Electrical Power Plan (On Site)

Phase III - Option 2: Direct Connection to IEC with Dedicated Lines

All power requirements would be met by constructing two dedicated lines from the GIE site directly to the IEC substation in Israel. Arrangements and purchase agreements would have to be made and cost estimates developed. No details regarding power line distances or routing, or the possible need for substation upgrading, are available at this time.

Phase III - Proposed Action: Connection to Future PEA Generating Facility

All power requirements would be supplied by a power plant that would be constructed within the Gaza Strip. The proposed power plant has not yet been approved, but approval will most likely occur during the coming months. The proposed location for the power plant is roughly 10 km southwest of the GIE site. This implies about 10 km of transmission line will be needed. However, the route is not certain and may be more than 10 km. As with the dedicated GIE plant, environmental evaluation of this facility is outside the scope of this EA.

A comparison of the described alternatives is summarized in Table 3-3.

Table 3-3
Summary Comparison of Alternatives

Item	Phase I Option 1 Proposed Action	Phase I Option 2	Phase III Option 1	Phase III Option 2	Phase III Option 3 Proposed Action
Transmission Lines	6.8 km	6.8 km	Not Determined	Not Determined	Not Determined
Trenching	4.5 km	0	Not Determined	Not Determined	Not Determined
Transformers Required	5	5	40	40	40
Standby Generation	2.2 MW	2.2 MW	—	—	—
Investment Cost (US$)	$665,000	$880,000	$3,000,000 (est.)	Not Determined	$863,000

3.3.3 Proposed Water Supply Provision and Alternatives

The proposed approach for provision of water supply service to the GIE is based on one overriding consideration. The freshwater resources of the Gaza Strip are limited and should not be overstressed. This consideration led to the decision to consider either bulk purchase of water from Mekorot (the Israeli water company) or the use of a dual system for potable water and brackish water with potable water provided for worker use (for drinking, washing, and ablutions) and for limited industrial applications. Brackish water would be provided for other industrial uses. This approach would require that each factory or industry treat brackish water to the

standards required for their use and store this treated water on their leased site. The total water requirement to meet the industrial and potable water needs of the GIE in its final phase has been estimated to be 3,200 m^3/day, with 800 m^3/day of this amount to meet the potable water needs (Ref. 10). Figure 3-6 shows the location of the proposed brackish water well, the reverse osmosis (RO) system, and the water storage tank.

Option 1: Drill Brackish Water Wells and Treat a Portion of the Water Using Reverse Osmosis to Meet Potable Water Needs, with Wastewater Recycle to Meet a Portion of the Industrial Water Demand

Four 120 meter-deep brackish water wells on the GIE property would be drilled to provide a brackish water to meet all water demands for the project. The water abstraction approved for Phase I is 1,100 m^3/day. A dual system for provision of brackish water and potable water is proposed. Water that would be used by industry and for nonpotable purposes will be provided by a combination of brackish water and recycled treated wastewater and stormwater and stored for use in a 3000 m^3 concrete ground level storage tank with an additional 600 m^3 steel elevated tank for emergency storage. An RO process is proposed to provide 400 m^3/day of water treated to acceptable international drinking water standards during Phase I and 800 m^3/day at project completion. Reject water (or brine) from the RO process (roughly estimated at 100 m^3/day for the first phase and 200 m^3/day when the GIE is fully developed) will be either trucked (Phase I) or piped (Phase III) to the sea. The proposed location of the RO plant and elevated storage tanks is on the GIE property near the north end of the present back-to-back goods exchange facility. A 400 m^3 elevated tank for storage of RO treated water also would be provided at this site.

The RO process selected would utilize pretreatment filters; a low pressure thin film composite membrane; a 10-20% bypass of filtered water for effluent blending; chemical treatment (acidification and pH adjustments of the permeates); and chlorination of the stored water. Alternatives for potable water production, which were proposed and studied, included various configurations in which electrodialysis reversal was used in place of RO. These approaches were rejected on technical grounds as not being appropriate because of the feed water chemical characteristics, complexity of operation, lack of flexibility to feed water changes, and limitations for future expansion. The building to house the RO units (one initially, a second for the final phase, and space for a third as a contingency) and all pumps, chemicals, and other ancillary equipment is expected to have a footprint of about 360 m^2.

Proposed Alternative (Option 2): Drill Brackish Water Wells and Treat Using a Portion of the Water from the Reverse Osmosis to Meet Potable Water Needs, without Treated Wastewater Recycling

This option is the same as option 1 without the recycle of treated wastewater or stormwater to augment water set aside for industrial uses. In this option, a single 1200 m^3 steel elevated storage tank will be used to contain the brackish water. This would simplify the physical layout and reduce the capital costs of the project.

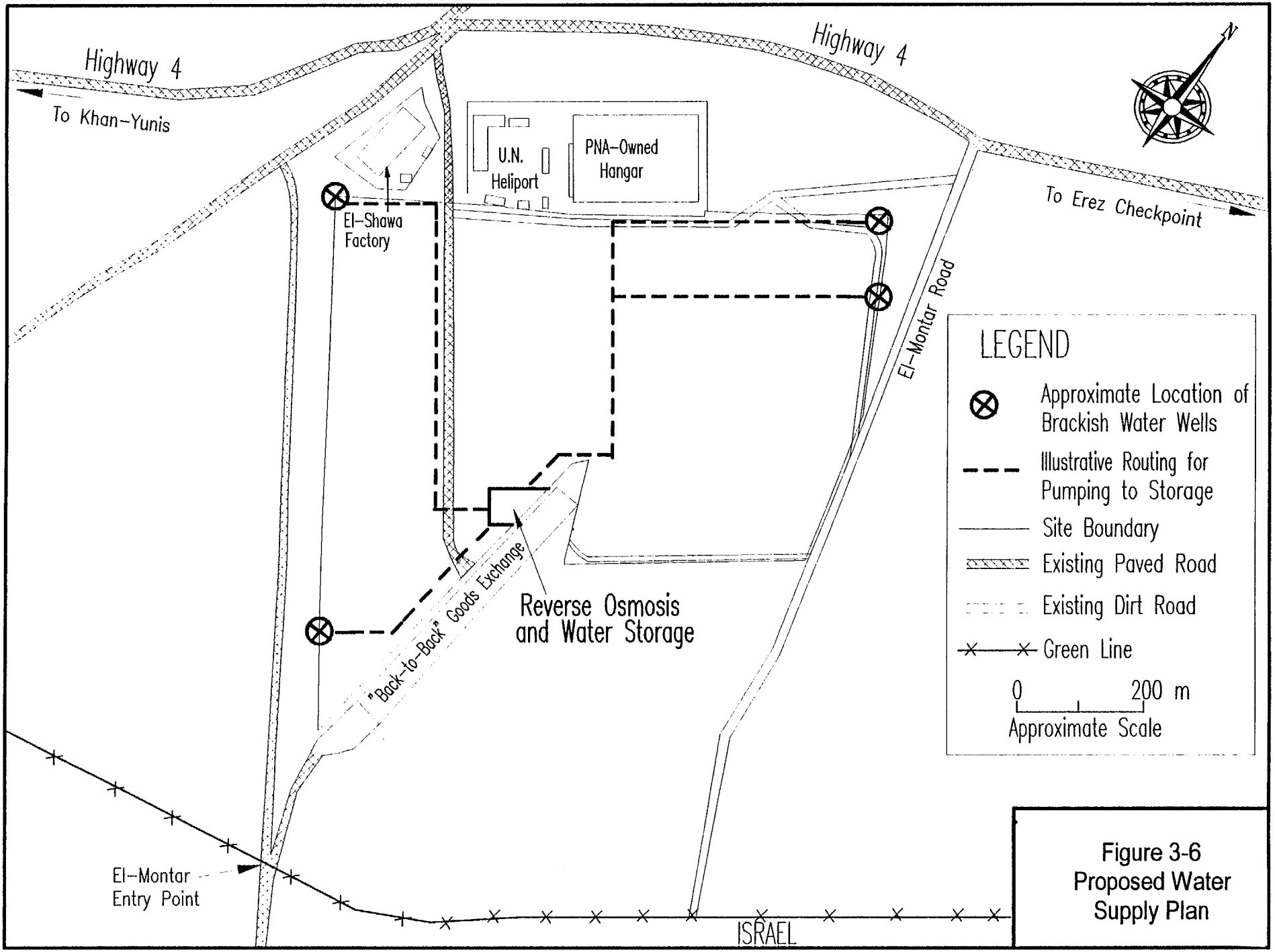


Figure 3-6
Proposed Water
Supply Plan

3.3.4 Proposed Wastewater Treatment and Alternatives

The proposed wastewater treatment action and its alternatives are based on three important assumptions. The first is that the influent to the wastewater treatment plant can be classified as domestic wastewater (does not contain synthetic organic compounds, heavy metals, or other chemicals). Secondly, each tenant at the GIE will be required to pretreat their industrial wastes to agreed standards prior to conveying them to the wastewater plant. To accomplish this, rigorous restrictions could be placed on the kinds of tenants allowed to operate in the zone and on the industrial processes allowed. Finally, the wastewater treatment plant effluent will be of a high enough quality for agricultural reuse and aquifer recharge. The wastewater treatment plant was designed to treat a flow of 2,000 m^3/day when the GIE is fully developed. Figure 3-7 shows the proposed location of the wastewater treatment plant.

Proposed Action: Pretreat Industrial Waste and Treat Combined Industrial and Domestic Wastes Using Sequencing Batch Reactors (SBR)

All tenants of the GIE will be required to pretreat their liquid wastes prior to discharge into the GIE wastewater treatment plant. The details of this pretreatment requirement have not yet been fully defined. A discussion of possible industrial wastewater pretreatment requirements is presented in Appendix F. The information presented in this appendix is based on information provided by PADICO for the proposed mix of industry types, and additional information developed by the EA team for the possible character of typical industries in the light-to-medium manufacturing range. The data presented in Appendix F are provided as a guide to assess the impacts of industrial development on wastewater treatment and effluent disposal by agricultural irrigation and recharge to the upper aquifer.

The basic premise is that wastewater produced by each of the industry types within the approved industrial mix at the GIE can be successfully treated to the effluent limits set for the end-of-pipe wastewater treatment plant. It is generally acknowledged that wastewater treatment and reuse technologies exist which will allow the tenant industries to meet these pretreatment requirements, and that these technologies have been successfully used throughout the world for this purpose (see Appendix F for a listing of industrial wastewater pretreatment unit operations). It is also acknowledged that the end-of-pipe treatment facility influent wastewater quality requirements can be met by a combination of wastewater pretreatment and applied restriction on the kinds of industrial tenants allowed to operate in the GIE. However, there is a need to maintain a balance between the types of industries that will provide raw materials to the basic product and those that produce the finished product that is sold to the market. Therefore, there also needs to be an understanding that some higher-polluting industries (i.e., usually the raw material producers) have to be present at the GIE for the industrial estate to be economically viable. Nevertheless, the pollution that the raw material processing industries generate can be controlled through the application of existing technologies for wastewater reuse and pretreatment, and the cost of deploying these technologies should be considered a normal part of doing business.

A fully automated end-of-pipe wastewater treatment plant will be constructed that includes a series of treatment processes with biological treatment the principle method of pollution reduction. The flow process proposed (Figure 3-8) includes a fine mesh primary screen; an aerated flow equalization tank; SBRs; aerobic digesters; post equalization; and tertiary filters. The resulting treated effluent will be of a high-quality liquid effluent, which will further undergo chlorination. The SBR process is a batch process that requires flow equalization both prior to and after treatment. The waste-activated sludge will be treated in an aerobic digester prior to supernatant return to treatment and sludge handling. The biological sludge and screenings produced in the wastewater treatment system will be dewatered using drying. For Phase I, one SBR would be built with a second added to complete the final phase of the project.

As designed and assuming adequate pretreatment, the wastewater treatment plant should produce a liquid effluent suitable for agricultural reuse (Ref. 1). The liquid effluent would be pumped away from the GIE site to the south to Wadi El-Katron. It will be deposited to infiltrate into the ground to recharge the aquifer or pumped by local farmers for use in agriculture.

There were three options for effluent disposal proposed in the GIE wastewater management plan report (Ref. 1). Option 1 recommended pumping the treated effluent to the United Nations Development Program (UNDP) facilities for storage and reuse as irrigation water. The preferred action recommended pumping the treated effluent to Wadi El-Katron for irrigation reuse and infiltration. Option 2 recommended storage of the treated effluent on-site so that the effluent can be made available to local farmers to haul to their land. All the options involve irrigation reuse and recharge. The proposed action was selected because the Wadi El-Katron is less than 3 km from the planned industrial estate, and a number of farmers along the Wadi had expressed interest in using the water for irrigation of citrus crops in the region. Presently, a number of these farmers use brackish well water for this purpose. The dewatered biological sludge is to be disposed of by land applications in local orchards for its fertilizer content. Alternately, the sludge could be disposed of at the landfill site.

Option 1: Pretreat Industrial Waste and Treat Domestic and Industrial Wastes Using the Biolac™ Process

This option is the same as the proposed action with the exception that the biological treatment process is different. The industrial pretreatment requirement remains and the disposal of the effluent and biological sludge options are unchanged.

This option would utilize the Biolac™ process, which involves the use of bubble diffusers to extend the aeration process and effect high Biochemical Oxygen Demand (BOD) and nitrogen removal (Figure 3-9). This approach includes internal clarification prior to post equalization and tertiary treatment of liquid effluent and aerobic digestion of sludge. The Biolac™ is a semi-continuous process not as fully automated as the SBR option outlined above. For Phase I, one Biolac™ unit would be built with a second added to complete the final phase of the project.

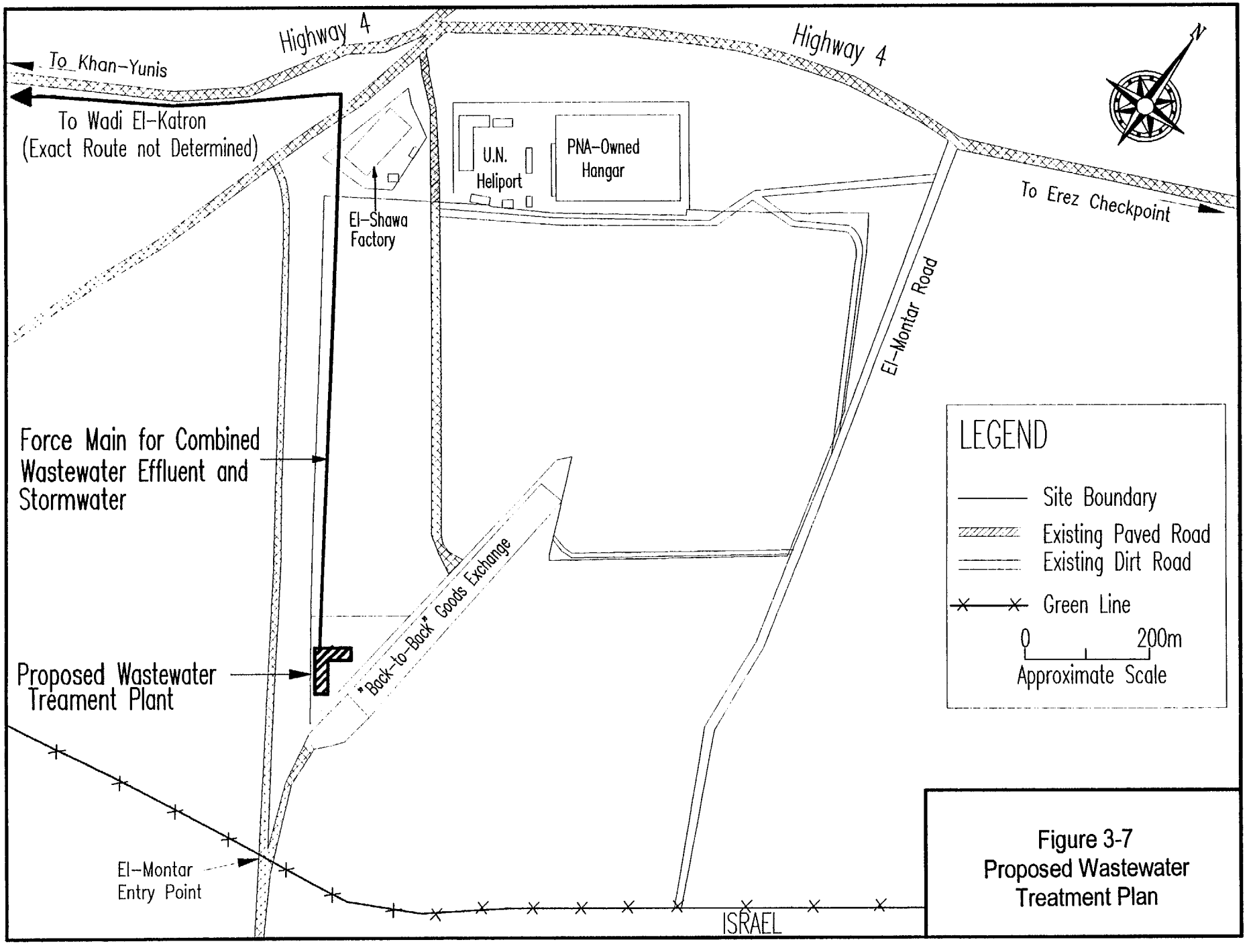


Figure 3-7
Proposed Wastewater
Treatment Plan

Option 3: Drill Brackish Water Wells and Purchase Bulk Water from Mekorot to Meet Potable Water Needs

Brackish water would be provided for industrial applications as outlined under option 1. The potable water requirement for the GIE (and select industries) would be supplied by the Israeli Water Company, Mekorot, through a 4 km pipeline, a booster pump, and a potable water storage tank.

Option 4: Purchase Bulk Water from Mekorot to Meet All Water Needs

All water requirements for the site, including potable and industrial water, would be provided by Mekorot through the pipeline described briefly under option 3. This option would alleviate the necessity for a dual water system at the GIE site.

A comparison of alternatives is provided in Table 3-4.

Table 3-4
Summary Comparison of Alternatives
(Total for First and Final Phases)

Item	Option 1	Option 2	Option 3	Option 4
Well Drilling and Equipping	$1,279,000	$1,230,000	$945,000	$0
Brackish Water Storage	$700,000 3,600 m^3	$400,000 1,200 m^3	$400,000 1,200 m^3	
Reverse Osmosis Plant and ancillary equipment	$1,735,000	$1,635,000		
Potable Water Storage	$250,000 400 m^3 total	$250,000 400 m^3 total	$350,000 800 m^3 total	$550,000 2,000 m^3 total
Supply line from Mekorot Including pumps and controls			$575,000	
Investment Cost (US$) Including contingencies and engineering and construction management	5,164,000	4,527000	2,924,000	2,048,000
Unit cost (annualized $US/$m^3$)	$0.40	$0.36	$0.39	$0.77

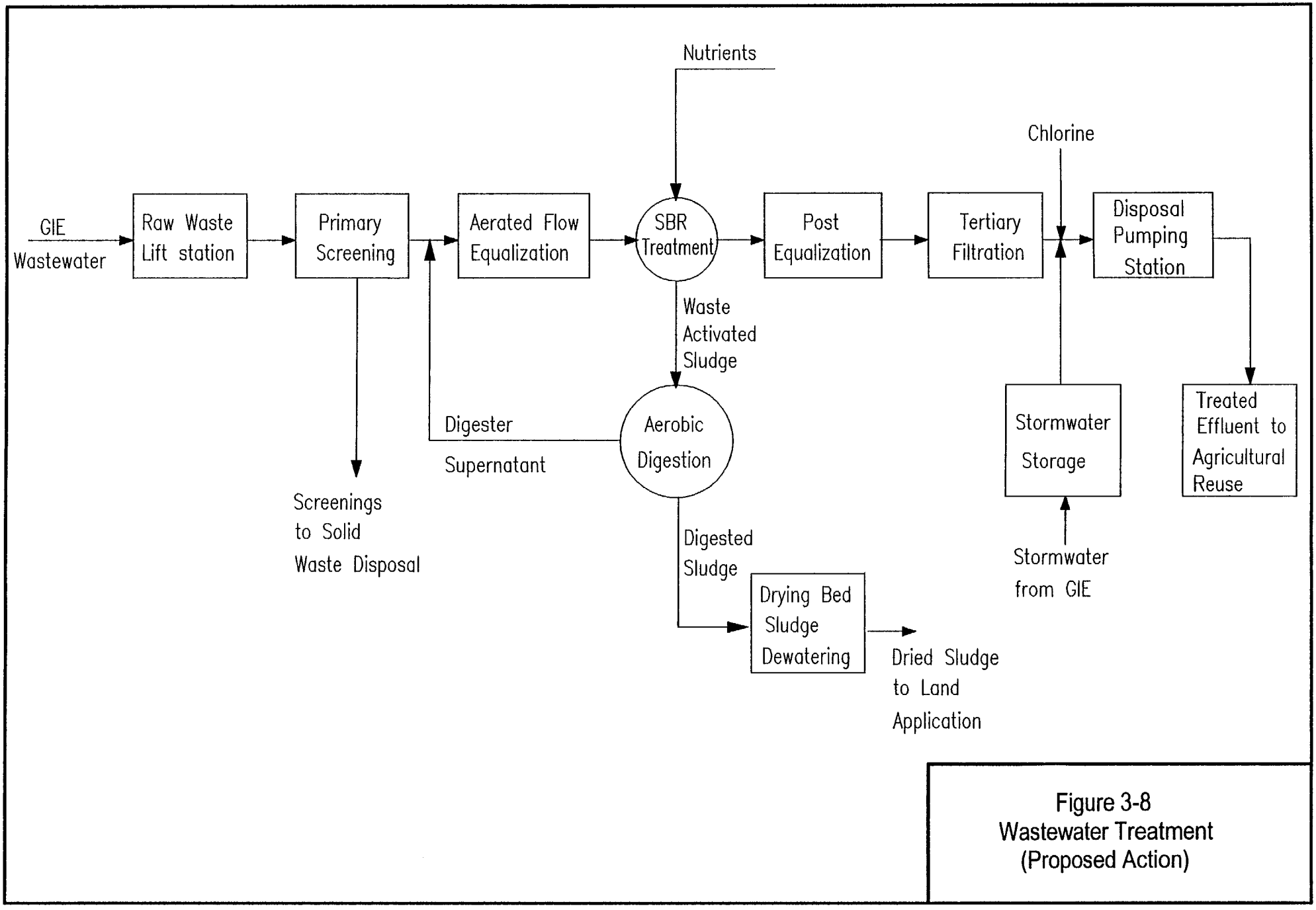


Figure 3-8
Wastewater Treatment
(Proposed Action)

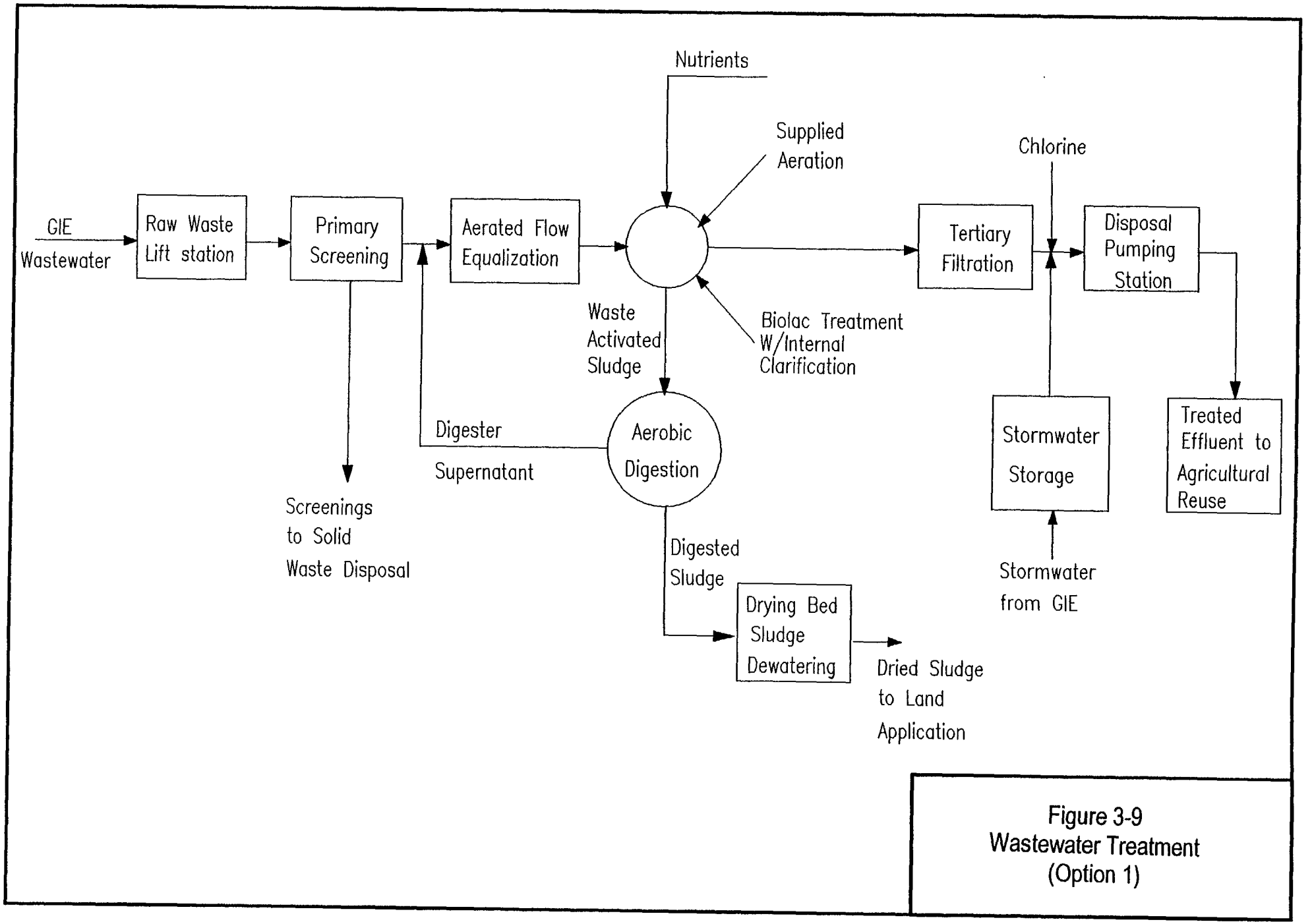


Figure 3-9
Wastewater Treatment
(Option 1)

Option 2: Pretreat Industrial Waste and Treat Domestic Waste Using Rotating Biological Contractors (RBC)

This option is also the same as the proposed action with the exception that the biological treatment process is different. The industrial pretreatment requirement is the same, and the options for the disposal of the effluent and biological sludge options are unchanged.

