CHAPTER VII PROJECT EVALUATION

7.1 Concept of Project Evaluation

Groundwater development will bear various benefits, both tangible and intangible ones. As mentioned in NPDS, water resource is the essential key to its realization. In project evaluation, not only tangible factors but also intangible factors shall be evaluated. In this chapter, evaluation is made on the following factors.

(1) Evaluation by intangible factors

(2) Economic and financial evaluation (tangible factors)

(3) Environmental evaluation

(4) Evaluation of groundwater storage

7.2 Evaluation by Intangible Factors

Major presumed intangible benefits from the prepared development Plan 1 to 5 are as follows.

(1) Mitigation of overpopulation in Cairo area by resettlement

(2) Saving the Nile water

(3) Others

7.2.1 Mitigation of Overpopulation in Cairo Area by Resettlement

A 99 % of the total population is excessively concentrated in the limited arable land along the Nile River and its delta. The government of Egypt has been faces to this problem. One of the main purposes of NPDS is to make sure the resettlement program from the Cairo area to Sinai.

Groundwater potential evaluation revealed that the potential of the Lower Cretaceous aquifer meets the water demand level of NPDS in target year for more than 280 years. Therefore, contribution of groundwater development is estimated to be huge for the resettlement program in terms of water supply.

7.2.2 Saving the Nile Water

Big projects other than NPDS are in progress in El Toshka, Shark El Oveirat, Gulf of Suez and so on. These projects will require huge amount of water resources relying mainly on

the Nile water. However, it will cause heavy deficit of the Nile water in future.

Water demand of NPDS in target year requires an amount of 134,900 m^3/day of water source. If this amount of water is covered by groundwater, same amount of the Nile water can be saved and used for other projects. At present it is difficult to specify usage of saved water in other project. Saving the Nile water itself is considered as big benefit.

7.2.3 Others

Other benefits are listed as follows.

- Reduction of water-bearing diseases
- Reduction of infant mortality
- Improvement of living standard
- Contribution to tourism promotion
- Land value hiking
- etc.

7.3 Economic and Financial Evaluation

7.3.1 Methodology of Project Evaluation

1) General

The project evaluation is conducted in accordance with the conventional methodology that is commonly applied for evaluation of development in Egypt under finance of the World Bank and other international agencies concerning to technical and economic corporation. At first, the project cost and benefit are identified and quantified in monetary terms. Then, they are compared and condensed into evaluation factors. The factors are Internal Rate of Return (IRR), and Net Present Value (NPV) and Benefit-Cost Ratio (B/C).

2) Concept of Economic Benefit

Benefits of water supply projects are estimated as the total cost of the optimum system under "without-project" conditions. The economic value of water under "with-project" conditions is evaluated by the total costs. The total costs of "without-project" case will be eliminated under the "with-project" case. The benefits of the proposed projects of Plans 1 to 3 are justified taking into account of water supply plans in the NPDS.

3) Assumptions and Input Data for Economic Evaluation

(1) Criteria of Evaluation

i) Criteria for Conversion to Economic Value

In estimating the economic benefit, the following criteria and assumptions are applied to transfer the financial values of the project benefits to the economic ones in this Study.

(i) Transfer Payments : Payment of taxes and subsidies were eliminated from the market values of cost and benefit as a whole.

(ii) Shadow Wage : The market prices of workers were converted into the social prices by using following adjustment factors: They are 1.0 for skilled workers and 0.6 for unskilled workers.

(iii) Conversion Factor : All the costs involved in every project were measured as "opportunity costs" assuming them approximately 90% of the financial costs.

(iv) Land Value

Most lands in South Sinai expropriated for the projects are not utilised for productive activity. In economic evaluation as well, accordingly, the value of these lands will be evaluated as nothing even in the future.

ii) Other Conditions

(i)	Base Year	Beginning of 1999
(ii)	Construction Period	The first year of 1999 is for detailed design, and after the second year construction period is different from one project to another
(iii)	Disbursement Schedule	Disbursed in corresponding to construction schedule
(iv)	Economic Life	25 years after the completion of the project
(v)	Evaluation Period	25 years after the completion of the major works
(vi)	Timing of Benefits Accruing	After the completion of the first stage of the project. In agricultural projects, the matured benefit is attained in five years later regarding cereals and vegetables, and nine years regarding fruits after the completion.

(vii)	Population in South Sinai	1996 (census year): 54,500 2017: 299,200
(viii)	Price Level	Cost and benefits of the project were set at the beginning of March 1998.
(ix)	Prevailing Exchange Rate	LE3.39 per US$1.00 at the official rate
(x)	Opportunity Cost of Capital	10% per annum

(2) Unit Benefits

i) Benefit of Water Supply Projects

Under without project condition, the water supply system of the minimum cost is planned to estimate a marginal cost for the project areas in this study. Taking into account of the water resources availability, the following systems could be the most applicable and realistic in the project areas.

(i) Plan 1

Sinai Development Authority (SDA) supplies the Nile River Water to Ras Sudr, Abu Zenima and Abu Rudeis in financially free of charge. The unit water cost is estimated at LE3.07/m^3 in 1997 on the basis of the data presented by SSDA. The unit cost is re-estimated at LE3.34/m^3 on average for coming 25 years in consideration of the future increasing water requirement.

Applying the conversion factors, the above financial unit water value of LE3.34/m^3 is converted to LE2.69/m^3 in economic terms. The annual benefit of Plan 1 is estimated as a product of this economic unit water value and the total water demand. The project benefit is expected to start in 2004, since the water demand of the three cities is estimated at 1.67 million m^3/year in 2004. The total benefit is expected to be LE4.50 million. In the same manner, the total benefit in 2017 of the target year is estimated at LE56.19 million per annum.

(ii) Plan 2

As the existing town facilities and hotels get domestic and municipal water through seawater or brackish water, the desalination system is the most realistic and applicable in urban areas along the East Coast. Thus, the new water demands are covered by the water supply systems of which water sources are provided with desalination system.

The water cost is calculated through a model study. The flat rate of fresh water is

estimated at LE3.94/m^3 in economic terms. It is segregated into LE1.48/m^3 of capital portion and LE2.46/m^3 of O/M portion.

(iii) Plan 3

In Plan 3, the water resource for the water supply in El Tur City will be provided by other than the proposed project after 2007. The pipeline is one of the convincing water sources for the city. Then, the benefit for Plan 3 is also estimated at LE2.97/m^3 in economic terms on the basis of the pipeline water.

ii) Benefit of Irrigation Projects

(i) Component of Agricultural Water Benefit

In the NPDS, 36,000 feddan (15,120 ha) of cropping fields is cultivated in total by the target year 2017. The detail plan, however, is not reported, so it is not clear at present to identify development areas and cropping system. In this study, to estimate the agricultural benefit for the development projects, the following crops are selected as typical products in South Sinai. These crops referred to the past records of performance in South Sinai in 1997.

(a) Wheat and barley for cereal crops
(b) Olive and orange for fruits
(c) Tomato and watermelon for vegetables

(ii) Unit Benefit of Irrigation Project

Unit benefit of irrigation project is estimated as a net return per unit cultivated area. A crop budget is calculated as a difference between gross income and production cost. Hence, the economic values of crops are basically evaluated applying international prices. The net returns from crop cultivation are estimated in the table below.

Net Return (Unit: LE/feddan)

	Financial Value	Economic Value
Wheat	760	463
Barley	279	177
Tomato	9,400	13,811
Watermelon	2,055	1,431
Olive*	8,371	7,301
Orange*	2,445	8,176

Note: * At matured stage

In the project areas, the cropping areas are assumed as follows: 25% of wheat;

20% of barley; 15% of tomato; 15% of watermelon; 15% of olive; and 10% of orange. Crop intensity is assumed to be 180%, referring to the "North Sinai Agricultural Integrated Rural Development Project". On the basis of these assumptions, the economic unit benefit is calculated at 4,000 LE/feddan/year in economic terms at the matured stage.

