CHAPTER 10
RESETTLEMENT ACTION PLAN FRAMEWORK STUDY

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10.1 Introduction

The purpose of the Resettlement Action Plan (RAP) Framework Study is to prepare a policy framework for land acquisition and resettlement by taking appropriate social considerations as a basis for detailed study of land acquisition and resettlement to be conducted in the next stage, namely, the Basic Design stage. In order to achieve this propose, the RAP Framework is prepared by reflecting regional conditions, which are studied through site reconnaissance and a socio-economic interview survey, and by considering donor policies such as JICA and ex-JBIC Guidelines as well as World Bank Operational Polices 4.12 on Involuntary Resettlement and Egyptian regulations. The results of RAP Framework Study are in a separate report (Resettlement Policy Framework (RPF) for Greater Cairo Metro Line No.4). Some results in the RAP Framework Study are utilized in this Chapter.

Land acquisition and resettlement conducted in the projects and executed by NAT are based on Egyptian regulations, supplemented by the initiative of relevant departments in governorates. In the case of donor funding projects, appropriate considerations for environmental and social issues as requested by donor policies are necessary for a project proponent. Therefore, the RAP Framework Study is expected to be utilized by NAT as a basis for resettlement and land acquisition to be conducted as well as to take serious considerations for different approaches between donor policies and Egyptian regulations.

As described in the previous chapters, the Metro Line 4 Project (hereafter referred to as the Project) is composed of different levels of study for Phase 1 and Phase 2, namely, preliminary design in the former and outline design in the latter. Thus, the project implementation schedule differs between the 2 phases. Under this circumstance, the RAP framework is examined in two different levels, as indicated below:

- Detailed examination of potential impact due to land acquisition and resettlement is done in Phase 1.
- Preliminary examination of potential impact due to land acquisition and resettlement is done in Phase 2.
- Policy for compensation is examined in Phase 1 and Phase 2.

10.2 Legislative System on Resettlement in Egypt

10.2.1 Fundamental Laws and Regulations on Land Acquisition and Resettlement

The relevant regulations on land acquisition and resettlement are shown in *Annex 9-1*.

Among relevant regulations, Law No. 10/1990 or the Expropriation of Real Estate for Public Interest serves as the fundamental regulation. The law defines that land acquisition can be exercised for the purpose of public interest, as indicated below:

- Construction, enlargement, amendment, and extension of roads, streets, and squares

- Projects related to water and wastewater
- Projects related to irrigation and drainage
- Projects related to power and energy
- Construction and amendments on bridge and surface passage (railroad crossings) and underground passage
- Projects related to transportation and communication
- Projects related to urban planning and improvement of public utilities, which is defined in other regulations

The law also defines that the owners are eligible to be compensated for loss due to land acquisition.

10.2.2 Procedure for Land Acquisition and Resettlement

Law No. 10/1990 defines the responsibilities of relevant governorate departments and procedures for land acquisition as mentioned below:

(1) Relevant Authorities

Several governmental bodies are involved in land acquisition or resettlement. An assessment committee plays the key role in land acquisition and resettlement under the supervision of the National Survey Authority. An assessment committee is established in each governorate by the decree of the Minister of Water Resources and Irrigation, and membership is changed every two years.

1) Central Level

The Egyptian General Survey Authority (EGSA), as the national authority, is mandated to assess property loss and the amount of compensation by Law No. 10/1990. The project proponent is responsible for budget arrangement on land acquisition and compensation.

2) Governorate Level

The assessment committee is composed of relevant bodies with responsibilities as indicated in Table 10-1. It is entitled to assess the amount of property loss and compensation under the supervision of EGSA, and is also entitled to have consultation with Project Affected Persons (PAPs)[1]. In the case of land acquisition within Cairo Governorate, assessment of property loss and compensation amount is implemented by relevant departments in the governorate without the supervision of EGSA.

[1] PAPs are defined as those who are entitled for compensation in this report.

Table 10-1 Responsibility of Relevant Authorities in the Assessment Committee

Authority	Responsibility
Directorate of Housing and Infrastructure	- Sets the resettlement options for the affected group and participates in all operational procedures concerning defining compensation and setting improvement actions within informal settlements
Department of Physical Planning	- Prepares detailed plans for areas subjected to resettlement - Provides all detailed maps and documents required to define the affected groups, e.g., road rights-of-way and set-backs
Department of Properties	- Provides all required documents for ownership or tenure status within the affected areas with historical documents for those properties that show the different transactions of the properties
Department of Land Surveying	- Identifies the size, area and locations of different ownerships affected by the resettlement - Defines the compensation mechanisms and values in cooperation with EGSA and other relevant local bodies
Department of Social Affairs	- Conducts all field surveys required to define the affected groups, their socio-economic status, affordability capacity, and their preference on different resettlement options and compensation mechanisms - Mitigates the negative impact during and after resettlement through preparing rehabilitation programs for the affected groups, and monitoring the impact of the process.
Department of Legal Affairs	- Deals with legal issues related to tenure and ownerships and resolve dispute between different involved parties
Head of District where the resettlement project takes place	- Manages the overall project

Source: JICA Study Team

(2) Procedure for Land Acquisition and Resettlement

The assessment committee identifies properties affected by a project, and it confirms the location and legal status of affected properties with a property owner. The survey result is disclosed to the governorate and municipality office, and to property owners with an official letter.

The assessment committee assesses loss of properties and calculates compensation amounts based on the evaluation. In the case of providing alternative residences, a necessary amount for making new residential arrangements is calculated. The result of compensation calculation is informed to the property owner through an official letter, and it is also announced at the governorate and municipality office within a certain period. In addition, information on land acquisition and compensation is publicized in an official gazette and newspapers (more than 2 newspapers), in order to make the calculation available to public.

Entitlement of property rights is transferred to the government, and compensation is provided to the property owner through the above process. In addition, those who have complaints against the assessment are given a right of grievance or redress (Section 10.4.6 provides details of the grievance process).

Table 10-2 summarizes the procedure of land acquisition and compensation.

Table 10-2 Procedure of Land Acquisition and Resettlement

Procedure	Stage	Items	Responsible Agency
Preliminary Survey	1-1	Identification of land/property owners and necessary area to be acquired	Project proponent
Preparation for Approval	2-1	Informing the result of identification to responsible ministry	Project proponent
	2-2	Responsible ministry informs relevant governorates about land acquisition	Responsible ministry
	2-3	Relevant governorates request the government to issue Prime Ministerial decree on land acquisition	Relevant governorates
Approval	3-1	Issuing Prime Ministerial decree on land acquisition for public interest	Prime Minister
Detailed Survey	4-1	Announcement of compensation targets	EGSA, relevant governorates
	4-2	Conducting detailed survey	EGSA, relevant governorates
Disclosure	5-1	Announcement of detailed survey result	EGSA, relevant governorates
Land Acquisition	6-1	Compensation payment and land ownership transfer	EGSA, relevant governorates

Source: JICA Study Team

10.2.3 Consistency with JICA & Ex-JBIC Guidelines

(1) Requirements of the Guidelines

In the case of an ODA loan project, the following items are requested in the ex-JBIC Guidelines to borrowers:

- Effective measures to minimize impact and compensate for losses must be agreed upon with the people who will be affected if involuntary resettlement is inevitable.
- People who will be resettled involuntarily and people whose means of livelihood will be affected must be sufficiently compensated in a timely manner.
- Project proponents must make efforts to enable the people affected by the project, improve their standard of living, income opportunities and production levels, or at least restore them to status prior to the project.
- Appropriate participation by the community affected must be promoted in planning, implementation and monitoring of involuntary resettlement plans and measures against the loss of their means of livelihood.

(2) Comparison and Verification between Egyptian System and Guidelines

1) Experience of Donor Funding Project

In the course of interpreting policies on land acquisition and resettlement, experience from previous donor-funding projects is also examined. There are several active projects funded by the World Bank (WB), African Development Bank (AfDB), and European Investment Bank (EIB), and no resettlement is confirmed on the basis of these projects. However, some of them prepare Resettlement Policy Framework (RPF) reports by considering donor policies in case studies. It is considered that there is no actual operational policy on resettlement in donor-funded projects in Egypt so far.

2) Policy Gap between Egyptian System and Guidelines

Table 10-3 identifies discrepancies between JICA and JBIC Guidelines, and Egyptian regulations regarding land acquisition and resettlement.

Table 10-3 Discrepancies between JICA and JBIC Guidelines and Egyptian Regulations

	Item	Donor Policies	Egyptian Regulations	Actual Operation in Egypt
1	Establishment of support system for socially vulnerable groups	Socially vulnerable groups tend to be exposed to environmental and social impacts. In addition, they have limited access to decision making processes. Thus, it is necessary to give appropriate consideration to them.	There is no description about support to socially vulnerable groups.	There is no operational experience to support socially vulnerable groups since there is no exact categorization of socially vulnerable groups in Egypt.
2	Provide assistance to restore and improve living standards.	Living standards, income opportunities, and production levels of project affected people should be improved or at least restored to their pre-project levels.	There is no description about improvement of living standards.	Assistance for restoring and improving living standards has not been provided. PAPs were provided with cash compensation based on property loss assessment, although additional financial and practical support appeared not to be provided.
3	Enhancement of public participation in planning and implementation of resettlement plans	Appropriate participation by the affected people and their communities should be promoted in planning, implementation and monitoring of involuntary resettlement plans and measures taken against the loss of their means of livelihood.	Property owners whose properties will be taken are requested to attend the identification of property. However, there is no description about participation of project affected people and communities in the preparation and implementation of measures, as well as in conducting monitoring.	In the case of Metro Line 3, there were some interviewees who were not given sufficient notice of their resettlement, in some cases being informed just before their relocation. Appropriate consultation with PAPs appeared not to be implemented.
4	Compensation for land acquisition with replacement cost[2]	Regarding environmental and social considerations, reference is made to	There is no description about replacement cost. Compensation amount	Compensation is basically calculated for land and properties based on market

[2] Replacement cost does not mean a market value or governmental rate. Replacement cost include: i) market cost for materials to build a replacement structure with an area and quality similar or better than the project scope; ii) cost for transporting materials to a new site; iii) cost for labour and contractor fee; iv) cost for tax and registration. Depreciation of asset and value of salvage should not be taken into account in determining the replacement cost. For details, please see footnote 1 of Annex-A of OP4.12 of World Bank.

	Item	Donor Policies	Egyptian Regulations	Actual Operation in Egypt
		regulations and good practices of international agencies, regional agencies, and developed countries, such as Japan, (in this project, compensation will be done with replacement cost in according with OP4.12 of World Bank on Involuntary Resettlement.	is evaluated based on the market value[3] at the time of the decree issued for land acquisition and resettlement for a specific project	value, and does not include transaction costs such as moving cost. Regarding administration cost, it was said to be covered by a project proponent according to interviews with relevant parties. In the case of Metro Line 3, compensation for licensed and unlicensed shops, and interior decoration ere made in addition to compensation for property loss. Besides, a uniform amount was paid when PAPs complained about their compensation amount.
5	Providing support for illegal occupants	People to be resettled involuntarily and whose means of livelihood will be affected should be sufficiently compensated and supported by the project proponents in an appropriate time.	The targets for compensation are the property owners. There are no definite plans about compensation for illegal occupants.	As a practical custom, there was an example in Cairo Governorate that apparent owners at the time of census were provided some compensation for their properties. Thus, illegal occupants would have an opportunity to be provided financial support if they had been regarded as apparent owners at the time of census. Due examination was done to decide whether financial support should be provided for illegal occupants.

Source: JBIC Guidelines and OP4.12 Involuntarily Resettlement compiled by JICA Study Team

10.2.4 Findings and Actual Practice of Land Acquisition and Resettlement in Egypt

From 1958 to 2009, approximately 200 decrees on land acquisition were issued according to the official gazette. Among them, two decrees were issued for the Metro Line 3 project, such as; i) Decree 1506/2006 for Phase 1 issued on 31st August 2006; and

[3] Article 6 of Section 2 in Law No. 10/1990 specifies that “the indemnity shall be evaluated according to the prices prevailing at the time of the promulgation of the expropriation decree”. It is confirmed from interviews so far that the prices mean the market value, although further confirmation is necessary.

ii) Decree 3296/2008 for Phase 2 issued on 15th January 2009. However, there was no decree on land acquisition for the Metro Line 1 and 2 projects.

When a project in the public interest is executed, implementation of land acquisition and resettlement is much more flexible than might be suggested by strict legal interpretation, by taking social aspects into consideration for compensation assessment. The following were found from relevant documents and interviews in the field to represent actual practice in the Metro Line 3 project.

(1) Magnitude of Impact on Affected Properties and Persons in the Metro Line 3 Phase 1 Project

The Phase 1 section of Metro Line 3 is from Attaba to Abbasia, and the negative impacts are shown in the table below.