The wastewater treatment proposed would be a continuous treatment process utilizing RBC (Figure 3-10). This process consists of contractors with an attached growth (fixed film) biological culture as opposed to the suspended growth process characteristic of the other proposed options. For Phase I, one RBC unit and a clarifier would be built. A second RBC unit and clarifier would be added to complete the final phase of the project. A summary of alternatives is provided in Table 3-5.

Table 3-5
Summary Comparison of Alternatives

Item	Option 1 Proposed Action	Option 2	Option 3
Industrial Pretreatment	Required	Required	Required
Process	Sequencing Batch Reactors	Biolac™	Rotating Biological Contractors
Process type	Batch	Semi-Continuous	Continuous
Post-Equalization	Yes	Not Necessary	Not Necessary
Sludge Handling	Activated Sludge Retained with excess removed by intervention	Activated Sludge Recirculated with excess removed by intervention	Activated Sludge Retained with excess removed by natural processes
BOD_5 Removal	Complete	Complete	Complete
Nitrogen Removal	Partial	Partial	Partial
Synthetic Organics Removal	No	No	No
Heavy Metal Removal	No	No	No
Liquid Effluent Disposal	Agricultural Use & Aquifer Recharge	Agricultural Use & Aquifer Recharge	Agricultural Use & Aquifer Recharge
Sludge Disposal	Agricultural Use	Agricultural Use	Agricultural Use
Investment Cost (US$)			
Phase I	$2,110,000	$2,717,000	(no estimate made)
Phase II	$891,000	$1,298,000	

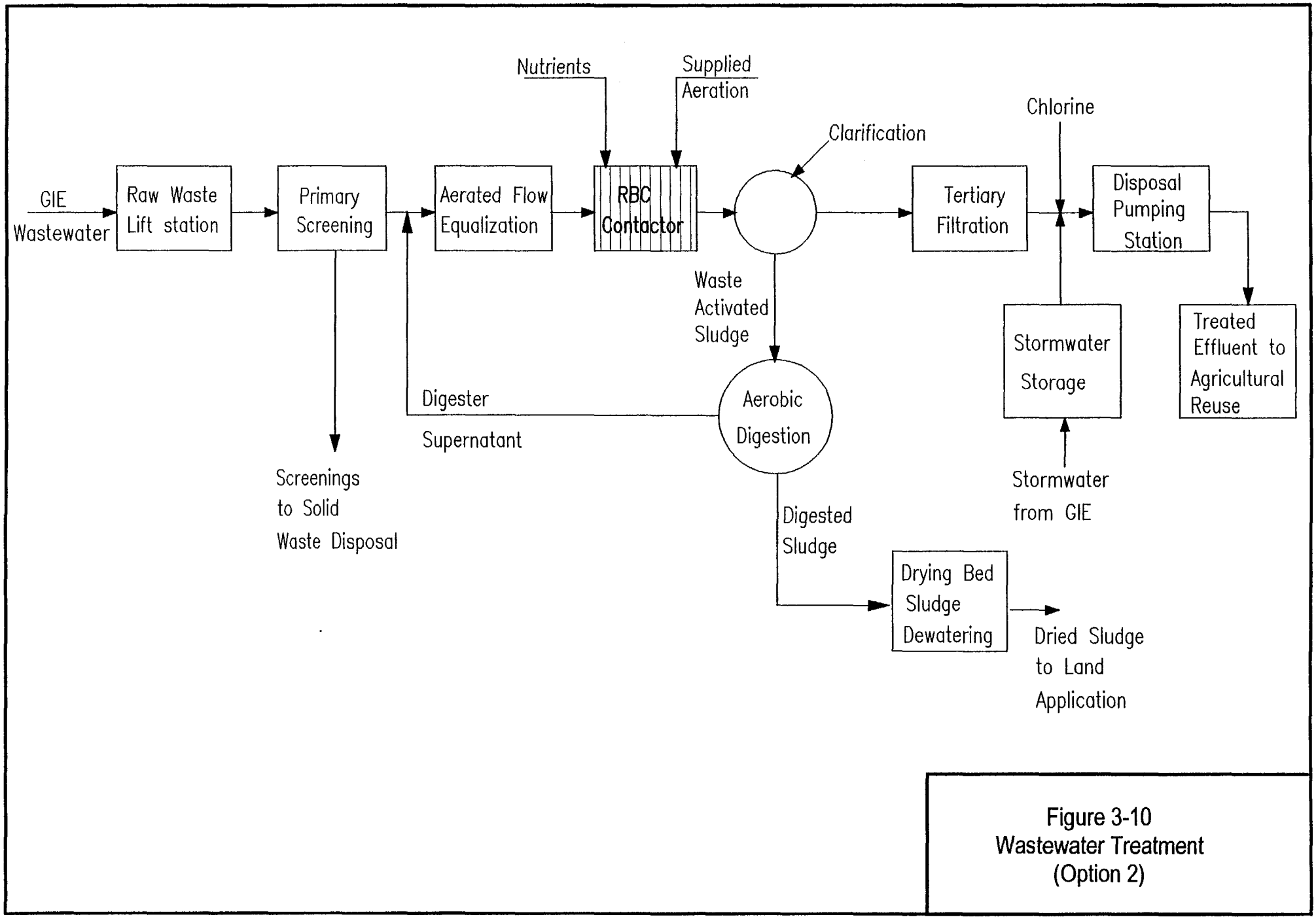


Figure 3-10
Wastewater Treatment
(Option 2)

3.3.5 Proposed Stormwater Control and Alternatives

Stormwater management plans are based on a five-year maximum daily precipitation of 52 mm dispersed over an area of 485,000 m^2. Provisions were made for a maximum runoff from the site of approximately 20,000 m^3 (assuming a runoff coefficient of 0.8).

Option 1: Collection and Pumping to Wadi El-Katron

The proposed action is to construct a network of stormwater catch basins and drain runoff by gravity to an off-site retention pond and pump the accumulated stormwater away from the GIE site. This retention pond will be designed to store 10,000 m^3, or half the anticipated five-year maximum daily runoff. The exact location of the retention pond is yet to be agreed upon. The proposed pumping system will be capable of conveying 16,000 m^3/day away from the site (the pumped site effluent will consist of accumulated stormwater in addition to the wastewater treatment plant effluent described in Section 3.3.4). Current plans call for stormwater to be pumped to Wadi El-Katron some 3 km south of the GIE site.

Proposed Alternative

No alternatives for stormwater collection, storage, disposal, or possible reuse were proposed, therefore option 1 is the selected alternative.

3.3.6 Proposed Solid Waste Disposal and Alternatives

Several types of solid waste will be generated by the GIE. Based on the industrial operations predicted for the GIE, solid waste products will fall into four major categories including municipal waste (paper, cardboard, plastic); industrial waste (metal cuttings, wood scraps); pretreatment sludge from industries operating in the estate; and residues possibly including hazardous waste. According to the agreement between the PA and the developer, the developer will be responsible for managing solid waste generated at the GIE.

The Municipality of Gaza maintains a landfill site in the El Mazraa area approximately 1.5 km south of the GIE and 7 km south of the city of Gaza. This landfill has been in operation since 1989. Prior to 1989, solid waste may have been disposed of in the same area as the landfill. The landfill area is approximately 13.5 hectares. Current projections suggest that this landfill will be sufficient for the needs of the city and surrounding areas for at least 8-10 years. An area of the landfill has been selected for future disposal of hazardous waste including industrial and medical wastes.

Proposed Action: Truck All Solid Wastes to the Gaza Municipal Landfill

The Municipality of Gaza, through agreements or contracts with the GIE, would collect all solid wastes generated at the site, including hazardous waste, and truck them to the Gaza landfill.

Hazardous waste would be segregated and disposed of in a lined section of the landfill as soon as this hazardous waste section is completed. Other solid waste disposal options were not considered in this evaluation because of the lack of available land within the GIE for a separate on-site waste disposal facility.

3.3.7 Proposed Telecommunications Service and Alternatives

All telephone lines are distributed in and out of Gaza through the Gaza Central Exchange (GCE) located in Gaza City on Omar Mokhtar Street. The system is connected by a fiber-optic cable to Israel, which runs through the Shija'iah area to the border at the Nahal ozi gate. This fiber-optic cable is used for all incoming and outgoing telecommunications including telephone, fax, and Internet access.

The current telephone service in the GIE area is very poor. The area will require the extension of the telecommunications network to provide the 800 lines planned for Phase I and the 1,800 lines ultimately planned for the GIE. Figure 3-11 shows the layout of the telecommunication lines.

Option 1: Microwave Station, Electronic Exchange, and Site Exchange

A microwave station would be built at the GIE facility with an electronic exchange to handle all incoming and outgoing telecommunications. A local exchange would then route all communications to subscribers within the industrial estate. The system would not be directly connected to the existing telecommunications system within Gaza.

Option 2: Fiber-Optic Line from Closure in the Shija'iah Area to the GIE

A new fiber-optic cable would be connected to the existing cable at the closure in the Shija'iah area and pulled through existing conduit to the intersection of Baghdad Street and Highway 4. A new conduit would be placed along Highway 4 and the site access road to the administration building just inside the GIE site to allow completion of the fiber-optic connection from the existing network to the GIE. A DEKEL remote exchange, along with ancillary equipment, would be placed in a locked room in the administration building. The GIE would have access to the distribution frame to allow connection of lines from GIE subscribers. One DEKEL unit with a capacity of 1,024 lines would be installed initially with an additional unit installed to complete the project.

Proposed Action: Dedicated Fiber-Optic Line from the GCE to the GIE

The proposed action is similar to option 2 except that a new fiber-optic line would be placed from the Gaza Central Exchange to the intersection of Baghdad Street and Highway 4 through an existing conduit. The remainder of the proposed action is as described above. A summary of alternatives is provided in Table 3-6.

Table 3-6
Summary Comparison of Telecommunication Alternatives

Item	Option 1	Option 2	Option 3 Proposed Action
Length of line	0	3.5 km	7.5 km
Trenching Required	0	2.5 km	2.5 km
Total Cost (based on MPT)	-	Not Determined	$1,173,700

3.3.8 The No-Action Alternative

EAs conducted pursuant to USAID and the World Bank guidelines must evaluate the environmental impacts of the no-action alternative. The no-action alternative is defined as USAID and other donors selecting not to fund the off-site infrastructure. The most likely scenario under these circumstances is that the GIE will develop as an industrial site, with or without PADICO, and that given the lack of regulatory authority, this industrial development would be largely without environmental controls.

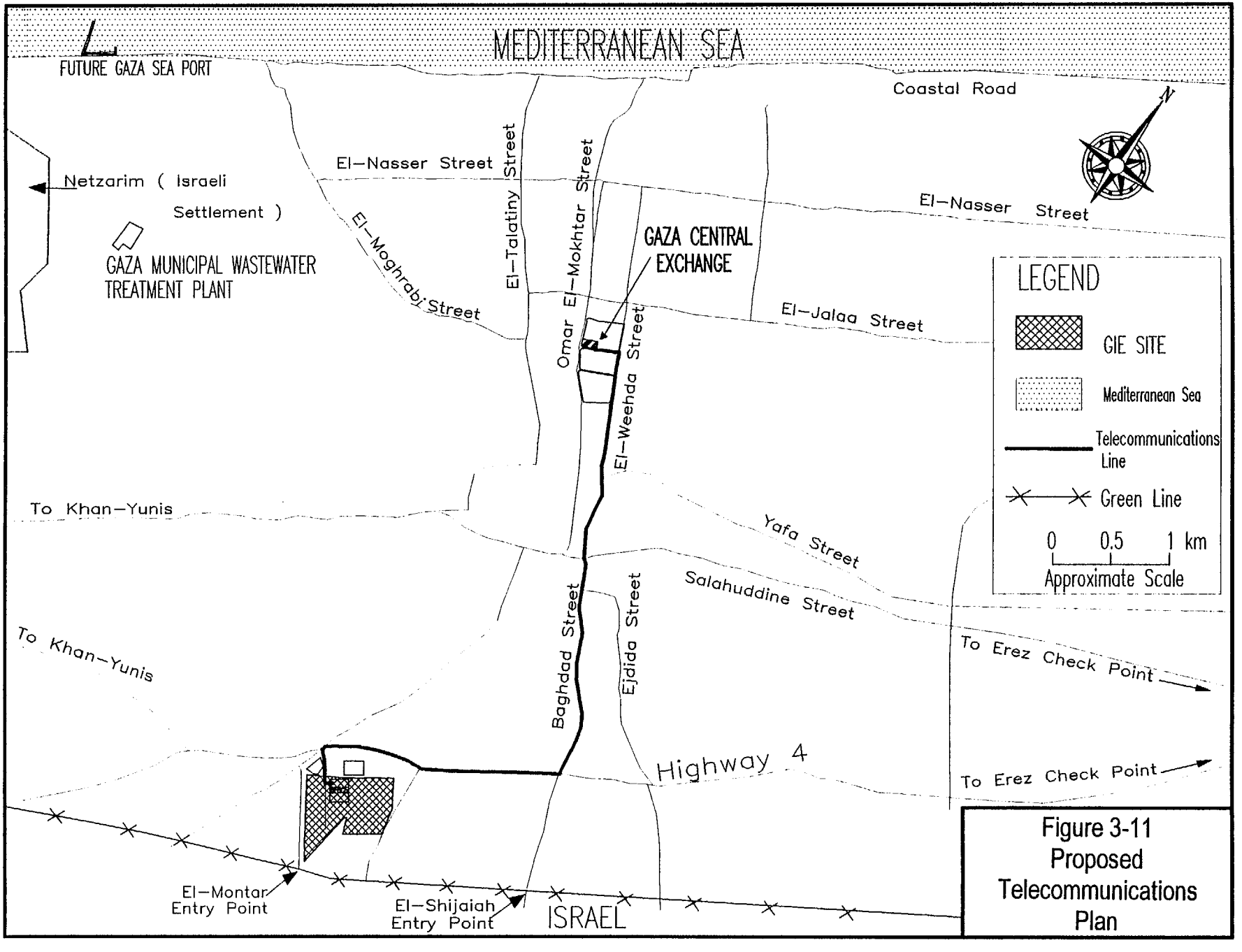


Figure 3-11
Proposed Telecommunications Plan

4 DESCRIPTION OF EXISTING ENVIRONMENT

This section briefly describes the existing environment in the GIE area. It is based on existing literature, contacts with knowledgeable local professionals, and reconnaissance of the site.

4.1 Climate and Meteorology

The climate of the Gaza Strip is influenced by the Mediterranean Sea. It has a typical Mediterranean climate—mild winters with rainy periods and a hot, dry summer. Annual rainfall varies considerably from year to year ranging from 900 mm to 200 mm. Average rainfall in the northern part of the Gaza Strip is 430 mm per year and declines to 200 mm in the far south. Average rainfall at the GIE site is approximately 300 to 400 mm per year. Almost half of this occurs in December and January.

Gaza has a sunny climate with little extreme temperatures. The mean annual temperature is 20°C, and the sun shines two-thirds of the daylight hours. Total solar radiation is estimated at 2,200 joules per cm^2 per day, which is considered high. Winds are predominantly off the Mediterranean—from the west and northwest. During the late night and early morning hours, winds are often from land to sea (easterly) as a result of temperature differentials between land and sea (Ref. 6).

4.2 Terrestrial Ecology

The GIE site is in a life zone transition area between the Saharo-Arabian phytogeographic zone to the south and Mediterranean zones to the north. The vicinity near the site has been characterized as dwarf shrub steepe on loessial (wind blown) soils (Ref. 6).

With the assistance of a local biologist (Ref. 43), an examination of the site and the immediate surrounding area indicates that there is only one tree (a tamor about 7 m tall) on the entire site. The location of the tree and other vegetation is shown in Figure 4-1. A plant species list is provided in Appendix I. There are only about three different species of common desert and semi-desert thorny shrubs that rarely are more than 1 m tall (with the species *fogonia mollis* identified as one of the three). The area was heavily grazed by goats with the remains of a large okra garden (about 1 hectare) in the northeast corner.

The site is bounded by vegetation on the northwest and northeast sides. This narrow corridor of vegetation is dominated by tamor trees, the thorny lugumonosi bush or tree, and pear cactus (suber) with an occasional Australian pine, date palm, and jomaze tree, tangerine tree, and grape vines. This corridor of vegetation is shown on the land use and vegetation map that appears in the land use subsection of this section. None of the vegetation was determined to be rare or threatened. However, given the paucity of native vegetation in the overall region and the fact that this vegetation appears on the boundary of the site, PADICO should consider the preservation of the corridor in its construction activities.

During the EA team's several site visits, the only animals observed were domestic goats grazing the stubble from what appears to be earlier hay crops. A few birds (sparrows and the "hudhud" bird) were also seen.

4.3 Geology and Soils

The Gaza Strip is essentially a foreshore plain gradually sloping westwards, underlain by a series of geological formations from Mesozoic to the Quaternary. Table 4-1 illustrates the history of geology in the Gaza Strip (Ref. 6). The soils of the Gaza Strip can be characterized into three categories: the sandy soils, the loess soil, and the alluvial soil. The sandy soil can be found approximately 5 km inland parallel to the coast, while alluvial soils can be found on the slopes of the northern depressions between Beit Hanun and Wadi Gaza. Borings east of the El-Montar area and near the GIE site have revealed the occurrence of alluvial deposits of about 25 m thick (Ref. 6).

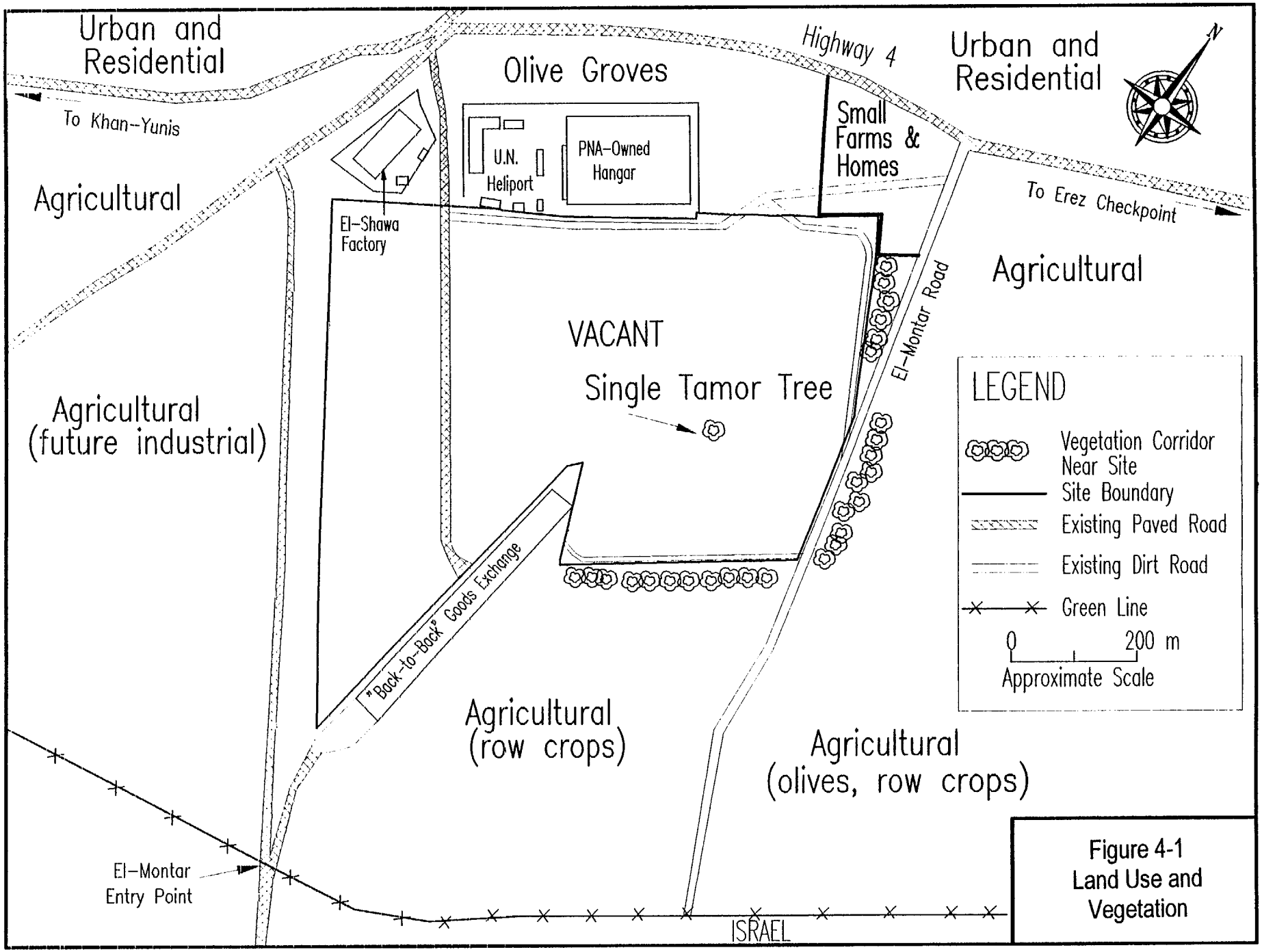


Figure 4-1
Land Use and Vegetation

Table 4-1
GEOLOGICAL HISTORY OF THE GAZA STRIP

Era	Epoch	Age (million years BP)	Formation	Environ-ment of Deposition	Lithology	Maximum Thickness (m)	Water Bearing Characteristics
Quaternary	Holocene	0.01	Alluvial	Terrestrial Eolian Estuarine/ Fluvial	Sand,loess Calcareous silt and gravel	25	Locally phreatic aquifer
	Pleistocene	1.8	Continental Kurkar complex	Eolian Fluvial	Calcareous sandstone and loamy sand	100	Main aquifer
			Marine Kurkar	Near Shore	Calcareous sandstone (sandy and porous)	100	Main aquifer
Tertiary	Pliocene	12	Conglomerate	Near shore		20	Base of the coastal zone aquifer
			Saqiya	Shallow marine	Clay, marl, shale	1000	Aquiclude
	Miocene	25		Marine	Marl, limestone, sandstone and chalk	500	Aquiclude alternating permeable layers with saline water

4.4 Land Use

The GIE site is on the fringe of the Gaza City urbanized area, which lies to the north and northwest. The predominant land use on three sides is agricultural (grazing, olive groves, cultivated row crops) with some scattered residential areas to the immediate north and government-owned former aircraft hangars to the northwest. The green line and the security zone buffer (100 m on either side of the green line) to the southeast have and will continue to create a barrier to development to the southeast. The agricultural land to the southwest of the site is planned for future industrial use by the PA. Figure 4-1 shows the land use immediately around the site.

4.5 Air Quality and Noise

Although no ambient air quality monitoring data were available for the Gaza Strip, the observations of the EA team and the consensus of PA environmental groups are the same: air quality is not a priority (relative to water availability and quality and other issues).

With the exception of fugitive particulate emissions, the ambient air quality appears to be acceptable. This is because the Gaza Strip is well-ventilated with ample dispersion of emissions from the primary air emission sources—trucks and automobiles. Winds are either from the Mediterranean or off the Negev desert—both of which are not sources of anthropomorphic emissions. Also, there is relatively little heavy industry in the Gaza Strip (such as fossil fuel-fired electric generation, chemical and refining, and metals processing).

Particulate matter appears to be principally in the form of dust from disturbed surfaces. The streets, paved and unpaved, are sources of particulates that are entrained into the air from motor vehicle tires and the wind. This occurs because the streets are not cleaned and there is little groundcover and poor street drainage resulting in large and thick layers of silt and dirt deposits. Some of the air-borne particulates result from wind blowing through disturbed construction sites and plowed fields and other large areas without vegetative groundcover. Other sources of the particulate matter may be from diesel-powered vehicles, fossil fuel, and wood combustion in residences and small commercial facilities.

Blowing dust at the GIE site is especially problematic given the truck traffic; the wide-open spaces, which are conducive to high winds; and the large expanse of plowed fields and bare soils.

Noise conditions at the site are typical of rural areas except for truck traffic associated with transport of goods to the back-to-back goods exchange.