(3) Project Benefits

The total benefits of the respective projects are estimated as a product of unit benefit and total volume for water supply schemes or total crop areas for irrigation schemes. The projects are implemented stepwise toward the target year 2017. The economic benefits of water supply projects are calculated for the respective stages as follows:

Water Supply Projects

	Plan 1	Plan 2	Plan 3
First Stage			
Year of Benefit Accruing	2004	2006	2001
Benefit (LE 1000)	4,502	10,890	1,435
Second Stage			
Year of Benefit Accruing	2009	2009	2004
Benefit (LE 1000)	15,764	16,766	3,208
Third Stage			
Year of Benefit Accruing	2014	2015	-
Benefit (LE 1000)	35,313	37,781	-

The irrigation projects are also divided into three stages. The economic benefits of irrigation schemes are calculated for the respective stages as follows. The full benefit of irrigation project is expected in the fifth year after crop production starts for cereal and vegetable crops, and in the ninth year for fruits. The benefit in the table below shows the compound figures of these stepwise cultivated production. Furthermore, the benefit figures are reduces to 80% of the total benefit, because the proposed projects include the water resource development schemes and exclude the distribution system.

Irrigation Projects

	Plan 4A	Plan 4B	Plan 4C
First Stage			
Year of Benefit Accruing	2001	2002	2001
Benefit (LE 1000)	219	267	219
Second Stage			
Year of Benefit Accruing	2006	2007	2006
Benefit (LE 1000)	2,651	3,233	2,651
Third Stage			
Year of Benefit Accruing	2011	2012	2011
Benefit (LE 1000)	4,383	5,288	4,383

(4) Project Costs

i) Conversion of Financial Cost to Economic Cost

The estimates of the proposed projects are enumerated in market prices, what is called "financial value". In economic evaluation, the financial value is converted into economic value applying conversion factors. The costs are summarised in the table below.

Water Supply Projects

	Plan 1	Plan 2	Plan 3
Financial Terms			
Construction Cost (LE Million)	461.5	535.8	17.0
O/M Cost (LE1000/Year)	11,600	15,060	412
Economic Terms			
Construction Cost (LE Million)	397.8	456.5	14.5
O/M Cost (LE1000/Year)	10,434	13,485	369
Ratio of Economic Construction Cost to Financial One (%)	86	85	85

Irrigation Projects

	Plan 4A	Plan 4B	Plan 4C
Financial Terms			
Construction Cost (LE Million)	74.5	86.3	74.5
O/M Cost (LE1000/Year)	2,139	2,529	2,139
Economic Terms			
Construction Cost (LE Million)	64.4	74.6	64.4
O/M Cost (LE1000/Year)	1,923	2,275	1,923
Ratio of Economic Construction Cost to Financial One (%)	86	86	86

ii) Disbursement Schedule

The disbursement schedule of the capital investment corresponds with the construction phase plan. The O/M cost also corresponds to the phase plan of main construction work.

iii) Replacement and Residual Values

The pipeline facilities of the respective projects are considered to last 25 years long. Then, the evaluation period is set up as 25 years after the completion. On the other hand, the machinery such as submersible pump and booster pump is considered to last 15 years. These machines have to be replaced during the system's life. In the disbursement schedule, then, the replacement costs of these machines are appropriated every 15 years after the completion of the project.

After the evaluation period of 25 years, the replaced machines will still be able to work

well, because they are in their durable period after the replacement. In the evaluation procedure, these machines are evaluated as residual value, and their values are added up into benefit in the final year of the evaluation period.

4) Results of Economic Evaluation

Applying economic costs and benefits for the evaluation period, the evaluation indices of EIRR, NPV and B/C are calculated for the respective proposed projects. The following table summarises all evaluation indices of the projects.

Project	EIRR (%)	NPV (LE Million)*	B/C*
Water Supply Projects			
Plan 1	5.2	-124	0.57
Plan 2	3.3	-181	0.45
Plan 3	24.0	19	2.41
Irrigation Projects			
Plan 4A	0.5	-32	0.44
Plan 4B	0.6	-36	0.43
Plan 4C	0.5	-32	0.44

Note: * Discounted at 10%.

As shown in the table above, the EIRR of Plan 3 is 24.0%, exceeding the opportunity cost of capital, 10%. Taking difficulty of water supply in South Sinai into consideration, the rate would not be low in the least as compared with other cases in the developing countries. In the report of "Investing in Development, Lessons of World Bank Experience" in 1985, the water supply project is mentioned as follows: "Water supply and sanitation agencies serving poorer consumers and providing a basic need have rarely been permitted to earn returns higher than 6 to 8 percent". Thus, the rate of 5.2% might be not so low as the general water supply projects in the developing countries. Incidentally, if the estimated costs decreased to 45% of the original estimation, the EIRR would be more than 10%.

The EIRR of Plan 2 is 3.3%. In other words, it is to be desired economically that the implementing agency should promote not the reverse osmosis desalination system but the proposed project. Incidentally, if the estimated costs decreased to 55% of the original estimation, the EIRR would be more than 10%.

The EIRRs of irrigation projects are much less than 10%. From the economic point of view, accordingly, the viable project is Plan 3 only. In consideration of the speciality in Sinai, Plans 2 and 3 might be viable as well.

The Nile River Water is utilised in many areas of the country. It is regarded as only one precious and ample resource of water for the country. However, the Nile River Water may not completely cover plenty of increasing water demand in the future. Considering

this trend, the benefit of Plan 1 and 3 may increase in the future, because the water value of Nile Water goes up due to its scarcity value. In particular, the economic value of water might gradually increases in recent development projects in the core areas of Egypt. From the economic viewpoint, thus, the new water resources from the groundwater are important for South Sinai in the future.

Regarding irrigation project, the investment and O/M costs of water resources are too high to realise the proposed projects from the economic viewpoint. Although it is important to promote agricultural project to raise self-sufficiency rate of food in South Sinai, the crop production under with-project conditions is not realistic economically. The production costs exceed the economic food values imported from other inland areas or from foreign markets. Thus, the crops would rather be cultivated under rainfed fields with farm rain ponds.

7.3.2 Financial Evaluation

1) General

The component for financial evaluation comprises cost and revenue. The costs for the proposed projects are estimated applying the market prices in South Sinai. They are composed of initial construction cost, O/M cost and replacement cost.

The revenue of the proposed projects accrues from expenses of the water consumers. The consumers pay for water charges in accordance with their water volume consumed and water tariff. The city governments concerned lay down the water tariffs on water consumers in their territories. At present, the city governments cover their city proper by a piped system and the surrounding communities by conveying water by tank lorries in principle.

2) Assumptions and Input Data for Financial Evaluation

(1) Project Revenues

i) Water Supply Projects

The water tariffs in El Tur, Ras Sudr and Sharm El Sheikh are identical completely. In particular, the water rate for domestic use is common in the five cities introducing the metered rate. Furthermore, the rate (LE6.00/m^3) for hotel is completely identical among the eight cities. The rates for industrial and commercial uses are different among the cities. In this study, then, these rates are set up applying the weighted average of the rates in eight cities concerned to the respective plans. Consequently, the

unit charge of the respective consumer types is calculated as follows.

(Unit: LE/m^3)

Type of Consumer	Plan 1 Ras Sudr, Abu Zenima, Abu Rudeis	Plan 2 Nuweiba, Taba	Plan 3 El Tur
Domestic			
Urban	0.183	0.030	0.183
Rural	0.178	0.067	0.178
Industrial	1.00	-	1.00
Hotel	6.00	6.00	6.00

The revenue from water supply services is calculated as a product of water volume consumed and unit prices settled in the water tariffs. The average unit volume of water consumption is set up and calculated as monthly and annual volumes as follows.