Table 10-4 Magnitude of Land Acquisition and Resettlement at Metro Line 3 Phase1

Category	Affected Number
Affected Persons	92
Affected Flats	21
Affected Shops	56
Affected Kiosks	7
Affected Wells	8

Source: JICA Study Team

Compensation for losses was basically provided at the rates given below.

- House owners: LE3,000 per square metre
- Tenants : LE15,000 per room
- Shop: LE2,000 per square metre (in the case of total shop area of up to 50 m²), LE500 per square metre (in the case that total shop area is bigger than 50 m²), LE5,000 for license, LE5,000 for decoration, and additional LE5,000 if there are any complaints
- Others: LE7,000 for kiosks, LE5,000 for licensed booths, and LE2,500 for unlicensed booths

(2) Findings of Compensation in the Metro Line 3 project

For land acquisition within Cairo Governorate, the property department of the governorate is responsible instead of EGSA, as mentioned previously. Although land acquisition in the governorate was implemented according to Law No. 10/1990, several considerations for compensation were carried out in addition to the law as a policy of Cairo Governorate and NAT. The major considerations are:

i) Compensation for tenants and illegal settlers

ii) Compensation for unlicensed shops

iii) Compensation for shops was provided based on the assessment of physical properties

iv) Compensation for loss of income source was not provided according to interviews with relevant departments in Cairo Governorate

v) Consultation and negotiation were carried out as necessary

vi) Timing of information disclosure was relatively late

Although compensation was made in addition to the law, replacement cost and livelihood restoration of people affected were not considered.

10.3 Baseline Information of Social Conditions

10.3.1 Objective and Methodology

It is indispensable to examine socio-economic conditions in the project area to grasp current living conditions of households for examining negative impacts on the affected area and households, as well as considering mitigation measures against negative resettlement impacts and necessary compensation to the affected persons.

The objective was achieved by collecting secondary information and conducting interview surveys in the regions alongside the proposed alignment. The questionnaires were used and were composed of two forms: a perception survey and a general socio-economic survey, as shown in Annex 10-1. In total, 240 samples in Phase 1 and 2 areas were interviewed, representing the following interviewee distributions as seen below.

Table 10-5 Distribution of Household Interview Survey

(Unit: %)

Variable		Phase 1	Phase 2	Total
Sex	Male	50.5	54.1	52.5
	Female	49.5	45.9	47.5
Age	Less than 30 years	7.5	9.0	8.3
	30-49	32.7	18.8	25.0
	40-49	23.4	29.3	26.7
	50-59	16.8	19.5	18.3
	Over 60 years	19.6	23.3	21.7

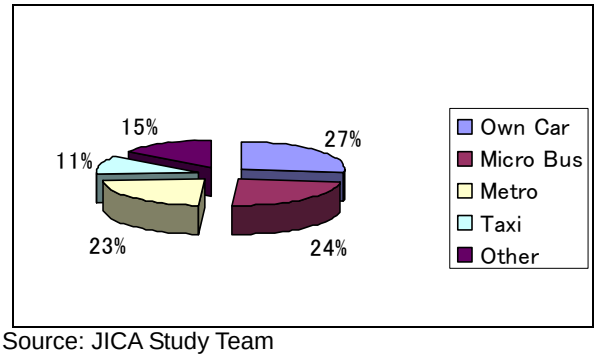
Source: JICA Study Team

10.3.2 Survey of Public Perception of the Project

In the perception survey, households were interviewed regarding the following:

(1) Current Situation of Transportation Mode

The most used transportation mode in the study area is through privately owned cars, as shown in the following figure.



Source: JICA Study Team

Figure 10-1 Transportation Mode Used at the Study Area

(2) Understanding about the Project

Most of interviewees had a positive perception on the project, although approximately 70% of interviewees were not aware of the project before the survey. However, a small percentage of the population (7%) had a negative perception on the project. The most dominant reasons on negative perceptions were reported as deterioration of environment during construction and disruption of livelihood due to resettlement.

(3) Opinion to Involuntary Resettlement

Approximately 35% of interviewees had no objection to resettlement while 55% had some concerns. Approximately 60% of interviewees who had concerns were afraid of receiving inappropriate compensation. Among the alternative modes of compensation, the method favourable to the majority of interviewees was providing alternative residences rather than cash compensation. From these findings, appropriate evaluation of compensation for loss of property and means of income is absolutely necessary, as a pre-requisite for people that requested to resettle.

10.3.3 General Socio-Economic Condition of Public

(1) Number of Persons in the Average Household

The interview survey was conducted in four governorates in the project area, namely Qalyobeya, Giza, Cairo, and 6th of October. The average family size of the project area is approximately 4.2 persons per household as the following table shows in detail:

Table 10-6 Average Number of Persons per Household in the Study Area

sl no.	Governorate	Average Family Number
1	Qaliobeya	4.8
2	Giza	4.2
3	Cairo	4.2
4	6th October	3.8
	Average	4.2

Source: JICA Study Team

(2) Average Monthly Income

The project area covers a wide range of people with varying occupations and sources of income, which ranges from the top management to the labour level. According to a study on minimum wage in sectors of the Egyptian economy conducted by Egyptian Center for Economic Studies in 2006, the minimum wage is LE168 per month in the public sector and

LE154 per month in the private sector. However, the minimum wage defined in Law No. 53 of 1984 for the Labuor Code is LE105 per month, after modifying from LE35 per month.

As for the monthly income in the study area, almost all interviewees exceeded the minimum salary described in the law, except for one. The following table shows the average monthly income in the project area:

Table 10-7 Average Monthly Income in Governorates of the Project Area

(Unit: LE)

sl no.	Governorate	Average Monthly Income
1	Qaliobeya	1,077
2	Giza	2,793
3	Cairo	2,319
4	6th October	2,064
	Average	2,793

Source: JICA Study Team

Table 10-8 Average Monthly Income by Occupational Category in the Project Area

(Unit: LE)

sl no.	Category	Distribution of persons by occupational category	Average Monthly Income
1	Top Management Level	23%	2,803
2	Top Technical Level	42%	2,790
3	Technical Assistant	25%	2,255
4	Service, Retail & Trade	21%	2,938
5	Administrative Work	1.7%	2,350
6	Industrial Labour	1.7%	1,300
7	Agriculture and Fishing	1.3%	1,900
8	Handicraft	1.3%	880

Source: JICA Study Team

As compared with the data in the Statistical Year Book 2008 by CAPMAS relating to average monthly income in Egypt, the average monthly income in the project area is considered to be higher.

Table 10-9 Average Weekly and Monthly Wage (for Selected Sectors) in Egypt

sl no.	Category	Average Weekly Wage (Public/Private)	Average Monthly Wage (Public/Private)
1	Construction & Building	255 / 214	1,020 / 856
2	Whole Sale, Retail, Trade & Repairing	254 / 222	1,016 / 888
3	Hotel & Restaurants	131 / 150	524 / 600
4	Transport, Storage & Communication	296 / 254	1,184 / 1,016
5	Real Estate Activity, Renting & Business Services	180 / 231	720 / 924

Source: JICA Study Team

(3) Rental Fee

Some 41% of tenants interviewed pay LE25 or less for rent per month; 18% pay LE26-50; 14% pay LE51-100; and 10% pay LE101-200. Approximately 16% pay more than LE200 per month. The mean average monthly rent is calculated to be LE128.56, between a minimum monthly rent of LE2 and a maximum of LE1,500. Disaggregated data shows that the rental amount is significantly higher in Phase 1 than in Phase 2. The average rent amount in the Phase 1 section is calculated at LE242.62 with a maximum rent of LE1,500, while the average in the Phase 2 section is LE57.47, with a maximum of LE350.

(4) Property Status

1) Unmovable Property

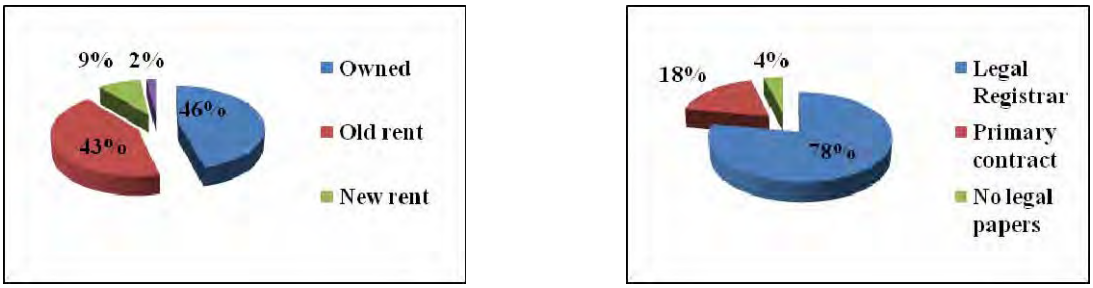
It was found from site reconnaissance that most households in the project area live in flat type residences. The property owning status among interviewees is almost equal between owned and rental accommodation as shown in Figure 10-2.

There are two types of rental system in Egypt: the old and new rental systems. The old rental system is the contract system in force before 1996. In this system, a property irrespective of its rental status can be inherited by the descendants of the owner, and the rent charge is much cheaper than the market value. After the law on landlords and tenants was enforced from 1996, the old rental system was abolished and a new rental system was established. The new rental system rectified the rental period, and set the maximum rental duration to nine years. The rent charge in this system is equivalent to the market value.

There are two categories in terms of legal property status as follows:

- Primary contract: where the process of obtaining formal legal rights for property is in process
- Legal register: where formal legal rights for property have already been obtained

As the following figure shows, almost all interviewees have legal property status. It is then expected that the possibility of occupation by informal settlers on the rights-of-way in the project area will be low.



Source: JICA Study Team

Figure 10-2 Property Ownership Status in the Study Area

2) Movable Property

Most of interviewees have basic household electrical appliances such as TV, radio, electric fan, fridge, and washing machine. On the other hand, the percentage of interviewees possessing advanced household electrical appliances such as air conditioners and microwaves is low, with 40% possessing air conditioners and only 15% possessing microwaves. Only 34% of interviewees reported that they have their own cars.

10.4 Policy and Framework of Resettlement for the Project

10.4.1 Basic Policy

Final and detailed investigation of the impact of the project on land acquisition and resettlement will be done upon delineation of the project area, and the basic policy for resettlement will be examined in detail. The RAP Framework Study leads in preparing a basic resettlement policy for future study.

Since this is the first experience for NAT to implement land acquisition and resettlement considering donor policies in addition to Egyptian regulations, due consideration should be given to basic policies, which are practical and feasible for NAT to implement within the Egyptian framework. Achieving donor requirements successfully is a must to minimize the gaps as mentioned in Section 10.2.3.

The main donor policies are as follows:

i) Effective measures to minimize impacts and compensate for losses must be agreed upon with the people who will be affected if involuntary resettlement is required.

ii) People who will be resettled involuntarily and people whose livelihood will be affected must be sufficiently compensated in a timely manner.

iii) Project proponents must make efforts to enable the people affected by the project, improve their standard of living, income opportunities, and production levels, or at least restore them to their pre-project status.

iv) Appropriate participation by the people affected and their communities must be promoted in the preparation, implementation and monitoring of involuntary resettlement plans and measures against the loss of their means of livelihood.

As described, donor policies pay attention to appropriate compensation and participation of PAPs. Socio-economic surveys on public opinions reveal the importance of appropriate compensation. Hence, it is essential for the project to consider the involvement of PAPs. It is proposed that the project should observe the following principles at the time of detailed study of land acquisition and resettlement in order to provide appropriate measures and compensation for the PAPs.

i) By examining all possible alternatives from engineering as well as environmental and social perspectives, land and property acquisition will be avoided or minimized as much as possible.

ii) PAPs must be consulted in a meaningful and timely manner in order to reflect their opinion on the resettlement plan and to promote their participation for planning and implementing of the resettlement plan.

iii) Compensation will be provided in a timely manner based on the agreement with PAPs, and will be completed not later than the date of evacuation.

iv) Compensation for loss of assets, income and business will be based on replacement cost in order to improve the livelihoods, standards of living or income opportunities of PAPs, or at least restore them to their pre-project levels.

v) All PAPs living, working, and doing business in the project area at the time of cut-off date will be entitled to compensation.

vi) The legal or tenure status and practical manner of the properties affected and operational practice in Egypt will be carefully considered in determining their eligibility for compensation.

vii) Necessary institutional arrangements, including grievance mechanisms, will be assured for preparation and implementation of resettlement in a timely manner.

viii) Adequate financial arrangements will be committed and arranged within the time frame to cover the cost of land acquisition, resettlement, and rehabilitation.

ix) An appropriate monitoring, reporting, and evaluation framework will be assured in the resettlement management system.