4.6 Energy Supply

There are no known oil, gas, or coal resources in the Gaza Strip. Refined products for transportation, heating, and industry come to Gaza from Israel. At the present time PEA does not have any electricity-generating capacity. All electrical power to the Gaza Strip is imported from the IEC. The IEC provides electricity to the Gaza Strip through 11 feeder lines (two of which are assigned to supply power to the Israeli settlements within the Gaza Strip boundaries) fed from three substations within Israel. The lines of relevance to the GIE originate from the same IEC substation at Bisor (Ref. 8). Lines 4 (El-Shaaf), 5 (Baghdad), 6 (Al-Quaba), and 7 are fed from the Bisor 161/22 KV transformer substation. Feeder lines 4, 5, and 6 (all to the north of the proposed GIE) all have a voltage load of 22 KV. The PEA has indicated that line 6 (nearest to the GIE) is now loaded to 88% of capacity, line 5 (about 2.5 km north of the GIE) is loaded to 70% of capacity, and line 4 (about 4.5 km north of the GIE) would require a transformer to be able to contribute to the GIE's needs (Ref. 11).

The PEA has proposed construction of a large fossil fuel-fired combined cycle power plant. (It would use either fuel oil or natural gas from a proposed Egyptian pipeline). The construction

of the first unit of this plant would alleviate immediate capacity concerns. The first unit of 80 MW capacity could be on-line in two years.

4.7 Hydrology and Water Availability

The groundwater resources of Gaza are restricted to the shallow aquifer, which is the sand (stone) and clay layers located on top of the Saqiya Formation. The shallow aquifer consists mainly of recent dune sand and calcareous sandstone; clay layers of limited thickness found close to the sea; and a covering clay layer of 20 m thickness in the east. Gaza relies almost entirely on groundwater drawn from the shallow aquifer for its freshwater supply. Minimal amounts of freshwater are also obtained from other sources, such as rooftop rainwater catchments (Ref. 7).

Gaza's aquifer is often only a few meters from the surface. It ranges in thickness from 120 m near the coast to 10 m in the east. Since it is near the Mediterranean and a deeper highly saline aquifer, it is vulnerable to declining water levels, saltwater intrusion, and contamination from agricultural and industrial activity (Ref. 20).

The fresh groundwater in Gaza typically occurs as lenses that float on top of brackish or saline groundwater. These lenses are located mainly in the north and under the dunes along the coast in the south where their thickness reaches greater than 80 m. The lenses are not present in the southeastern portion of Gaza. In the central area the uppermost groundwater is mostly brackish. The freshwater resources of Gaza are limited, with roughly two-thirds of the groundwater resources in the shallow aquifer being brackish or saline (Ref. 7).

The major source of fresh groundwater in Gaza is the rainfall. The average annual rainfall is approximately 300–400 mm/year. On average, 40% of the total rainfall replenishes the groundwater with the remaining 60% lost to evaporation. An additional source of fresh groundwater is infiltration of surface water in the wadi (or dry creek) beds during days that discharge occurs (Ref. 7).

The brackish or saline groundwater in Gaza includes seawater that has recently intruded into the aquifer and ancient brackish groundwater that has remained stagnant in a deeper part of the aquifer but has been mobilized by increased groundwater abstraction (Ref. 7).

Other sources of groundwater include inflows from the surrounding areas of Israel and infiltrating surface water. There is also inflow from wastewater that infiltrates from city sewers and irrigation return flows from local agriculture (Ref. 7).

The estimates of the aquifer's renewable yield vary widely, ranging from 25 to 80 million m^3 per year, with an average of approximately 65 million m^3 per year (Ref. 7, 20). The groundwater aquifer, from which almost all municipal and agricultural water supplies are drawn, is seriously overdrafted. Annual abstractions (or withdrawals) prior to Palestinian autonomy were at 110 million m^3, which are at least 40, and possibly 60, million m^3 in excess of annual recharge (Ref. 2). There are no surface freshwater bodies in the Gaza Strip. The wadis flow in the streambed only for a few days per year.

4.8 Water Quality and Existing Treatment

Of the 131 million m^3 of water that replenishes the Gaza aquifer in a year, approximately 60% is of poor quality. These recharge waters have increasing levels of salinity and nitrates (mainly from irrigation return flows and domestic wastewater infiltration). The increased salinity results from mixing fresh groundwater with more saline components like domestic wastewater, irrigation return flow, and brackish groundwater or sea water. In areas where domestic wastewater infiltrates, there exists high nitrate concentrations in the groundwater. This is also true for areas with less rainfall and, therefore, less dilution (Ref. 7).

Irrigation return flow is rich in nitrogen because of overfertilization of crops, which results in excess nitrogen in the irrigated inflows. In certain agricultural areas, this leads to a nitrogen load to the groundwater that is similar to that in unsewered urban areas. The nitrates in the study area could range from 50 to 150 mg/l as NO_3^-, depending on location (Ref. 7).

Increasing groundwater salinity is a problem in Gaza. The salinity of the Gaza groundwater is determined by a mix of flow components like infiltrating rain, irrigation return flow, domestic wastewater, sea water, and brackish groundwater. There is no lateral flow between the different systems. Therefore, an erratic spatial variability in groundwater quality exists. Where an intrusion of sea water occurs, groundwater salinity can easily reach 1000 to 1500 mg/L as chloride (fresh groundwater is defined as having chloride content of less than 500 mg/L). This, in turn, would cause a municipality to close a drinking water well. However, irrigation wells operate up to a 2000 mg Cl per liter level of salinity (Ref. 7).

The deteriorating water quality of the Gaza aquifer creates primarily aesthetic effects, but can also have health impacts. According to WHO, 600 mg Cl per liter is the ration for acceptable drinking water. Higher concentrations may have adverse health effects on those who have heart or kidney problems. The concentrations of nitrate in Gaza groundwater are typically a factor 2 to 4 in excess of the WHO guideline of 50 mg NO_3^- per liter for drinking water (potential health impact of methemoglobinemia).

In agriculture, one of the direct impacts of salinization of the irrigation water is that yields of salt-sensitive crops, like citrus, decrease. This may result from salt accumulation in the soil or an excess of fertilizer application.

The groundwaters in the lower brackish water aquifer can be characterized as "hard," with high levels of dissolved solids. The waters contain color, turbidity, metals, and hydrogen sulfides. The characteristics of water from the lower brackish water aquifer are shown in Table 4-2 (Ref. 10).

Table 4-2
Water Characteristics of the Groundwater Aquifer

Parameter	Concentration
pH	8.1
Hydrogen Sulfides	0.05 mg/L
Alkalinity	498 mg/L
Total Dissolved Solids	2913 mg/L
Hardness	380 mg/L
Color	<5 mg/L
Total Organic Carbon	<5 mg/L
Calcium	58.3 mg/L
Magnesium	51.9 mg/L
Sodium	800 mg/L
Potassium	2.6 mg/L
Fluoride	0.7 mg/L
Iron	ND
Carbonate	496 mg/L
Bicarbonate	554 mg/L
Sulfate	356 mg/L
Chloride	983 mg/L
Nitrate	1.0 mg/L

Existing treatment in the study area occurs only in the Gaza City wastewater treatment plant, which was designed to treat 12,000 m^3 per day of wastewater. The actual inflows to the plant are substantially higher than this. The system consists of grit removal, two sedimentation ponds, two aeration ponds, and an effluent pump station. The effluent presently discharges into a natural drainage course that flows into Wadi Gaza, which then flows to an estuary and finally to the Mediterranean Sea (Ref. 2).

The original UNDP plan to Gaza City included an agriculture reuse system and a groundwater recharge system via soil infiltration beds and a delivery line to the irrigation reuse area. However, the line connecting the treatment plant to the irrigation reservoir was never

constructed. The physical infrastructure has significantly deteriorated due to corrosion and lack of upkeep (Ref. 2). A thorough assessment of the system is needed prior to including any elements of the agricultural reuse system in the wastewater treatment plant.

4.9 Existing Solid Waste Management Practices

The Municipality of Gaza maintains a landfill in the El-Mazraa area which is situated about 7 km south of Gaza City. The existing landfill has been in operation since 1989 when the old landfill located at the entrance road to the new site was closed. The current landfill, which is adjacent to the Israeli border, has a total land availability of 13.5 hectares. It is anticipated that the size of the site will be sufficient for the next 8-10 years, if substantial industrial development in Gaza City does not occur. At present, the Municipality of Gaza does not own the land where the landfill is located. The municipality is currently negotiating with the owners of the property for a 10-year lease (personal communications with Henri Disselkoen).

The existing landfill site is located at the confluence of three wadis. Two originate in Israel to the southeast; the third wadi is entirely within the Gaza Strip. The catchment of the landfill wadi is characterized by slightly undulating terrain, which can produce surface runoff in the rainy months. The subsoil at the landfill site consists of unconsolidated material. Coastal and continental deposits make up the mainly unconsolidated materials. These materials are dominant up to about 65-75 m below the landfill site. Groundwater is present under both saturated and unsaturated conditions in these deposits. The groundwater level of the fully saturated deposit is approximately 45 m below the surface.

Depending on rainfall and leachate infiltration rates, a downward groundwater flow could be present in the unsaturated subsoil below the landfill site. The groundwater quality in the immediate area of the landfill is a function of the quality of leachate that combines with the existing groundwater below the landfill.

The freshly deposited waste of the Gaza Municipal Landfill consists of municipal refuse of which 65% is biodegradable organic matter. The moisture content of the freshly deposited waste may be greater than 50% when first deposited at the landfill. The wastes are systematically compacted at the site using bulldozers, which first spread the refuse and flatten the material in lifts before covering it with a combination of sand and sewage sludge.

Leachates that percolate through the landfill are monitored with an under-drain system that collects both the vertical and crossflow of leachates in the landfill. The under drains are slotted pipes for collection of samples of seepage from the landfill and conveyance of liquids to the central storage tanks, which hold the waters for analysis. All other leachates follow the flow path of the wadi that is underneath the landfill. The leachates consist of mainly soluble organic compounds typical of municipal landfills. Organic constituents are mainly soluble organic compounds such as fatty acids and other low molecular weight compounds that result from organic decomposition. The inorganics include chlorides, sulfates, potassium, calcium, and magnesium salts. The leachate can also contain nitrogen compounds such as ammonia and

Kjeldahl nitrogen. Based on studies of similar facilities, low levels of heavy metals may also be present.

The Gaza Municipal Landfill currently accepts all types of waste including industrial solid wastes and sludge. By 1997, the landfill site will include an area of 0.5 hectares for storage of hazardous wastes. This facility will be a repository of industrial and hospital wastes and will have a double-layered liner and a leachate collection system. The Gaza landfill will require that all hazardous materials sent to the facility be identified, but there will be no restrictions on the types of materials or quantity (within the limitations of the landfill).

4.10 Archaeological and Historical Resources

The Gaza Strip has functioned as a land bridge that has enabled an important cultural, economic, scientific, and military exchange to take place over several millennia. Trade caravans brought goods to Egypt from remote areas such as China, Persia, and the Middle East in exchange for goods from the Nile Delta, Nubia, the Sudan, and Ethiopia. Military expeditions frequently passed through the desert. This route has been called Way of Horus, Way to the Sea, Way to the Land of the Philistines, Via Maris. This route was parallel to the coast, several kilometers inland, where a chain of archaeological sites can be found indicating the importance of this area and the numerous settlements constructed along the way to serve the different purposes of trade and military actions.

The history of this area and the archaeological findings indicate that it was occupied by different civilizations during different periods. These periods are the Pharaonic, Assyrian and Babylonian, Persian, Hellenistic, Roman and Byzantine, Islamic, Crusades, Mamluk, and the Ottomans. Any undisturbed surface area is potentially rich in undiscovered archaeological resources.

No systematic archaeological investigations have been conducted in Gaza since the end of the British mandate, which ended in 1948. Excavations conducted since that time were limited to incidental trenches and soundings to serve specific studies and projects. Figure 4-2 shows the archaeological sites in the Gaza Strip. According to the Department of Antiquities, no designated archaeological sites are known to exist at the proposed site of the GIE. Two Pharaonic sites were found in the general area. This indicates the possibility of the presence of other uncovered archaeological sites on the site and the need for an archaeological survey prior to construction.

4.11 Socioeconomic Conditions

Gaza was a part of Palestine under the British mandate from 1917-1948. The Arab Israeli War in 1948 resulted in the current boundaries of the Gaza Strip. This war forced around 250,000 Palestinians to flee to Gaza, increasing the population by about 300%. The huge population influx, combined with the loss of resources and disruption of domestic trade, created an unstable economic situation. The economic situation continued to deteriorate because of the internal

economic and political problems within Egypt, which administrated the Gaza Strip until 1967. In 1967, Israel occupied the West Bank and Gaza Strip, which resulted in Israel controlling the available resources and the economy of the occupied areas. This situation created almost complete dependence on the Israeli economy, with many people in Gaza working as unskilled laborers in Israel (Ref. 6).

The uprising, or Intifadah, started in 1987 and lasted for almost six years. The Israelis responded with border closures that cut off thousands of Gazan workers from their jobs. The Gulf War, in 1990, worsened economic conditions. Many Palestinians were forced out of the Gulf states to return to Gaza and the West Bank imposing tremendous burdens on the Palestinian economy and infrastructure. Further border tightening cut off about 130,000 Palestinians from their jobs in Israel.

The current population of the Gaza Strip is estimated at almost one million. The last population census was conducted by the Israeli Military in 1967 following the war. Population figures have been updated by using an annual estimate of the population growth rate of 5.2. The refugee camps have some of the highest population densities in the world, estimated at 100,000 people per km^2. These refugees, which account for two-thirds of Gaza's population, live in very poor conditions.

Agriculture accounted for 34.4% of the Gaza gross domestic product (GDP) in 1966 but declined to 17.3% in 1990 because of limited water resources and the conversion of farmland to urban uses. Animal husbandry is also limited by the lack of water and grazing lands.

Industry's share in Gaza's GDP was estimated at 13.7% in 1987 but declined to 12.2% in 1990. Construction occupies the largest share of Gaza's GDP estimated at 69% in 1987. Prior to 1988, 70% of Gaza's workforce was employed in Israel. In 1994, this number was significantly reduced to 11%. Because of the closure measures taken by Israel, unemployment in Gaza is currently estimated at 60%.

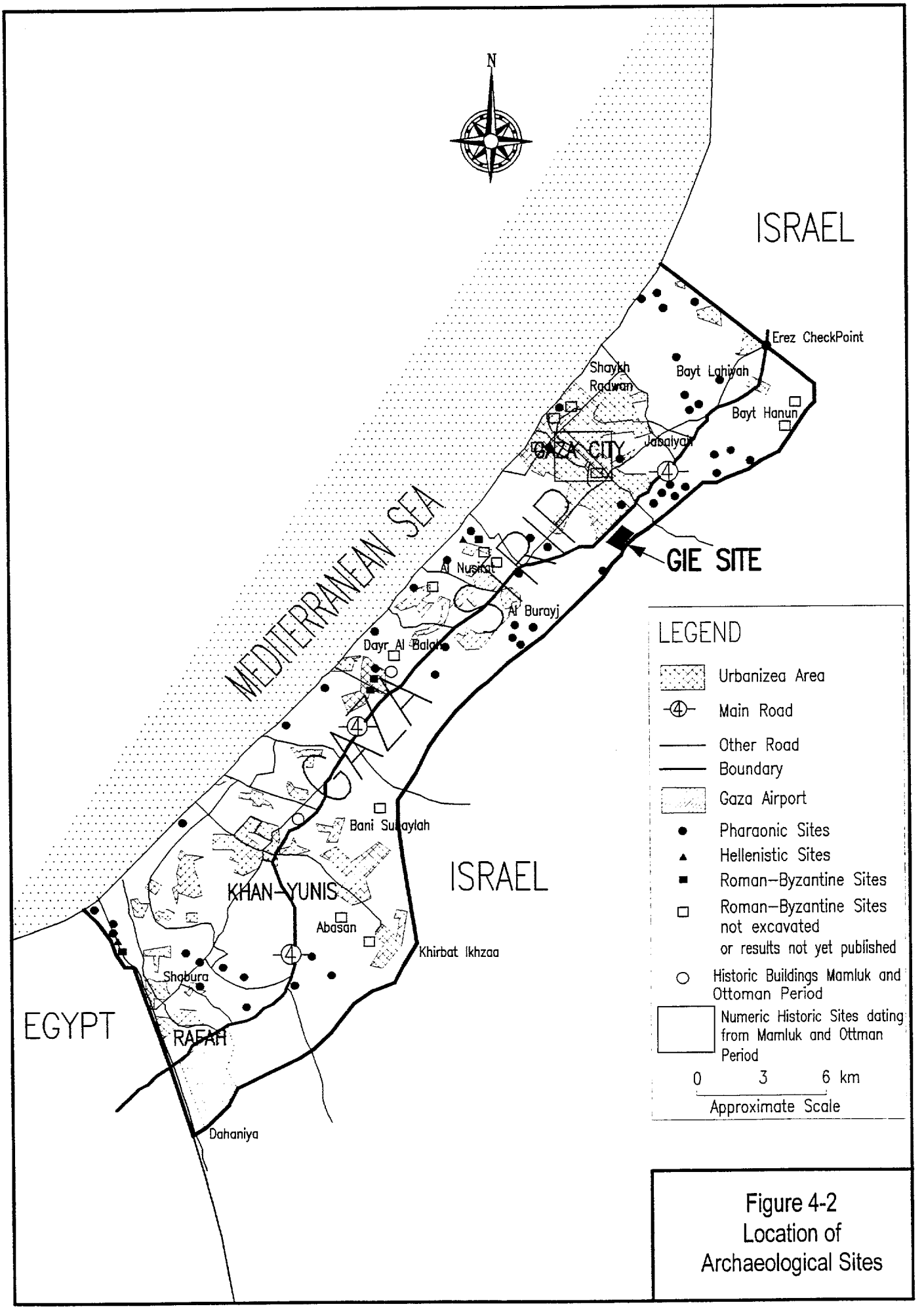


Figure 4-2
Location of
Archaeological Sites

5 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The scope of this EA is to assess the impacts of the proposed GIE with a focus on the off-site infrastructure, which would be funded by USAID and the World Bank. The off-site infrastructure is better defined than the on-site industries, which are not known with enough detail to adequately assess their impacts. Sections 5.1 through 5.8 evaluate the impacts of each of the infrastructural elements taking into account the proposed action and the various alternatives. In Section 5.9, the overall GIE is addressed, including the on-site infrastructure and the tenant industries. Since only assumptions about the general categories of tenants exist, this discussion must be sketchy. Finally, in Appendix H, the EA team looked at the impacts and made suggestions regarding the emergency or interim phase plan for the accelerated construction of the GIE. This activity is outside the scope of USAID or World Bank funding but is considered as a connected action.

On October 28, a scoping meeting was held to gather opinions and concerns regarding the issues and likely impacts that would be associated with the GIE and, in particular, the off-site infrastructure elements. The results of this scoping meeting are summarized in Appendix B. Based on these results and the experience of the EA team, other potential impact areas and issues were added to those that were identified in the scoping meeting. The resulting set of potential impacts and issues are as follows:

- Solid and hazardous waste generation—concern that the various infrastructural elements and the GIE as a whole would produce solid and hazardous wastes that would not be managed in a way to prevent soil and groundwater contamination.
- Water quality—concern that the groundwater would be contaminated directly by the GIE discharges or indirectly through increased salt water intrusion from overexploitation of the groundwater.
- Water resource availability—concern that the overexploitation of groundwater would deplete Gaza's diminishing freshwater supplies.
- Socioeconomic—anticipation of the positive benefits labor-intensive industries would have on the very high unemployment rates in Gaza.
- Land use—concern that the presence of the GIE and its off-site infrastructure might induce inappropriate development in the absence of land use controls (housing for workers located adjacent to industrial uses).

- Lack of ambient standards and discharge limits—concern that the GIE would exacerbate the lack of environmental regulations because of its timing (before controls are in place) or its precedent-setting nature.
- Transboundary concerns—concerns expressed in a memo (Ref. 41) from an Israeli representative that the GIE could adversely affect Israel because of its location. (Effects specifically mentioned were odors from the wastewater treatment plant, handling of chlorine gas, runoff from stormwater, and use of the 100-m security zone between the GIE and the green line.)
- Emissions from the GIE—particular concern over the emissions from the tenants given the lack of air emission regulations.
- Energy supply—particular concerns about the availability of electrical power given the lack of power generation in Gaza and the dependence of Gaza on Israeli electrical power with the potential for being shut off based on political developments.
- Worker safety and health—concern that lack of occupational safety standards could result in industrial accidents.
- Noise—concern that construction or operation of the off-site or on-site infrastructure could result in hearing damage to workers or annoyance to nearby residents.
- Archaeology—concern that, given the long history of human settlement in this part of the world, construction of the GIE could result in irretrievable loss of archaeological resources.
- Flora and fauna—concern that, given the paucity of biological resources in the Gaza Strip (from urbanization and lack of preservation efforts), the GIE would further diminish these resources.
- Loss of agricultural lands—concern that, given the diminishing acreage available for agriculture in the Gaza Strip, the GIE would result in irretrievable loss of agricultural land.

In the following nine subsections, each of the alternatives in each of the infrastructural elements, and the GIE overall, were evaluated against these 14 issues and impact areas. The construction and operational phases were evaluated separately because their impacts are usually quite different. Also, in each section, mitigation measures are suggested—especially for those impacts that were judged to be significant or where there was considerable uncertainty. The EA team judged an impact to be significant based on its duration, magnitude, and extent. Ways to reduce the uncertainty are suggested in most instances. The evaluation of these impacts was conducted by developing a consensus of the entire EA team in group deliberations. Thus, it reflects multiple disciplines and a wide range of experience.

Each subsection below contains a summary table where each alternative is evaluated in terms of whether the impacts would be significant, minor, negligible or none, or uncertain (but potentially significant). Also, the tables indicate whether the EA team thought that the impacts were long term or temporary and whether they would be negative or positive.

5.1 Vehicular Access Options

Table 5-1 illustrates environmental consequences associated with the different proposed options for vehicular access. This table is a simplified and a summarized version of the discussion included in the following sections. Basically, options proposed for the vehicular access have similar environmental consequences except when the option involves a longer route or wider access. Other technical and economic differences are discussed in the section on the description of the proposed action and alternatives.

5.1.1 No-Action Alternative

The no-action alternative is defined here as no construction of the proposed off-site infrastructure services. This may or may not be associated with the construction of the on-site industrial facilities (that is, industries may start moving into the area without planning or off-site infrastructure support since it has already been designated for industrial use). This action will not have an impact during construction because roads will not be constructed; rather the existing roads will be continued to be used. However, heavy use of the badly maintained existing roads will further deteriorate their condition.

During operation, significant short-term impacts will be associated with stormwater management. Stormwater will continue to run along existing roads causing more deterioration. Ponding and soil erosion will be a result of the use of existing roads. Road dirts, including oil and fuel, may reach groundwater resources if stormwater is not properly collected, treated, and disposed of. Land use impacts are uncertain, but additional unplanned construction of new roads may lead to acquisition of private or agricultural lands or could induce other development. Archaeological sites may be subject to destruction by the unplanned construction of new roads.

5.1.2 Vehicular Access Proposed Action (Option 4 of the Conceptual Plans for Roads on Northern Side with Extension of Montar Street)

The proposed action, as with all other actions, will generate debris that will need to be properly handled and disposed of. The impact will be minor and last only during the construction of the roads. It can be mitigated by allocating a specific disposal site for debris or adopting trench-to-truck construction methods. Construction of roads will require minimal amounts of water for construction activities, therefore, the impact will be minor and of a short duration and will not impose significant over-drafting concerns.

Construction of roads will result in a minor, positive, short-term impact on creating job opportunities. Although construction of roads alone will not create many job opportunities, the cumulative impact of all construction work associated with the construction of off-site infrastructure is significant. Operation and maintenance of roads will create a minor, positive, short-term impact due to the need for maintenance and patrolling personnel. To maintain the

positive significance of this impact, construction work should be designed to be as labor intensive as feasible rather than machine operated.

The impact on land use during operation is uncertain, but it could be a minor, negative, short-term impact due to the expansion of roads after the full development of the industrial areas. Construction of roads will be associated with a minor, short-term impact of noise during the construction activities, which can be mitigated by adopting construction management plans that restrict work to daylight hours. Minor long-term noise may be associated with the use of the roads by the cars, buses, and trucks expected to serve the industrial estate.

Construction of roads may cause the destruction of archaeological sites. No known archaeological sites are found in the vicinity of the proposed roads, but due to the lack of archaeological surveys conducted in this area, accidental destruction of archaeological sites may occur. Adopting specific archaeological mitigation and monitoring plans, as described later in this chapter, is essential.

5.1.3 Vehicular Access Option 1 (Road on Northern Side of GIE)

This option will have the same environmental impacts as the proposed action. This option differs from the proposed action in the technical design aspects and the possibility of creating congestion at some intersection points.

5.1.4 Vehicular Access Option 2 (Road on Eastern Side of GIE)

This option will have the same environmental impacts as the proposed action. However, this action involves constructing longer stretches of roadway, which will increase the magnitude of the different impacts as well as increase the construction cost. This action will require acquisition of more lands causing a slight increase in loss of agricultural lands.

5.1.5 Vehicular Access Option 3 (Road on Northern Side of GIE)

This option will have the same environmental impacts associated with option 2.