Type of Consumer	Unit	Annual Volume	Monthly Volume
Domestic			
Urban	m^3/household	179	14.7
Rural	m^3/household	197	16.2
Industrial	m^3/feddan	90,000	7,500
Hotel	m^3/tourist	102	8.4

The unit revenue is calculated as a product of unit rate (LE/m^3) and unit water consumption volume for consumer types. The table below shows the average annual unit revenue of the respective consumers.

Type of Consumer	Unit	Plan 1	Plan 2	Plan 3
Domestic				
Urban	LE/household/year	32.76	5.37	32.76
Rural	LE/household/year	35.07	13.20	35.07
Industrial	LE1000/feddan/year	540	-	540
Hotel	LE/tourist/year	102	102	102

ii) Irrigation Projects

The revenue of the proposed irrigation projects is estimated applying the same procedure done in the economic evaluation. Needless to say, the values of all items are evaluated in market prices. They are as follows: LE760/feddan for wheat; LE279/feddan for barley; LE9,400/feddan for tomato; LE2,055/feddan for watermelon; LE8,371/feddan for olive; and LE2,445/feddan for orange.

iii) Revenue from Proposed Projects

The total revenues of the respective projects are estimated as a product of unit price on the water tariff and total volume for water supply schemes or total cultivated areas for

irrigation schemes. However, the total revenue are reduces in proportion to the ratio of the construction cost of the proposed schemes against the total construction cost of the complete water supply system for the end users. These ratios are shown in the table below. Furthermore, the projects are implemented stepwise toward the target year 2017. The total revenue of water supply projects are calculated for the respective stages as follows:

Water Supply Projects

	Plan 1	Plan 2	Plan 3
Ratio of Project to Entire Scheme	70%	80%	20%
First Stage			
Year	2004	2006	2001
Revenue (LE 1000/Year)	2,226	7,874	59
Second Stage			
Year	2009	2009	2004
Revenue (LE 1000/Year)	4,302	9,592	109
Third Stage			-
Year	2014	2015	-
Revenue (LE 1000/Year)	6,728	12,772	-

The irrigation projects are also divided into three stages. The financial revenue of irrigation schemes is calculated for the respective stages as follows. The matured revenue of irrigation project is expected in the fifth year after crop production starts for cereal and vegetable crops, and in the ninth year for fruits. The revenue in the table below shows the compound figures of this stepwise production. Furthermore, the benefit figures are reduced to 80% of the total benefit, because the proposed projects include the water resource development schemes and exclude the distribution system.

Irrigation Projects

	Plan 4A	Plan 4B	Plan 4C
First Stage			
Year	2001	2002	2001
Revenue (LE 1000/Year)	131	159	131
Second Stage			
Year	2006	2007	2006
Revenue (LE 1000/Year)	2,082	2,538	2,082
Third Stage			
Year	2011	2012	2011
Revenue (LE 1000/Year)	3,391	4,092	3,391

(2) Project Costs

i) Construction Cost

The estimates of the proposed projects in market prices are summed up as follows.

Water Supply Projects

Item	Plan 1	Plan 2	Plan 3
Financial Terms			
Construction Cost (LE Million)	461.5	535.8	17.0
O/M Cost (LE1000/Year)	11,600	15,060	412

Irrigation Projects

Item	Plan 4A	Plan 4B	Plan 4C
Financial Terms			
Construction Cost (LE Million)	74.5	86.3	74.5
O/M Cost (LE1000/Year)	2,139	2,529	2,319

ii) Disbursement Schedule

The disbursement schedule of the capital investment corresponds with the construction phase plan. The O/M cost also corresponds to the phase plan of main construction work.

iii) Replacement and Residual Values

As discussed in the economic evaluation, the machinery is replaced during the evaluation period of 25 years after the completion. Thus, the replacement costs of the machinery are appropriated every 15 years after the completion of the project. After the evaluation period of 25 years, however, the replaced machines will still be able to function, because they are in their durable period after the replacement. In the evaluation procedure, these machines are evaluated as residual value, and their values are added up into revenue in the final year of the evaluation period.

3) Results of Financial Evaluation

Applying financial costs and benefits during the evaluation period, the evaluation indices of FIRR, NPV and B/C are calculated for the respective projects. The table below summarises all evaluation indices of the projects.

Project	FIRR (%)	NPV (LE Million)*	B/C*
Water Supply Projects			
Plan 1	-	-299	0.10
Plan 2	-	-327	0.15
Plan 3	-	-15	0.10
Irrigation Projects			
Plan 4A	-	-38	0.34
Plan 4B	-	-42	0.33
Plan 4C	-	-38	0.34

Note: * Discounted at 10%.

The FIRRs of the all projects are negative. Thus, the all proposed projects would not be viable, if the projects are based on the "cost-recovery" policy under the present tariff and financial situation. The total costs are greatly in excess of the revenues from the management of the proposed projects. The projects can not be managed without any financial supports by the government.

In the water supply projects, it might be difficult to raise the rates of water tariff because of the NPDS policy. If so, the following financial support would be necessary, that is, the capital costs of the projects are covered by the government and the O/M costs are covered by 50% of the government. The rest 50% of the O/M costs is covered by the revenue from the water charges on beneficiaries under present tariffs. In that case, the FIRR could exceed 10%. Although this is a heavy burden for the government, there is no way to bring the proposed projects into fruition.

In the irrigation projects, it might be impossible for the beneficiaries to get the net returns of three times more than the present ones. For making the projects having more than 10% of FIRR, 70% and more subsidies than the all costs have to be committed by the government.

7.4 Initial Environmental Examination (IEE)

7.4.1 Evaluation Factors

Main objective of IEE is to evaluate whether EIA (Environmental Impact Assessment) is necessary for the further study and to examine, from the environmental viewpoint, the measures for alleviating the effects of the project which requires environmental consideration but not a full-scale EIA.

Table 7.4.1 (1) to (5) summarizes the estimation of the environmental changes and assessment of the influence by the changes. These environmental items apply corresponding to "Environmental Guidelines for Infrastructure Projects VIII Groundwater Development, JICA Environmental Guidelines, and September 1992".

Environmental items for examination against development plan are discussed as follows:

1) Social Environment

Concerning "(2) Economic Activities" and "(7) Public Health Condition", the development plan will give the benefit to inhabitants of service areas. That will be prompt economic activities of service areas: especially agricultural outputs will increase by the supply of irrigation water. Also, health condition of inhabitant will be improved by

supply of drinking water.

Development plan will seldom affects other items of "(1) Resettlement", "(3) Traffic and Public Facilities", "(4) Split of Communities" and "(9) Hazard (Risk)". The reason is why most of development plan is conducted in non-resident areas.

Serious impacts against items of other social environment are not observed.

2) Natural Environment

The main facilities of the development plan consist of intake facilities and transmission pipelines; most of intake facilities are proposed in non-inhabitant areas and pipelines are buried along roads. Therefore, the development plan will not affect directly item "(15) Fauna and Flora".

Also, the development plan does not need large-scale reclamation works. Therefore, environmental items "(10) Topography and Geology", "(11) Soil Erosion" and "(16) Meteorology" will not be given effect by the development plan.

However, each item of "(12) Groundwater", "(13) Hydrological Situation" and "(17) Landscape" should be paid attention as follows:

Development of wells for irrigation and common use is proposed in Bedouin community. Locations of new wells should be selected in the points that are not given effect such as lowering of groundwater table against existing wells.

Increase of wastewater related to increase of water consumption is expected to have impact against water quality of sea, if the necessary measures against increase of wastewater are not taken. The Gulf of Aqaba belongs to the protected area; consequently necessary measures such as improvement of wastewater treatment facilities should be taken.

Also, locations of pressure reduce tanks of 7 sites in Wadi Watir should be decided considering the conservation of landscape because this section has superior landscape.