10.4.2 Eligibility and Entitlement

(1) Eligibility

The first criterion to for eligibility will be the cut-off date. If the residency was identified through the census survey, the owner will be entitled for compensation for their loss of properties and/or assistance for livelihood stabilization. On the other hand, if a person encroached the project area after the cut-off date, they are not entitled to compensation

The second criterion for eligibility will be the legal status of those who were qualified from the first criterion. Identified PAPs are basically classified into the following categories in the donor policies:

- Those who have formal legal rights to land (including customary and traditional rights recognized under the laws of the country)
- Those who do not have formal legal rights to land at the beginning of the census, but have a claim to such land or assets; provided that such claims are recognized under the law of the country or process identified in the resettlement plan
- Those who have no recognizable legal right or claim to the land they are occupying

Although Egyptian regulations do not mention entitlement of compensation for those who do not have legal rights, such persons have been compensated in the course of operational practice if they were previously regarded as the apparent owners of the affected properties. Considering donor policies and Egyptian legal status and practical manner, the categorization for entitlement to compensation in the project will be proposed as follows.

A) Household or Individual

i) Those who are identified at the cut-off date and regarded as apparent owners of properties by the assessment committee. Apparent owners shall include the following legal categories:

- Those who have legal rights to land and/or property (including customary and traditional rights recognized under the laws of the country);
- Those who do not have legal rights to land and/or property at the cut-off date but have a claim to such land or assets - provided that such claims are recognized under the laws of the country or become recognized through a process identified in the resettlement plan;

- Those who have no recognizable legal right or claim to the land and/or property they are occupying but regarded as apparent owners at the cut-off date if they are occupying permanent structures such as flats and houses.

ii) Those who are identified at the cut-off date and regarded as apparent tenants by the assessment committee. Apparent tenants include the following:

- Those who have legal right or in the course to obtain legal right on land
- Those who have no recognizable legal right or claim on tenant status but regarded as tenants at the cut-off date.

iii) Those who have no recognizable legal right or claim to land they occupy but regarded as apparent owners by the assessment committee due to their settlement in illegally established structures such as sheds.

B) Business Owners

Those who are identified at the cut-off date and regarded as apparent business owners by the assessment committee. Apparent business owners shall include the following legal categories:

i) Those who are registered business owners (including customary and traditional rights recognized under the laws of the country);

ii) Those who are not yet registered business owners at the cut-off date but have a claim to such land or assets - provided that such claims are recognized under the laws of the country or recognized through a process identified in the resettlement plan;

iii) Those who are not regarded as registered business owners at the cut-off date but as apparent business owners

(2) Entitlement

The entitlement to compensation and assistance of livelihood stabilization shall be defined according to Egyptian regulations in compliance with donors' policies. Entitlement shall be categorized based on the proposed eligibility to the loss:

1) Compensation for Land Loss:

Project affected land users, households and individuals regarded as the apparent land owners shall be compensated through either of the following:

- Allocation of land with equivalent value and same use purposes
- Cash compensation for acquired land at full replacement cost.

2) Compensation for Households, Structure and Other Establishment Loss:

a) Apparent Owners

- Cash compensation for acquired properties at full replacement cost

- Allocation of equivalent value of property with equivalent social convenience

b) Tenants

- Providing assistance according to the decision of the assessment committee,
- Providing additional assistance for moving if it is not included in the decision.

c) Temporary Apparent Owners

Resettlement of temporary apparent owner in the current proposed route is not confirmed by the site reconnaissance, but the following policies are proposed in case:

- Providing cash assistance for relocation
- Providing cash and administrative assistance for new properties and their administrative registration

3) Compensation for Social Service

Orphanage and hospital in Station 1, bus terminal in Station 4, public school in Station 6, governmental hospital in Station 10, and mini bus terminal in Station 11 are regarded as social service in this report[4]. They shall be assisted with the following:

- Orphanage affected partially shall be relocated and renewed in the same site, and
- Compensation for bus and mini bus terminal shall be based on full replacement cost

4) Compensation for Business Owners and Employees:

Eligible business owners shall be compensated for their income loss based on the decision by the assessment committee. In addition, the following measures should be taken if the decision is not regarded as considering livelihood stabilization:

- Cash compensation for allowance
- Assistance for rehabilitation of livelihood stabilization

Employees and labourers whose job will be affected either temporarily or permanently shall be compensated in stabilizing their livelihood.

- Cash compensation equivalent to three months of salary as maximum
- Assistance to secure new jobs including training for job applications.

[4] Acquisition of public land is conducted by transferring ownership between relevant ministries. Thus, compensation for relevant ministries is not included in the entitlement.

5) Compensation for Street Stalls

According to the Metro Line 3 experience, street stalls are categorized as kiosks, licensed booths, and unlicensed booths. Compensation for them is proposed as follows.

- Cash compensation for relocation at each category based on the decision by the assessment committee
- Assistance for relocation.

6) Compensation for the Poor

In the course of site reconnaissance, habitation of poor was not confirmed. However, those who are less than the poverty line will be provided with the following assistance if such persons are identified as PAPs during the basic design stage:

- Cash compensation equivalent to three months of income in case of not relocation
- Cash compensation equivalent to six months of income in case of relocation Cash compensation equivalent to twelve months of income in case of relocation in the different socio-economic condition
- Providing programs for new job applications if necessary

10.4.3 Overall Procedure

The procedure for land acquisition and resettlement will conform with the procedure of the Egyptian regulations as mentioned in section 10.2.2. For this project, it is also important to consider donor policies in the implementation procedure of land acquisition and resettlement.

10.4.4 Institutional and Organizational Arrangement

Land acquisition and resettlement is implemented by the assessment committee initiated by EGSA, or governorate in the case of Cairo governorate, in cooperation with NAT, as described in the statement of responsibilities (see Table 10-2). This system is considered to be applicable for the project since an assessment committee, which has much experience with legal rights, is better equipped to deal with this issue than a working group established within NAT.

10.4.5 Monitoring and Evaluation

Monitoring will be done during and after land acquisition and resettlement to confirm proper completion in accordance with the following objectives:

i) verification of proposed activities in the resettlement plan
ii) evaluation of implementation situation and the effectiveness of the mitigation measures proposed
iii) confirmation of any unforeseeable situation at the time of preparation of resettlement plan (to allow preparation of additional support)

Monitoring is proposed to be done both internally and externally to ensure its reliability.

There seems to be no established system for monitoring land acquisition and resettlement. It was found that monitoring was not implemented in previous NAT projects. Therefore, appropriate instructions and training prior to monitoring is required. Necessary action for land acquisition and resettlement is generally the responsibility of the assessment committee under EGSA or relevant departments in governorates. Under such circumstances, it is proposed that internal monitoring will be conducted regularly by the assessment committee in cooperation with NAT. Monitoring result will be reported to the responsible ministries and relevant governorates quarterly.

For external monitoring, the project executing agency will hire an independent consultant possessing adequate experience and capacity in the monitoring and evaluation of land acquisition and resettlement. It is necessary for external monitoring to be implemented for the period between the early stages of land acquisition and resettlement, and a specified period after the completion of compensation.

The proposed checklist for internal and external monitoring is given in Table 10-10.

Table 10-10 Proposed Monitoring Checklist

Internal Monitoring	External Monitoring
a) Identification of entitlement of project affected people according to the policy enunciated in the RAP to be prepared for review and update in the BD stage b) Timely implementation of compensation and resettlement in various categories, according to RAP, to be prepared. c) Public consultation, information dissemination and grievance resolution procedures in accordance with Egyptian regulations and donor polices. d) Implementation of rehabilitation assistance to PAPs in accordance with RAP. e) Confirmation of completion of compensation and resettlement, as well as commencement of civil works.	a) Review of existing baseline data obtained through site investigation and population census b) Assessment of effectiveness, impact and sustainability of entitlement c) Assessment of discrepancy between RAP and actual implementation d) Assessment of further mitigation measurements and recommendation for improvement of resettlement e) Monitoring and assessment of grievances f) Assessment of satisfaction level of project affected people g) Assessment of project awareness of affected people on compensation policy

Source: JICA Study Team

10.4.6 Consideration of Grievance Redress

All PAPs enjoy their right to complain and express their grievances about the result of land acquisition and resettlement (including compensation, if it is not agreeable). In addition, it is also important that the grievance process covers the entire procedure of land acquisition and resettlement including compensation. Law No. 10/1990 ensures that both PAPs and the expropriating entity(ies) are given grievance rights, as follows:

- Give owners thirty days after the expiry of public announcement to notify grievances to the central office of the expropriating entity or governorate.
- Allow the expropriating entity until four months after expiry of the public announcement to contest the evaluation.

However, Law No. 10/1990 does not cover completion of compensation. Therefore, it is proposed to establish a contact window in the assessment committee where PAPs can communicate their grievances at any time. It is proposed to inform all PAPs of this procedure during the stakeholder meeting, as well as during individual consultations.

10.4.7 Assurance of Participation and Consultation

Information disclosure and public consultation will contribute to the transparency of the project and encourage public participation. In addition, potential conflict with the affected people on resettlement and compensation will be avoided if they are consulted during the very early stages of the project, since their opinions should be reflected in the preparation of policies. On the other hand, it is difficult to disclose project information to the public, since the provision of incorrect information can confuse the people affected. This could introduce a negative factor for project implementation. Therefore, the appropriate timing for information disclosure and public consultation is important.

A project proponent does not have any right to conduct consultation with PAPs in Egypt, as mentioned in Section 10.2.2. Only relevant departments in governorates and the assessment committee are entitled to conduct such consultation. For regulations, only the relevant departments in governorates and the assessment committee can conduct consultations with PAPs during the preliminary assessment if necessary. Considering Egyptian regulations and donor policies, the following policies on consultation are proposed:

- As a first step, hold meetings with stakeholders and PAPs at the stage of EIA disclosure to provide PAPs an opportunity to understand the project;
- As the second step, consult with all PAPs in individual meetings at the time of population census, which will be conducted when the station locations are almost fixed;
- As the third step, a governorate and an assessment committee will establish a contact window, where PAPs can contact freely and obtain necessary information at any time.

10.4.8 Implementation Schedule

Land acquisition and resettlement is basically implemented according to the procedures of Egyptian regulations, while taking donor policies into account. The major procedure is proposed as follows for the preparation, implementation and monitoring of a detailed plan of resettlement, which is summarized in Table 10-11 and Table 10-12.

i) Preliminary Survey and Individual Consultation

The first step in the preparation of a detailed resettlement and compensation plan involves identifying potential PAPs. Relevant departments in a governorate and an assessment committee will conduct a preliminary survey to identify ownership of land and properties to be acquired upon project implementation, and individual consultations will also be held at that time to know their opinions and requirements on land acquisition and resettlement.

ii) Approval of Land Acquisition and Issuing Prime Ministerial Decree on Public Interest

The Prime Ministerial decree on land acquisition in the public interest will issued when the preliminary survey is completed and if it is approved. The decree will include the detailed procedure to be applied for land acquisition and compensation.

iii) Preparation of Basic Policy on Land Acquisition/Resettlement and Compensation

Based on the result of the preliminary survey and individual consultation, a basic policy will be prepared, including: i) legal framework; ii) compensation and assistance for livelihood stabilization rates with replacement cost; iii) brief clarification of entitlement on compensation; and iv) financial source(s). This policy will be prepared by referring from previous lessons and considering donor policies.

iv) Detailed Survey

When the decree on land acquisition in the public interest is issued by the Prime Minister, a detailed survey by relevant departments in a governorate and the assessment committee will commence. During that period, several individual consultations will be held to assess property loss and prepare appropriate compensation.

v) Preparation of Resettlement Plan

A resettlement plan will be prepared including detailed entitlement and estimation of compensation amount based on the result of the detailed survey and individual consultations. It will be notified in a public place, not only to PAPs, but to people who are interested in the project.