Table 6-1
Comparison of Impacts Associated with Vehicular Access to the GIE

Environmental Impacts	No Action		Proposed Action (Road on Northern Side and Extension of Muntar Street)		Option 1 (Road on Southern Side)		Option 2 (Road on Eastern Side)		Option 3 (Road on Northern Side)	
	During Construction	During Operation	During Construction	During Operation	During Construction	During Operation	During Construction	During Operation	During Construction	During Operation
Issues Identified at the Scoping Session										
Solid and Hazardous Waste Generation	No construction involves no impacts	No construction involves no impacts	Minor short term negative impact due to disposal of debris	No impact	Same as the proposed action	No impact	Same as the proposed action but slightly higher since this option is longer	No impact	Same as the proposed action but slightly higher since this option is longer	No impact
Water Quality (Wastewater and Stormwater Management; Protection of Groundwater Quality)	No impact	Minor short term. Use of existing roads will result in uncontrolled stormwater	Minor short term negative impact resulting from stormwater. Mitigating by adequately collecting stormwater and monitoring the groundwater quality	No impact	Same as the proposed action	No impact	Same as the proposed action but slightly higher since this option is longer	No impact	Same as the proposed action but slightly higher since this option is longer	No impact
Water Resource Availability (Overexploitation of Groundwater)	No construction involves no additional water withdrawals	No construction involves no additional water withdrawals	Minor short term negative impact due to the need of minimal amounts of water for road construction	No impact during operation. Cleaning roads with water is not a common practice	Same as the proposed action	No impact	Same as the proposed action but slightly higher since this option is longer	No impact	Same as the proposed action but slightly higher since this option is longer	No impact
Socioeconomic (Job Creation)	No construction involves no new jobs	No maintenance involves no new jobs	Minor short term positive impact during the construction	Minor long term positive impact due to the need of road maintenance and patrolling	Same as the proposed action	Same as the proposed action	Same as the proposed action but slightly higher since this option is longer	Same as the proposed action but slightly higher since this option is longer	Same as the proposed action but slightly higher since this option is longer	Same as the proposed action but slightly higher since this option is longer
Land Use	No impact	Uncertain but could result in long term negative impacts due to the unplanned development expected	No impact during construction	Uncertain but could result in long term negative impacts due to the expansion of roads on the expense of the surrounding private lands	No impact	Same as the proposed action	No impact	Same as the proposed action but slightly higher since this option is longer	No impact	Same as the proposed action but slightly higher since this option is longer
Lack of Ambient and Discharge Standards and Controls	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Transboundary Concerns	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Emissions from New Firms	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Energy Supply (Availability of Electric Power and Dependence on Israel)	No impact	No impact	No impact	No impact. Electricity required for lighting is minimal	No impact	No impact	No impact	No impact	No impact	No impact
Worker Health and Safety from Routine Operations and Accidents	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Noise	No impact	No impact	Minor short term negative impacts resulting from construction activities	Minor long term negative impacts resulting from cars and trucks using the roads	Same as the proposed action	Same as the proposed action	Same as the proposed action but slightly higher since this option is longer	Same as the proposed action but slightly higher since this option is longer	Same as the proposed action but slightly higher since this option is longer	Same as the proposed action but slightly higher since this option is longer
Other Impacts Identified by the EA Team										
Archaeology	No impact due to no excavation expected	Uncertain impacts. Unplanned widening and improvement works could destroy archaeological sites	Uncertain impacts. No known archaeological sites in the area, but there is a potential for finding or accidentally destroying sites during excavation works. Adopt mitigation and monitoring plan	No impact	Same as the proposed action	No impact	Same as the proposed action but slightly higher since this option is longer	No impact	Same as the proposed action but slightly higher since this option is longer	No impact
Flora and Fauna	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Loss of Agricultural Land	No impact	No impact	No impact	No impact	No impact	No impact	Same as the proposed action but slightly higher since this option is longer	Same as the proposed action but slightly higher since this option is longer	Same as the proposed action but slightly higher since this option is longer	Same as the proposed action but slightly higher since this option is longer

5.2 Water Supply Options

Table 5-2 identifies the environmental consequences associated with the different options for providing water to the GIE. This table summarizes the information presented in the following sections. In general, the options proposed for water supply involve different levels of local brackish groundwater abstraction with the needed makeup water provided by reusing treated wastewater or acquiring a provision to purchase water from Mekorot (options 2 and 3). The major considerations are water quality, water resource availability, and RO reject water generation and disposal. Other technical and economical differences are discussed for the proposed action and the alternatives.

5.2.1 No-Action Alternative

The no-action alternative is defined as unplanned industrial development, with or without PADICO, in the area of the proposed GIE. It is assumed that, because the site has already been designated for industrial use, industries may move into the area in an uncontrolled manner and without the benefit of planned off-site infrastructure support services. The no-action alternative will not result in impacts during construction except for the uncertainties associated with water well installation, which may be installed either in the upper freshwater or lower brackish water aquifer as there would be no direct management of the water resources.

The no-action alternative poses uncertainty regarding solid and hazardous waste generation. There would be no controls on development, and the production of waste brines and/or sludge from other types of water treatment technologies may be poorly conceived, managed, and disposed of in and around the area of industrial development.

The impact on water quality during the construction phase is also uncertain because there is no control on the number of wells that may be installed. Moreover, the negative impacts could be significant and long-term should the area be developed without a planned approach to set limits on the draft-rate of the aquifer, thereby increasing salt water intrusion and salinization.

The no-action alternative would have no impact on water resource availability during construction. However, there would be a significant, negative, long-term impact on water availability with this alternative because of potentially uncontrolled overdrafts and the lack of a managed water resource.

5.2.2 Water Supply System Proposed Action

The proposed action would result in an environmental impact related to solid and hazardous waste generation during the construction phase that would have a minor, temporary, but negative effect because of pipeline construction. There would also be a possible minor, long-term, negative impact that would result from the production, conveyance, and disposal of RO process

reject waters (brines), which result from brackish water upgrade for domestic (drinking, washing, ablutions) and limited industrial applications. These reject waters will vary from 1 to 3 wt % solids and will be high in sodium, chloride, sulfate, and carbonates. The quantity of RO reject waters may also increase if the future industries require higher quality water. Under the proposed action, the reject waters would initially be trucked to the coast and discharged into the Mediterranean Sea (Phase I). When the GIE is fully developed, the RO rejects would be pumped to the Mediterranean. Regardless of the conveyance method employed, there exists the possibility of spills along the transfer route. This could adversely impact the quality of the fresh water. Also, the method of reject water discharge into the Mediterranean has not been defined. This could result in the potential for improper mixing and dispersal of the reject waters along the beach front, which could impact the water quality and effect a deterioration of this recreational resource. While it is apparent that the existing beachfront waters are of poor quality, this will not likely be the case in the future once improvements of sewerage and sewage treatment facilities are complete for the Gaza Strip. Much of the existing beachfront water pollution results from untreated sewage discharges from the Gaza City WWTP, "beach camps," and raw waste from individual households. Historically, significant water quality improvements have resulted from adequate control and treatment of municipal wastewaters. With improved water quality will come increased residential and commercial development in the beachfront area. Hence, the need to be concerned about the method of RO reject water disposal seems justified. These same issues are common to option 1, but they would not occur with options 2 and 3 because reverse osmosis would not be used in these alternatives.

Water quality impacts that would result from the proposed action during construction are uncertain, but could potentially effect a contamination of the upper freshwater aquifer quality if proper well installation methods are not employed. More significant, long-term, negative water quality impacts may occur during operation of the brackish water wells because of increased salt water intrusion and the potential for increased salinization of this water resource due to overdraft. There is also the long-term potential for cross-contamination of the freshwater aquifer with the underlying brackish water because of corrosion of well casings and/or improper installation of the brackish wells.

Since the sustainable yield of the brackish water aquifer near the proposed well fields has not been defined, it is recommended that a long-term monitoring program be put in place to ensure that the supply of brackish water to the industrial estate does not result in overdraft of the aquifer. Based on the previous groundwater studies, the availability of this brackish water resource does not appear to be a concern. However, five agricultural wells close to the GIE site currently withdraw water from the brackish water aquifer. The projected future water demand for the GIE is estimated at 3,200 cubic meters per day, which is significant. There are also concerns about the long-term yield of these wells. Consequently, the recommendation that a long-term water level monitoring program be put in place to ensure that the supply of "brackish" water not be overburdened seems prudent. To moderate the effects of increased aquifer salinization, a program to reduce industrial water use should be implemented at each industry. The program would involve a combination of wastewater reuse and the implementation of treatment in-place high-quality water conservation technologies that would permit each industry to reduce its overall

water use requirements and, thereby, cut back on brackish well water use. Financial incentives to increase industrial water conservation should also be considered.

The proposed action would not impact water resource availability during construction. However, a significant, long-term, negative impact could occur due to overdraft of the brackish water aquifer because of salt water intrusion and increased salinization. Overdraft of the brackish water aquifer will adversely impact the water quality and quantity of the overlying freshwater aquifer.

Because abstraction of water from the Gaza aquifer is a major concern for future water availability, abstraction from all wells in the region should be monitored. The use of other water resources and stormwater should be reevaluated as the actual water demand associated with the different water uses at the GIE are more fully defined. Policies for water pricing should be studied to arrive at approaches to encourage conservation and water reuse as described previously.

The proposed action would have a minor, but temporary, positive impact on socioeconomics (job creation) during construction and a minor, long-term, positive impact during operation since skilled labor will be required for the operation and maintenance of the water supply facilities throughout the life of the GIE.

The proposed action would have no impact on land use during both the construction and operation phases of the GIE.

The proposed action would have no impact on air quality, energy supply, and worker health and safety considerations during the construction phase of the GIE. The same is true for the operations phase, except for minor, long-term, negative health and safety impacts associated with the operation of the chemical conditioning activities of the RO unit.

There will be minor, temporary, and long-term negative impacts associated with the creation of noise during the construction and operations phases, respectively. This noise originates from the operation of light to heavy machinery for well construction and pumps and mixers during RO plant operation.

5.2.3 Water Supply System Option 1

This option will have similar environmental considerations for solid and hazardous waste generation as the proposed action. The same water quality issues are common to option 1, but to a lesser extent because less brackish water is pumped under this alternative.

5.2.4 Water Supply System Option 2

This option will have similar environmental considerations for water quality and quantity as the proposed action, but to a lesser extent as less brackish water is pumped under this alternative because of the use of Mekorot water in lieu of RO treatment for potable water needs. However,

there is also the potential for a minor, temporary, negative impact during construction associated with the installation of the Mekorot pipeline under this option. This option would have minor, temporary, negative impacts on land use during the construction phase. These negative impacts would continue through the operation of the GIE.

There are also significant transboundary concerns under this option resulting from the installation and operation of a pipeline to carry Mekorot water to the GIE from Israel. There are uncertainties regarding damage to archaeological sites and impacts on flora and fauna during pipeline construction with this option.

5.2.5 Water Supply System Option 3

Option 3 may result in a minor, temporary, negative impact on water quality during construction because of the installation of a larger Mekorot pipeline than option 2. However, option 3 is assumed to provide a significant, positive, long-term effect on water quality during operation because a fresh water resource (Mekorot water) would be brought to the site from outside the area. This option serves to eliminate the need for possible RO treatment of the water for domestic and industrial use, thereby eliminating the production of brine for ultimate disposal. Option 3 has the net effect of improving the water quality of the Gaza aquifer (provided the Mekorot water is of better quality than the available resource) because it permits eventual direct recharge of a freshwater resource into the upper aquifer when the treated effluent is used for irrigation of local agriculture. Option 3 also would not impact water resource availability during construction. Option 3 is assumed to offer a significant, positive, long-term effect on water resource availability because the aquifer would not be pumped during operation of the GIE.

However, option 3 would provide no additional job creation during GIE operation because water generation and upgrading would occur outside of the Gaza Strip. There are also significant transboundary concerns under this option, which result from the installation and operation of a pipeline to convey 3,200 m^3/day of Mekorot water to the GIE from Israel and the possible depletion of a water resource of unknown quantity from outside Gaza. The same uncertainties as in option 2 regarding damage to archaeological sites and impacts on flora and fauna exist during pipeline construction with this option.

Table 6-2
Comparison of Impacts Associated with Water Supply Systems

Environmental Impacts	No Action Development Without Planning		Proposed Action (Dual Brackish /RO Water Without Recycle)		Option 1 (Dual Brackish /RO Water Without Recycle)		Option 2 (Dual Brackish/Mekorot)		Option 3 (Mekorot Water)	
	During Construction	During Operation	During Construction	During Operation	During Construction	During Operation	During Construction	During Operation	During Construction	During Operation
ssues Identified at the Scoping Session										
Solid and Hazardous Waste Generation	No impact	Uncertain because of uncontrolled development	Minor short term negative impact	Minor long term negative impact	Same as proposed action	Same as proposed action	No impact	No impact	No impact	No impact
Water Quality (Wastewater and Stormwater Management; Protection of Groundwater Quality)	Uncertain because brackish water wells may still be constructed	Significant long term negative impact because area will be developed without planning	Uncertain potential for cross-contamination of aquifers	Significant long term negative impact due to salinization	Same as proposed action	Same as proposed action	Uncertain for aquifer quality, minor short term impact for pipeline	Same as proposed action	Minor short term negative impact	Significant long term positive impact
Water Resource Availability (Overexploitation of Groundwater)	No impact	Significant long term negative impact because area will be developed without planning	No impact	Significant long term negative impact due to over-draft	No impact	Slightly less than proposed action	No impact	Same as proposed action but less significant	No impact	Significant long term positive impact
Socioeconomic (Job Creation)	Minor short term positive impact	Minor long term positive impact	Minor short term positive impact	Minor long term positive impact	Same as proposed action	Same as proposed action	Same as proposed action	Same as proposed action	Same as proposed action	No impact
Land Use	No impact	No impact	No impact	No impact	No impact	No impact	Minor short term negative impact	Minor long term negative impact	Minor short term negative impact	Minor long term negative impact
Lack of Ambient and Discharge Standards and Controls	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Transboundary Concerns	No impact	No impact	No impact	No impact	No impact	No impact	Minor short term negative impact	Significant long term negative impact	Minor short term negative impact	Significant long term negative impact
Emissions from New Firms	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Energy Supply (Availability of Electric Power and Dependence on Israel)	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Worker Health and Safety from Routine Operations and Accidents	No impact	No impact	No impact	Minor long term negative impact from handling of chemicals	No impact	Same as proposed action	No impact	No impact	No impact	No impact
Noise	Minor short term negative impact	Minor long term impact	Minor short term negative impact	Minor long term negative impact	Same as proposed action	Same as proposed action	Same as proposed action	Same as proposed action	Same as proposed action	Same as proposed action
Other Impacts Identified by the EA Team										
Archaeology	Uncertain. Potential destruction during construction	No impact	Uncertain. Potential destruction of sites during construction	No impact	Same as proposed action	No impact	Same as proposed action	No impact	Same as proposed action	No impact
Flora and Fauna	No impact	No impact	No impact	No impact	No impact	No impact	Uncertain/pipeline	No impact	Uncertain	No impact
Loss of Agricultural Land	No impact	No impact	No impact	No impact	No impact	No impact	Minor short term negative impact	No impact	Minor temporary negative impact	No impact

5.3 Wastewater Treatment and Stormwater Management

Table 5-3 identifies the environmental consequences associated with the different options for providing wastewater treatment and management of stormwater at the GIE. The table summarizes the discussion included in the following subsections. All of the options for wastewater treatment are essentially similar in that they provide for wastewater pretreatment of each industrial wastewater to proposed specified effluent quality limits (see Appendix F) and then send the combined pretreated effluent to end-of-pipe treatment. The end-of-pipe wastewater treatment options were also similar in that they provide for a combination of wastewater screening, equalization, biological treatment, post-equalization, tertiary filtration, and chlorination of treated effluents in each case. The biological treatment technologies used in each of the options were not significantly different from the proposed action and, consequently, did not warrant separate impact analysis. Also the biological sludge digestion and drying option was the same for each wastewater treatment system option.

For all options, stormwater is collected from the GIE and combined with the treated effluent from the end-of-pipe wastewater treatment plant in a final effluent disposal pumping station for conveyance to application at an agricultural reuse and groundwater recharge site. Therefore, the impact analysis was conducted by comparing the no-action alternative to the proposed action only. Wastewater and stormwater disposal methods are considered in a separate impact analysis section.

5.3.1 No-Action Alternative

For the purpose of analysis, the no-action alternative is defined as unplanned industrial development with no industrial wastewater pretreatment or end-of-pipe treatment of contaminated effluents. However, it is assumed that since the area has already been designated for industrial use, it will undergo industrial development with or without the involvement of PADICO. The no-action alternative will not impact anything during construction because no facilities will be provided for wastewater treatment or stormwater management at the site.

During operation, significant, long-term, negative impacts associated with water quality will occur because of uncontrolled discharges of untreated industrial wastewater to the environment. These discharges will impact both surface and groundwater and result in unacceptable levels of toxic and hazardous substances in the environment. These toxic and hazardous constituents will include heavy metals (such as As, Ba, Cd, Cr, Cu, Pb, Ni, Ag, and Zn) and organic substances such as aromatics, phenolics, phthalates, and solvents (methyl chloride). Acids, alkali, surfactants, and dyes may also be discharged and will have an adverse impact on aesthetics, as well as result in toxicity to local flora and fauna.

These uncontrolled discharges may also have a significant, long-term, negative impact on air quality in the immediate area resulting from odors and fumes that emanate from industrial wastes (such as paint vapor controls, alkaline or acid wastes, and spray booth quenches). Uncontrolled

wastewater discharges will also result in the loss of agricultural land beyond the immediate area, and these impacts could be long term and severe.

The no-action alternative will set a harmful precedent for noncompliance with certain industrial categories, which could make it more difficult to regulate industries in the future. It is also uncertain how these uncontrollable discharges would impact transboundary concerns.

5.3.2 Wastewater Treatment and Stormwater Management Proposed Action

During construction, the proposed action will result in minor, temporary, negative impacts associated with solid waste generation, water quality, noise, flora and fauna, and agricultural land use. However, all of these impacts can be mitigated using standard construction practices and procedures. What impact construction might have on archaeological sites would also need special consideration.

The construction and operation of the GIE wastewater treatment facilities would have a minor, positive impact on employment, primarily in the skilled labor categories.

During operation, the proposed action would result in a minor, long-term, positive impact on water resource availability because waters treated in the GIE industrial wastewater treatment facility would be used for irrigation of crop land and aquifer recharge. All stormwater runoff from the GIE would also be used for irrigation and recharge. The wastewater treatment facility would have a significant, long-term, positive effect on the development of ambient and discharge quality standards and controls for industries in the Gaza Strip by establishing a favorable precedent regarding the control of toxic and hazardous substances in industrial wastewater and sludges. This positive impact would also be extended to the development of standards for disposal of solid hazardous materials, solvents, and refuse from industrial operations (albeit minor).

Minor, negative, water quality impacts could result from treatment system equipment failures and/or process performance upsets associated with the operation of the wastewater treatment facilities. With stormwater management, effluent quality deterioration can result from the buildup of sand and silt in the effluent disposal pumping station and the possible presence of untreated contaminants in runoff from the industrial sites. These same negative impacts can result from improper management of industrial pretreatment sludges, either at the GIE or the Gaza Municipal Landfill. However, given that controls at the landfill are already in place, the impacts would be minor.

Other areas that would experience minor, long-term, negative impacts are air quality in the vicinity of the sludge drying beds; worker health and safety in and around chlorine-handling facilities; and noise related to the operation of pumps, surface aerators, and other mechanical equipment.

Table 6-3
Comparison of Impacts Associated with Wastewater Treatment and Stormwater Management

Environmental Impacts	No Action (Industrial development without planning and without wastewater treatment)		Proposed Action (Industrial wastewater pretreatment with SBR treatment at end-of-pipe)	
	During Construction	During Operation	During Construction	During Operation
Issues Identified at the Scoping Session				
Solid and Hazardous Waste Generation	No impact	No impact	Minor short term negative impact	Minor long term negative impact. Potential positive impacts due to the use of dried sludge
Water Quality (Wastewater and Stormwater Management; Protection of Groundwater Quality)	No impact	Significant long term negative impact	Minor short term negative impact	Minor long term negative impact
Water Resource Availability (Overexploitation of Groundwater)	No impact	No impact	No impact	Minor long term positive impact
Socioeconomic (Job Creation)	No impact	No impact	Minor long term positive impact	Minor long term positive impact
Land Use	No impact	No impact	No impact	No impact
Lack of Ambient and Discharge Standards and Controls	No impact	Significant long term negative impact from uncontrolled discharge of industrial wastewater	No impact	Significant long term positive impact. Establish performance criteria in line of regulations
Transboundary Concerns	No impact	Uncertain	No impact	No impact
Air Quality	No impact	Significant long term negative impact results in odor and fumes from uncontrolled discharges	No impact	Minor long term negative impact from drying sludge beds
Energy Supply (Availability of Electric Power and Dependence on Israel)	No impact	No impact	No impact	No impact
Worker Health and Safety from Routine Operations and Accidents	No impact	No impact	No impact	Minor long term negative impact from handling chlorine and bacterial aerosols
Noise	No impact	No impact	Minor short term negative impact	Minor long term negative impact. Pump motors, surface aerators and other mechanical equipment
Other Impacts Identified by the EA Team				
Archaeology	No impact	No impact	Uncertain	No impact
Flora and Fauna	No impact	Significant long term negative impact	Minor short term negative impact	Minor long term positive impact
Loss of Agricultural Land	No impact	Significant long term negative impact	Minor shert term negative impact	Minor long term positive impact

5.4 Environmental Consequences and Mitigating Measures for Treated Wastewater and Stormwater Disposal

Table 5-4 identifies the environmental consequences associated with the different options for treated wastewater and stormwater disposal. This table summarizes the discussion included in the following subsections. There were originally three options for effluents disposal proposed in the GIE wastewater management plan report (Ref. 1). The first option recommended pumping the treated effluent and stormwater to the UNDP facilities for storage and reuse as irrigation water. The second option, which is the proposed action, recommended pumping the treated effluents and stormwater to Wadi El-Katron for irrigation reuse and infiltration. The final option recommended storing the treated effluents on-site so that they could be available to local farmers to haul to their land. All the options involve irrigation reuse and recharge. The proposed action was preferred because the Wadi El-Katron is less than 3 km from the planned industrial estate and a number of farmers along the Wadi have expressed interest in using the water for irrigation of citrus crops in the region. Presently, a number of these farmers use brackish wellwater for this purpose.

Consequently, the environmental impact analysis for treated wastewater and stormwater disposal was conducted by comparing the no-action alternative to the proposed action. Results of the analysis of environmental consequences and mitigating measures follows.

5.4.1 No-Action Alternative

The no-action alternative is defined as unplanned development in the area of the proposed GIE with or without the involvement of PADICO. The discharge of untreated wastewater into the environment will be uncontrolled under this option. Since the site has already been designated for industrial use, development will proceed without the benefit of a planned off-site infrastructure support service. This action will not impact anything during construction because no facilities will be built to support the disposal of the untreated wastewaters.

During operation, significant, long-term, negative impacts on the water quality of surface and groundwater are expected under this option. These impacts are similar to those described in Section 5.3.1 for the no-action option associated with wastewater treatment. A significant negative impact on the development of ambient and discharge quality standards and controls would also occur as discussed in Section 5.3.1. Similarly, there would be significant negative impacts on air quality and worker health and safety. These impacts were also discussed under the wastewater treatment impact analysis. In general, the no-action alternative would result in significant, long-term, negative environmental impacts associated with plant life and cropland deterioration.

5.4.2 Treated Wastewater and Stormwater Disposal Proposed Action

The proposed action would involve construction of a pipeline from the GIE to Wadi El-Katron, where the treated effluents and stormwater would be deposited. In general, the proposed action would not have an impact during construction except for the possible effect on potential archaeological sites and the minor, temporary impact on flora and fauna along the route of the pipeline.

During operation, the proposed option, with its strict controls, would result in significant, long-term, positive impacts on the development of ambient and discharge quality standards and controls for irrigation and treated wastewater effluent recharge. As presently proposed, the use of industrial effluent for irrigation and recharge would require an extensive groundwater monitoring system to guarantee that industrial pollutants would not deteriorate aquifer water quality. Such a monitoring program would establish a favorable precedent for the creation of criteria and regulatory standards for this application.

During operation, the proposed action would result in a minor, long-term, positive impact on water availability because the treated wastewater from the GIE would be returned to the aquifer (upper aquifer) during irrigation and recharge. All stormwater runoff from the GIE would also go to irrigation and recharge. However, the salt content of this water would have a minor, long-term, negative impact on water quality. In some incidences, it may cause water logging and salinization of the soils in the area where agricultural activities are occurring. Other potential effects include the increased incidence of water-borne diseases and increases in agricultural pests. Nevertheless, these impacts can be mitigated by the liming ($Ca(OH)_2$) of the soils in the immediate area of the treated wastewater application. This will both lower the sodium adsorption ratio (SAR) and help control potential pathogens in the wastewater. The design process provides for chlorination of the wastewater prior to its use as irrigation water, which should help reduce the incidence of water-borne diseases.

The use of high TDS water for agricultural irrigation will require careful management because these waters can have adverse effects on many crops. Most tree crops and woody plants are sensitive to high concentrations of sodium and chloride in irrigation water. However, many annual crops are not sensitive.