3) Pollution

Groundwater development in Bedouin communities is proposed. Drilling under construction may cause water pollution against existing wells of Bedouin. Therefore, item "(19) Water Pollution" should be paid attention.

Drilling machines under construction generate noise and vibration however the period of

construction is limited, item "(21) Noise and Vibration" will not be seriously affected by the development plan. Moreover, lift pumps in the operation also generate noise, however its sites are almost located in non-resident areas. Concerning noise of lift pumps in Bedouin communities will not seriously affect the environment for small-scale size.

Serious impacts against items of other pollution are not observed.

7.4.2 Conclusion of IEE and Recommendation for Development Plan

1) Conclusion of IEE

Based on the results of the study, the degree of the possible impact is assessed using the following three categories.

A: Impact is deemed strong

B: Some impact is expected

C: Impact is very small

Table 7.4.1 (1) to (5) summarizes the estimation of the environmental changes and assessment of the influence by those changes.

The results of IEE for each plan are as follows:

Category	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5
A	0	0	0	0	0
B	0	2	2	3	3
C	23	21	21	20	20

Thus, it is concluded that due to the reasons explained below, the environment will not be seriously affected by the implementation of the development plan. As a consequence, an EIA is not necessary.

The reasons supporting the conclusions are as follows:

(1) Most of South Sinai consists of scarce natural condition under desert climate; the habitats of plants and animals are limited. Plants grow in the mountainous area representing St. Catherine and wadis and gullies. Animals also are observed in a part of the district. The development plan is not proposed in these areas. Therefore, the natural environment in the Study Area will not be directly affected by development plan.

(2) Concerning facility plan, well fields of Plan1, 2 and 3 need expensive areas; however these areas consist of non-resident areas. Also, the pipeline of Plan 2 has the length of 181 km; however pipes are buried along existing roads. Other facilities consist of

small-scale size and a large-scale reclamation is not needed.

Thus, development plan does not seriously affect environment.

(3) Rather, development plan will contribute to the economic activities and the improvement of public health condition. For instance, increase of water supply to service areas will develop tourism of the major industry in South Sinai. Also, agricultural outputs will increase by supply of irrigation water. At same time, development plan will give job opportunities through construction works.

However, concerning the "B" category, the necessary countermeasure should be taken. These measures and related subjects are shown in Table 7.4.2.

2) Recommendation for Development Plan

Concerning groundwater development plan, its characteristics and fundamental considerations against environmental viewpoints are summarized as follows:

(1) Water Resources

Scales of water resources are different according to the purpose of water supply. Water resources with the largest scale is for portable use; the area of each well field of Plan1 and Plan2 has the scale of 5,130 ha (9,500 m x 5,400 m). Plan 3 is 1,100 ha (5,500 m x 2,000 m). These areas are formed in desert lands and there are no inhabitants. Also, valuable species of wildlife and plants can not be found in these areas.

Therefore, forced displacement of inhabitants by land acquisition is not needed; and special considerations against other environmental viewpoints are also not needed.

On the other hand, water resource for irrigation of Plan 4A, 4B and 4C and common use of Plan 5 consists of a well; and these wells will be established in the inside of irrigation area and residential area. These plans will not seriously affect the environment for small-scale size. However, development of new well in these areas should be carried out considering the effect against existing wells.

(2) Life of Aquifer

The increase of water demand by the growing population threatens to deplete the aquifer in the area. According to the study of water balance, life of the aquifer in the Study Area is estimated as 143 years if all the water demand in South Sinai depends on groundwater source. Also, life of the aquifer is estimated as 268 years if alternative water sources are used.

There is room for discussion in the length of life of the aquifer; however it is obvious that storage capacity of groundwater is limited. Especially, groundwater in the Lower Cretaceous Aquifer is so-called Fossil Water because it is never recharged by present surface water and is not sustainable. Therefore, development of groundwater in the Lower Cretaceous Aquifer should be carefully carried out under the strict management.

(3) Development Water Capacity

Total development water capacity in potable water sector is 118,880 m^3/day; and about 550,000 persons can get the benefit of development plan. Considering the total population 39,009 of South Sinai in 1996, the scale of development plan can be realized.

Also, total development water capacity for irrigation water is proposed in 37,100 m^3/day; and then agricultural land of 2,268 ha is newly irrigated. Agricultural land of South Sinai in 1994 was 1,400 feddans (588 ha).

On the other hand, increase of water consumption leads to increase of wastewater. Ras Sudr, Nuweiba and El Tur are the largest benefit area of development plan. Especially, Nuweiba that faces Gulf of Aquba is included in ABU Galum Managed Resource Protected Area. At present, wastewater in these cities is mostly treated by means of oxidation pond system. The treated wastewater is lost through evaporation and infiltration to underground; and then a part of wastewater is reused for irrigation.

However, existing wastewater treatment facility is impossible to treat the increased wastewater. Therefore, the countermeasures including the improvement of wastewater treatment facility should be considered.

(4) Conveyance Pipelines and Pressure Reduce Tanks

Conveyance pipelines of Plan 1, 2 and 3 have each length of 64 km, 181 km and 9 km.

In these, the route of Wadi Watir in Plan 2 is formed in deep narrow valleys; and it has superior landscape. This area also is proposed as new Protected Area, namely Taba Protected Area.

Almost of pipeline are constructed along existing road and pipe is buried. Therefore, the construction of pipeline will not seriously affect environment.

(5) Other Environmental Issues

"(8) Waste" and "(20) Soil Contamination" are not fallen into the " B" category. The

reasons are that these items are not affected "directly" by development plan. However, development plan will lead to the following indirect effects on environment.

i) Solid Waste

The problems of solid waste management and disposal are reported in St. Catherine area. Despite the existence of an official dump and an incinerator in St. Catherine, solid waste, particularly plastic bags and paper is mostly disposed of haphazardly. The existence of such foreign articles in the environment disturbs wildlife, and represent a danger if they ingested. Further more, the availability of excessive amounts of discarded food items leads to the unnatural increase in the population of certain scavengers. As an example, the dramatically increase of the Brown-necked Raven (a sort of crow) is recorded in the St. Catherine area. The increase of feral cats and dogs is also known; and they cause damage to populations of small mammals, small birds and reptiles.

These problems have been caused with the increased numbers of visitors and residents at St. Catherine.

A large numbers of immigrant will be received in development areas, particularly the areas in Plan 1, 2 and 3. At the same time, increase in domestic and other human wastes will also occur. Therefore, measures of solid waste disposal in development area should be considered. Solid wastes should be collected, stored, and placed in municipally managed landfills.

ii) Soil Contamination

Agricultural lands of total 2,268 ha in Plan 4A, 4B and 4C are newly developed by supply of irrigation water. In these areas, agrochemical will be used for the purposed of intensification of agriculture; introduction of high yielding varieties and new crops. However, utilization of agrochemical will cause soil contamination, if continuous application of agrochemical with high residual toxicity or excessive use of agrochemical is conducted.

Utilization of agrochemical should be carried out with definition of criteria on agrochemical with high residual toxicity and employment of strict regulation on use.

iii) Soil Salinization

Soil salinization is caused through unsuitable management of irrigation water, particularly in arid zone. It is a phenomenon in which soluble salts accumulate in the surface layer of soil. Crop growth is consequently adversely affected; and then it

reaches in decrease of land productivity and deterioration of land. These phenomena were observed in a part of agricultural lands of the Study Area.

Therefore, the management of irrigation water in development area should be carried out considering the problem of soil salinization. As mitigation measures, attention to impact to lower reaches in irrigation and drainage, the formulation of cropping pattern including time required for desalinization, introduction of salt tolerant crop and alteration of land use; etc. are needed.

7.5 Evaluation of Groundwater Storage

7.5.1 Quaternary Aquifer in El Qaa Plain

As discussed in Chapter IV, additional 3,000 m^3/day of groundwater development will be allowed in the Quaternary Aquifer in the El Qaa Plain. It becomes 12,415 m^3/day of yield in total. The water demand in the El Qaa Plain will reach to this amount in 2007.