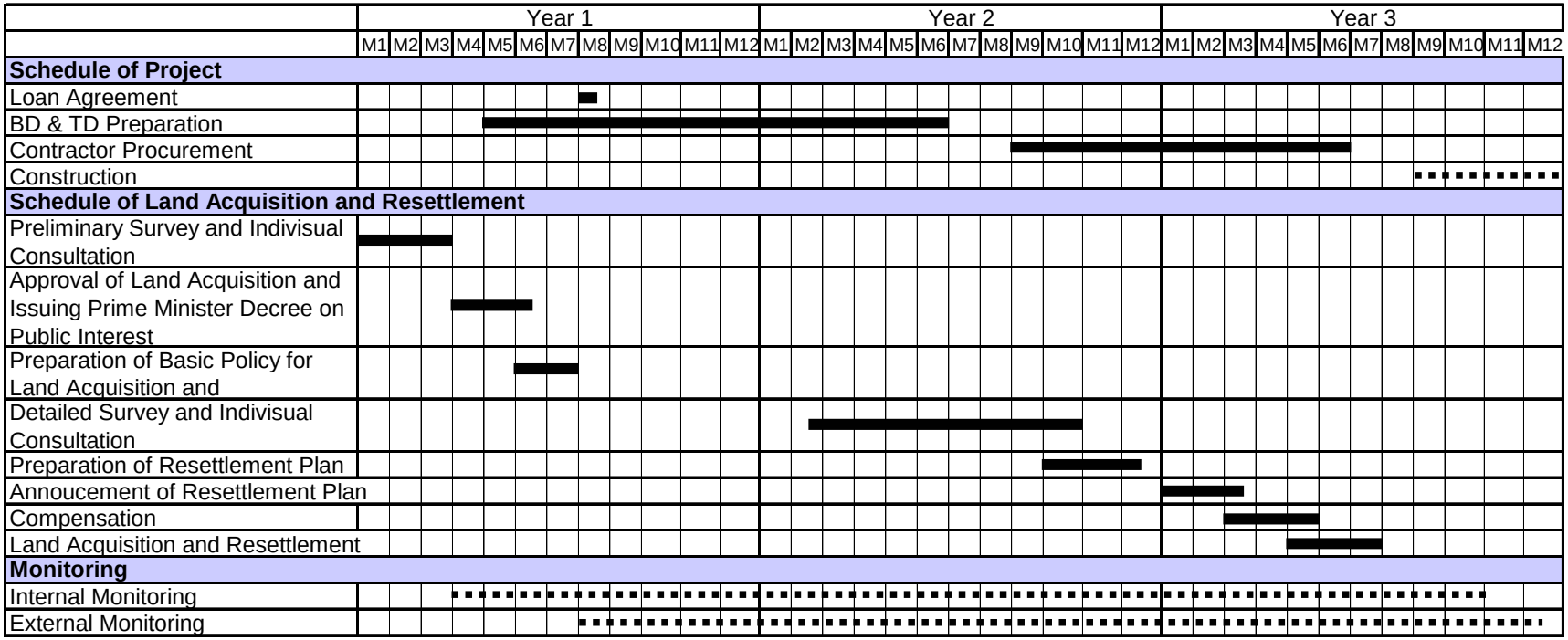
vi) Compensation and Evacuation

Compensation will be paid to PAPs according to the resettlement plan, and evacuation must be completed within five months.

vii) Monitoring

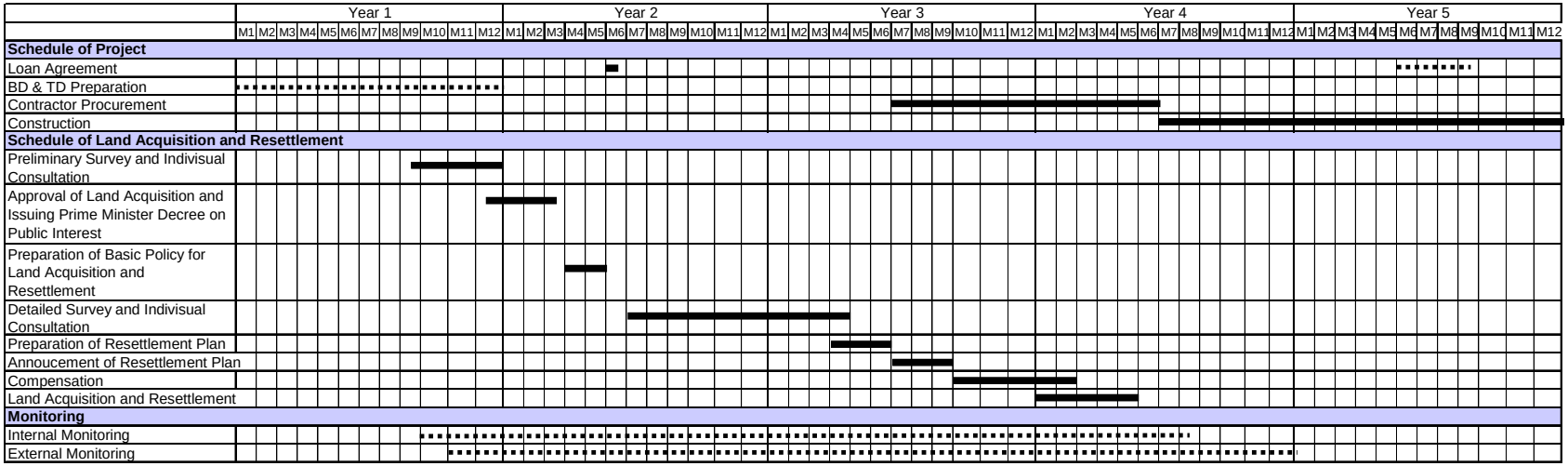
Internal and external monitoring will be conducted regularly during and after implementation of resettlement to examine and confirm its appropriateness and fairness. It will provide a basis for preparation of additional measures on compensation if the necessity for these is confirmed during monitoring.

Table 10-11 Proposed Schedule of Land Acquisition and Resettlement for Phase 1



Source: JICA Study Team

Table 10-12 Proposed Schedule of Land Acquisition and Resettlement for Phase 2



Source: JICA Study Team

10.5 Preliminary Cost Estimation for Compensation

10.5.1 Objective, Methodology and Limitation

The objective is to estimate the compensation cost as an input for the project capital cost estimate and for the economic and financial appraisal of the project.

The compensation estimate is based on available secondary data, such as the census data issued by CAPMAS on December 2008, and socio-economic data related to the project area obtained from a household survey conducted by JICA Study Team in July 2009. Since the available data is very limited, it will be necessary to review the cost estimate during the preparation of the resettlement plan.

10.5.2 Consideration of Minimizing Resettlement

The route and the station location have been designed with due consideration during the F/S stage in order to minimize potential impacts of land acquisition and resettlement. Since the project includes construction of stations, land acquisition and resettlement is necessary.

The following measures are taken in general to minimize potential impacts of land acquisition and resettlement.

- In the case of road crossings, it is designed under the existing roads and also designed to be constructed by a tunnel boring machine (TBM). Therefore, resettlement will be avoidable.
- Stations are basically constructed by the cut and cover method. If the resettlement impact is not negligible, alternative construction methods, instead of cut and cover, will be applied to minimize the resettlement impact.

A typical effort to minimize the negative impact of land acquisition and resettlement is described as follows:

Station 1

It is planned to construct scissor crossings for the purpose of shuttling and emergency use. If the cut and cover method is applied for the construction of the entire station including the scissors portion in the currently proposed area, acquiring two additional residential buildings and a mosque with clinics is necessary. Thus, the cut and cover method is not considered to avoid significant impacts caused by land acquisition of these properties.

Station 2

There will be a high possibility of acquisition of a large size of residential building if the cut and cover method is used without any countermeasures. Since the impact of such an acquisition is significant, measures such as underpinning of large residential buildings will be proposed. It is expected that the resettlement of residents will be avoided through this method.

10.5.3 Estimated Magnitude of Socio-Economic Impacts

(1) Phase 1

Prior to construction for Phase 1, land acquisition and resettlement for construction of stations, exits and annexes will be necessary at the following stations, although some mitigation measures will be taken as mentioned above. Table 10-13 gives a summary of the estimated magnitude of the proposed land acquisition and resettlement, while Annex 10-2 provides detailed information on the properties to be demolished.

a) Station 1

Land acquisition is necessary since this station is planned to be made with the cut and cover method. Due to construction of the station, land acquisition of one residential building, a part of an orphanage, a part of a hospital, and eight shops will be necessary. In addition, nine street stalls will be requested to relocate during construction.

b) Station 2

Land acquisition for exits and station construction is necessary. It will be necessary to acquire one gas station and two fast food restaurants to permit construction. In addition, it will be necessary to acquire three shops for the construction of exits. However, resettlement of residents due to land acquisition is not expected.

c) Station 3

It is expected to acquire eight shops for the construction of station exits (i.e., 3 shops for exit construction and 5 shops for cooling tower and ventilation installation). In addition, it will be necessary to acquire open space, including a garden on private land, for the installation of a cooling tower.

d) Station 4

This is the connection to El Giza station of Metro Line 2, and therefore an appropriate traffic arrangement, such as preparation of bus terminal, is necessary. Land acquisition is necessary to allow construction of this terminal. Although resettlement of residents is not expected, temporary relocation of 27 street stalls is required.

e) Stations 5 to 15 except Stations 6, 10 and 12

In the cases of stations 5 to 15 of Phase 1, no resettlement of residents is expected, since the existing road width is sufficient for station construction. However, land acquisition of open spaces, including a garden on private land and a footpath on public land will be necessary to allow the construction of exits and the installation of a cooling tower.

f) Station 6

Four exits are planned to be constructed, where two are planned to be constructed in public spaces, such as sidewalks. The remaining two exits will require land acquisition of an open space from a public school.

g) Station 10

Land acquisition for construction of an exit is necessary. The planned location for the exit is inside the area of a government hospital. Therefore, it is expected that land ownership be transferred through negotiation with the relevant ministries.

h) Station 12

Land acquisition for facility installation and exit construction is necessary. As for facility installation, it is planned to use a public land, which is reported to be owned by the Ministry of Tourism. Therefore, transfer of ownership between ministries is necessary.

Table 10-13 Expected Magnitude of Land Acquisition and Resettlement at Phase 1

	Land		Residential Building			Shops		Social Service	Street Stall	Displaced Persons[5]
No.	Private (m^2) (*1)	Public (m^2) (*1)	Total Area (m^2) (*1)	Affected Building (*2)	Affected Family (*3)	Total Area (m2) (*1)	Affected Shop No.	Affected Area (*2)	Affected Number (*4)	Expected Number (person)
1	-	-	2,700	1	11	1,394	6(*5)	3,334	9	47
2	-	155	-	-	-	1,900	6	-	-	-
3	105	293	-	-	-	844	8	-	-	-
4	315	100	-	-	-	-	-	2,115(*6)	27	-
5	-	400	-	-	-	-	-	-	-	-
6	-	670	-	-	-	-	-	-	-	-
7	60	533	-	-	-	-	-	-	-	-
8	358	538	-	-	-	-	-	-	-	-
9	-	370	-	-	-	-	-	-	-	-
10	409	255	-	-	-	-	-	255	-	-
11	250	100	-	-	-	-	-	265	-	
12	30	595	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-

Remarks:
*1: Information about total area is obtained form the drawings based on satellite image.
*2: Information is obtained through site investigation.
*3: Information about affected family number is obtained from site investigation and interviews with the neighbourhood
*4: Information is obtained through site investigation.
*5: Two shops which did not open at the time of site investigation are included.
*6: Only necessary area for construction in the bus terminal is calculated.
Source: JICA Study Team

(2) Phase 2

Land acquisition and resettlement are necessary at Station 2 and Station 8, respectively. For Station 2, five residential buildings and two shops will be acquired. For Station 8, six residential buildings will be acquired. The estimated magnitude of land acquisition and resettlement is summarized in the following table and Annex 10-2 shows detailed information of the properties to be demolished.

[5] Displaced persons is defined as those who are requested physical displacement in this report.

Table 10-14 Expected Magnitude of Land Acquisition and Resettlement at Phase 2

Sta. No.	Land (m2) (*1)	Residential Building			Shops		Street Stall
		Total Area (m2) (*1)	No. of Affected Building	No. of Affected Family (*3)	Total Area (m2)	No. of Affected Shop (*4)	No. of Affected Street Stall (*4)
2	2,890	2,310	5	27	150	2	-
8	-	15,520	6	119	2,520	30	-

Remarks are same at the Table 10-13.
Source: JICA Study Team

10.5.4 Preliminary Cost Estimation for Compensation

(1) Condition for Preliminary Estimation of Compensation Cost

Preliminary compensation estimation is composed of costs such as i) private land acquisition; ii) private property acquisition (mainly residential flat); iii) commercial property acquisition (mainly small shops); iv) allowances for flat tenants including moving cost; v) allowances of income restoration for shops including moving cost; and vi) administration fee. In addition, preliminary compensation is estimated with the following conditions:

i) Cash compensation is provided to all PAPs, instead of providing alternatives.

ii) For public lands such as sidewalks, land in governmental hospital, and space in public schools, compensation amount is not estimated since it is said that land acquisition of public land is done through ownership transfer between relevant ministries.

iii) Properties which are difficult to distinguish as public or private from external appearance are regarded as privately owned.

iv) Since during the F/S stage, it is impossible to distinguish the status of property ownership for flats whether they are owners or tenants. Therefore, a residential building is considered as owned by one owner and households living in flats are regarded as tenants.

v) The unit cost of flats is composed of costs for land and property. These costs cannot be separated in any practical manner.

vi) The unit price of land and flats is identified from interviews with local real estate agents at each station location.

vii) The allowance for tenants is assumed to be based from the experience with the Metro Line 3 project, without any modification. In addition, one family is estimated to have three rooms in their flat.

viii) Allowance for shops, such as rehabilitation assistance, is estimated by referring to the average monthly salary data collected from the household survey conducted by JICA Study Team, since JICA Study Team does not have the right to obtain exact data.

ix) The number of workers in shops is estimated to be four based on the result of

socio-economic interview survey.