The proposed action also provides for indirect groundwater recharge through the process of streambed infiltration. Water also percolates into the upper aquifer through spread-irrigation methods. There is a need to establish specific water quality criteria for groundwater recharge (see Appendix F) to guarantee that pollutants such as nitrate, ammonia, oil, and biochemical oxygen demand not exceed water quality levels for public acceptance. These water quality criteria need to be developed before extensive groundwater recharge using industrial effluents is permitted to occur.

The proposed action would also have a minor, long-term, positive impact on the development of farmland and the creation of jobs in agriculture. The net effect should be an increase in the land available for cultivation or an intensification of crop production in a smaller area. However,

Table 6-4
Comparison of Impacts Associated with Treated Wastewater and Stormwater Disposal Methods

Environmental Impacts	No Action (Industrial development without planning and with uncontrolled effluent discharge)		Proposed Action (Irrigation and recharge using Wadi El-Katron for conveyance)	
	During Construction	During Operation	During Construction	During Operation
ues Identified at the Scoping Session				
lid and Hazardous Waste Generation	No impact	No impact	No impact	No impact
ater Quality (Wastewater and Stormwater anagement; Protection of Groundwater Quality)	No impact	Significant long term negative impact from discharge of untreated wastewater.	No impact	Minor long term negative impact. Treated wastewater to specified limits but with high salinity
ater Resource Availability (Overexploitation of oundwater)	No impact	No impact	No impact	Minor long term positive impact. Potential groundwater recharge
cioeconomic (Job Creation)	No impact	No impact	No impact	Minor long term positive impact. More industrial jobs and continued development of farmland (more
nd Use	No impact	No impact	No impact	Minor long term positive impact. Additional land for cultivation
ck of Ambient and Discharge Standards and Controls	No impact	Significant long term negative impact	No impact	Significant long term positive impact. Establish standards based on need
ansboundary Concerns	No impact	No impact	No impact	No impact
r Quality	No impact	Significant long term negative impact. Results in odor and fumes from uncontrolled discharge	No impact	No impact
ergy Supply (Availability of Electric Power and ependence on Israel)	No impact	No impact	No impact	No impact
orker Health and Safety from Routine Operations and cidents	No impact	Significant long term negative impact. Direct health concerns for farmers using the water or residents in the vicinity	No impact	Minor long term negative impact
oise	No impact	No impact	No impact	No impact
her Impacts Identified by the EA Team				
chaeology	No impact	No impact	Uncertain. Potential destruction of	No impact
ora and Fauna	No impact	Significant long term negative impact. Plant life deterioration	Minor short term negative impact during pipeline construction	Minor long term positive impact. Providing water for irrigation around the site
oss of Agricultural Land	No impact	Significant long term negative impact. Crop land deterioration	No impact	Minor long term positive impact. Providing water for irrigation around the site

these benefits depend on the long-term impact of the salt content of the irrigation waters on crop development and yield.

5.5 Solid Waste Disposal

The proposed action for the disposal of solid waste that will be generated from GIE activities involves the transfer of the waste to the Gaza Municipal Landfill. No other alternatives were considered to be viable options. The landfill, located approximately 1.5 km south of the GIE, is operated and maintained by the Municipality of Gaza. Based on conversations with the municipality, solid waste from the GIE will be accepted at the landfill regardless of the type or quantity of waste produced.

The proposed action (described in Section 3.8) has been measured against a no-action alternative. Table 5-5 summarizes the results of the impact analysis and provides a comparison of impacts between the proposed action and the no-action alternative. The results are discussed in detail below.

5.5.1 No-Action Alternative

The no-action alternative involves a solid waste management program that does not transfer the GIE solid waste to the Gaza landfill. No defined waste disposal mechanism would be available and, therefore, the waste would be disposed of improperly. Significant negative impacts are anticipated if the no-action alternative is selected.

If the solid waste from the GIE cannot be transferred to the Gaza landfill, the two conceivable alternatives for disposing of the waste are dump sites and open burning. Although these waste disposal practices are no longer acceptable in the Gaza Strip, no controls are in place to completely eliminate indiscriminate dumping. Open burning is prevented by local police when possible as there is an ordinance against this practice.

It is expected that if the waste from the GIE is not channeled to an approved landfill, water quality and flora and fauna would be affected. Uncontrolled dumping can cause stormwater contamination from surface runoff and infiltration of contaminants into the soils and groundwater. Surface runoff and soil contamination can also impact vegetation and sensitive habitats.

Illegal waste dumping and open burning may occur in vacant areas that are privately or publicly owned. As a result, conflicts and liability may arise in the future. Also, these practices may impact land use by altering the conditions of the soils and restricting the use of the land specifically for agriculture and rangeland purposes.

There is concern for the health and safety of the GIE workers who will handle the disposal of solid waste. Without the proper mechanism for transferring waste off site, it would be unsafe for workers to handle the ultimate disposal of hazardous waste. The implementation of the no-action

alternative could result in many significant negative impacts. The lack of a proper waste disposal mechanism would clearly create environmental problems in the Gaza Strip. Transferring the solid waste to the Gaza landfill would be the most suitable approach to control waste disposal practices and minimize environmental impacts.

5.5.2 Proposed Action: Transfer of Solid Waste from the GIE to the Gaza Landfill

The impact analysis shows that minor negative and positive impacts would result from the implementation of the proposed action. An EA team visit to the Gaza landfill and conversations with the Municipality of Gaza on the operation of the landfill indicated that the landfill is well managed. However, since the landfill is not lined and a leachate collection system is not in place, future disposal of the GIE waste may negatively impact the environmental condition of the landfill area if hazardous waste is not properly segregated. Based on the type of industrial operations planned at the GIE, the following categories of wastes will be generated:

- Municipal waste (for example, domestic trash)
- Industrial waste (solids such as metal cuttings, plastics, and excess material)
- Sludge collected from industrial pretreatment operations
- Residues from the biological process at the proposed wastewater treatment plant

The characteristics of these wastes clearly differ from one category to another.

With the support of the European Union (EU), the municipality is currently constructing a cell in the landfill area with a plastic liner and a leachate collection system to store future hazardous waste including industrial and medical wastes. Completion is planned for mid-1997. Without these controls, the landfill would not meet the standards for accepting hazardous waste and landfill disposal would not be an option. Although a leachate monitoring system is in place at the landfill, no means for leachate collection is available.

Minor negative impacts could arise in the area's water quality, land use, worker health and safety, noise, flora and fauna, and loss of farmland. These impacts are long term, however, they are manageable under defined controls, such as the institution of a solid waste management program. Such a program would create jobs in waste collection, waste segregation, and waste transfer and therefore have a minor, long-term, positive socioeconomic benefit.

The construction of the hazardous waste storage cell and the leachate collection system in the landfill will complement the proposed action and should be completed as planned. It is recommended that a simple manifest or tracking system be maintained by the individual tenant industries to document the materials used in the processes. Waste should be properly manifested using either material safety data sheets for each chemical used or sample analysis results for the waste generated. Testing procedures for the waste would vary and would depend on the nature of

Table 6-5
Comparison of Impacts Associated with Solid Waste Disposal

Environmental Impacts	No Action		Proposed Action (Transfer Solid Waste to Gaza Landfill)	
	During Construction	During Operation	During Construction	During Operation
Issues Identified at the Scoping Session				
Solid and Hazardous Waste Generation	No impact	Significant long term negative impact	No impact	Minor long term negative impact if proper disposal controls are not adopted
Water Quality (Wastewater and Stormwater Management; Protection of Groundwater Quality)	No impact	Significant long term negative impact due to improper solid waste disposal may lead to groundwater contamination	No impact	Minor long term negative impact if solid waste is not properly managed which could lead to groundwater contamination
Water Resource Availability (Overexploitation of Groundwater)	No impact	No impact	No impact	No impact
Socioeconomic (Job Creation)	No impact	No impact	No impact	Minor long term positive impact. Create job opportunities for waste collection
Land Use	No impact	Significant long term negative impact due to possibility of altering land use patterns	No impact	Minor long term negative impact. Land use is altered by expanding landfill to accommodate waste
Lack of Ambient and Discharge Standards and Controls	No impact	Significant long term negative impact due to absence of control measures	No impact	Minor long term negative impact. Absence of controls and standards, but evolving good management practices
Transboundary Concerns	No impact	No impact	No impact	No impact
Emissions from New Firms	No impact	No impact	No impact	No impact
Energy Supply (Availability of Electric Power and Dependence on Israel)	No impact	No impact	No impact	No impact
Worker Health and Safety from Routine Operations and Accidents	No impact	Significant long term negative impact due to exposure of workers to dangerous waste handling	No impact	Minor long term negative impact. Apply training programs
Noise	No impact	No impact	No impact	Minor long term negative impact caused by waste collection activities
Other Impacts Identified by the EA Team				
Archaeology	No impact	No impact	No impact	No impact
Flora and Fauna	No impact	Significant long term negative impact as solid waste may contaminate and harm vegetation and animals	No impact	Minor long term negative impact. Surface runoff could carry away wastes to affect vegetation
Loss of Agricultural Land	No impact	Significant long term negative impact as solid waste may contaminate and harm croplands	No impact	Minor long term negative impact. Land will be acquired for expansion of landfill

the data gap such as the unknown characteristics of a sludge or the unknown characteristics of a solid waste leachate. Once the waste property is known, the waste can be placed in the landfill cells according to its hazardous or nonhazardous property.

Studies are currently being conducted on recycling and composting opportunities under the auspices of the EU. These efforts could result in the minimization of solid waste disposal thereby reducing or eliminating some of the environmental impacts identified in the EA. Incineration has not yet been considered for the Gaza Strip, however, this treatment approach, when properly designed and operated, can reduce solid waste disposal impacts on land availability.

5.6 Telecommunication Services

Based on the Off-Site Infrastructure Conceptual Plan (Ref. 11), the preferred alternative for the telecommunication infrastructure is option 3, which is described in Section 3.9. Since the other two options addressed in Reference 11 were not considered feasible by the parties involved, only option 3 and a no-action alternative have been further evaluated to determine their impact and identify mitigation measures. Table 5-6 summarizes the results of the impact analysis and provides a comparison of impacts between option 3 and the no-action alternative. The results are discussed in detail below.

5.6.1 No-Action Alternative

The no-action alternative would be to develop the site into an industrial complex with no comprehensive telecommunication infrastructure (for example, firms would provide their own telephone service). Therefore, no communication lines would be connected to the GIE site from the GCE.

5.6.2 Proposed Action: Dedicated Fiber-Optic Cable from the GCE to the GIE

The EA team's evaluation determined that there are no significant environmental impacts associated with the installation of telecommunication lines in accordance with option 3. However, uncertainties and minor negative and positive impacts have been identified in some environmental areas. There is the potential that archaeological resources exist in the area where buried telecommunication lines would occur.

Because no archaeological studies have been conducted in the immediate area of the GIE site, insufficient information is available to exclude the possibility that artifacts exist. It is therefore not known whether archaeological artifacts could be uncovered during drilling and excavation activities that would be conducted along Highway 4 and the access road. Therefore, mitigation measures should be taken to ensure that archaeological resources are protected in the event they are encountered. These are discussed in Chapter 6.

Table 6-6
Comparison of Impacts Associated with Telecommunication Infrastructure

Environmental Impacts	No Action		Proposed Action (Dedicated Fiber-Optic Line from GCE to GIE)	
	During Construction	During Operation	During Construction	During Operation
Issues Identified at the Scoping Session				
Solid and Hazardous Waste Generation	No impact	No impact	Minor short term negative impact due to construction of underground lines	No impact
Water Quality (Wastewater and Stormwater Management; Protection of Groundwater Quality)	No impact	No impact	Minor short term negative impact associated with erosion during construction	No impact
Water Resource Availability (Overexploitation of Groundwater)	No impact	No impact	No impact	No impact
Socioeconomic (Job Creation)	No impact	No impact	Minor short term positive impact	No impact
Land Use	No impact	No impact	No impact	No impact
Lack of Ambient and Discharge Standards and Controls	No impact	No impact	No impact	No impact
Transboundary Concerns	No impact	No impact	No impact	No impact
Emissions from New Firms	No impact	No impact	No impact	No impact
Energy Supply (Availability of Electric Power and Dependence on Israel)	No impact	No impact	No impact	Minor short term negative impact due to dependence on Israel
Worker Health and Safety from Routine Operations and Accidents	No impact	No impact	No impact	No impact
Noise	No impact	No impact	Minor short term negative impact due to construction works	No impact
Other Impacts Identified by the EA Team				
Archaeology	No impact	No impact	Uncertain. Potential destruction of archaeological sites	No impact
Flora and Fauna	No impact	No impact	No impact	No impact
Loss of Agricultural Land	No impact	No impact	No impact	No impact

It is expected that minor negative and positive impacts will result from the development of the telecommunication infrastructure. The negative impacts relate to solid waste generation, water quality, energy supply, and worker health and safety. It is expected that construction rubble will be generated from excavation and paving activities and will require disposal. Also, during excavation and filling operations, sediment runoff occurring in rainy periods would enter the stormwater system if erosion controls are not in place. Further, the Gaza Strip currently depends on Israel for telecommunication. The proposed action would prolong this dependency. Lastly, workers may be exposed to accidents during construction if safety measures are not instituted. These impacts are unlikely, can be easily avoided in some cases, and do not represent a major concern when weighed against the overall benefits.

The proposed action will provide jobs in the short term during construction. This impact is positive but minor since the quantities and the duration of the jobs created are not significant.

5.7 Provision of Electric Power

The proposed action for providing electric power to the GIE over the short term (Phase I) is to provide 3 MW of power from two feeder lines that the PEA would route to the site from power imported from Israel. Even with this purchased power, a standby diesel generator is proposed. Because it is premised to be used up to 10 hours per day, the standby generator would probably supplement the purchased power (rather than serve as an emergency backup); therefore this analysis evaluates the standby diesel generator as a peaking plant. The ultimate power requirements (Phase III) for the GIE assume that either a large, new, combined cycle power plant will be built in Gaza to service much of the Gaza Strip or that a large diesel generator dedicated to the GIE will be constructed off site. Either of these two power plants would be subject to a separate EA and therefore only the Phase I option and the no-action alternative are considered in this section.

5.7.1 No-Action Alternative

The no-action alternative designates that the powerlines and the standby generator would not be funded by USAID or the World Bank and that the industries developed at the site would purchase their electricity from the PEA, which in turn, purchases its power from the Israelis. Because there is no operation of a standby generator, there would be no environmental impact. The availability and reliability of power would be uncertain, however. The uncertainty stems from two causes: power provided from the Israelis is nearing maximum capacity of the feeder lines, and power could be intentionally interrupted because of political circumstances. If the plans for either a dedicated power plant or a large combined cycle power plant materialize, the issue of power reliability would be temporary.

5.7.2 Proposed Action

The proposed action results in few impacts, none of which are significant. Water quality could be impacted as a result of improper fuel handling and storage. The greatest threat is the loss of the diesel fuel from the storage container with subsequent contamination of the soil and ultimately groundwater. Secondary containment (a mound or wall around the container) and impervious cover inside the containment area are recommended. Although an underground storage tank would conserve space, the U.S. and other areas with a long history of underground storage tanks have experienced that the tanks eventually leak and contaminate the groundwater unless extraordinary controls and monitoring exist. An above-ground fuel container is more easily monitored for leaks.

The generator would emit minor amounts of combustion products (carbon monoxide, sulfur dioxide, oxides of nitrogen) plus some particulate matter and therefore would contribute to a minor amount of air pollution. Emission controls for small diesel-powered generators are probably not cost-effective especially given that air quality is not a critical issue in the Gaza Strip. Therefore, emission control strategies could focus on assuring fuel quality (low sulfur content) and upon minimizing the use of the generator.

The generator would also pose a potential noise problem. With some containment and consideration for the location of the generator, it is not likely that the noise would be significant.

The location of the generator is still uncertain. It should take into account the need for secondary containment of the fuel storage, the need for noise shielding, and the provision of at least 30 meters of a buffer zone for dispersion of air pollutants and attenuation of noise.

5.7.3 Option 1

The alternative to the proposed action for Phase I is to bury the power lines leading to the GIE. The initial costs and repairs could be higher for this option. The environmental tradeoff between overhead and buried power lines is that buried lines are more aesthetic. These are long-term benefits, but the aesthetic quality is marginal given that there are no visually sensitive resources in the immediate area. The ditching required for the buried lines would pose a short-term and, at most, minor impact from runoff of stormwater in the area of disturbed surfaces. But the potential for disruption of archaeological resources is greater when ditching is involved as opposed to overhead lines, which only disrupt the surface.

5.8 Environmental Impacts Associated with On-Site Activities

The focus of this EA is on the off-site infrastructural elements. However, for this EA to be a comprehensive study that covers all aspects and activities related to the GIE project, the EA team decided to dedicate a separate section to briefly discuss on-site activities and to evaluate the GIE

Table 6-7
Comparison of Impacts Associated with Power Supply

Environmental Impacts	No Action		Proposed Action		Option I/Phase I	
	During Construction	During Operation	During Construction	During Operation	During Construction	During Operation
ssues Identified at the Scoping ession						
olid and Hazardous Waste eneration	No impact	No impact	No impact	No impact	No impact	No impact
ater Quality (Wastewater and ormwater Management; otection of Groundwater uality)	No impact	No impact	No impact	Minor long term negative impact	Minor short term impact	Same as proposed action
ater Resource Availability Overexploitation of roundwater)	No impact	No impact	No impact	No impact	No impact	No impact
ocioeconomic (Job Creation)	No impact	No impact	Minor short term positive impact	Minor long term positive impact	Minor short term positive impact	Same as proposed action
and Use	No impact	No impact	No impact	No impact	No impact	No impact
ack of Ambient and Discharge andards and Controls	No impact	No impact	No impact	No impact	No impact	No impact
ransboundary Concerns	No impact	No impact	No impact	Minor long term negative impact	No impact	Minor long term negative
ir Quality	No impact	No impact	No impact	Minor long term negative impact	No impact	Same as proposed action
nergy Supply (Availability of lectric Power and Dependence Israel)	No impact	Uncertain reliability because of total dependence on Israel and no backup power	No impact	Uncertain reliability. Backup generator provides some measure of emergency power for some facility operations	No impact	Same as proposed action
orker Health and Safety from outine Operations and ccidents	No impact	No impact	No impact	Minor long term negative impact	No impact	Same as proposed action
oise	No impact	No impact	No impact	Minor long term negative impact	No impact	Same as proposed action
Other Impacts Identified by ie EA Team						
rchaeology	No impact	No impact	Uncertain. Potential for destruction of archaeological sites	No impact	Uncertain long term negative impact	No impact
lora and Fauna	No impact	No impact	No impact	No impact	No impact	No impact
oss of Agricultural Land	No impact	No impact	No impact	Minor long term negative impact	No impact	Same as proposed action

as a whole. The scope of work for this EA calls for the assessment of off-site infrastructure services proposed to be funded by USAID, the World Bank, and possibly other donor organizations. However, any assessment of GIE off-site infrastructural components must take into account the benefits and adverse impacts of the on-site activities.

For the purpose of comparing environmental impacts associated with the on-site activities, the proposed action for the on-site activities assumes that PADICO will develop the site by adopting a technically and environmentally sound design. The no-action alternative will reflect the fact that the area has already been designated as an industrial zone and industries will ultimately move into that area individually or collectively with little or no planning or control.

5.8.1 Environmental Consequences of On-Site Activities

Table 5-9 summarizes the environmental consequences associated with the on-site activities. The same environmental categories used to evaluate the off-site infrastructure were used here. Approximately 250 varied individual tenant firms (mostly industrial) are proposed to function within the planned industrial estate. Figure 5-1 shows PADICO's plans for the ultimate buildout.

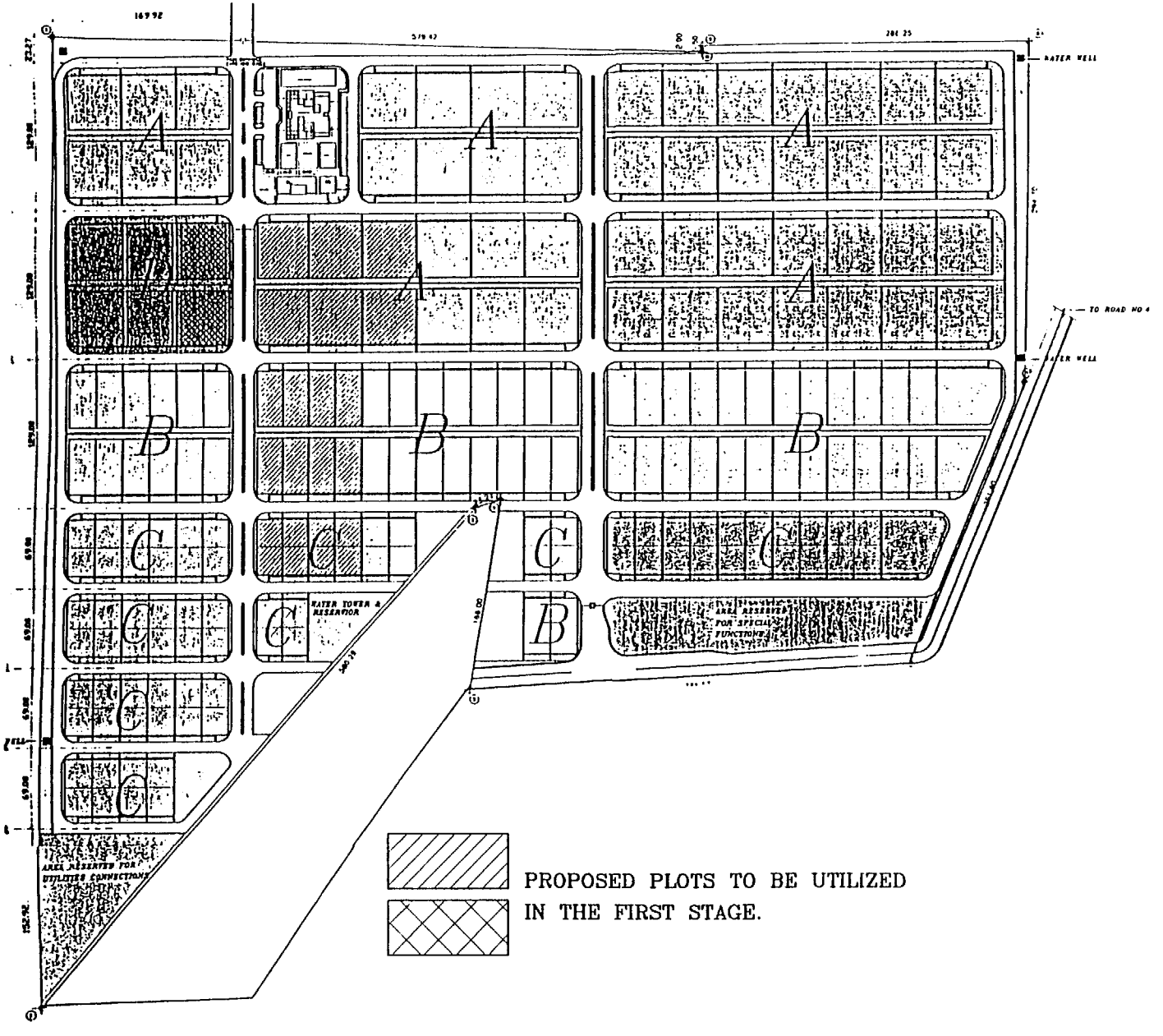
5.8.2 No-Action Alternative

In the absence of a planned industrial estate with adequate off-site infrastructural elements, industries could start locating at the site on an individual basis and begin generating a variety of solid waste. This could result in a significant, long-term, negative impact during operation of these industries. There would be no overall control over the production of hazardous and nonhazardous solid wastes, which could be dumped in an uncontrolled area or landfill. During construction, generation of solid waste debris would also be uncontrolled, therefore creating a minor, short-term, negative impact.

Similarly, the production and treatment of wastewater and stormwater could result in uncontrolled discharge into a nearby wadi or onto agricultural lands, or even become connected to the existing domestic wastewater treatment facilities without pretreatment. This would create a minor, short-term, negative impact during construction due to uncontrolled stormwater flows and a significant, long-term, negative impact during operation of the industries due to the improper disposal and treatment of wastewater.

The availability of water resources would not be affected by the no-action alternative during the construction phase. However, the impact of operation on groundwater resources would be significant because of the uncontrolled use of domestic supplies and the digging of new private wells in the area. The water resources are already overexploited. Therefore the improper utilization of this scarce resource would lead to a significant, long-term, negative impact.

On the other hand, the no-action alternative would create new jobs during construction and operation. But this impact would be uncertain during operation because industries could prefer



LEGEND :

- A — *LARGE FACTORIES PLOTS (2880m)*
- B — *MEDIUM FACTORIES PLOTS (1440m)*
- C — *SMALL FACTORIES PLOTS (720m)*
- D — *CONCRETE MULTI-STOREY FACTORIES PLOTS (2882m)*

Figure 5-1
GIE On-Site Plan

MARK	DATE	MADE BY
REVISION		

GAZA INDUSTRIAL ESTATE
PALESTINE DEVELOPMENT & INVESTMENT CO.
(PADICO)

M P C E — HADI & PARTNERS CONSULTING ENGINEERS
شركة الأطلال للاستشارات الهندسية

SITE MASTER PLAN

DRAWN BY :	CAD TEAM	SCALE : 1 : 2000	
DESIGNED BY :	M.SH.	DATE : 9/1996	
CHECKED BY :	M.SH.	PROJECT No. 8613	DRAWING No. A100
APPROVED BY :	M.M.		

automated processes to labor-intensive processess (as proposed by PADICO) thereby reducing, to some extent, the significant socioeconomic benefits of the proposed action.