Therefore, other water source shall be provided to meet increasing water demand after 2007.

7.5.2 Lower Cretaceous Aquifer

Water demand in 2017 is estimated in Chapter IV. They are tabulated below.

	Item	Volume
i)	Available groundwater volume	13.9×10^9 m^3
ii)	Groundwater flow rate to North Sinai:	1.38×10^6 m^3/year
iii)	Existing groundwater extraction:	0.76×10^6 m^3/year
iv)	New development volume for Plan 1:	20.99×10^6 m^3/year
v)	New development volume for Plan 2:	12.78×10^6 m^3/year
vi)	New development volume for Plan 4:	13.54×10^6 m^3/year

If all the development plans 1, 2 and 3 will be attained, total water demand will become 49.45×10^6 m^3/year. Therefore, life of available groundwater storage is calculated as shown below.

$$13.9 \times 10^9 \text{ m}^3 / 49.45 \times 10^6 \text{ m}^3/\text{year} = 281 \text{ (years)}$$

This calculation means that the life of Main Block of the Lower Cretaceous Aquifer is about 281 years, provided that development plans 1 to 3 are carried out.

On the other hand, according to the NPDS, agricultural development in the Central Sinai area (Malha, Sudr El Heitan and Themed) intends to use flood water of the Wadi El Arish

instead of groundwater. If this idea will be applied, the life of available groundwater storage is,

$13.9 \times 10^9\ m^3 / 35.91 \times 10^6\ m^3/year = 387$ (years)

Table 7.4-1 (1) Checklist of IEE (Groundwater Development) for (Plan 1)

No	Environmental Item	Description	Evaluation	Reasons
A. Social Environment				
(1)	Resettlement	Resettlement by land occupation (transfer of rights of residence, land ownership)	C	Most of development plan is proposed in non-residential areas. Therefore, forced displacement of inhabitants by land acquisition is not needed.
(2)	Economic Activities	Loss of production base (land, etc.) and change of economic structure	C	Economic activities are prompted. Especially, agricultural outputs will increase by supply of irrigation water. Tourism will be also developed by increase of water supply.
(3)	Traffic and Public Facilities	Impacts on existing traffic, schools, hospitals, etc. (e.g., traffic jam, accidents)	C	No wells are proposed in public facilities. Pipelines are buried structure.
(4)	Split of Communities	Separation of regional communities by hindrance of regional traffic	C	Most of development plan is carried out in non-residential areas. Also, pipelines are buried structure.
(5)	Cultural Property	Loss or deterioration of cultural properties, such as temples, shrines, archaeological assets, etc.	C	No development plan is proposed in the area of cultural property.
(6)	Water Rights and Rights of Common	Obstruction of fishing rights, irrigation and water rights	C	No overdraft that causes lowering of groundwater is proposed. However, development of wells in Bedouin community should be carried out considering the location of existing wells.
(7)	Public Health Condition	Worsening of health and sanitary condition due to generation of garbage and appearance of harmful insects	C	Public health condition will be improved by water supply. Especially, improvement of public health condition in Bedouin community is expected, because much of the well water, particularly shallow well water is unsuitable for human consumption.
(8)	Waste	Generation of construction waste, surplus soils, sludge, domestic waste, etc.	C	Generation of construction wastes is small. However, increase in domestic and other human wastes will occur due to population increase by development.
(9)	Hazard (Risk)	Increase in risk of cave-ins, ground failure and accidents	C	There is no facilities plan that causes hazard and risk.
B. Natural Environment				
(10)	Topography and Geology	Change of valuable topography and geology due to excavation and earthfill	C	Large-scale reclamation works are not needed; therefore, the changes of topography and geology are small.
(11)	Soil Erosion	Topsoil erosion by rainfall after land reclamation or deforestation	C	Large-scale reclamation works are not needed; therefore soil erosion do not occur.
(12)	Groundwater	Lowering of groundwater table due to overdraft and turbid water caused by construction work	C	Development aquifer bears a vast water volume.
(13)	Hydrological Situation	Change of discharge and water quality due to reclamation and drainage	C	There's no natural protected zone along the coastal line.
(14)	Coastal Zone	Coastal erosion and sedimentation due to change of littoral drift and reclamation	C	No development plan is proposed in coastal zone.
(15)	Fauna and Flora	Interruption of reproduction or extinction of species due to change of habit condition	C	No valuable species of fauna and flora inhabit in development areas.
(16)	Meteorology	Change of micro-climate, such as temperature, wind, etc., due to large scale reclamation and construction	C	Large-scale reclamation works are not needed, therefore meteorology in development areas is not affected.
(17)	Landscape	Deterioration of aesthetic harmony by structures and topographic change by reclamation	C	Location of pressure reduce tanks in Wadi Watir should be selected considering the conservation of landscape because this section is blessed with superior landscape.
C. Pollution				
(18)	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	C	Exhaust gas by drilling machines under construction will generate, however the period of construction is limited. Also, there is not facilities plan that generates toxic gas.
(19)	Water Pollution	Water pollution of river and groundwater caused by drilling mud and oil	C	Construction scale is relatively small against the project and there's no natural protected zone along coastal line.
(20)	Soil Contamination	Contamination caused by discharge or diffusion of sewage or toxic substances	C	Soil contamination against agricultural lands will occur by utilization of agrochemical, if continuous application of agrochemical with high residual toxicity or excessive use of agrochemical is conducted.
(21)	Noise and Vibration	Generation of noise and vibration due to drilling and operation of pumping machines	C	Most of drillings and operation of pumping machines are conducted in non-inhabitant area. Pumping machines in Bedouin community consist of small-scale size, and noise and vibration of machine is also small.
(22)	Land Subsidence	Deformation of the land and land subsidence due to lowering of groundwater table	C	Exploitation of groundwater will be conducted under suitable management. Therefore, land subsidence by excessive exploitation of groundwater will not occur.
(23)	Offensive Odor	Generation of offensive odor and exhaust gases	C	Exhaust gas by drilling machines under construction will generate, however the period of construction is limited. There are not facilities that generate offensive odor.

Evaluation; A: Serious impact, B: Some impact, C: Very small impact

Table 7.4-1 (2) Checklist of IEE (Groundwater Development) for (Plan 2)