(2) Estimated Cost for Compensation for Phase 1

Based on the conditions mentioned in Section 10.5.4(1), the cost of land acquisition and compensation are estimated as shown in Table 10-15.

Table 10-15 Estimated Cost for Land Acquisition and Compensation for Phase 1

Sta. No.	Category	Area (sq.m)	Unit (LE)	Total (LE)	Remarks
1	Land	2,614	6,000	15,684,000	Amount for land acquisition
	Flat	2,700	4,000	10,800,000	Amount for land and property acquisition
	Shop (*1)	1,394	8,000	11,152,000	Amount for land and property acquisition
	Construction	720	2,500	1,800,000	Renewal or restoration of orphanage
	Allowance to Family(*6)	11 families	15,000	495,000	Amount for compensation
	Allowance to Shop (*2) (*3)	7 shops(*6)	-	490,000	Amount for compensation
	Allowance to Street Stall (*4)	9 stalls	5,000	45,000	Amount for compensation
2	Shop	1,900	3,000	8,100,000	Amount for land and property acquisition
	Allowance to Shop (*2) (*5)	6 shops	-	1,585,000	Amount for compensation
3	Land	105	10,000	1,050,000	Amount for land acquisition
	Shop	844	7,000	5,908,000	Amount for land and property acquisition
	Allowance to Shop (*2)	8 shops	-	291,000	Amount for compensation
4	Land	2,115	10,000	72,800,000 (*7)	Amount for land acquisition
	Allowance to Street Stall (*4)	27 shops	5,000	135,000	Amount for compensation
5	-	-	-	-	-
6	-	-	-	-	-
7	Land	60	10,000	600,000	Amount for land acquisition
8	Land	358	10,000	3,580,000	Amount for land acquisition
9	-	-	-	-	
10	Land	409	10,000	4,090,000	Amount for land acquisition
11	Land	515	10,000	5,150,000	Amount for land acquisition
12	Land	30	15,000	450,000	Amount for land acquisition
13	-	-	-	-	-
14	-	-	-	-	-

Remarks:
*1: Shops located above the first floor of residential buildings falls under the flat category.
*2: Allowance to shop includes: i) rehabilitation of loss of income source, ii) LE5,000 of licence cost, iii) LE5,000 of decoration cost, iv) LE5,000 of administration cost, and v) LE5,000 of moving cost.
*3: Rehabilitation of loss of income is estimated based on multiplying the estimated number of workers as five people, unit cost, and duration for three months.
*4: Unit cost is based on average cost for kiosks during the Metro Line.3 project.
*5: In the case of Station 2, large scale shops are considered to be affected. Since information of allowances for similar sizes of shops was not obtained from the Metro Line 3 project, allowances are estimated specifically by referring to the experience of other countries.
*6: Compensation for 2 shops which did not open at the time of site investigation was not included.
*7: Although necessary area for construction is only calculated, compensation amount is calculated for the entire area of the bus terminal. There is a possibility that compensation amount will be decreased

to the necessary area only (around 30% to the entire area) as a result from negotiations with land owners.

Source: JICA Study Team

Table 10-16 Estimated Cost for Land Acquisition and Compensation for Phase 2

Sta. No.	Category	Area (sq.m)	Unit (LE)	Total (LE)	Remarks
2	Flat	2,310	3,000	6,930,000	amount for land and property acquisition
	Shop(*1)	150	15,000	2,250,000	amount for land and property acquisition
	Parking	1,244	6,000	7,464,000	amount for land acquisition
	Garden	1,665	6,000	9,990,000	amount for land acquisition
	Allowance to Family	27 families	15,000	1,215,000	amount for compensation
	Allowance to Shop (*2)(*3)	2 shops	-	122,000	amount for compensation
8	Flat	15,520	7,000	108,640,000	amount for land and property acquisition
	Shop(*1)	2,520	10,000	25,250,000	amount for land and property acquisition
	Allowance to Family	119 families	15,000	6,435,000 (*4)	amount for compensation
	Allowance to Shop (*2)(*3)	30 shops	-	2.100,000	amount for compensation

Remarks:
*1: Shops located above the first floor of residential buildings falls under the flat category.
*2: Allowance to shop includes: i) rehabilitation of loss of income source; ii) LE5,000 of licence cost; iii) LE5,000 of decoration cost; iv) LE5,000 of administration cost; and v) LE5,000 of moving cost.
*3: Rehabilitation of loss of income is estimated based on multiplying the estimated number of workers as five people, unit cost, and duration for three months.
*4: Compensation cost is calculated for the entire rooms of a residential building regardless of some empty rooms. That means, there were 24 empty rooms in total in the residential buildings at Station 8 during site investigation, and compensation to these rooms are included in the calculation.

Source: JICA Study Team

10.6 Plan of Population Census for Potential PAPs

As mentioned in the procedure of land acquisition in Section 10.2.2, identifying potential PAPs is the first step for implementing land acquisition and resettlement. Identification of potential PAPs in the early stages of a project will help avoid influx of squatters and unnecessary compensation to them. In addition, it is also expected that cooperation from potential PAPs will enhance by disclosing appropriate information in a timely manner.

Potential PAPs will be identified by conducting a population census, which is regarded as the stage of preliminary survey in the Egyptian procedure mentioned in the implementation schedule (see Section 10.4.7). The preliminary survey will be conducted by the relevant departments in governorates in cooperation with NAT after the project area is almost delineated. In these circumstances, it is emphasized that all relevant bodies should have close communications for the smooth execution of census. The implementation schedule is given in Table 10-11 and Table 10-12 for Phases 1 and 2, respectively.

It is necessary to consider donor policies in conducting the population census. Questions to be covered in the population census are outlined below, and Annex 10-3 provides these in detail.

- Number of target properties
- Names of household heads in the target properties
- Family structure with number
- Legal status of the property
- Living period in the property

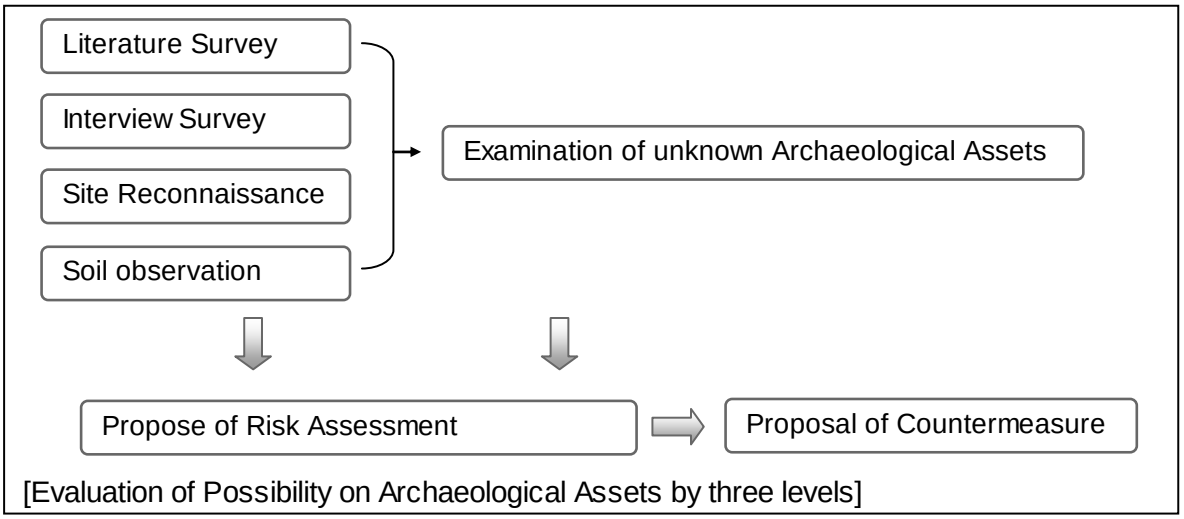
CHAPTER 11
ARCHAEOLOGICAL ASSESSMENT STUDY

CHAPTER 11 ARCHAEOLOGICAL ASSESSMENT STUDY

11.1 Introduction

11.1.1 Scope and Procedure of the Study

Preservation of the archaeological and cultural properties as well as their landscapes was prioritized in this study. In line with this policy, with all available information, we examined the archaeological assets of the area along the proposed routes for the Metro Line 4. This study aims to eventually propose the risk assessment and countermeasures for the buried cultural properties. For this evaluation, study items and the procedure are carried out as shown below:



Source: JICA Study Team

Figure 11-1 Study Items and Procedure

- Literature Study about the Known Sites:
  Collection of information on existing archaeological assets and their features from previous research reports, site distribution map from the Supreme Council of Antiquities (SCA) GIS Center, etc.
- Interview with Local Experts:
  Collection of information on existing and unpublished archaeological assets and the previous cases of treatment for the archaeological remains under construction through interviews with SCA experts.
- Site Reconnaissance on the Route Line:
  Surface observation on study area to confirm topography and evidences of artificial distribution.
- Soil Observation from Borehole Research:
  Observation on the soil samples from boreholes conducted by geological research to know the existence of buried archaeological properties along the route.
- Examination of Unknown Archaeological Assets:

Examination of the location and features of unknown buried assets based on collected information.

- Results of these researches were combined to consider the possibility of unknown archaeological properties. Then, risk assessment was evaluated in three levels with dividing small areas along the proposed routes. Finally, countermeasures were proposed in accordance with the risk assessment.

In addition, to understand the work procedure and treatment for the possible findings, the legal system for archaeological properties and SCA were examined.

11.2 Examination of the Legal System and SCA's Organization

11.2.1 Legal System

The Egyptian legal system, Law No. 117/1983 "Protection of Antiquities", is the fundamental regulation for all issues concerning cultural assets[1]. The law stipulates all antiquities, even those yet to be discovered, are regarded as the possession of Egypt. It also regulates that the Egyptian Antiquities Authority has all responsibility for archaeological and historical properties, and has authority for the excavation, restoration and protection of antiquities. The "Authority" mentioned in the law means the present SCA, which was reorganized by virtue of the Presidential Decree Number 82 of 1994.

This law consists of 51 articles, in which some essential and relevant to our project are outlined below:

a) Article 5

The Egyptian Antiquities Authority shall be the quarter concerned with control and supervision of all antiquities affairs in the antique, ancient and historical sites and areas, even if these have been come across by accident.

b) Article 17

Violating party shall restore the situation to its original condition, otherwise the Authority may proceed with restoring it to its original condition at the cost of the violator.

c) Article 20

No construction licenses shall be granted for archaeological sites and lands. No third party shall erect establishments or build roads in archaeological sites or the lands lying within the approved lines of beautification of such antiquities.

d) Article 23

Any person who discovers and finds a real antiquity shall notify the Authority. The Authority shall take steps as necessary to preserve and maintain such antiquity, and it shall have the power within three months either to lift the antiquity existing in

[1] It was purchased at The Middle East Library for Economic Services, Agouza

the realty of individuals, or take steps of land expropriation where the antiquity is found, or leave the antiquity in its place. The value of antiquities existing in the expropriated land shall not enter in the estimation of its value.

e) Article 24

Any person who comes accidentally across antiquity shall notify such discovery to the nearest administrative department within 48 hours, and preserve and maintain it until the appropriate authority shall receive it, otherwise he shall be considered as holder of the antiquity without being licensed therefore. The department shall also notify the Authority thereof, on the spot.

To summarize the articles, the points regarding this study are as follows:

- No construction is permitted on the existing archaeological sites.
- Any antiquities which would be discovered must be reported to the SCA within 48 hours.
- The SCA shall determine appropriate countermeasure on the antiquities.

11.2.2 SCA Organization[2]

SCA is an agency under the Ministry of Culture. In SCA, the Administrative Council acts as a governing body in which the President of the Council is the Minister for Culture who is the sole legal representative of SCA. Their tasks are undertaken by six sectors: the General Secretariat Sector; the Egyptian (Pharaonic) and Greco-Roman Antiquities Sector; the Coptic and Islamic Antiquities Sector; the Antiquities and Museum Financial Support Fund Sector; the General Projects Sector; and the Museums Sector. The heads of the six sectors form the executive core of the Administrative Council as permanent members (ex officio; by virtue of their office) in which the head of the General Secretariat Sector, the General Secretary, acts as the executive head of SCA.

The SCA has Inspectorate Offices in each governorate to manage the excavation, management and supervision on their jurisdiction. As mentioned in Law No. 117/1983 Article 24, discovery of antiquities should be informed to the nearest administrative department, which corresponds to the present Inspectorate Office. The local Inspectorate Offices, which cover the area along the planning route of Metro Line 4 in the Greater Cairo, are listed in Table 11-1.