The no-action alternative would not impact land use during construction, but it would have a significant, long-term, negative impact during operation. Individual industries might not move into the designated industrial estate area, but rather could move to nearby agricultural lands.

The impact of the lack of control measures and discharge standards, although minor during construction, would be significant during operation as placement of firms would be haphazard rather than planned. Industries would be less inclined to adopt control measures or standards than they would in a managed industrial estate, thereby creating significant impacts on the environment.

The no-action alternative would not impact transboundary concerns during construction, but would have an uncertain and possibly significant, long-term, negative impact during operation. The severity of the impact would be uncertain because of the uncertainty associated with the type of industries that would be built in that area. The type and direction of wastewater, air emissions, odor, and so forth would be uncertain.

The construction of uncontrolled industries in the area will not impact the energy supply during the construction phase. During the operation phase, it could impact electricity reliability because of the already overloaded electricity lines in this area and the dependence on the Israelis. If power to the GIE were to be interrupted as a result of political circumstances, the loss of jobs in Gaza would be similar to a border closing.

The lack of occupational health and safety standards could impact workers during the operation of these uncontrolled industries. This impact would probably be less significant during the short construction phase.

Noise from on-site activities mostly impacts workers. Occupational standards should protect against hearing loss.

Archaeology could be subject to destruction during the construction phase due to the absence of control and the individual and scattered nature of development. Therefore, the impact would be uncertain but potentially significant, negative, and long-term.

Flora and fauna could be subject to adverse impacts because of the uncontrolled disposal of solid and liquid wastes. This minor impact would be short-term during construction, but long-term during operation. The impact may not occur in areas remote from the GIE such as the disposal sites.

Agricultural land could be negatively impacted during construction and operation through waste generation and conversion of agricultural land to industrial uses.

5.8.3 Proposed Action Alternative

In the proposed action, PADICO will develop the site and USAID and others will fund the off-site infrastructure. Therefore, the impacts on the different environmental categories will be more

or less the same as those associated with the proposed activities of the off-site infrastructure elements discussed earlier. However, some impacts are specific to the on-site activities.

Construction of on-site activities will generate debris during the construction phase creating minor, short-term, negative impacts. The operation of the industries could impose minor, long-term, negative impacts if the hazardous and nonhazardous wastes generated are not properly disposed of and controlled.

Construction of on-site activities will generate wastewater that will need to be treated. Improper pretreatment of industrial waste could result in a long-term, negative impact. Assuming that improper pretreatment is only occasional rather than gross and pervasive, the impact would be relatively minor compared to no treatment. If stormwater is not properly managed, it would cause soil erosion and contamination of nearby lands, but the impact would be minor and short-term during construction and long-term during operation.

Construction would have no impact on the availability of water resources because minimal amounts of water would be required. However, the impact could be significant, negative, and long-term during operation due to the scarcity of the water resources. The water resources are already overexploited and salinized. Mitigation measures should be applied to monitor withdrawals from the proposed brackish wells as recommended in Chapter 6.

The construction an operation of the on-site activities would have significant, positive, long-term and short-term socioeconomic impacts. The on-site industries are planned to provide about 22,000 job opportunities for Gazans. This would reduce the chronic and severe unemployment and the effects of border closing on employment.

The proposed action will not impact land use during construction but could have a minor, long-term, negative impact during operation. Future expansion of the industrial estate and the attractiveness of the availability of infrastructure services could encourage investors to develop nearby lands.

The lack of regulatory ambient and discharge standards and controls would have a minor impact during construction and operation of on-site activities. It is assumed that PADICO and MOI will adopt some or all of the management and control mitigation recommended in this EA, but the opportunity would still exist for noncompliance without effective monitoring.

Operation of on-site activities could be associated with a minor, long-term, negative impact as a result of transboundary and ambient air quality concerns. The proposed mix of industries does not appear to result in major sources of air pollution (characteristic of low-intensity labor) and therefore, downwind impacts from these labor-intensive operations should be relatively minor.

Although it is unlikely that the type of industries envisioned by PADICO and MOI for the GIE would be major emitters of air pollution, there is no guarantee that one or more of the 250 firms would not emit toxic air pollutants. Given that the wastewater and solid wastes will be collectively managed through off-site infrastructure, air emissions would be the one area that was not reviewed or managed. At a minimum, there should be some potential review of proposed tenants based on simple screening using emission factors and activity factors. This is addressed in Chapter 6.

As discussed earlier, the operation of the GIE may have a minor, long-term impact on the energy supply. The conceptual plans propose the use of a standby generator for peak power.

The impact on worker health and safety is uncertain. The lack of standards and controls might result in occupational health and safety problems. Therefore, occupational health standards and emergency preparedness plans should be put in place during the early years of GIE operations.

Noise will have a minor impact during construction and operation of the industrial facilities. If the occupational standards for workers are adopted, off-site noise impacts should not be significant.

Construction might be associated with the destruction of archaeological sites. Because of the lack of archaeological surveys and the long history of human habitation in the area, the impact is uncertain. Therefore, archaeological mitigation and monitoring plans should be adopted as described in Section 6.1.4 and Appendix G.

Noncompliance with the pretreatment and disposal measures could be associated with adverse impacts on flora and fauna in the area. The same can be said about the loss of agricultural lands. Given the lack of biological resources on site, the impacts would be minor and short-term during construction. However, contamination could eventually reach other areas leading to long-term impacts on the flora and fauna.

Table 6-8
Comparison of Impacts Associated with the Construction of On-Site Activities

Environmental Impacts	No Action		Proposed Action	
	During Construction	During Operation	During Construction	During Operation
ssues Identified at the Scoping Session				
Solid and Hazardous Waste Generation	Minor short term negative impact due to uncontrolled disposal of debris	Significant long term negative impact due to uncontrolled disposal of hazardous and non-hazardous solid waste	Minor short term negative impact due to possibility of uncontrolled construction activities	Minor long term negative impacts due to possibility of failure of disposal and treatment methods and capacity and capability of landfill
Water Quality (Wastewater and Stormwater Management; Protection of Groundwater Quality)	Minor short term negative impact due to uncontrolled disposal of wastewater and stormwater	Significant long term negative impact due to no control on wastewater treatment and disposal	Minor short term impact due to possible soil erosion from stormwater	Minor long term negative impacts due to possible non-compliance with pretreatment requirements and accidental spills
Water Resource Availability (Overexploitation of Groundwater)	No impact	Significant long term impact due to uncontrolled use of domestic supplies and construction of new wells	No impact	Significant long term negative impacts due to withdrawals from new wells
Socioeconomic (Job Creation)	Minor short term positive impact	Uncertain but positive long term impact	Minor long term positive impact	Significant long term positive impact
Land Use	No impact	Significant long term negative impact due to uncontrolled movement into the area	No impact	Minor long term negative impact due to possible future expansions
Lack of Ambient and Discharge Standards and Controls	Minor short term negative impact	Significant long term negative impact due to absence of standards and controls	Minor short term negative impact	Minor long term impact
Transboundary Concerns	No impact	Uncertain impacts. Industries to move to the area are not known	No impact	Minor long term negative impacts. Concerns are wastewater reuse, odor, security, and chlorine use and disposal
Emmissions from New Firms	No impact	Uncertain negative impacts. No limitation on industries	No impact	Minor long term negative impacts. Industry mix does not appear to be high polluting
Energy Supply (Availability of Electric Power and Dependence on Israel)	No impact	Minor long term negative impact, because of reliability of supply	No impact	Minor long term negative impacts. Standby generator provides a measure of reliability
Worker Health and Safety from Routine Operations and Accidents	Minor short term negative impact	Significant long term negative impact due to absence of occupational health and safety standards	No impact	Uncertain impacts but could be minor negative if occupational health and safety standards are not adopted
Noise	Minor short term negative impact	Significant long term negative impact. Industries will have their own generators increasing the number of noise points	Minor short term negative impact	Minor long term negative impact. Pump motors, surface aerators and other mechanical equipment
Other Impacts Identified by the EA Team				
Archaeology	Uncertain negative impacts. Potential destruction of archaeological sites	No impact	Uncertainty due to the lack of archaeological surveys and the absence of visible sites. Archaeological surveys should be done before construction	No impact
Flora and Fauna	Minor short term negative impact	Minor long term negative impact due to uncontrolled disposal of wastes	Minor short term negative impact	Minor long term negative impact due to accidental spills and improper pretreatment
Loss of Agricultural Land	Minor short term negative impact	Minor long term negative impact due to uncontrolled disposal of wastes	Minor short term negative impact	Minor long term negative impact due to expected spills and improper pretreatment

6 FINDINGS AND RECOMMENDATIONS

This section presents the key findings and mitigation measures for the proposed actions and alternatives. The focus of mitigation is on those impacts that were judged to be either significant or uncertain (and potentially significant). Section 6.1 presents findings and mitigation measures that apply to the entire GIE; Section 6.2 presents findings and mitigation measures that relate specifically to various off-site infrastructure elements.

6.1 General Findings and Mitigation Measures

There are four sets of findings and recommendations that cut across all off-site infrastructure elements and/or apply to the overall operations of the GIE. These include the following:

- With one exception, none of the infrastructure alternatives is clearly environmentally superior to the proposed action.
- There is a need for a single, on-site, full-time, environmental coordinator.
- A system of individual tenant-specific environmental reviews is needed.
- There should be a front-end archaeological investigation of all areas where surfaces will be disturbed for the construction of the GIE, buried cables, roads, and other off-site infrastructure.

6.1.1 Most of the Off-Site Infrastructure Alternatives Are Not Clearly Environmentally Superior to the Proposed Action

Finding: With the possible exception of the water supply alternative to the proposed action, none of the other various alternatives, including the no-action alternative, was judged to be clearly superior to the proposed action, which takes into account cost and engineering feasibility. The implication of this is that the focus of mitigation can be on making the proposed action more environmentally benign rather than on substituting alternatives. Nevertheless, Chapter 5 and this chapter address the alternatives should the project team elect to pursue these. The alternative of purchasing all of the GIE water requirements from Mekorot may be environmentally superior to the proposed action because (depending upon the source of the Israeli water) it provides a

freshwater resource that would be brought to the site from outside the area and would add to rather than deplete the upper freshwater Gaza aquifer (See Section 5.2.5). On the other hand, the Mekerot water supply option is linked to a proposal in the peace negotiations in which a fixed amount of water would be sold by the Israelis to the Palestinian Authority for use in the Gaza Strip. It is possible that any water provided by Mekerot to the GIE would be included in this fixed amount. Thus, the Mekerot supply option would not add to the total fresh water supply for the Gaza Strip. Instead, this becomes an allocation issue to be resolved by the Palestinian Authority.

Recommendation: None necessary.

6.1.2 The Need for a Full-Time, On-Site, Environmental Coordinator at the GIE

Finding: The PA has yet to enact legislation that would require environmental controls for new or existing industries, but draft legislation has been developed. It may be several months before such legislation is enacted and possibly years before a full-fledged regulatory and permitting system is in place. Further, it is uncertain whether the eventual regulations will be as stringent as any of the international standards (such as the WHO, U.S. Environmental Protection Agency, World Bank, or European Union guidelines) or whether the PA will adopt regulations that reflect those in other Middle Eastern countries or some combination of standards and discharge limits that reflect Gaza-specific conditions (stringent water use and water quality standards but relatively less stringent air emission limits). Therefore, it would not be reasonable to impose the most stringent international limits on the GIE and subsequent industrial estates. This could discourage rather than encourage tenants to locate in industrial estates given the option of locating elsewhere in Gaza with little or no environmental controls. A balance is required in stringency, and some mechanism is needed to bridge the time gap between the current lack of controls and the likelihood that a system may soon be in place.

Recommendation: Most of the mitigation measures that are suggested throughout this report would be effected through a single, on-site, environmental coordinator who would serve at the pleasure of the Ministry of Planning (Environmental Protection Division), PADICO, and a donor agency that would provide the funding for this function. One of several possible arrangements would be for the environmental coordinator to function as a joint PADICO/EPD staff member who would report to both the EPD and the PADICO on-site managers but who would be selected by the EPD and the donor. As a means of institution building, a donor such as the World Bank should pay the person's salary to minimize the cost impact to PADICO and to reduce conflict-of-interest pressures. Through submission of periodic reports to PADICO, PIESZA, EPD, and the donor, the progress of achieving these mitigation measures can be tracked and the environmental monitoring can be reported. The selection of the environmental coordinator is critically important. Some of the capabilities and qualities that this individual should have are as follows:

- A degreed environmental professional preferably with industry and regulatory experience
- A mature individual who can balance the need for industrial efficiency and environmental protection
- An individual who is committed to the financial success of the GIE and industrial estate concept and is equally committed to the need for environmental and safety controls

The role of the environmental coordinator will be defined, in part, by the recommendations that follow.

6.1.3 Need for Tenant-Specific Environmental Review

Finding: Given that only a general categorization of tenants is available, the impacts of the on-site activities could not be predicted. To allow for some form of tenant screening—either by PADICO or other authorities—and to provide for cumulative determination of water, wastewater, solid waste, and air emission quantities, some form of environmental review and follow-up auditing are necessary.

Recommendation: The lack of a government permitting system or clearly defined limitations on specific industries suggest that a simple internal surrogate means of screening tenants for environmental impacts should be conducted prior to acceptance of the individual tenants. With the assistance of the environmental coordinator, the owner or operator of the prospective firm should complete a questionnaire that addresses the following:

- Number of workers
- General description of process
- Anticipated water demand broken out by potable and brackish water
- Other raw materials required
- Chemicals to be used (such as solvents) and quantities stored and consumed
- Pretreatment requirements for wastewater (may require outside consultant)
- Project quantities by general type of solid and hazardous wastes generated
- Proposed employee health and safety precautions that will be taken

The completed questionnaire would be kept on file at PADICO and, with appropriate guarantees for confidentiality, would be available for EPD use. These questionnaires would be updated periodically and would be used as a basis for the environmental coordinator to perform random audits. Perhaps under the proposed PIESZA legislation, the environmental coordinator could be statutorily empowered to enforce a kind of "internal permit" between PADICO and the

individual tenants that would result in surcharges for exceedances of the standard wastewater pretreatment guidelines. Similarly, the questionnaires could be required to be revised as conditions change.

6.1.4 The Need for a Front-End Archaeology Assessment

Finding: The Gaza Strip, especially the area in and around Gaza City, has been the site of continuous human habitation for several millennia. Although no *known* archaeological resources exist on site, this does not mean that an investigation would not turn up any. If construction of the GIE occurs without an archaeological investigation, there could be an irreversible and irretrievable loss of archaeological resources.

Recommendation: An archaeological survey should be undertaken of the entire site and any off-site infrastructural components where the surface would be disturbed or paved over. Appendix G contains specific mitigation language that has been used in previous USAID West Bank projects and would adequately address the need for an archaeological survey at the GIE.

6.2 Findings and Recommendations for Specific Infrastructure Components

6.2.1 Roads and Transportation

Findings: The proposed action and the alternatives related to vehicular access did not pose any significant impacts that require mitigation. Also, the broader issue of transportation was not identified as a concern during the scoping meeting. However, the EA team believed that there could be significant impacts associated with transportation if as many as 22,000 persons were trying to converge on the site at the same time. This would be especially difficult if a significant percentage attempted this in individual automobiles. However, transportation was not identified as a significant issue because PADICO has planned relatively few parking spaces, which forces the employees to rely on mass transit. It was assumed that private transportation firms would respond to the demand and would provide buses that would transport workers to the site. If a transportation problem were to occur, it would not be irreversible and would occur gradually enough to permit PADICO to respond. Nevertheless, some precautionary planning, as described generally below, is recommended.

Recommendations: PADICO, perhaps through the environmental coordinator, should develop a transportation plan through meetings with private transportation firms and relevant PA representatives. The goal would be to plan for the need to provide efficient and inexpensive transport of workers to the site. Elements of the plan could include designation of dedicated bus stops and incentives to encourage tenants to stagger work hours to spread out the need for buses

and to reduce road congestion. Also, tenants and PADICO should avoid material deliveries or product shipments during peak commuting periods. The encouragement of mass transportation would have the additional benefits of reducing air pollution from the increased use of automobiles and would reduce demand for motor fuels, thus conserving energy.

6.2.2 Water Supply

Findings: The proposed action (option 2) and the alternatives related to water supply pose a number of significant negative impacts that require careful monitoring and control. These impacts are primarily associated with the water quality and water availability of the brackish water aquifer. There is also the need to mitigate the potential effects of improper RO reject water disposal during the operation of the GIE potable water supply system. These impacts are less severe with options 1 and 3 because less brackish water would be pumped under these alternatives, and RO treatment for potable water production is not employed under option 3. The impact on water quality results from the potential cross-contamination of the underlying brackish water with the upper freshwater resource and the potential for increased salinization of the brackish water because of salt water intrusion resulting from overdraft of this aquifer. The sustainable yield of the brackish water aquifer has not been determined for the well fields near the GIE. Also, the method of reject water discharge into the Mediterranean has not been defined, which could result in the potential for improper mixing and dispersal of the RO reject waters along the beachfront. This could impact the water quality and deteriorate this recreational resource.

On the issue of potential deterioration of beachfront resources, the principal concern was with the method proposed for introduction of the RO reject waters to the Mediterranean. It is not defined for Phase I as to how the RO reject waters would be introduced to minimize adverse health and environmental impacts in the immediate area of discharge. It is the opinion of the EA team that an ocean outfall should be constructed that would permit adequate dispersal of the reject waters with the surrounding sea. RO wastes for conveyance to the sea could be delivered by truck to a pump station that serves the outfall. In the future, this outfall would then be integrated into the reject water disposal pipeline that would be constructed as part of the Phase III activities.

The EA team is of the opinion that disposal to the Mediterranean Sea is a reasonable option for the RO reject waters. In addition to the constituents in the Lower Aquifer groundwaters, the RO reject stream may also contain chemical additives to control scale formation (e.g., polyacrylates and polymethacrylates) and prevent polymeric oxidative degradation of the RO membranes. In the United States, RO reject waters are sometimes disposed of by "brine concentration" and chemical fixation of the residue. However, it is more typical to see the use of solar evaporation ponds. The GIE site does not have adequate land area to use ponds for solar evaporation, and brine concentration is too costly an option for use in developing countries.

Although not evaluated by the EA team, an option for RO reject water disposal that deserves an evaluation is disposal of the reject waters at the mouth of the Wadi Gaza. Disposal in this

manner would effectively augment an existing brackish water wetland that appears to be partly natural and partly a result of the impoundment of the Wadi Gaza as a result of the construction of a highway bridge. The existing wetland, which may be the only surface water body in the Gaza Strip, encompasses an area of 1,500 square meters. The salinity of the water in this area has been recently measured at 7 parts per thousand (ppt).

Based on the conditions set by the design of the RO system (Ref. 10), the reject water would average a TDS of 14,600 mg/L (14.6 ppt). [In actuality, this RO system should be capable of achieving a salt rejection rate of between 95% and 97% across the membrane. At a 10% reject volume, this could yield reject water at a TDS of 29,000 mg/L or 29 ppt. As noted elsewhere in this EA, RO reject waters could range from 1 to 3% dry weight solids and should be high in sodium, chloride, sulfate, and carbonates. Waters from the lower brackish aquifer average 3,000 mg/L TDS (Ref. 10).]

Depending on the freshwater inflows into the Wadi Gaza over the course of the year, the salinity of this wetland would be expected to increase significantly upon addition of RO reject water. The existing wetland would not be impacted provided there is no accumulation of potentially harmful or inhibitory substances in the area. The compounds of concern are the sulfates, which are formed naturally in the brackish water, and the chemical additives used to control scale formation and prevent degradation of the RO membranes. The Wadi would experience a natural flushing with each major rainfall runoff event which would reduce the salinity and prevent the buildup of potentially harmful substances. However, the immediate impact on the shallow freshwater aquifer is not apparent.

Recommendation: The EA team recommends a study to evaluate the impacts of disposing of the RO reject waters at the mouth of the Wadi Gaza. This study should include a bench- or pilot-scale demonstration of the concept of RO reject water disposal in a restricted area wetland. It is also recommended that a long-term brackish water aquifer water level monitoring program be put in place to ensure that the supply of brackish water to the industrial estate does not result in overdraft of the aquifer. The brackish water aquifer monitoring program should also include quality measurements for salt content to determine the rate of salinization. To moderate the effects of brackish water overdraft and increased aquifer salinization, a program to reduce industrial water use should be implemented at each industry. This water use reduction program should require a combination of wastewater reuse and the implementation of treatment in-place water conservation technologies, which would permit each industry to reduce its overall water use requirements and, thereby, cut back on brackish wellwater pumping. Other water conservation measures include the use of captured stormwater runoff to supplement the industrial brackish water demand and the imposition of financial incentives to increase industrial and potable water conservation at the GIE. The negative impacts associated with improper ocean disposal of the RO reject waters can be mitigated by employing an ocean outfall, which will improve the mixing and dispersal of the brines in the Mediterranean Sea such that their environmental impact will be minimized.

6.2.3 Wastewater Treatment and Stormwater Management

Findings: The proposed action related to wastewater treatment and stormwater management did not pose any significant impacts that require mitigation. However, the EA team identified a number of issues relating to industrial wastewater pretreatment, end-of-pipe treated effluent quality requirements, industrial wastewater pretreatment sludge generation and disposal, and associated impacts on water and air quality that require attention to prevent potential environmental impacts during operation of the future GIE. The consensus of the EA team is that these issues will present only minor, negative impacts to the environment provided that proper industrial wastewater treatment and sludge management practices are implemented during operation of the industrial estate. To guarantee that proper wastewater and sludge management practices are followed, the EA team has made the following recommendations.

Recommendations: It is recommended that the appropriate pretreatment requirements for the industrial wastewaters generated at the GIE be established as an integral component of the estate development. These industrial wastewater pretreatment requirements should take into consideration that the treated effluents will eventually be used for agricultural irrigation and groundwater recharge (see Appendix F). Each tenant industry at the GIE should establish a waste minimization program to reduce pollutant loadings from the industrial site. This could be accomplished through the creation of a pollution prevention program that may also serve to limit water use. Each tenant industry should meet handling and disposal requirements for solid and hazardous wastes from industrial wastewater pretreatments. This will be necessary to minimize potential environmental impacts associated with the disposal of wastes in the Gaza Municipal Landfill (see Section 6.2.5). To effectively accomplish these objectives, the following activities are recommended:

- Establish a program of monitoring industrial pretreatment effluents and residues
- Establish a program of monitoring stormwater runoff quality from the industrial operations
- Establish effluent quality criteria for SBR treatment to allow unencumbered use for agricultural irrigation and/or aquifer recharge
- Establish solid waste and air quality criteria for the use of dried biological sludge as a source of agricultural fertilizer

These recommendations require the establishment of a fully outfitted environmental laboratory to perform the required analyses and provide the necessary quality assurance procedures to guarantee accurate results.

To ensure a consistent design basis for stormwater management, it is recommended that the off-site infrastructure consultant review and approve all engineering designs for stormwater collection and conveyance within the GIE. The design storm should be the one-in-five-year maximum daily precipitation event for Gaza (Ref. 1).

6.2.4 Treated Wastewater and Stormwater Disposal

Findings: The proposed action related to treated wastewater and stormwater disposal did not pose any significant impacts that require mitigation. However, the EA team identified a number of issues relating to water quality and agricultural land availability that require attention to prevent potential environmental impacts during operation of effluent irrigation reuse and/or recharge facilities associated with the GIE. The consensus of the EA team is that these issues will present only minor negative impacts on water quality because of the salt content of these waters, which in some incidences may cause salinization of the soils in the area where agricultural activities are occurring. The use of high TDS water for agricultural irrigation will require careful management because these waters can adversely affect many crops. Most tree crops and woody plants are sensitive to high concentrations of sodium and chloride in irrigation water. To guarantee that proper treated wastewater irrigation and recharge management practices are followed, the EA team has made the following recommendations.

Recommendations: It is recommended that a long-term water quality monitoring program be established to examine the change in chemistry of the freshwater (upper) aquifer in the area of agricultural use. There is a need to establish specific water quality criteria for groundwater recharge to guarantee that such pollutants as nitrate, ammonia, oil, and BOD_5 not exceed water quality levels for public acceptance. These water quality criteria need to be developed before extensive groundwater recharge using industrial effluents is permitted to occur. To ensure that the net effect of the practice of effluent irrigation is an increase in the land available for cultivation or an intensification of crop production on a smaller area, the following activities are recommended:

- Manage the agricultural lands where effluent irrigation is applied in order to moderate the SAR so that soil permeability is not reduced
- Provide for the addition of calcium to the treated effluents to reduce salinity effects on crop yield
- Establish a monitoring program that measures changes in soil characteristics and plant yield in the areas where treated effluents are used for irrigation

These recommendations require the establishment of a fully outfitted environmental laboratory to perform the required analyses and provide the necessary quality assurance procedures to guarantee accurate results.

Finally, some consideration should be given to an additional alternative involving use of the Gaza Municipal Wastewater Treatment Plan in lieu of a dedicated plant. This is briefly discussed in Appendix J.