No	Environmental Item	Description	Evaluation	Reasons
A. Social Environment				
(1)	Resettlement	Resettlement by land occupation (transfer of rights of residence, land ownership)	C	Most of development plan is proposed in non-residential areas. Therefore, forced displacement of inhabitants by land acquisition is not needed.
(2)	Economic Activities	Loss of production base (land, etc.) and change of economic structure	C	Economic activities are prompted. Especially, agricultural outputs will increase by supply of irrigation water. Tourism will be also developed by increase of water supply.
(3)	Traffic and Public Facilities	Impacts on existing traffic, schools, hospitals, etc. (e.g., traffic jam, accidents)	C	No wells are proposed in public facilities. Pipelines are buried structure.
(4)	Split of Communities	Separation of regional communities by hindrance of regional traffic	C	Most of development plan is carried out in non-residential areas. Also, pipelines are buried structure.
(5)	Cultural Property	Loss or deterioration of cultural properties, such as temples, shrines, archaeological assets, etc.	C	No development plan is proposed in the area of cultural property.
(6)	Water Rights and Rights of Common	Obstruction of fishing rights, irrigation and water rights	C	No overdraft that causes lowering of groundwater is proposed. However, development of wells in Bedouin community should be carried out considering the location of existing wells.
(7)	Public Health Condition	Worsening of health and sanitary condition due to generation of garbage and appearance of harmful insects	C	Public health condition will be improved by water supply. Especially, improvement of public health condition in Bedouin community is expected, because much of the well water, particularly shallow well water is unsuitable for human consumption.
(8)	Waste	Generation of construction waste, surplus soils, sludge, domestic waste, etc.	C	Generation of construction wastes is small. However, increase in domestic and other human wastes will occur due to population increase by development.
(9)	Hazard (Risk)	Increase in risk of cave-ins, ground failure and accidents	C	There is no facilities plan that causes hazard and risk.
B. Natural Environment				
(10)	Topography and Geology	Change of valuable topography and geology due to excavation and earthfill	C	Large-scale reclamation works are not needed; therefore, the changes of topography and geology are small.
(11)	Soil Erosion	Topsoil erosion by rainfall after land reclamation or deforestation	C	Large-scale reclamation works are not needed; therefore soil erosion do not occur.
(12)	Groundwater	Lowering of groundwater table due to overdraft and turbid water caused by construction work	C	Development aquifer bears a vast water volume.
(13)	Hydrological Situation	Change of discharge and water quality due to reclamation and drainage	B	Increase of water consumption leads to increase of wastewater. Increase of wastewater is expected to have impact against water quality of sea.
(14)	Coastal Zone	Coastal erosion and sedimentation due to change of littoral drift and reclamation	C	No development plan is proposed in coastal zone.
(15)	Fauna and Flora	Interruption of reproduction or extinction of species due to change of habit condition	C	No valuable species of fauna and flora inhabit in development areas.
(16)	Meteorology	Change of micro-climate, such as temperature, wind, etc., due to large scale reclamation and construction	C	Large-scale reclamation works are not needed, therefore meteorology in development areas is not affected.
(17)	Landscape	Deterioration of aesthetic harmony by structures and topographic change by reclamation	B	Location of pressure reduce tanks in Wadi Watir should be selected considering the conservation of landscape because this section is blessed with superior landscape.
C. Pollution				
(18)	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	C	Exhaust gas by drilling machines under construction will generate, however the period of construction is limited. Also, there is not facilities plan that generates toxic gas.
(19)	Water Pollution	Water pollution of river and groundwater caused by drilling mud and oil	C	Construction scale is relatively small against the project.
(20)	Soil Contamination	Contamination caused by discharge or diffusion of sewage or toxic substances	C	Soil contamination against agricultural lands will occur by utilization of agrochemical, if continuous application of agrochemical with high residual toxicity or excessive use of agrochemical is conducted.
(21)	Noise and Vibration	Generation of noise and vibration due to drilling and operation of pumping machines	C	Most of drillings and operation of pumping machines are conducted in non-inhabitant area. Pumping machines in Bedouin community consist of small-scale size; and noise and vibration of machine is also small.
(22)	Land Subsidence	Deformation of the land and land subsidence due to lowering of groundwater table	C	Exploitation of groundwater will be conducted under suitable management. Therefore, land subsidence by excessive exploitation of groundwater will not occur.
(23)	Offensive Odor	Generation of offensive odor and exhaust gases	C	Exhaust gas by drilling machines under construction will generate, however the period of construction is limited. There are not facilities that generate offensive odor.

Evaluation; A: Serious impact, B: Some impact, C: Very small impact

Table 7.4-1 (3) Checklist of IEE (Groundwater Development) for (Plan 3)

No	Environmental Item	Description	Evaluation	Reasons
A. Social Environment				
(1)	Resettlement	Resettlement by land occupation (transfer of rights of residence, land ownership)	C	Most of development plan is proposed in non-residential areas. Therefore, forced displacement of inhabitants by land acquisition is not needed.
(2)	Economic Activities	Loss of production base (land, etc.) and change of economic structure	C	Economic activities are prompted. Especially, agricultural outputs will increase by supply of irrigation water. Tourism will be also developed by increase of water supply.
(3)	Traffic and Public Facilities	Impacts on existing traffic, schools, hospitals, etc. (e.g., traffic jam, accidents)	C	No wells are proposed in public facilities. Pipelines are buried structure.
(4)	Split of Communities	Separation of regional communities by hindrance of regional traffic	C	Most of development plan is carried out in non-residential areas. Also, pipelines are buried structure.
(5)	Cultural Property	Loss or deterioration of cultural properties, such as temples, shrines, archaeological assets, etc.	C	No development plan is proposed in the area of cultural property.
(6)	Water Rights and Rights of Common	Obstruction of fishing rights, irrigation and water rights	C	No overdraft that causes lowering of groundwater is proposed. However, development of wells in Bedouin community should be carried out considering the location of existing wells.
(7)	Public Health Condition	Worsening of health and sanitary condition due to generation of garbage and appearance of harmful insects	C	Public health condition will be improved by water supply. Especially, improvement of public health condition in Bedouin community is expected, because much of the well water, particularly shallow well water is unsuitable for human consumption.
(8)	Waste	Generation of construction waste, surplus soils, sludge, domestic waste, etc.	C	Generation of construction wastes is small. However, increase in domestic and other human wastes will occur due to population increase by development.
(9)	Hazard (Risk)	Increase in risk of cave-ins, ground failure and accidents	C	There is no facilities plan that causes hazard and risk.
B. Natural Environment				
(10)	Topography and Geology	Change of valuable topography and geology due to excavation and earthfill	C	Large-scale reclamation works are not needed, therefore, the changes of topography and geology are small.
(11)	Soil Erosion	Topsoil erosion by rainfall after land reclamation or deforestation	C	Large-scale reclamation works are not needed, therefore soil erosion do not occur.
(12)	Groundwater	Lowering of groundwater table due to overdraft and turbid water caused by construction work	B	Development of wells in Bedouin community should be carried out considering the effects against existing wells such as lowering of groundwater table.
(13)	Hydrological Situation	Change of discharge and water quality due to reclamation and drainage	C	Construction scale is relatively small against the project and there's no natural protected zone along coastal line.
(14)	Coastal Zone	Coastal erosion and sedimentation due to change of littoral drift and reclamation	C	No development plan is proposed in coastal zone.
(15)	Fauna and Flora	Interruption of reproduction or extinction of species due to change of habit condition	C	No valuable species of fauna and flora inhabit in development areas.
(16)	Meteorology	Change of micro-climate, such as temperature, wind, etc., due to large scale reclamation and construction	C	Large-scale reclamation works are not needed, therefore meteorology in development areas is not affected.
(17)	Landscape	Deterioration of aesthetic harmony by structures and topographic change by reclamation	B	Location of pressure reduce tanks in Wadi Watir should be selected considering the conservation of landscape because this section is blessed with superior landscape.
C. Pollution				
(18)	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	C	Exhaust gas by drilling machines under construction will generate, however the period of construction is limited. Also, there is not facilities plan that generates toxic gas.
(19)	Water Pollution	Water pollution of river and groundwater caused by drilling mud and oil	C	
(20)	Soil Contamination	Contamination caused by discharge or diffusion of sewage or toxic substances	C	Soil contamination against agricultural lands will occur by utilization of agrochemical, if continuous application of agrochemical with high residual toxicity or excessive use of agrochemical is conducted.
(21)	Noise and Vibration	Generation of noise and vibration due to drilling and operation of pumping machines	C	Most of drillings and operation of pumping machines are conducted in non-inhabitant area. Pumping machines in Bedouin community consist of small-scale size; and noise and vibration of machine is also small.
(22)	Land Subsidence	Deformation of the land and land subsidence due to lowering of groundwater table	C	Exploitation of groundwater will be conducted under suitable management. Therefore, land subsidence by excessive exploitation of groundwater will not occur.
(23)	Offensive Odor	Generation of offensive odor and exhaust gases	C	Exhaust gas by drilling machines under construction will generate, however the period of construction is limited. There are not facilities that generate offensive odor.