[2] It was referred to SCA Homepage (Eternal Egypt http://www.eternalegypt.org/).

Table 11-1 SCA Inspectorate Covering the Area of Metro Line 4

Area	Inspectorates	Current Director (as of 2009)
Phase 1	Giza	Dr. Mahmoud Afifi
Phase 2: Historic Cairo	El-Ghoury	Mr. Sayed Ismaeil
Phase 2: Historic Cairo	El-Gamaliah	Mr. Ragaey Mostafa Houssin
Phase 2: Historic Cairo	Middle Cairo	Mrs. Salwa Heram
Phase 2: Northern Corridor: Heliopolis	Matariya	Mr. Adel Al-Sadani

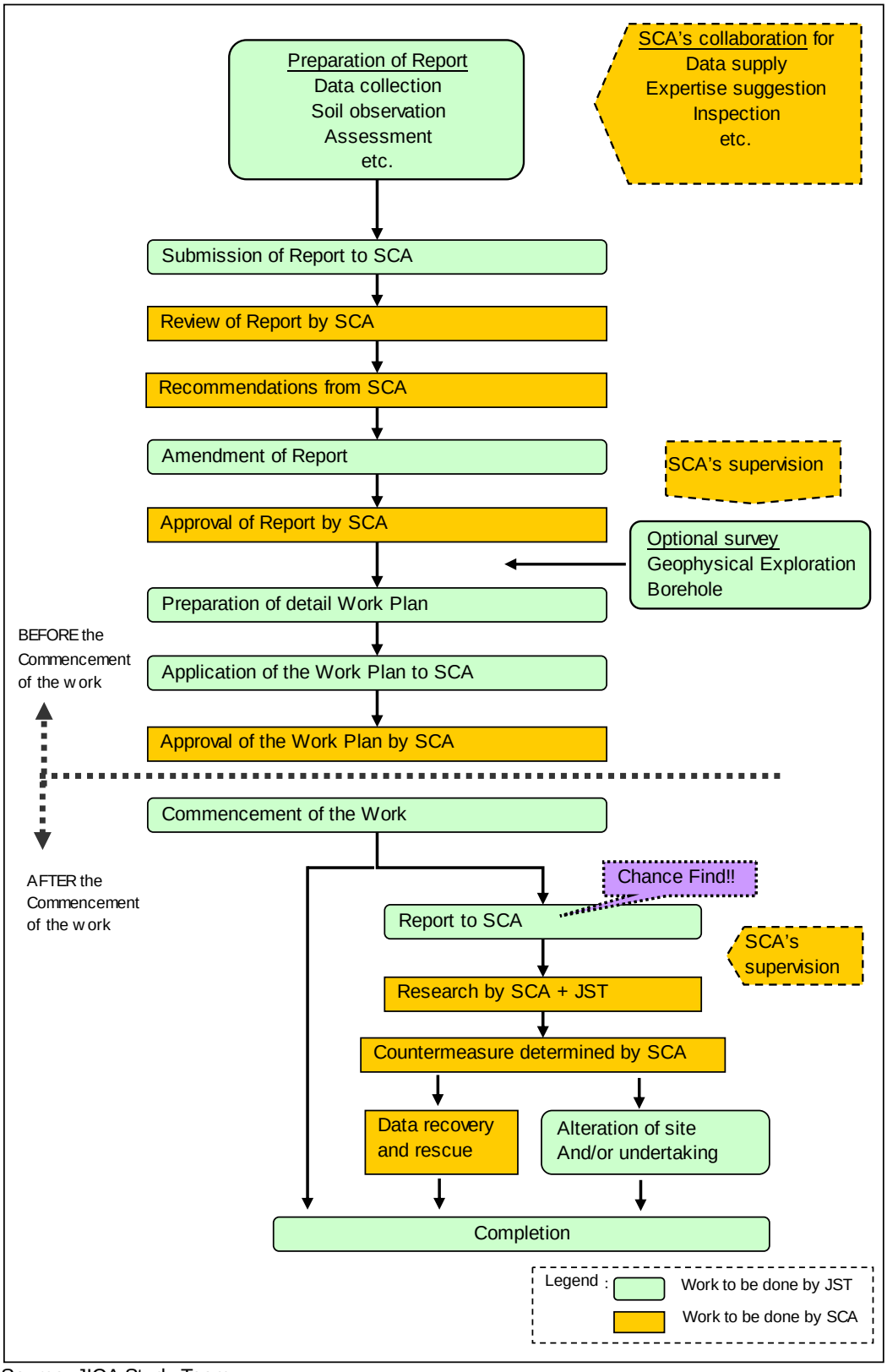
Source: JICA Study Team

11.3 Work Procedure

Law No.117/1983 stipulates the roles of SCA only after the antiquity is discovered. However, it is necessary to discuss the project with SCA from the planning stage, and to formulate the appropriate work procedure with their understandings and suggestions. The ongoing meetings have provided the tentative work procedure before and after the project implementation (Figure 11-2).

From the preparation stage, the SCA collaborates and supports by supplying their data, expertise suggestion and lessons learnt from the previous experiences to examine all aspects of the archaeological properties along the supposed routes. After the completion of the preparatory study report (FS stage), it is submitted to the Permanent Committee of SCA to gain agreement with them on this project. This procedure is same for the next report of the detail work plan (BD stage) although, in this stage, geophysical survey and borehole under supervision of SCA would be carried out in order to verify the existence of possible buried properties.

After the commencement of work, in the case that an archaeological property is found during construction, the actual procedure is as follows. Immediately notify the discovery to the nearest Inspectorate Office, and then SCA staff with the JICA Study Team conducts archaeological research with records of mapping, drawing and photographs. After the research, the most suitable countermeasure is determined by SCA judging from the condition of the properties. Their criteria are shown later. Whether undertaking of JICA Study Team is to keep as planned or to alter depends on the decision of SCA.

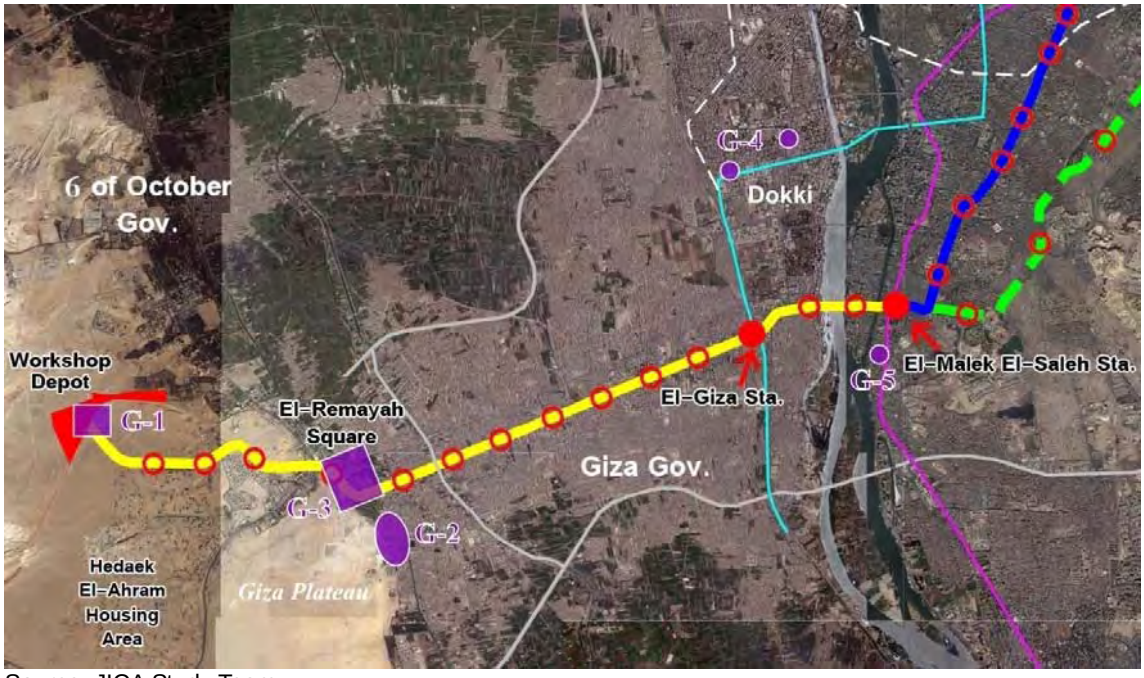


Source: JICA Study Team

Figure 11-2 Work Procedure of Archaeological Asset Study

11.4 Baseline Information

To confirm the location and characteristics of the archaeological properties along the route of Metro Line 4, examination of literature and interviews with SCA and relevant authorities were undertaken. In addition, this baseline information is reinforced by the up-to-date digital map showing the location of the archaeological and historical sites with a description of their value, which was prepared by SCA-GIS Center.



Source: JICA Study Team

Figure 11-3 Map Showing Location of Existing Archaeological Properties at Giza Area

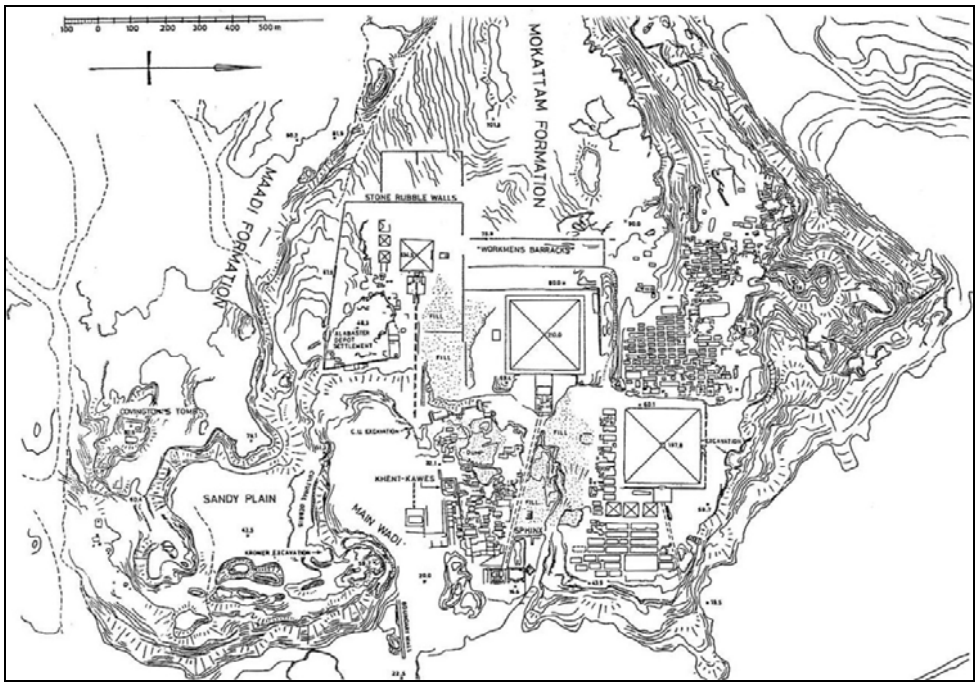
11.4.1 Phase 1: Giza Area

(1) G-1: Desert Area near Workshop (Depot)

Around the desert area where the workshop is planned to be constructed, there have been no reports on the existence of archaeological properties. Confirmation of this general survey was conducted on the area. This survey was especially focused on area from the proposed depot site to the back of the Grand Egyptian Museum (GEM), which covers about 6.0 km extending west to east. Although it was a surface observation by walk, there appeared to be no archaeological remains on the desert area. This result is also in agreement with the literature data and historical perspective of the Giza Plateau, which show that the archaeological sites have been found at the fringe of the Nile alluvial cultivation area.