6.2.5 Solid Waste Disposal

Findings: The proposed action related to solid waste disposal did not pose any significant impacts that require mitigation. However, the EA team identified a number of issues relating to water quality, solid and hazardous waste management, and ambient and discharge standards and controls that require attention to prevent a potential environmental impact on the Gaza Municipal Landfill. Because the Gaza landfill is not lined and leachate collection is not provided, future disposal of GIE solid waste into the landfill may have a negative impact on the environment if the wastes are not properly classified (hazardous waste separated from nonhazardous waste). To guarantee that proper solid waste management practices are followed, the EA team has made the following recommendations.

Recommendations: It is recommended that the GIE have a program of waste collection and segregation to ensure that hazardous materials and solid wastes are kept separate from normal municipal refuse and other nonhazardous wastes. With the support of EU, the municipality is currently constructing a cell in the municipal landfill that has a plastic liner and a leachate collection system for storage of hazardous wastes (industrial and medical). In the future, tenant industries at the GIE can dispose of hazardous materials in this cell. The construction of the hazardous waste storage cell and leachate collection system in the Gaza landfill will compliment the proposed action and, therefore, should be completed as planned. To ensure that there be no adverse environmental impact, the following activities are recommended:

- Establish a monitoring program to identify hazardous constituents in the industrial solid wastes and sludges from the GIE
- Establish water quality criteria for discharge of leachate from the Gaza Municipal Landfill
- Monitor groundwater and surface water runoff quality from the Gaza Municipal Landfill

These recommendations require the establishment of a fully outfitted environmental laboratory to perform the required analyses and provide the necessary quality assurance procedures to guarantee accurate results.

Finally, some consideration should be given to an additional alternative involving use of the Gaza Municipal Wastewater Treatment Plant in lieu of a dedicated plant. This is briefly discussed in Appendix J.

6.2.6 Provision of Electric Power

Findings: It may be several years before either a dedicated power plant to meet all of the GIE's electric power requirements is on line or a large combined cycle baseload plant in Gaza is built and operating. Thus, for the early phases of the GIE, electric power provision could be an issue.

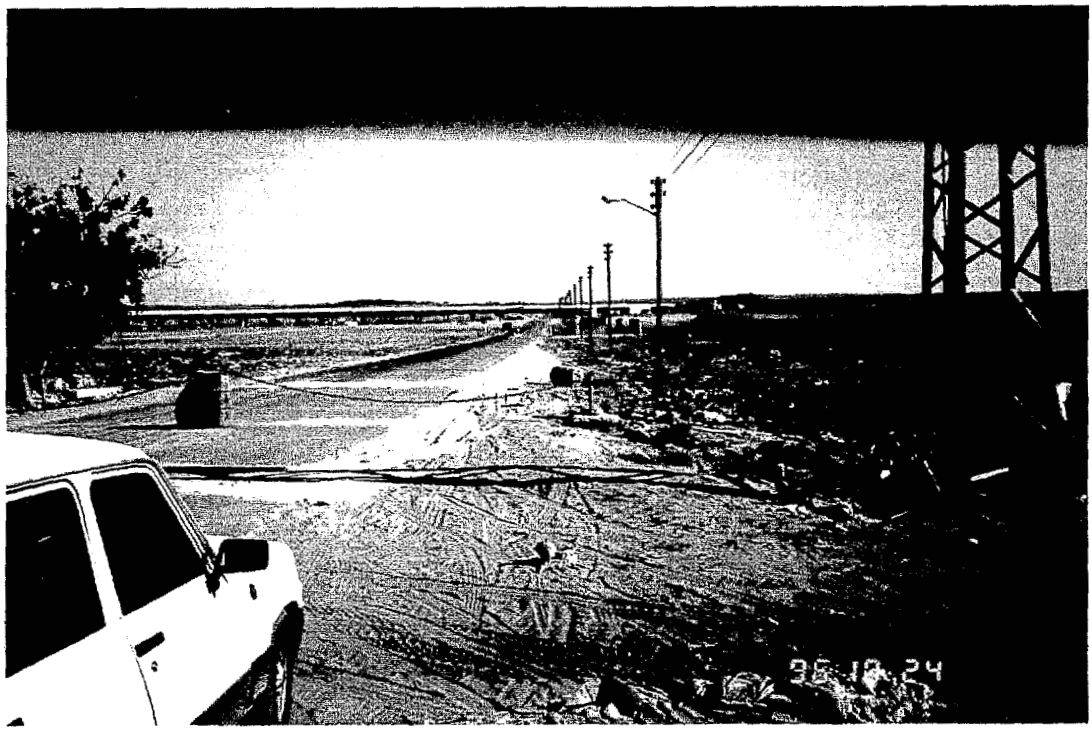
The principal concern is reliability of supply. Reliability is threatened by system overloads and faults and by the perception that reliance on Israel for electric power could result in a total loss of power should political circumstances deteriorate. A 2.2 MW backup generator is planned, but it appears that this generator would be used for peaking power requirements rather than simply as a standby emergency generator given that only about 3 MW can be supplied to the GIE by the PEA (which gets all of its power from Israel). Thus, the standby generator (which is premised to be used up to 10 hours per day) is important as is the need to reduce power demands through system management and energy conservation. The following recommendations apply to minimizing impacts from the standby generator and to reducing overall demand.

Recommendations related to minor impacts from standby generator: The impacts from on-site power generation from the 2.2 MW diesel generator include noise, air pollution, and potential fuel leaks and spills from the handling or loss of containment of diesel fuel. Although none of these impacts were judged to be significant by the EA team, the following mitigation measures are recommended, given the uncertainty of the location of the unit vis-a-vis sensitive receptors:

- The generator should be shielded for noise abatement if the manufacture cannot guarantee that the unit would produce less than 85 A-weighted decibels (dBA) at one meter from source.
- Products of combustion can be partially controlled through fuel specifications to avoid high particulates and high sulfur contents. Fuel specifications should be developed consistent with fuel costs. The discharge stack should be tall enough to adequately disperse contaminants depending upon the exact location of the unit.
- An underground fuel storage tank was premised presumably to conserve on space and to minimize risk of explosions. Given the porosity of the soil, the presence of the groundwater, and the propensity for leaks to occur undetected in underground storage tanks, an above-ground tank on a concrete pad with secondary containment is recommended.

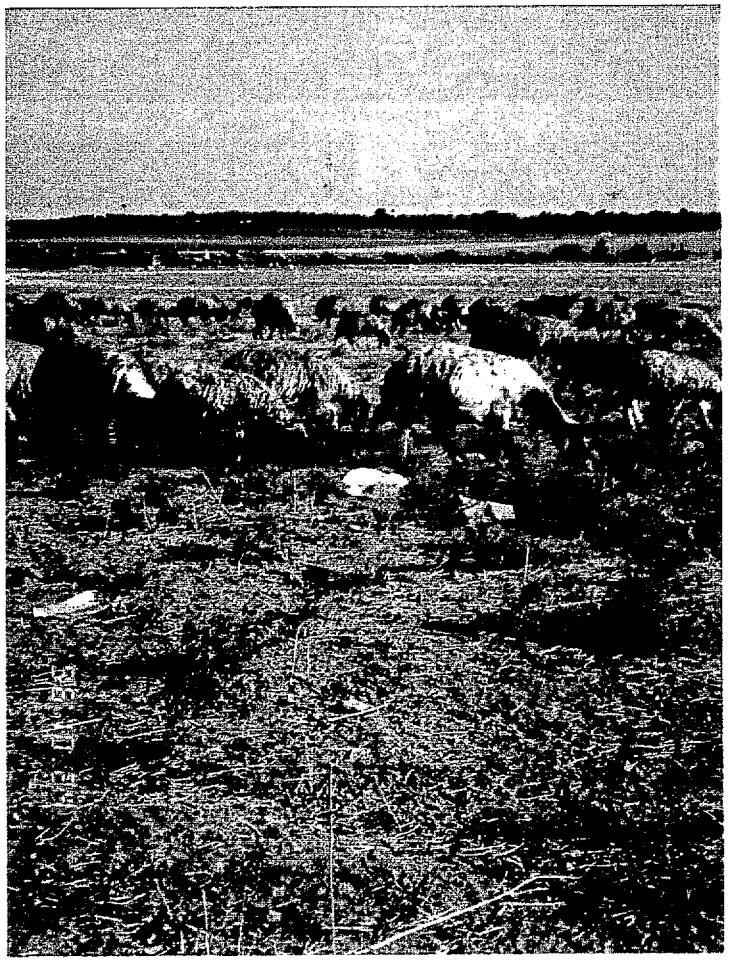
Recommendations related to overall energy conservation:

- GIE should promote the use of individual solar water heaters to supplement water heating requirements.
- Photovoltaic energy should be considered for providing roadway and parking area lighting.
- Skylights and windows should be used to provide natural lighting.
- Although it does not bear upon electric power use, the development of the employee mass transportation plan will reduce consumption of fossil fuels in Gaza.



Top: Looking southeast from the main entrance of the GIE down an existing paved road leading to the back-to-back goods exchange at the El-Montar checkpoint in the background. The GIE site is on both sides of this road.

Bottom: Guards on the site with the back-to-back exchange in the background. The exchange is the old airstrip used by the British in the 1940s. A metal shed covers the runway. The nearly bare ground is characteristic of most of the site.



Top: From the northwest portion of the site looking along the west boundary toward the south. The west boundary is bordered by trees and pear cactus (foreground). In the background are hayfields and pastures in Israel.

Left: Near the center of the site looking south with Israel in background. The site has been used by neighbors for small garden plots and for grazing of goat herds.

APPENDIX A

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45. The EA team was assisted in the biological overview of the site by Nadia El-Khodary, a biologist with the Environmental Protection Division of the Ministry of Planning.
46. Interview with Dr. Jaber Naser of the Department of Industry.

APPENDIX B
SCOPING SESSION MEETING MINUTES

Meeting Minutes
Scoping Session for the Gaza Industrial Estate
Held at Shawa Center
October 28, 1996

Introductions

Mr. Tom Staal (USAID): Mr. Staal started the meeting by introducing the role of USAID. He indicated that the USAID office in Tel Aviv focuses on the development of the West Bank and the Gaza Strip. USAID, in cooperation with MOI, the World Bank, PADICO, and other donors, is providing support for the development of the GIE. USAID will contribute U.S. $6 million to the development of the off-site infrastructure. The GIE will serve as a mechanism for creating jobs in the Gaza Strip and developing cooperation between the Palestinians and the Israelis and between the Palestinians and other countries.

Mr. Staal added that the environmental scoping session is intended to identify environmental issues. The EA is a requirement before the initiation of the GIE project. There is urgency in the GIE report; as a result, the EA is on a fast track. Input from the audience is needed. The final report will be in English. The scoping session will be presented in both English and Arabic.

Mr. Abdul Rahman Naim (MOI): Mr. Naim introduced MOI attendees. He thanked the various parties involved in the GIE project, specifically USAID, World Bank, and EA team, and Shawa Center for providing the auditorium to conduct the scoping session.

Mr. Bob Davis (Environmental Assessment Team Leader (EHP)): Mr. Davis introduced the EA team and described the role and responsibilities of each member. He also presented the ground rules for the meeting.

Mr. Fawaz Abu Ramadan (PADICO): Mr. Abu Ramadan stated that the GIE project and other future similar projects are the result of the Palestinian Authority (PA) commitment to promote economic growth and to attract local, regional, and international investors to the Gaza Strip. PADICO is committed to channeling these investments into the Gaza Strip and the West Bank. PADICO is a $1 billion company with affiliates providing services in areas such as tourism, real estate, housing, and industrial investments.

Mr. Abu Ramadan added that the GIE is located in a strategic area: 3 km from Gaza City; 25 km from Gaza airport; 5 km from the future Gaza seaport; and 1 km from a road that connects into roads leading to Egypt and Israel. The site area is 485,000 m^2, of which 70% will be industrial and 30% will consist of roads and offices. The built-up area of each industrial lot will represent 80% of the site, and 20% will contain services. The GIE is expected to provide 22,000

jobs and contain 250 firms in the final stage of the development. The GIE project will be implemented in a three-phase approach. These phases are as follows:

- Phase I:
  - 60% of the infrastructure
  - 25% of the built-up area
- Phase II:
  - 20% of the infrastructure
  - 25% of the built-up area
- Phase III:
  - 20% of the infrastructure
  - 50% of the infrastructure

The emergency phase is expected to be completed by the end of January 1997 and will consist of the following activities:

- Installation of a fence
- Foundations Standard Factory Buildings (SFB)
- Steel and finishes for SFB
- Administration building
- Infrastructure

Presentations

Mr. Jonathan Hodgkin (EHP): Mr. Hodgkin presented the different options for the off-site infrastructure that were evaluated in previous studies conducted by other consultants. He also pointed out the preferred alternatives based on the conceptual plans and other studies.

Ms. Sana Hamady (EHP): Ms. Hamady presented the environmental impacts associated with the off-site infrastructure . She demonstrated the EA team approach to evaluating the environmental impacts that may potentially result from the off-site infrastructure development.

Dr. Iyad Abumoghli (EHP): Dr. Abumoghli presented USAID environmental assessment requirements. He described the EA process that will be followed by the EA team and explained the scoping session requirements and types of impacts.

Mr. Mario Zelaya (World Bank): Mr. Zelaya indicated that the impact on public health should be considered in the process.

Comment Period

Mr. Sayyed Aljadba (Gaza Municipality) indicated that the quantity and type of solid waste that will be generated from GIE activities are unknown. The municipality cannot plan for the disposal of the waste unless additional information is made available.

Dr. Abdul Qaissaunee (USAID consultant) responded that in one of his most recent studies he had included an appendix that contains information and alternatives for solid waste disposal. He recommended that PADICO haul out domestic waste to the landfill or sign a contract with the municipality for solid waste pickup. To manage hazardous waste, the "cradle-to-grave" concept should be instituted.

Mr. Henri Disselkoen (Consultant, EU) pointed out that the solid waste issue is important and that PADICO should make arrangements with the municipality for waste disposal. The municipality will be able to handle the hazardous waste since an area in the landfill will be ready by mid-1997 to accept hazardous waste. Disposal cost for nonhazardous waste is $5 per cubic meter while disposal cost for hazardous waste is anticipated to be $35 per cubic meter.

Mr. Atef Jaber (EPD/MOPIC) expressed concern about the capacity of the Gaza landfill and whether the landfill should be used for hazardous waste. He suggested that a new landfill be dedicated to hazardous waste generated by GIE. He also asked questions about the type and quantity of waste that will be generated and of any recycling planed for the future.

Dr. Frank Castaldi (EHP) explained that the Gaza landfill can be used for waste produced by GIE since a cell will be dedicated to hazardous waste.

Ms. Sana Hamady (EHP) explained that the EA team did identify the type of waste that will be produced and has some estimates of the quantities. This information is based on the mix of industries planned for the GIE.

Mr. Sami Drabih (EPD/MOPIC) questioned the security and the legal arrangements, that is, how to deal with Israel, the relationship between MOI and PADICO and between PADICO and other companies, the control and management of the GIE, and the agreements signed in Cairo and Washington.

Mr. Mario Zelaya (World Bank) said that there will be studies to address environmental management.

Dr. Yousef Abu-Safieh (Committee on Natural Resources, PLC) questioned the contents of the Industrial Estate Law. He said the law requires that production be for internal purposes and not for export.

Mr. Abdul Rahman Naim (MOI) indicated that the discussions are ongoing to address environmental management, monitoring, and the MOI responsibilities. The Industrial Estate Law has been revised. The law is not specifically for Gaza.

Mr. Tom Staal (USAID) clarified the on-site versus off-site infrastructure. The type of industries is limited by environmental resources.

Mr. Bob Davis (EHP) said that the EA team will consider on-site and off-site when they are related.

Mr. Muin Madi (PADICO) explained that there are no limitations to the type of industries. There is already an approved mix of industries for the GIE.

Mr. Mohsen Ghazali (USAID) asked why other studies conducted by other consultants were not addressed in the presentation and how the stormwater was going to be managed.

Dr. Frank Castaldi (EHP) indicated that the EA team is aware of these studies, but they were not included in the presentation due to time limitation. Stormwater will be combined with the wastewater.

Mr. Mohammad Al-Wali (Ministry of Agriculture) expressed concern about groundwater availability. He suggested using two wells located in the north that can provide nonbrackish water. The possibility of families who will have a job at the GIE moving near the site was brought up as a potential impact.

One individual asked if a cost-benefit analysis will be included in the EA.

Dr. Frank Castaldi(EHP) responded that such an analysis will not be included.

Mr. Muhammad Almuqaied (EPD/MOPIC) asked if the EA covers the GIE area only or the entire Gaza City area. He expressed concern about archaeological sites and the wastewater that may be discharged in the Wadi Gaza.

Mr. Yasser Al-Nahal (Environmental Research Institute) commented that there is no absolute positive or negative. However, since heavy labor is expected, the environmental impact is expected to be significant.

Dr. Atiyah Al-Eglah (MOH) inquired about the future distribution of the industries within the GIE. He also asked if there will be new types of industries or if the GIE will absorb industries that already exist in the Gaza Strip; if the treated wastewater can be used for all agricultural purposes; and how are the residues from the reverse osmosis handled.

Mr. Haider Noori (Metcalf and Eddy) discussed the collection and treatment of the industrial wastewater during the emergency period. The existing wastewater treatment plant has a capacity of 12,000 m^3 per day and currently receives 15,000 m^3 per day. The plant may not be able to handle the flow from the GIE.

Ms. Rima Abu Middein (PWA) indicated that more information is needed to understand the impact on the environment. The type of industries and chemicals used, the physical characteristics in the GIE area, and emergency response procedures are some of the questions that need to be addressed.

Mr. Yousef Al-Muqaied commented that all aspects of environmental impacts should be addressed.

APPENDIX C
LIST OF INVITEES

SUGGESTED LIST OF INVITEES TO THE ENVIRONMENTAL ASSESSMENT SCOPING SESSION

USAID
- Carl Maxwell - Chief Engineer/Mission Environmental Officer
- Thomas Stall - Project Development Officer
- Mohsen Ghazali - Project Engineer

Ministry of Industry
- Dr. Nasr Jabr - DG
- Abdul Rahman Naim - Industrial Estates Director
- Baker Thabat

Ministry of Planning and International Cooperation (Physical Planning)
- Dr Kamil El-Shami

Ministry of Planning and International Cooperation (Environmental Unit)
- Jehad Safi - Agricultural Engineer
- Mohammed Al Muqaid - Water Pollution Expert
- Wae'l Safi - Water Engineer

Palestine Development & Investment Corporation (PADICO)
- Amin Hadad - Project Manager
- Fawaz Abu Ramadan - Technical Manager
- Christine Shmidt - Marketing Manager
- Muin Madi - Consultant

Ministry of Agriculture
- Mohammed Al-Wali

Ministry of Public Works
- Hisham Mater - Civil Engineer

Ministry of Health
- Atiah Al-Ejlah

Palestinian Economic Council for Development and Reconstruction (PICDAR)

Ministry of Posts and Telecommunications
- Samir Abdalqader - Planning Department

Palestine Energy Authority (PEA)
- Fadel Skaik - General Manager
- Dr. Rafiq Mauha - Director of Generation

Palestine Water Authority (PWA)
- Monthar Shoblak - Head of Section

Municipality of Gaza
- Maged Abu Rahma - Head of Planning Department

Hussain Abu-Zaid - Head of the Sewerage Department
Adjacent Land Owners
World Bank
Alistair McKechnie - Div Chief PSD/Infrastructure
Judith Press - PSD Specialist
Nagy Hanna - Principal Officer
Environmental NGOs
Palestinian Women's Organizations
Ministry of Economics
Ministry of Local Authorities
Ministry of Housing
Yaser El Ashkar - Dept of Surveying
Ministry of Tourism and Antiquities
Aleram Ejla - Director
Yasser Hassuna - Head of Department
Gaza Chamber of Commerce
Gaza Chamber of Industries
Islamic University
Israeli Electric Corporation
Mekorot
Ministry of Environment (Israel)

APPENDIX D
LIST OF ATTENDEES

List of Attendees
Scoping Session for the Gaza Industrial Estate
Held at Shawa Center
October 28, 1996

Name	Position	Organization
Tom Staal	Project Development	USAID
Carl Maxwell	Chief Engineer	USAID
Abdul Qaissaunee	Consultant	USAID
Mohsen Ghazali	Project Engineer	USAID
Bob Davis	EA Team Leader	Environmental Health Project (EHP)
Frank Castaldi	Industrial Engineer Specialist	EHP
Jonathan Hodgkin	Environmental Engineer Specialist	EHP
Sana Hamady	EA Specialist	EHP
Iyad Abumoghli	EA Specialist	EHP
Abdul Rahman Naim	Director	Ministry of Industry (MOI)
Baker Thabet	Engineer	MOI
Sami Abu Zarfa		MOI
Mahmoud Erhim	Hydrologist	MOI, Dept. of Natural Resources
Fawaz Abu Ramadan	GIE Technical Manager	PADICO
Muin Madi	Consultant	PADICO
Mario Zelaya	Senior Projects Officer	World Bank
Judith Press	PSD Specialist	World Bank
Hussam Abudagga		World Bank
Shams Al-Wazir	Coordinator	Center for Engineering and Planning (CEP)
Omar Muhasien	Engineer	CEP
Samir Abdel Kader	Engineer	Ministry of Post and Telecommunications (MPT)
Ghada Nassman	Engineer	Ministry of Post and Telecommunications (MPT)
Henri Disselkoen	Consultant	European Union

List of Attendees (Continued)

Name	Position	Organization
Rifat Diab	Engineer	CEP
Ben Gesers'	Consultant	European Union
El-Sayed Elgadba	Head Engineer	Gaza Municipality
Rezik Negim	Managing Director	Gaza Municipality
Majed Abu Rahman	Engineer	Gaza Municipality
Rima Abu Middain	Administrator	Palestine Water Authority (PWA)
Monther Shoblak	Engineer	PWA
Mohammad Fadel Skaik	Electrical Enginner	Palestine Energy Authority (PEA)
Mohammad Alwali	General Director	Ministry of Agriculture (MOA)
Hassan Abu Etah	Director of Field Services	MOA
Haider Noori	Project Manager	Metcalf & Eddy
Hisham Mater	Civil Engineer	Ministry of Public Works
Alaedeen Shawa	Director	Development Resource Center, DRC
Bassem Al-Ashi	Research Coordinator	DRC
Yousef Abu-Sefieh	Chairman	Committee on Natural Resources, PLC
Atiah Al-Eglah		Ministry of Health (MOH)
Atef Jaber	Planner	Ministry of Planning and International Cooperation (MOPIC)
Muhammad Al-Muqaied		MOPIC/EPD
Wael Safi		MOPIC/EPD
Sami Drabih		MOPIC/EPD
Yasser Al- Nahal	Vice-president	Environmental Protection and Research Institute (EPRI)
Husam Al-Najar	Sanitary Engineer	EPRI
M. Abu Mourad	Research Assistant	EPRI
Bassem Abu Shaban	Engineer	Gaza Ministry of Planning
Norihird Noda	Leader	JICA Study Team
Ulf Sorensen	Engineer	JICA Study Team

List of Attendees (Continued)

Name	Position	Organization
Kamil El-Shami	Director of Land Use	MOPIC/ Physical Planning
Jawad Audeh	Engineer	JICA Study Team

APPENDIX E

LIST OF PERSONS CONTACTED BY EA TEAM

List of Persons Contacted by EA Team

Abu Shammalah, Mohammed - Land Use Expert, Ministry of Planning and International Cooperation (MOPIC).
Abudagga, Hussam - World Bank.
Al-Muqaied, Mohammed - Water Resources Protection Department.
Austin, John - Senior Technical Advisor, USAID.
Disselkoen, Henri - Management Consultant, European Union.
El-Hawi, Mustapha - Solid Waste Department, MOPIC.
El-Khodary, Nadia - Environmental Protection Directorate, MOPIC.
El-Nahhal, Yasser - Vice Chairman, Environmental Protection and Research Institute.
Ghazali, Mohsen - Project Engineer, USAID.
Goodson, Jeffrey - Bureau Environmental Officer, U.S. Department of State.
Jaber, Naser - Director General, Ministry of Industry.
Jaber, Atef - Solid Waste Department, MOPIC.
Madi, Muin - General Manager, Madi and Partners Consulting Engineers.
Maxwell, Carl - Chief Engineer, USAID.
McKechnie, Alastair - Division Chief, the World Bank.
Naim, Abdul Rahman - Director, Ministry of Industry.
Noori, Haider, - Project Director, Metcalf & Eddy.
Press, Judith - Senior Private Sector Development Specialist, the World Bank.
Qaissaunee, Abdul - Consulting Engineer, CABE Associates, Inc.
Safi, Wa'el - Wastewater Department, MOPIC.
Shoblak, Monther - Water/Wastewater, Palestinian Water Authority.
Staal, Thomas - Project Development Officer, USAID.
Starnes, John - USAID.
Thabet, Baker - Engineer, Ministry of Industry.
Zelaya, Mario - Senior Projects Officer, the World Bank.