Evaluation; A: Serious impact, B: Some impact, C: Very small impact

Table 7.4-1 (4) Checklist of IEE (Groundwater Development) for (Plan 4)

No	Environmental Item	Description	Evaluation	Reasons
A. Social Environment				
(1)	Resettlement	Resettlement by land occupation (transfer of rights of residence, land ownership)	C	Most of development plan is proposed in non-residential areas. Therefore, forced displacement of inhabitants by land acquisition is not needed.
(2)	Economic Activities	Loss of production base (land, etc.) and change of economic structure	C	Economic activities are prompted. Especially, agricultural outputs will increase by supply of irrigation water. Tourism will be also developed by increase of water supply.
(3)	Traffic and Public Facilities	Impacts on existing traffic, schools, hospitals, etc. (e.g., traffic jam, accidents)	C	No wells are proposed in public facilities. Pipelines are buried structure.
(4)	Split of Communities	Separation of regional communities by hindrance of regional traffic	C	Most of development plan is carried out in non-residential areas. Also, pipelines are buried structure.
(5)	Cultural Property	Loss or deterioration of cultural properties, such as temples, shrines, archaeological assets, etc.	C	No development plan is proposed in the area of cultural property.
(6)	Water Rights and Rights of Common	Obstruction of fishing rights, irrigation and water rights	C	No overdraft that causes lowering of groundwater is proposed. However, development of wells in Bedouin community should be carried out considering the location of existing wells.
(7)	Public Health Condition	Worsening of health and sanitary condition due to generation of garbage and appearance of harmful insects	C	Public health condition will be improved by water supply. Especially, improvement of public health condition in Bedouin community is expected, because much of the well water, particularly shallow well water is unsuitable for human consumption.
(8)	Waste	Generation of construction waste, surplus soils, sludge, domestic waste, etc.	C	Generation of construction wastes is small. However, increase in domestic and other human wastes will occur due to population increase by development.
(9)	Hazard (Risk)	Increase in risk of cave-ins, ground failure and accidents	C	There is no facilities plan that causes hazard and risk.
B. Natural Environment				
(10)	Topography and Geology	Change of valuable topography and geology due to excavation and earthfill	C	Large-scale reclamation works are not needed; therefore, the changes of topography and geology are small.
(11)	Soil Erosion	Topsoil erosion by rainfall after land reclamation or deforestation	C	Large-scale reclamation works are not needed; therefore soil erosion do not occur.
(12)	Groundwater	Lowering of groundwater table due to overdraft and turbid water caused by construction work	C	Development aquifer bears a vast water volume.
(13)	Hydrological Situation	Change of discharge and water quality due to reclamation and drainage	B	Increase of water consumption leads to increase of wastewater. Increase of wastewater is expected to have impact against water quality of sea.
(14)	Coastal Zone	Coastal erosion and sedimentation due to change of littoral drift and reclamation	C	No development plan is proposed in coastal zone.
(15)	Fauna and Flora	Interruption of reproduction or extinction of species due to change of habit condition	C	No valuable species of fauna and flora inhabit in development areas.
(16)	Meteorology	Change of micro-climate, such as temperature, wind, etc., due to large scale reclamation and construction	C	Large-scale reclamation works are not needed, therefore meteorology in development areas is not affected.
(17)	Landscape	Deterioration of aesthetic harmony by structures and topographic change by reclamation	B	Location of pressure reduce tanks in Wadi Watir should be selected considering the conservation of landscape because this section is blessed with superior landscape.
C. Pollution				
(18)	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	C	Exhaust gas by drilling machines under construction will generate, however the period of construction is limited. Also, there is not facilities plan that generates toxic gas.
(19)	Water Pollution	Water pollution of river and groundwater caused by drilling mud and oil	B	Drillings have possibility that occur water pollution. Especially, drillings in Bedouin community should be conducted considering effect against existing wells.
(20)	Soil Contamination	Contamination caused by discharge or diffusion of sewage or toxic substances	C	Soil contamination against agricultural lands will occur by utilization of agrochemical, if continuous application of agrochemical with high residual toxicity or excessive use of agrochemical is conducted.
(21)	Noise and Vibration	Generation of noise and vibration due to drilling and operation of pumping machines	C	Most of drillings and operation of pumping machines are conducted in non-inhabitant area. Pumping machines in Bedouin community consist of small-scale size; and noise and vibration of machine is also small.
(22)	Land Subsidence	Deformation of the land and land subsidence due to lowering of groundwater table	C	Exploitation of groundwater will be conducted under suitable management. Therefore, land subsidence by excessive exploitation of groundwater will not occur.
(23)	Offensive Odor	Generation of offensive odor and exhaust gases	C	Exhaust gas by drilling machines under construction will generate, however the period of construction is limited. There are not facilities that generate offensive odor.

Evaluation; A: Serious impact, B: Some impact, C: Very small impact

Table 7.4-1 (5) Checklist of IEE (Groundwater Development) for (Plan 5)

No	Environmental Item	Description	Evaluation	Reasons
A. Social Environment				
(1)	Resettlement	Resettlement by land occupation (transfer of rights of residence, land ownership)	C	Most of development plan is proposed in non-residential areas. Therefore, forced displacement of inhabitants by land acquisition is not needed.
(2)	Economic Activities	Loss of production base (land, etc.) and change of economic structure	C	Economic activities are prompted. Especially, agricultural outputs will increase by supply of irrigation water. Tourism will be also developed by increase of water supply.
(3)	Traffic and Public Facilities	Impacts on existing traffic, schools, hospitals, etc. (e.g., traffic jam, accidents)	C	No wells are proposed in public facilities. Pipelines are buried structure.
(4)	Split of Communities	Separation of regional communities by hindrance of regional traffic	C	Most of development plan is carried out in non-residential areas. Also, pipelines are buried structure.
(5)	Cultural Property	Loss or deterioration of cultural properties, such as temples, shrines, archaeological assets, etc.	C	No development plan is proposed in the area of cultural property.
(6)	Water Rights and Rights of Common	Obstruction of fishing rights, irrigation and water rights	C	No overdraft that causes lowering of groundwater is proposed. However, development of wells in Bedouin community should be carried out considering the location of existing wells.
(7)	Public Health Condition	Worsening of health and sanitary condition due to generation of garbage and appearance of harmful insects	C	Public health condition will be improved by water supply. Especially, improvement of public health condition in Bedouin community is expected, because much of the well water, particularly shallow well water is unsuitable for human consumption.
(8)	Waste	Generation of construction waste, surplus soils, sludge, domestic waste, etc.	C	Generation of construction wastes is small. However, increase in domestic and other human wastes will occur due to population increase by development.
(9)	Hazard (Risk)	Increase in risk of cave-ins, ground failure and accidents	C	There is no facilities plan that causes hazard and risk.
B. Natural Environment				
(10)	Topography and Geology	Change of valuable topography and geology due to excavation and earthfill	C	Large-scale reclamation works are not needed; therefore, the changes of topography and geology are small.
(11)	Soil Erosion	Topsoil erosion by rainfall after land reclamation or deforestation	C	Large-scale reclamation works are not needed; therefore soil erosion do not occur.
(12)	Groundwater	Lowering of groundwater table due to overdraft and turbid water caused by construction work	B	Development of wells in Bedouin community should be carried out considering the effects against existing wells such as lowering of groundwater table.
(13)	Hydrological Situation	Change of discharge and water quality due to reclamation and drainage	C	Development aquifer bears a vast water volume.
(14)	Coastal Zone	Coastal erosion and sedimentation due to change of littoral drift and reclamation	C	No development plan is proposed in coastal zone.
(15)	Fauna and Flora	Interruption of reproduction or extinction of species due to change of habit condition	C	No valuable species of fauna and flora inhabit in development areas.
(16)	Meteorology	Change of micro-climate, such as temperature, wind, etc., due to large scale reclamation and construction	C	Large-scale reclamation works are not needed, therefore meteorology in development areas is not affected.
(17)	Landscape	Deterioration of aesthetic harmony by structures and topographic change by reclamation	B	Location of pressure reduce tanks in Wadi Watir should be selected considering the conservation of landscape because this section is blessed with superior landscape.
C. Pollution				
(18)	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	C	Exhaust gas by drilling machines under construction will generate, however the period of construction is limited. Also, there is not facilities plan that generates toxic gas.
(19)	Water Pollution	Water pollution of river and groundwater caused by drilling mud and oil	B	Drillings have possibility that occur water pollution. Especially, drillings in Bedouin community should be conducted considering effect against existing wells.
(20)	Soil Contamination	Contamination caused by discharge or diffusion of sewage or toxic substances	C	Soil contamination against agricultural lands will occur by utilization of agrochemical, if continuous application of agrochemical with high residual toxicity or excessive use of agrochemical is conducted.
(21)	Noise and Vibration	Generation of noise and vibration due to drilling and operation of pumping machines	C	Most of drillings and operation of pumping machines are conducted in non-inhabitant area. Pumping machines in Bedouin community consist of small-scale size; and noise and vibration of machine is also small.
(22)	Land Subsidence	Deformation of the land and land subsidence due to lowering of groundwater table	C	Exploitation of groundwater will be conducted under suitable management. Therefore, land subsidence by excessive exploitation of groundwater will not occur.
(23)	Offensive Odor	Generation of offensive odor and exhaust gases	C	Exhaust gas by drilling machines under construction will generate, however the period of construction is limited. There are not facilities that generate offensive odor.