(2) G-2: Giza Plateau

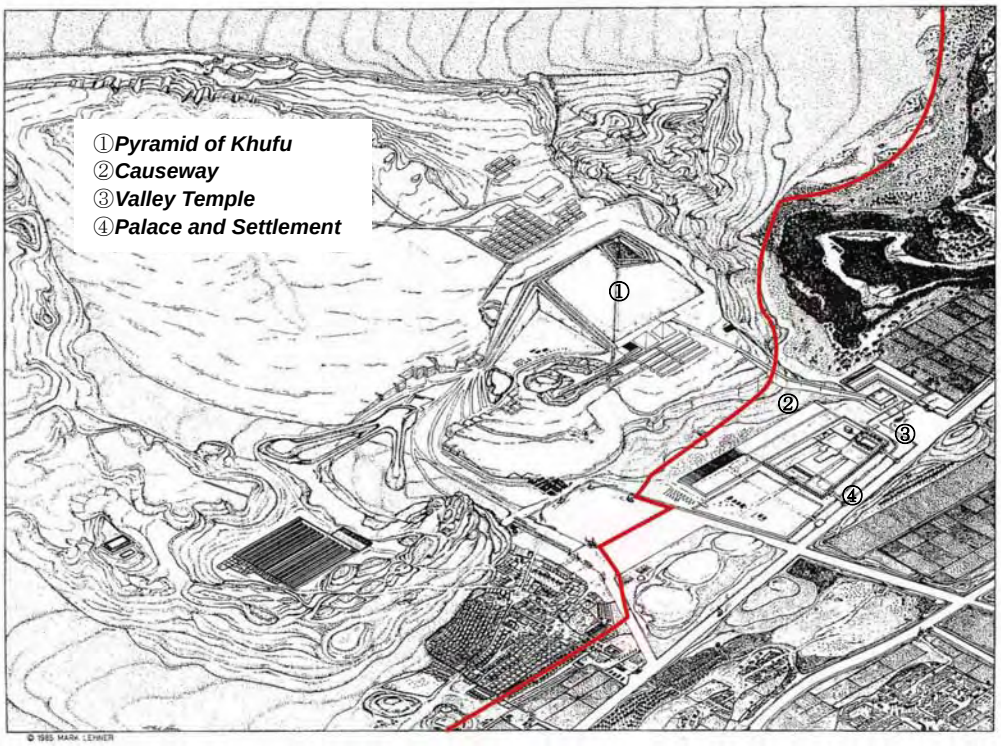
On the Phase 1 route, most attention should be given to the Giza Plateau area, which has been on the UNESCO's World Cultural Heritage List since 1979[3]. Famous for the Great Pyramids, Giza Plateau is located several meters from the last houses in the western most part of Giza City, where a limestone cliff (Middle Eocene Moqattam Formation) rises abruptly from the other side of a sandy desert plateau, and 20-35 m higher than the alluvial area. To keep away from the Nile inundation, the pyramids as well as tombs had been built on the higher plateau, which made a huge complex of Necropolis as we can see nowadays (Figure 11-4). However, some archaeological remains have been found in the alluvial area. Dr. Mark Lehner provides a reconstructed plan at the time of Pyramid construction of Khufu (Figure 11-5), which shows that the valley temple, causeway, palace and settlement stand far beyond the limestone plateau[4]. This plan was based on evidences from borings and trenches by American British Consultants (AMBRIC) to install sewage system under the Greater Cairo Waste Water Project (Contract 27) by the Ministry of Reconstruction, New Communities, Housing and Utilities, and the following salvage excavations by SCA in the late 1980s and early 1990s[5]. The project revealed that parts of the causeway and valley temple of Khufu as well as the old kingdom settlement remained over the alluvial area of Nazelet el-Samman (Figure 11-6).



Source: JICA Study Team

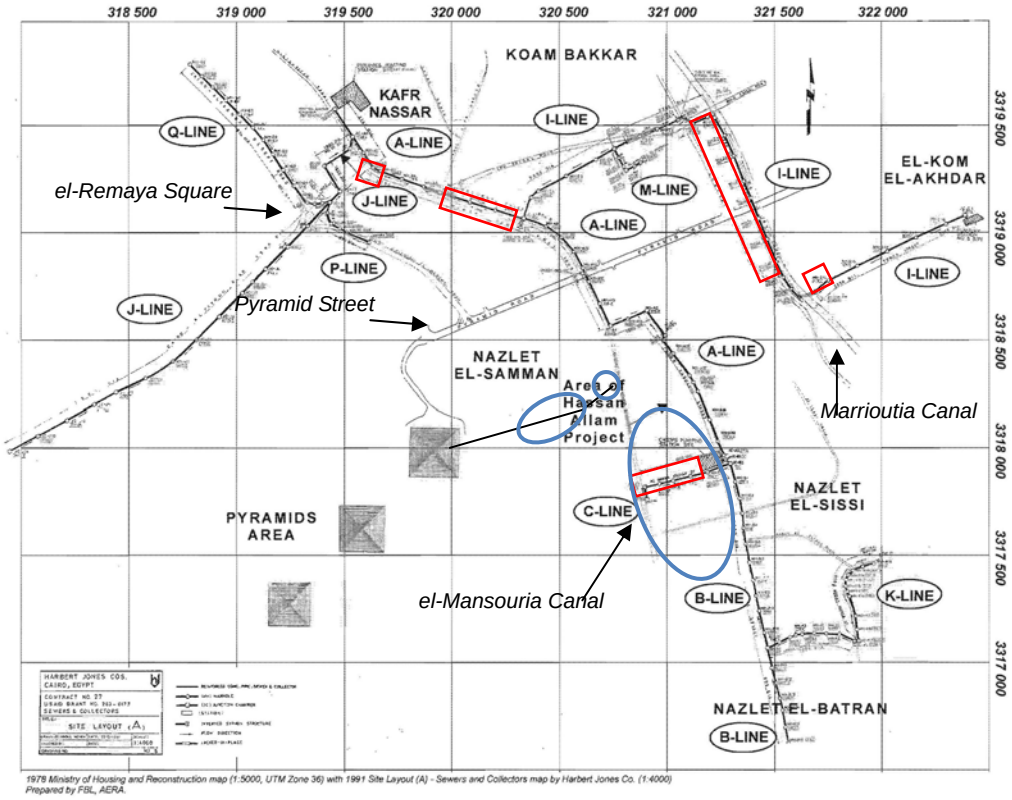
Figure 11-4 Archaeological Map of Giza Plateau （Lehner 1985: Fig.2）

[3] The official title of the UNESCO list is “Memphis and its Necropolis – the Pyramid Fields from Giza to Dahshur”.
[4] M. Lehner, 1985, “The Development of the Giza Necropolis: The Khufu Project”, *MDAIK* 41: 109-143.
[5] Z. Hawass and A.Senussi, 2008, *Old Kingdom Pottery from Giza*, Cairo; Z. Hawass, 1997, “The Discovery of the Harbors of Khufu and Khafre at Giza”, *Études sur l’Ancien Empire et la nécropole de Saqqâra dédiées à Jean-Philippe Lauer*, Or.Monsp. IX: 245-256.



Source: JICA Study Team

Figure 11-5　Reconstruction Plan at the Time of Pyramid Construction of Khufu (Lehner 1985: Fig.3C）　(Red line: Modern Border between Desert and Alluvial Areas)



Source: JICA Study Team

Figure 11-6 Map of Sewers with Spots of Archaeological Founds (Hawass and Senussi 2008: Plan 6) (Blue: Architectural Remains, Red: Scattered Objects)

(3) G-3: Near El Remayah Square

The Greater Cairo Waste Water Project covered a wide area stretching 3 km to the north from the plateau, where a large amount of pottery sherds and some mudbrick structures were found scattered around the El Remayah Square and the Pyramids Street (Figure 11-6, Figure 11-7). In response to this, the archaeological works were conducted by SCA in 1992. In this research, an open trench excavation and over 400 borings were conducted on the wider area. The trench excavation was carried out on the north-east side of the Mansouria Canal Road[6] near the El Remayah Square. In the trench, there were discoveries of some pottery vessels and a fragment of a basalt beaker, which are parallel in shape to those from Predynastic Maadi Culture context[7]. The vessels were buried at the depth of 6.5-6.8 m below the road surface.

A series of boreholes were mainly made beside the Marrioutia Canal[8]. Archaeological deposits composed of pottery fragments and other indicators of human presence were recognized at the elevation of 12 m in borings 1 and 7, and at 7.5 m in Boring 8. The former

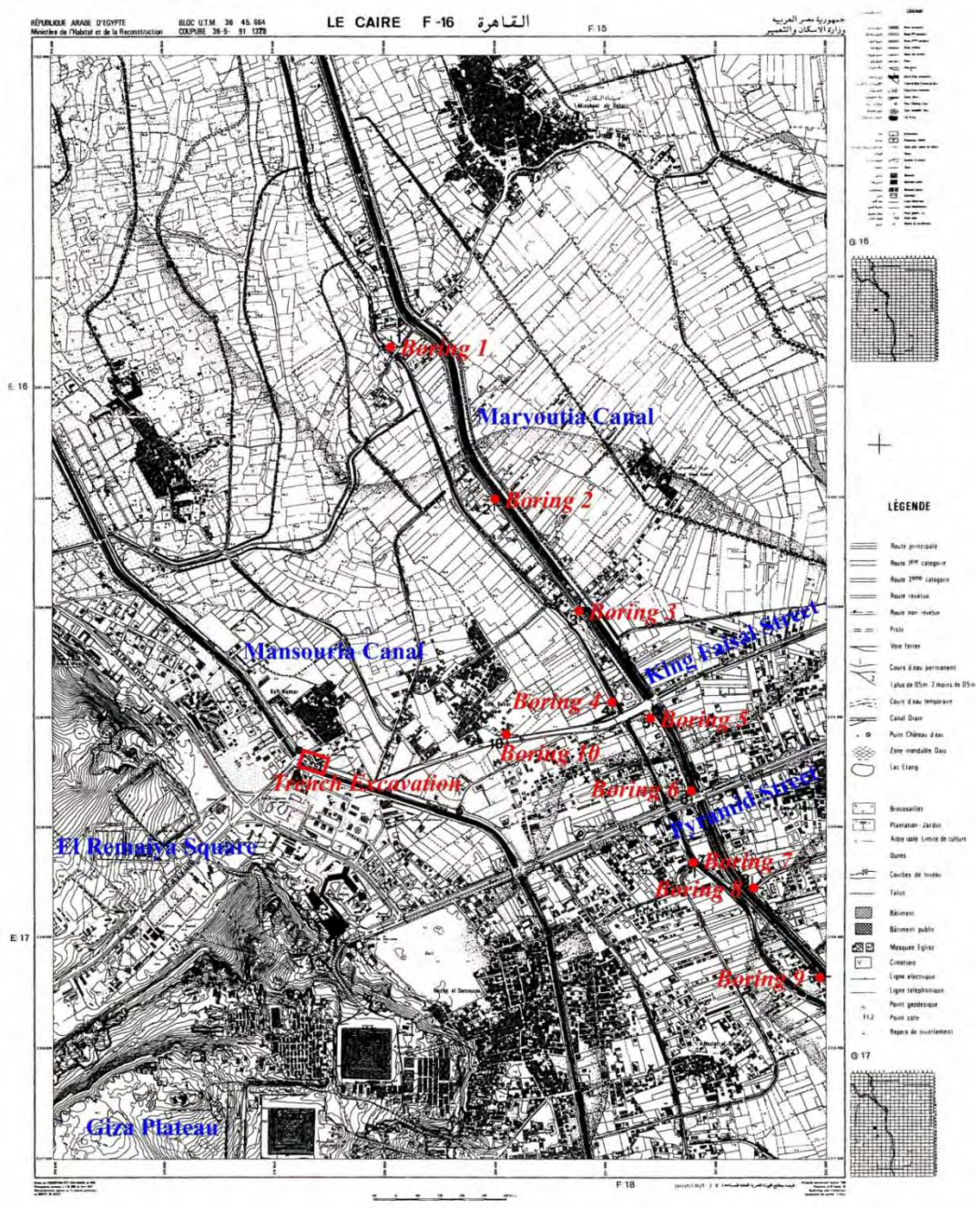
[6] The Mansouria Canal was dug in the 1930s.
[7] A. El-Sanussi and M. Jones, 1997, "A Site of the Maadi Culture near the Giza Pyramids", *MDAIK* 53: 241-253.
[8] The Maryoutia Canal is considered to have been used since Ancient time.

elevation is almost equivalent to the results of the boreholes in the Nazelet el-Samman area.

A probable reason that archaeological remains were found deep in the Marrioutia Canal was due to the migration of the Nile. The Nile channel is supposed to be moving laterally at rates of up to 9 km per 1000 years, and on the Giza area, the Nile appears to shift eastward. Based on their topographical map around the Giza, it is suggested that a branch of the Nile was located to the far west of the valley prior to the building of Giza pyramids, and the Marrioutia Canal is a former levee in ancient time[9]. The levee is suitable for the living place because the Nile flood did not reach the area.

In addition, according to authors, there was a previous report of Maadi Culture pottery found at Giza in 1898. It described that two small oval jars (egg-shaped with short necks and not very prominent lips) were found during the construction of a part of a tramway near the Giza Pyramids. Although the provenance is not exactly known, the authors suggest that the spot is probably close to the northern edge of the present Mena House golf course or a little further east along the Pyramids Street.

[9] K. Lutley and J. Bunbury, 2008, “The Nile on the move”, *Egyptian Archaeology* 32: 3-5.