APPENDIX F
INDUSTRIAL WASTEWATER PRETREATMENT

Industrial Wastewater Pretreatment

This appendix presents a discussion of industrial water quality requirements and wastewater pretreatment criteria for a number of industries that may take up residence at the future GIE. The information presented in this appendix is based on information PADICO provided on the proposed mix of industry types and on additional information the EA team developed on the possible character of typical industries in the light-to-medium manufacturing range. The data presented in this appendix are provided as a guide to assess the impacts of industrial development on water supply, wastewater treatment, and effluent disposal by agricultural irrigation and recharge to the upper aquifer.

The development plans for the GIE indicate that 70% of the site will be industrial and the remainder will be roads and offices. The mix of industries planned for the GIE includes garments/textiles, construction industries, electric appliances, shoes/leather, data processing, automotive parts, agro-industries/food processing, hardware, pharmaceuticals, and jewelry. However, the specific type of industry within each of these broad categories has not yet been established. The areas on the site have been allocated to small, medium, and large factories, which will generally house light-to-medium manufacturing operations. The industries will be generally labor-intensive, employing large numbers of individuals performing repetitious production activities.

Table F-1 presents water quality standards for industrial use for a possible mix of light to medium manufacturing operations. These data indicate that the brackish water to be provided for industrial use would not generally meet the water quality requirements of these manufacturing processes. Consequently, RO process water will be needed to meet both selected industrial water quality requirements and domestic (drinking, washing, ablutions) water needs. To the extent that desalinized water is made available at the GIE, this could result in the use of RO treatment for brackish water upgrade at each tenant industry. The quantity of RO reject waters may also increase if the future industries at the GIE require higher quality water.

Table F-2 presents information for the possible character of selected industrial wastewater at the GIE. Depending on the industries identified, the industrial wastewater may contain acids, alkali, solvents, suspended solids, dissolved and colloidal organics, heavy metals, dissolved solids, soaps, fats, oils, and grease. Some of these constituents are highly biodegradable and can be effectively treated in the proposed GIE wastewater treatment facility. However, others will require treatment in a dedicated industrial wastewater pretreatment facility to meet acceptable effluent criteria for agricultural irrigation and groundwater recharge.

Table F-3 presents data for heavy metals that may be present in selected industrial wastewaters from light to medium industries. The most important metals for reclaimed water applications are arsenic, boron, cadmium, chromium, cobalt, iron, lead, copper, mercury, nickel, and selenium. The concentrations of these metals in treated wastewater are important in irrigation applications

because they may shorten the lifetime of an agricultural site through the accumulation of a given metal or a combination of metals in excess of the biological toxicity threshold.

Heavy metal dischargers have a number of options for control of metals in their discharges. They may either modify their manufacturing process to reduce the loss of a given metal or pretreat the wastewaters to remove the metal entirely. When an industry applies a process modification to reduce the loss of metals, it will also effect a reduction in the overall pollutant load. Such practices as applying spray rinses to reduce drag-out from plating baths and recycling rinse water from washing operations are typically cited as process modifications. Pretreatment methods for heavy metals removal from wastewater usually involve oxidation, reduction, neutralization, precipitation, clarification, and filtration. Metals recovery methods include evaporation, reverse osmosis, electrodialysis, and ion exchange.

Table F-4 presents possible pretreatment unit operations for organics and metals in selected industrial wastewaters. In addition to the control of hydraulic overloads or temperature extremes, the pretreatments presented in Table F-4 are designed to reduce excess amounts of oil and grease, highly acidic or alkaline wastewaters, suspended solids, organic wastes, inorganic wastes, heavy metals, organic colloids, and odorous or corrosive gases. These pretreatments are designed to mitigate any impacts on the GIE wastewater treatment facility that may result from materials or circumstances that interfere with, or upset, the biochemical activity of the SBR process. These include high variability in waste organic content, high organic loading for extended time periods, waste components at potentially toxic levels, nutrient imbalances, and pH extremes. The type of pretreatment selected depends on wastewater characteristics, applicable pretreatment standards, and anticipated production changes that may affect wastewater characteristics.

Table F-5 presents suggested industrial wastewater pretreatment limits for the GIE wastewater treatment facility (proposed action). These pretreatment limits are designed to meet the industrial wastewater mitigation requirements of the GIE wastewater treatment facility and to provide a pretreated wastewater with constituents acceptable for use as reclaimed water for irrigation. Concern is for the total minerals, heavy metals, and stable organic substances in the industrial wastewaters. This pretreatment requirement assumes that the GIE wastewater treatment facility will be effective for the removal of BOD_5, COD, TSS, and nitrogen from the combined industrial and domestic wastewaters generated at the site. However, provision is not made for the removal of dissolved salts (for example, sodium, chloride, sulfate) from the treated wastewaters. The concentrations of sodium, calcium, and magnesium ions in water used for agricultural irrigation must also be considered. High sodium concentrations will reduce a clay-bearing soil's permeability and affect soil structure. When calcium is the predominant cation adsorbed in the exchange complex, the soil tends to be granular and readily permeable. When sodium concentrations are high, the clay particles are dispersed and the soil permeability is reduced. Sodium levels in the GIE combined wastewater can exceed 800 mg/L, and the calculated SAR for the waters is greater than 18 or more than twice an acceptable level for irrigation reuse. However, the extent of sodium accumulation in the soil depends on the concentration of sodium

in the irrigation water and the rate that it is removed by leaching. The addition of calcium to the impacted soil and/or the irrigation water will have a mitigating effect.

To allow for safe reuse of reclaimed water for agricultural irrigation, the WHO criteria recommends that wastewater be biologically treated plus disinfected to produce a coliform count of not more than 100 coliform organisms per 100 ml (Ref. 4).

Table F-1 Possible Water Quality Standards for Industrial Use

Industry	Color ppm	Alkalinity ppm ($CaCO_3$)	Chloride ppm	Hardness ppm ($CaCO_3$)	Iron ppm	Manganese ppm	pH
Textiles	5	-	-	25	0.1	0.01	6.5-10
Plastics	2	<1	<5	<5	<0.01	<0.01	7.5-8.5
Pharmaceutical	2	<5	<5	<5	<0.01	<0.01	7.5-8.5
Soaps	5	50	40	130	0.1	0.1	-
Paint	5	100	30	150	0.1	0.1	6.5
Gum and Wood	20	200	500	900	0.3	0.2	6.5-8.0
Fruit and Vegetable Canning	5	250	250	250	0.2	0.2	6.5-8.5
Soft Drinks	10	85	-	-	0.3	0.05	-
Leather Products	5	-	250	150	50	-	6.0-8.0
Construction Materials	-	400	250	-	25	0.5	6.5-8.5

Reference: Industrial and Hazardous Waste Treatment, Nemerow and Dasgupsta, 1991

Table F-1 (Continued)

Industry	Sulfate ppm	TDS ppm	TSS ppm	Calcium ppm	Magnesium ppm	Bicarbonate ppm	SiO_2 ppm
Textiles	-	<100	<5	-	-	-	-
Plastics	<1	<1	<2	<1	<1	<0.1	<0.1
Pharmaceutical	<1	2	2	<1	<1	0.5	<0.1
Soaps	150	300	10	30	12	60	<0.1
Paint	125	270	10	37	15	125	<0.1
Gum and Wood	100	1000	30	100	50	250	50
Fruit and Vegetable Canning	250	500	2	100	-	-	<0.1
Soft Drinks	-	-	-	-	-	-	-
Leather Products	250	-	-	60	-	-	-
Construction Materials	250	600	100	-	-	-	35

Reference: Industrial and Hazardous Waste Treatment, Nemerow and Dasgupsta, 1991

Table F-2 Possible Character of Industrial Wastewater at GIE

Industry	Origin of Waste	Characteristics
Metal Plating	Stripping of oxides, cleaning and plating of metals	Acid, metals, cleaning solvents
Glassware	Polishing and cleaning of glass	Color, Alkaline nonsettleable suspended solids
Plastics (molded)	Spills and equipment wash downs	Acids, caustic, dissolved organic matter
Paint and inks	Solvent-based rejected materials, scrubber waste from paint vapor control	Organic solids from dyes, resins, oils, and solvents
Glue manufacture	Alkaline and acid washes	Dissolved organics, heavy metals (chromium), and acid / alkali
Canned goods	Trimming, culling, juicing, and blanching of fruits and vegetables	Suspended solids, colloidal and dissolved organics
Dairy products	Dilutions of whole milk, separated milk, butter milk, and whey	Colloidal and dissolved organics, mainly protein, fat, and lactose
Leather goods	Soaking and alkaline washes	Dissolved and suspended solids, colloidal and dissolved organics
Meat and poultry products	Rendering of bones, fats, greases, and wash water residue	Dissolved and suspended organic matter, protein, and fats
Pharmaceutical products	Spent filtrate and wash waters	Suspended and dissolved organic matter
Wood furniture	Spray booth quenches	organics from staining and sealing wood products
Soap manufacture	Washing and purifying soaps	Dissolved organics and saponified soaps

Table F-3 Light to Medium Industries with Possible Occurrence of Certain Metals in Selected Industrial Wastewater

Industry	As	Ba	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Ni	Se	Ag	Zn
Wire drawing			X				X	X							
Metal plating			X	X	X	X	X	X	X	X		X		X	X
Alloying	X			X		X	X			X	X	X		X	X
Automotive parts					X		X	X	X						X
Glassware	X	X	X	X	X	X				X			X		
Ceramics	X	X	X	X	X				X	X			X		
Porcelain	X		X	X			X	X	X	X		X	X	X	X
Plastics (molded)				X							X				
Paint manufacture		X		X	X		X		X	X	X	X	X		X
Cosmetics manufacture			X								X				
Ink manufacture					X					X				X	
Animal-glue manufacture					X										
Footwear manufacture	X		X		X			X							
Carpet production			X	X									X		
Photographic supplies			X	X	X				X		X		X	X	
Textile manufacture				X			X	X					X		X
Food/ beverage processing								X							
Printing				X					X			X			X
Television tube manufacture				X					X						X
Jewelry manufacture							X							X	
Electrical/electronics manufacture		X					X				X		X	X	

Source: Water Environment Federation, Pretreatment of Industrial Wastes, Manual of Practice No.FD-3, 1994

Table F-4 Possible Pretreatment Unit Operations for Organics and Metals in Selected Industrial Wastewater

Industry		Pretreatment Unit Operation
Food processing		
	Dairies	Equalization and whey separation
	Meat, Poultry and Fish	Screening, clarification or flotation, and coagulation / precipitation
	Fruit and vegetable canning	Screening, equalization, clarification, neutralization, and coagulation / precipitation
Pharmaceutical products		Equalization, neutralization, coagulation / precipitation, and adsorption
Plastics (molded)		Coagulation / precipitation, clarification, and adsorption or chemical oxidation
Textiles		Equalization, neutralization, coagulation / precipitation, and adsorption
Leather tanning and finishing		Screening, gravity separation, neutralization, and coagulation/ precipitation
Metal Plating		Alkaline chlorination of cyanide, reduction and precipitation of chromium, and precipitation of other metals
Glassware		Precipitation and clarification
Paint and inks		Coagulation / precipitation and clarification
Wood furniture		Evaporation and burning
Glue Manufacture		Chemical precipitation and flotation
Soap Manufacture		Flotation and skimming, precipitation with $CaCl_2$

Table F-5 GAZA INDUSTRIAL ESTATE WASTEWATER SUGGESTED PRETREATMENT LIMITS

Parameter	Discharge Limit (mg/l)	Reference
BOD5	400	1
COD	500	1
TSS	400	1
pH, S.U.	6.0-9.0	1
TKN, as N	50	1
Ammonia, as N	35	1
$NO^{-}_{3,}$, as N	10	1
Oil and Grease	40	1
Fluoride	1.0	4
Arsenic	0.10	4
Cadmium	0.01	4
Chromium (Total)	0.10	5
Copper	0.20	3
Cyanide	0.3	3
Lead	5.0	4
Nickel	0.20	4
Selenium	0.02	4
Silver	0.25	2
Zinc	2.0	4
Boron	0.75	4
Cobalt	0.05	4
Toluene	0.1	2

Modified from "Gaza Industrial Estate Wastewater Management Plan Report" for USAID, by Abdul G. Qaissaunee, November 12, 1996

1. Plant specific limits
2. Activated sludge inhibition
3. Nitrification inhibition
4. Recommended limits (long-term use) for constituents in Reclaimed water for irrigation (Ref. 4)
5. Typical sewer ordinances

APPENDIX G
MONITORING PLAN
FOR ARCHAEOLOGICAL STUDIES

Monitoring Plan for Archaeological Studies

Since the final routings for the off-site infrastructure related to the GIE Project have not been established, it is difficult to argue that archaeological impacts are not a significant issue. The development of an archaeological monitoring plan ensures that important archaeological resources are identified, avoided, and documented to the maximum extent feasible in the design and construction of water/wastewater system, telecommunication, energy supply, and transportation facilities. A detailed statement of work for archaeological investigations should be developed once off-site infrastructure locations are identified. It will be the responsibility of the architectural and engineering firm to engage an archaeologist to carry out the monitoring plan requirements of the EA.

The archaeological investigation associated with the Gaza Industrial Project will be designed to minimize the potentially adverse impact that facility construction and operation could have on known and unknown resources. The investigations are proceeding in step-wise fashion, each step involving greater and greater detail over smaller areas. Early phases of the work have consisted of literature searches to assemble known information concerning an area, followed by field surface surveys by trained professionals to determine the likely presence of historically important resources in certain areas. Information gathered during these efforts will be incorporated into the preliminary engineering and environmental analysis of this project.

The method of studies will differ among different types of facilities. For example, since the location of water transmission and distribution mains can be adjusted to account for obstacles, the detailed examination of the routes of these alignments for archaeologically important resources will be conducted at the time of final design. Adjustments can be made at this stage to avoid important resources, without significantly altering the overall water.

On the other hand, since major facilities such as pump stations and treatment plants cannot be moved without corrupting the overall plan, it is important to conduct a more comprehensive assessment in the planning stage, such that the likelihood of adverse impacts on archaeological resources is minimized. Thus, for the well sites and location of storage tanks, the archaeological investigations conducted as part of the planning have included walkover surveys of significant areas to minimize the possibility of problems later. The central purpose of these walkovers is to note the existence of surficial artifacts and structures that would indicate resources of a more important nature that need to be avoided.

Following the planning phase, more detailed archaeological investigations are proposed concurrent with the design and construction phases of the project. These will include the following:

Design Phase: For pipelines, water reservoirs and well fields, roads, communications, and energy facilities, field investigation work will be conducted along specific alignments and locations to important resources. These studies will include surficial surveys and detailed transect surveys where warranted. If any such resources are noted, then decisions will need to be made whether to adjust the alignment and locations, or to document the resources prior to commencement of construction.

Construction Phase: During excavation, it will be possible to uncover resources that have not been previously uncovered. To provide for proper treatment of the archaeological resources during this stage, on-call archaeologists will be retained during excavation.

APPENDIX H

CONSIDERATIONS OF PADICO'S PROPOSED EMERGENCY OR INTERIM PHASE CONSTRUCTION PLANS AT THE GIE

Considerations of PADICO's Proposed Emergency or Interim Phase Construction Plans at the GIE

As noted in Chapter 3 of this EA, there are three phases for the construction and operation of the GIE. In late 1996, PADICO proposed an accelerated construction schedule that would begin limited construction of the GIE but would not require the provision of significant off-site infrastructure. The legal necessity for this EA is to satisfy USAID and World Bank requirements for projects where EA funding is involved. Because USAID and the World Bank do not intend to provide funding for this interim phase, which would begin before the end of 1996, this EA has focused on the original plans for the three-phase buildout rather than the interim phasing plan. Nevertheless, because this interim phase does pose environmental issues and is directly connected to the overall project, USAID agreed with the EA team to include this cursory evaluation of the environmental impacts of the interim phase.

Section 1 of this appendix briefly describes the interim phase. Section 2 identifies the advantages and arguments in favor of the plan. Section 3 identifies problems and concerns. Section 4 suggests mitigation measures that could be made contingent upon future USAID (and/or World Bank) funding in the event that the interim phase plan goes forward.

Section 1—Description of the Interim or Emergency Phase of the GIE Construction

To accelerate the provision of jobs and to provide a tangible sign of economic opportunity to the many unemployed residents of the Gaza Strip (the unemployment rate has been estimated at up to 60%), PADICO has suggested that initial construction of a portion of the GIE begin immediately with planned completion at the end of January 1997. According to PADICO, at least 12 firms have signed letters of intent to move onto the site as soon as the interim phase construction is completed.

The elements of this interim phase plan are as follows:

- Installation of fence around the construction site
- Site leveling, foundations, and construction of several standard factory buildings
- Construction of the administration building
- Installation of a pipe that would connect with the city of Gaza water system for the provision of 300 m^3 of potable water
- Construction of a single water well to provide brackish water for industrial use
- Construction of a sewer line to send untreated and domestic sewage to the city of Gaza wastewater treatment plant
- Provision of some telecommunications connections

The wastewater that would be generated by the industrial activities would be stored during the day in a 1,000 cubic meter containment vessel and would then be pumped to the wastewater treatment plant during the night when the wastewater volume from the city is lower than during the day.

Section 2—Advantages and Arguments for the Interim Phasing Plan

- The principal rationale for the plan is to accelerate employment opportunities and to provide a tangible sign of hope to the people that economic relief may be on the way. Some of the violence associated with the Intifadah and the more recent protests and violence in September 1996 are believed to be attributable to frustration over the pace of the peace process and the accompanying anticipated benefits of economic progress. Therefore, the tangible signs of industrial development and job opportunities may reduce the likelihood of future outbreaks of violence in the Gaza Strip.
- An argument for the interim phase plan is that there is nothing to prevent this group of industries from constructing and operating at available sites in the Gaza area without any environmental controls. Thus, even if the treatment of their wastewater discharges is not effective and if their water supply strategy is not optimal, the impact these industries would have on the environment under the interim phase plan would not be long-term (assuming that off-site infrastructure is eventually provided).
- From an economic perspective, implementing the interim phase would minimize or avoid financial losses that PADICO may incur if the GIE project is delayed. PADICO has already signed an agreement with MOI and has already committed investments towards the project. The interim schedule would allow PADICO to begin to recoup its investment. Delays in construction and operation affect the financial viability of the industrial estate. To the extent that the viability of the industrial estate is adversely affected, the costs to tenants would increase and the attractiveness of siting in an industrial estate would be diminished. Environmental management is more easily accomplished when industries are collocated in industrial estates. Thus, the long-term control of industrial impacts is best accomplished when industrial estates are financially viable.
- There are advantages in initiating the interim phase because it would move the project forward and possibly accelerate the decision-making process in the selection of feasible alternatives. PADICO and other project proponents are concerned that the study of options could be prolonged unnecessarily because of administrative (such as funding-related paper work) and political factors.

Section 3—Concerns and Potential Problems with the Interim Phasing Plan

- Given the uncertainty surrounding the existence of archaeological resources below the surface of the site, it is possible they could exist and therefore be disturbed and lost forever

unless a survey by qualified archaeologists is conducted and it is determined that construction at the site would not affect archaeological resources.

- The Gaza wastewater treatment plant is overloaded and is only providing marginal treatment to the wastes it now receives (aeration ponds are inoperative). Sending additional wastewater to the plant, even at off hours, might not avoid additional overloads, and, in any event, would not result in the degree of treatment as would be provided by the off-site wastewater treatment plant dedicated to the GIE.
- The proposed interim phasing plan does not address industrial wastewater pretreatment or stormwater management needs. In the case of stormwater, this could result in the uncontrolled release of contaminated storm water runoff from the site, which may have a deteriorating effect on the environment adjacent to the GIE.
- The construction of the water line, the wastewater line, and the sewage containment structure could be a long-term, unnecessary cost depending upon the option selected for the provision of water. Arguably, this investment could be better spent on long-term environmental controls.
- The immediate construction and leasing for future occupancy at the GIE could result in some of the tenants avoiding environmental controls that would be in place for future tenants. Immediate construction and leasing do not allow sufficient time for mitigation measures to be fully developed.
- One of the benefits of PADICO's plans for the GIE is that it will be possible to segregate facilities into zones to prevent inappropriate adjacent uses (such as an auto painting firm and a food processing firm with possible cross contamination). If only a portion of the site is available for a diverse mix of firms, then the advantage of zoning would be defeated.

Section 4—Conclusions and Recommendations

The decision as to whether USAID and the World Bank should agree to fund the off-site infrastructure for the GIE (should PADICO proceed with the interim phasing plan) is a policy decision that must weigh the plan's economic and other benefits against the short-term environmental uncertainties and impacts as well as any irreversible environmental impacts.

A compromise solution would be for the donors to agree to fund the off-site infrastructure for the GIE and for PADICO to be allowed to move ahead with the interim phasing plan. This would occur provided that any irreversible impacts be mitigated and that the initial tenants agree to any environmental mitigation that is eventually required of the other tenants (rather than to allow the firms to be "grandfathered" out of the system or to force decision makers into hasty, poorly conceived plans for mitigation).

The irretrievable and irreversible impacts that should be covered include the possibility of damage to archaeological resources and the construction of facilities to accommodate the interim

phase that would interfere with the optimal placement of off-site infrastructural elements for the GIE's long-term future.

In short, a potential compromise would include three provisions:

- There would be a legally binding means by which PADICO and its tenants agree that the initial tenants would conform to whatever future mitigation and controls are required for the other tenants. It would be reasonable to place a limit on the uncertainty that the initial tenants would face—say 6 to 12 months.
- An archaeological survey would be conducted of the entire site.
- The uncertainties regarding the exact placement of the various off-site infrastructure elements, including the wastewater treatment plant and the standby generator, would be resolved.

An additional approach to mitigating the impacts of the accelerated development of the interim phase would be to shorten the implementation time for off-site infrastructure construction at the GIE. This can be accomplished through the mechanisms of sole-source contracting and turnkey construction of key infrastructure items (water supply, wastewater treatment, solid waste handling). These activities could be accomplished in tandem with the interim phase development so that the interval between the interim phase development of site utilities and the Phase I infrastructure components is shortened.

APPENDIX I

PLANT SPECIES IDENTIFIED ON AND IMMEDIATELY ADJACENT TO THE GIE SITE

Plant Species Identified On and Immediately Adjacent To the GIE Site

Trees:

Acacia dealbata (common name is Tamor)
Cupressus sempervirens
Pinus halepensis (common name is Kaphore)
Ficus carica
Vebascum undulatum

Herbs:

Nabk (common name is Christ's thorn)
Pokeberry or Pokeweed (common name)
Fogonia mollis
Centaura Compositae

Species identified by Nadia El-Khodary with the Environmental Planning Division of the Ministry of Planning.

APPENDIX J

CONSIDERATION OF USE OF THE GAZA MUNICIPAL WASTEWATER TREATMENT PLANT TO TREAT WASTEWATER FROM THE GIE

Consideration of Use of the Gaza Municipal Wastewater Treatment Plant to Treat Wastewater from the GIE

An option that was not considered in the EA under the wastewater treatment off-site infrastructure element of the GIE is to convey the GIE pretreated industrial wastewaters to the Gaza municipal wastewater treatment facility for final treatment and disposal. This option assumes that the Gaza City WWTP would be upgraded to meet quality standards typical of most well performing sewage treatment plants. The option would require the installation of a pipeline (i.e., force main) that would have capacity for conveyance of 2,000 cubic meters per day of pretreated industrial wastewaters from the GIE.

The wastewaters would be pumped to the Mansoura Street main where they would proceed by gravity to Lift Station No 7A for pumping to the Gaza City WWTP. Alternatively, the pretreated wastewaters may be pumped from a surge tank at the GIE to pump station No. 6 for conveyance to the Gaza City WWTP. This wastewater treatment option assumes that the Gaza City WWTP would undergo extensive renovation and upgrading so that it meets the standards necessary to treat industrial wastewaters.

The potential advantages of this option are as follows:

- The pretreated industrial wastewaters from the GIE would account for only about 12% of the total hydraulic load on the Gaza City WWTP. Therefore, extensive dilution of these wastewaters would be achieved with a subsequent reduction in environmental impact.
- The apparent operational and maintenance cost of wastewater treatment to the GIE should be lower than the costs associated with the operation of a dedicated industrial WWTP at the industrial estate.
- The industrial wastewater pretreatment requirements could probably be reduced because of the dilution associated with the Gaza City sewage flow.

Some concerns and potential problems associated with this option are as follows:

- There is considerable uncertainty in the effectiveness of an upgrade/renovation of the Gaza City WWTP for industrial wastewater applications, particularly if the pretreatment requirements for each industrial tenant are lowered under this option. The industrial wastewaters would contain dissolved organic compounds which are not typically treated in municipal wastewater treatment facilities. Although the hydraulic loads will be low, the organic loadings from the industries (depending on industry type) could be quite high. This could impact the performance of the biological treatment system if the bacteria are not acclimated to these pollutants. There are also shock load impacts which could deteriorate the performance of the treatment plant and cause numerous process upsets or failures.

- The failure of a 15,000 cubic meter per day wastewater treatment system because of toxic loads from the industrial sources would have a greater environmental consequence than the failure of a 2,000 cubic meter per day industrial facility which can be contained and managed to control discharges to the environment.
- The uncertainty associated with the Gaza City sewerage system, which is subject to overflows and infiltration losses of wastewater to the environment, could cause major long-term problems with the discharge of untreated industrial wastes to the freshwater shallow aquifer.

Given the uncertainty in the consequences of implementing this option, additional engineering studies should be conducted to assess the needs related to Gaza City sewerage improvements and renovation/upgrade of the municipal WWTP.