Evaluation; A: Serious impact, B: Some impact, C: Very small impact

Table 7.4-2 Environmental Impact and the Countermeasures

Environmental Item	Causes of Impacts	Case in Study Area	Possible Environmental Impacts	Useful Factors for Evaluation	Countermeasures
(12) Groundwater	1. Overdraft in the operation	1. Wells for irrigation in Plan 4A, 4B and 4C 2. Wells in Bedouin community of Plan 5	1. Lowering of the groundwater table of existing wells 2. Exhaustion of wells which may affect the groundwater use in the area	1. Existence of existing wells 2. Shallow wells tend to receive serious impacts. 3. Lowering of the groundwater table of existing wells 4. Utilization of a large quantity of groundwater for irrigation	1. Restriction of irrigation water 2. Groundwater utilization plan (water for living use should be given priority) 3. Implementation of monitoring (periodic observation of groundwater table)
(13) Hydrological Situation	1. Increase of domestic wastewater by increase of water consumption	1. Wastewater in Ras Sudr, Abu Zenima and Abu Rudeis of Plan 1 2. Wastewater in Nuweiba and Dahab of Plan 2 3. Wastewater in El Tur of Plan3	1. Deterioration of water quality caused by the increase of the domestic wastewater	1. Existing capacity of wastewater treatment facilities 2. Water quality in sea (Aqaba Bay, Suez Bay) has a recent tendency to lower.	1. Improvement of wastewater treatment facilities 2. Implementation of monitoring (periodic water quality survey)
(17) Landscape	1. Construction of facility in area with superior landscape 2. Implementation of reclamation works	1. The route of Wadi Watir in Plan 2	1. Deterioration of aesthetic harmony by structure 2. Topographic changes by reclamation	1. Existence of area with superior landscape	1. Review of location of facilities 2. Harmony between facilities and landscape (Design, Color, etc)
(19) Water Pollution	1. Disturbance of ground layer by drilling and the use of muddy water 2. Lowering of groundwater table caused by overdraft	1. Wells in Bedouin community of Plan 5	1. Groundwater pollution caused by the construction of wells (drilling) would affect the utilization of groundwater 2. Deterioration of water quality caused by the lowering of the groundwater table in operation	1. Shallow wells may be affected by water pollution. 2. Lowering of groundwater table is observed. 3. Utilization of a large quantity of groundwater for irrigation	1. Restriction of overdraft 2. Groundwater utilization plan 3. Improvement of sewage treatment facilities 4. Implementation of monitoring (periodic water quality survey)

CHAPTER VIII CONCLUSION AND RECOMMENDATION

8.1 Conclusion

(1) Through the Study, Hydrogeological Map and Groundwater Evaluation Map has prepared covering the both South Sinai and North Sinai. These investigations included the following:

a) Revision of the Geological map for South Sinai.

b) Preparing a complete inventory for all the existing wells in the study area.

c) Conducting geophysical surveys, which resulted in the preparation of geoelectric, profiles for Egma and El Tih Plateaux, El Qaa Plain and Major wadi areas, and the delineation of the basement of the Lower Cretaceous in the Central Sinai zone.

d) A total of 6351m of test wells were drilled concentrating mainly in the El Tih and Egma plateau where no test wells had been drilled before. The well drilling program included observation of stratigraphy, pumping tests, water quality analysis, age dating analysis, grain size analysis and fossil analysis.

The compilation of the above mentioned two maps is the main and most important output of this Study because they serve as the basis for any future groundwater development and insure efficient use of investment in this field.

(2) The study concluded that the groundwater volume in the Main Block of the Lower Cretaceous aquifer is about 100 billion cubic meters of good quality water (TDS less than 1500 mg/l, drinking water quality). Hydrogeological analysis and age dating analysis revealed that this water is non-renewable fossil water. Estimating that about 14% of this stored water could be tapped for consumption, the available resources could meet the water demand level of the target year of NPDS of about 50 x 10^6 m^3/year for more than 280 years.

(3) Due to the importance of the aquifer in the El Qaa Plain because it is the main water resource for the South Sinai Capital of El Tur City, detail investigation of that aquifer was made including computer simulation. The results of the study revealed that due to the limited recharge of that aquifer, it could meet the water demand level of El Tur City in 2007 without serious saline water intrusion. Water demand beyond that level should be met through as water resources such as Nile water or desalination of seawater.

(4) A water development scheme based on the water demand of the NPDS is proposed. Preliminary investigation of the feasibility of the proposed projects has been conducted. Although the results of the feasibility show that the EIRRs for the proposed projects are relatively low, this does not mean that the proposed projects should be discarded. In arid zones such as Sinai, the availability of groundwater resources could be one of the

most important factors for the execution of the projects. Since the Study concluded that groundwater development potential of the Quaternary aquifer in El Qaa Plain and the Lower Cretaceous aquifer could meet the water demand of NPDS, the proposed projects are worth to execute as basic infrastructure for NPDS.

(5) An Initial Environmental Examination was conducted for the proposed projects which revealed that the implementation of the proposed projects will not seriously affect the environment and thus an Environment Impact Assessment is not required.

(6) A new groundwater aquifer has been found at the Southern reaches of El Qaa Plain, however, the present study could not cover its size and hydrogeological features.

8.2. Recommendations

(1) New groundwater aquifer was confirmed in the south of El Qaa Plain. However, its distribution and hydrogeological features shall be studied in detail.

(2) Detailed feasibility study including the assessment of the water supply impact on the NPDS should be started as soon as possible. Such study should cover both groundwater and surface as will. The study should include the establishment of groundwater monitoring system to avoid excessive extraction. The study for wastewater treatment and disposal should be also included in the schemes.

(3) The availability of good quality groundwater at Central Sinai should encourage the settlement of Bedouin in that area. This in return will have a very positive impact on the living standards of these people. More comprehensive plans should be prepared for the Bedouin settlement in central Sinai.

(4) Number of production well is increasing in both South and North Sinai. They are tapping groundwater in the Lower Cretaceous Aquifer. Groundwater in the Lower Cretaceous Aquifer is essentially of fossil water although a little recharge is expected from the surface water. Groundwater development of the Lower Cretaceous Aquifer will lead recession of groundwater level. Considering this situation, groundwater development in Sinai shall be carried out under proper control system. Especially, careful attention shall be paid to the change of groundwater level in the development. From this point of view, groundwater level monitoring shall be properly continued using automatic water gauges installed in the Test Wells.