Source: JICA Study Team

Figure 11-7 Map with Location of Trench Excavation and Borings (El-Sanussi and Jones 1997: Fig.2)

(4) G-4: Dokki

There have been no archaeological reports about the area of the eastern portion of the Pyramid Street and around the Giza Station, but two archaeological spots were found at the Dokki area. The first was discovered in 1993 roughly 100 m north of the Dokki Square, which was also during the work of the Greater Cairo Waste Water Project Contract 20A. The discovery was made during the manually operated drilling of three well points for dewatering in advance of open trench excavation, and followed by rescue research by SCA. They only found scattered movable artifacts composed of potsherds, redbrick limestone fragments, quartzite chips and pieces of broken bone at a depth of 15.0 to 18.0 m beneath the modern road surface, which is 20.7 m above sea level.

Information of the second spot was obtained from the interview with Dr. Mahmoud Afifi, General Director of Giza Antiquities. Two pottery jars were found at the 60 m deep during the construction of the Bohooth Station of the Metro Line 2 near the Tahrir Street. Because there were no scientific reports, the detail is unknown.

11.4.2 Phase 1: Near El Malek El Saleh Station (G5)

The area south to El Malek El Saleh Station is famous for the monuments from Roman and Christian to Islamic times, e.g., Babylon, Hanging Church and Amr Mosque; however, Pharaonic sites were also reported[10]. Late period tombs were found in the quarry site and other Ramesside monuments were recorded to the south at Athar Al-Nabi, which is supposed to be the place called *Pi-Hapi* (House of God Hapi) in Pharaonic time.

11.4.3 Phase 2: Historic Cairo Area

Known as a UNESCO World Heritage registered area, the Historic Cairo encompasses a number of cultural monuments; especially standing historical properties. Based on the digital map produced by SCA-GIS Center and the literature survey[11], the important sites located close to the proposed metro route are listed below (Figure 11-8, Figure 11-9).

(1) Northern Corridor

GIS No. 114: Qanatir al-Miyah (Magra al-'Uyun Wall)
Location: Route intersection
Description: Known as an aqueduct running from Fumm Al-Khalig on the bank of the Nile to the Sayeda Aisha area of Cairo, the wall was built in the reign of Sultan Al-Nasser Mohamed Ibn Qalawun at the beginning of the 14th century (Mamluk Period). Afterwards, a plan was instigated to construct waterwheels linking up with the great Al-Qanatir barrages, north of Cairo, and channelling water to the citadel. Water flowed through the aqueduct as

[10] D. Jeffreys and A. Tavares, 1994, "The Historic Landscape of Early Dynastic Memphis", *MDAIK* 50: 143-173.
[11] Referred mainly to N. Warner, 2005, *The Monuments of Historic Cairo: A Map and Descriptive Catalogue*, Cairo.

far as the Citadel of Salaheddin. The aqueduct remained an integral part of the Cairo water system until the mid 19th century.

GIS No. 101: Mosque and shrine of 'Ali Zayn al-'Abidin
Location: 50 m to the east
Description: The mosque dates back to the Fatimid period. It is believed that the mosque is dedicated to Ali Zein Al-Abedeen, the son of El-Hussein, prophet Mohamed's grandson. The mosque has been renovated and enlarged to 4,600 m^2.

GIS No. 39: As-Sayyidah Zaynab mosque area
Location: 30 m to the west

Description: This mosque is dedicated to Sayeda Zeinab, daughter of Aly Ibn and Abu Taleb, and the granddaughter of the prophet Mohammed. Her mosque which houses her shrine is located in the Sayeda Zeinab Mosque built originally at the time of the Hussein Mosque. Her mosque was set up shortly after her arrival to Egypt on the appearance of the new crescent moon of Shaaban (the eighth month of the Hegira calendar) in the year 61 A.H (AD 680 – 681, Islamic Period). It was renovated in 1549, rebuilt again in 1761 and completely rebuilt in 1884 and 1942. The main façade, minaret and cupola are typical of the Mameluke style. The interior is finely decorated with arabesque and inscriptions. It contains a colonnaded prayer hall with a painted wood ceiling and cupola in front of the *mihrab*. The western mausoleum is topped by a cupola also, supported by a pendentive of stalactites, and the cenotaph is enclosed within a finely worked bronze grille.

In this area, there are other historical monuments close to route, i.e., Sabil Ibrahim Bik Al-Mnesterli (GIS No. 154), Al-Ginyid mosque minaret (GIS No. 156), Ibrahim Katkhuda as-Sinnari house and as-Sayyidah Zaynab endowment house (GIS No. 36), Sabil and Kuttab as-Sit Salhah (GIS No. 35), Sabil and mosque of Timraz al-Ahmadi (GIS No. 34), and Zu al-Fuqar Bik mosque (GIS No. 42).

GIS No. 31: Khanqah Sa'd ad-Din Ibn Ghurab
Location: Above the route
Description: This building is known also as the zawiya of Sa'ad al-Din Ibrahim al-Arabi, which is occupied today by SCA offices. A Comité-style kuttab projection in timber to the south side of the portal has been glazed to make an office. The interior has the remains of a fine inlaid marble qibla wall and mihrab. The floor and ceiling are modern, perhaps dating 1910, when the building was remodeled by the Comité.

GIS No. 30: Al-Amir Bashtak mosque (interior door and minaret)
Location: Beside the route, to the east
Description: The minaret and door of the original mosque of the amir Bashtak (AD 1336) have been incorporated into the structure of a 17th century mosque. The portal of the original mosque has an extraordinary deep horizontal muqarnas soffit. A spiral stair leading to the roof level is set within the solid masonry to one side of the portal, while the other side provides the base for the minaret itself. All three tiers of the stone-baluster minaret are intact.

GIS No. 32: Sabil Waldit Mustafa Basha Fadel
Location: Above the route
Description: This is a typical Ottoman-style bow-fronted sabil (AD 1863). The ornate floral bronze grilles appear to be intact, but are boarded over. The marble cladding and inscriptions are generally in good condition. The building is used as a storeroom and is permanently locked. The building was registered in the dying days of the Comité but has no official number.

GIS No. 28: Sabil Bashir Agha
Location: Beside the route, to the east
Description: This sabil-kuttab was built by the black eunuch Bashir Agha along traditional Mamluk lines (AD 1718), before he undertook the construction of the following takiya of Sultan Mahmud. It has original bronze grilles with intact shutters and marble basins behind and marble slabs in front of them. The building was extensively restored by the Comité.

GIS No. 27: Tikiyyit and Sabil as-Sultan Mahmud
Location: Beside the route, to the east
Description: This building was constructed for Sultan Mahmud (AD 1750) by the block eunuch Bashir Agha who had already built his own opposite foundation (GIS No. 28). The crenulated façades have two continuous decorative bands of arabesques running around them. The main portal is a pointed arch with cushioned voussoirs, decorative strapwork framing, tiled inlay panels, and marble inscriptions. The courtyard has a central baldachin on four columns at its centre, and is surrounded by an arcade of columns that relates to an outer ring of cell units with shallow pendent domes. The interior is now occupied by the offices of the main inspectorate of SCA's Coptic and Islamic Section (South Sector).

GIS No. 150: Sabil Kalsan Endowement
Location: Beside the route, to the west
Description: This Ottoman sabil (AD 1689) has a finely decorated interior that belies its rather run-down external appearance. The interior is extremely ornate, with a painted wood ceiling, deep cornice, and flat wooden muqarnas niche-heads on the flank walls, as well as a muqarnas hood to the missing salsabil. This building seems to be a part of the adjacent Aqsunqur dome (GIS No. 151).

GIS No. 26: Remains of Katkhuda hostel (Ribat) and ash-Shaykh Ramadan mosque
Location: 70 m to the west
Description: This complex was originally constructed by Abd al-Rahman Kathhuda (AD 1762), whose decorative style can be seen in the two cusped moulded arches on the northern façade fronting the tomb chamber. There is no evidence of the sabil today, and only the base of the minaret survives. The interior had been recently refurbished.

GIS No. 95: Yusuf Agha al-Hin mosque
Location: Above the route
Description: This mosque was originally built on the Khalig al-Masri (AD 1625). This may account for the presence of the large mashrabiya on the western façade which would have overlooked the canal. The Sabil-kuttab on the eastern façade is original to the complex and is noteworthy for its fine painted wood ceiling. The Ottoman-style minaret is intact. The building was restored by the SCA in 1999.

GIS No. 135: Islamic Art museum building
Location: Beside the route, to the west
Description: The Museum was established by a decree from Khedive Ismail, on an initiative from Ali Pasha Mubarak. By virtue of that decree in AD 1870, the Library of the Egyptian Khedivite occupied the first floor in the Palace of Prince Mustafa Fadel, the Khedive's brother, in Darb Al Gamamiz. As the library grew, the palace became crowded with the collection, and a new location was found in Bab El Khalq Square for the Khedivite Library and the House (*Dar*) of Arab Antiquities, the present Museum of Islamic Art. The ground floor was allocated to the latter, while the two upper floors were allocated to the former. The library moved to the new premises in the year 1903 and was officially opened in the beginning of the following year. The bulk of the various collections of the museum originate from Egypt and the Arab countries, and as the other regions where Islam dominated. It was reopened and renewed in 2007 to become a magnificent architectural

masterpiece and a beacon of science and knowledge from which a ray of Arab culture and global climate trends and the movement of cultural and civilization in Egypt.

GIS No. 15: Madrasit al-Amir 'Abd al-Ghani al-Fakharani (al-Banat mosque)
Location: Beside the route, to the east
Description: This mosque was built in AD 1418 for a wazir of Sultan Farag ibn Barquq and al-Mu'ayyad Shaykh. It is known as the Mosque of the Girls (al-banat). The main portal leads through a bent corridor into a courtyard with four iwans. The ceilings of the qibla and western iwans are Comité-period decorated ceilings. It was restored in the nineteenth century by Umm Husayn who added the Ottoman-style minaret, and again most recently (in 2000) by the SCA.

GIS No. 13: Al-Qadi Yahya Zayn ad-Din mosque
Location: Above the route
Description: The building (AD 1444) was originally situated within an urban block beside the Khalig al-Masri, which ran its eastern side. This was heavily restored by the Comité from 1884 to 1897, during which the entire southern façade and part of the northern façade were created. The main entrance is through an inscribed portal at the north that leads through a dog-legged approach into a covered four-iwan madrasa. The minaret remains intact.

GIS No. 14: Murad Basha mosque
Location: Beside the route, to the east
Description: This mosque's principal façade has two trilobed portals separated by three recessed window bays (AD 1578). A minaret of typical Ottoman design used to stand above the southern portal; it was taken down by the Comité and never rebuilt. The interior of the mosque has four marble columns supporting the roof and a stone mihrab with arabesque carving at its top.

GIS No. 11: Abd al-Wahhab ash-Sha'rani dome
Location: 70 m to the east
Description: 'Abd al Wahhab ash-Sha'rani was a popular Sufishaykh. The mausoleum (dome) was added to a large complex (AD 1567), including a takiya, mosque, and madrasa, that had been built for ash-Sha'rani during his lifetime by Qadi 'Abd al-Qadir. Of these buildings, only the mausoleum survives. The interior is decorated with polychrome arabesque painting, which also covers the vault of dome.

GIS No. 136: Northern Wall of Cairo
Location: Beside the route, to the east
Description: As a part of the entire extent of the Ayyubid city walls, the walls in this sector extend west to the Bab al-Shariya and east to the Bab al Futuh. The break in the wall at the Bab al Shariya is marked with a plaque. From the Bab, the wall continued west toward the Bab al-Hadid, and sections of it can be seen at various points along its route.

(2) Eastern Corridor

GIS No. 114: Qanatir al-Miyah (Magra al-'Uyun wall)
Location: Intersect and beside the route, to the east
Description: See above.

GIS No. 66: As-Sayyidah 'A'ishah an-Nabawiyyah mosque
Location: Beside the route, to the west
Description: The 'A'ishah, a descendant of Husayn, came to Egypt in AD 762; this is her cult center, which has been rebuilt many times over the centuries. The current listing seems to apply to the mosque that was built on this site by ‘Abd al-Rahman Kathhuda in 1762, now demolished. The present mosque was built in 1895.

GIS No. 22: "As-Sultan Hasan mosque"
Location: Beside the route, to the west
Description: This famous monument (AD 1356-62) combines a madrasa, khanqah, and mausoleum on an unsurpassed scale. The building, constructed by Hasan, a son of al-Nasir Muhammad, was once surrounded by a much denser urban fabric; it now stands in isolation opposite the following mosque. The plan is that a cruciform madrasa, surrounded to the north and south by multistory cells. The portal was originally intended to have two flanking minarets; only one was built, and it collapsed in AD 1361. The original doors to the mosque can now be seen on the mosque of al-Mu’ayyad Shaykh. The courtyard is flanked on its four sides by four enormous iwans - one for the use of each school. The courtyard has one surviving fountain pavilion at its center; a second pavilion was removed in the nineteenth century to the mosque of al-Maridani, and the polychrome marble inlaid floor was heavily restored at the same time.

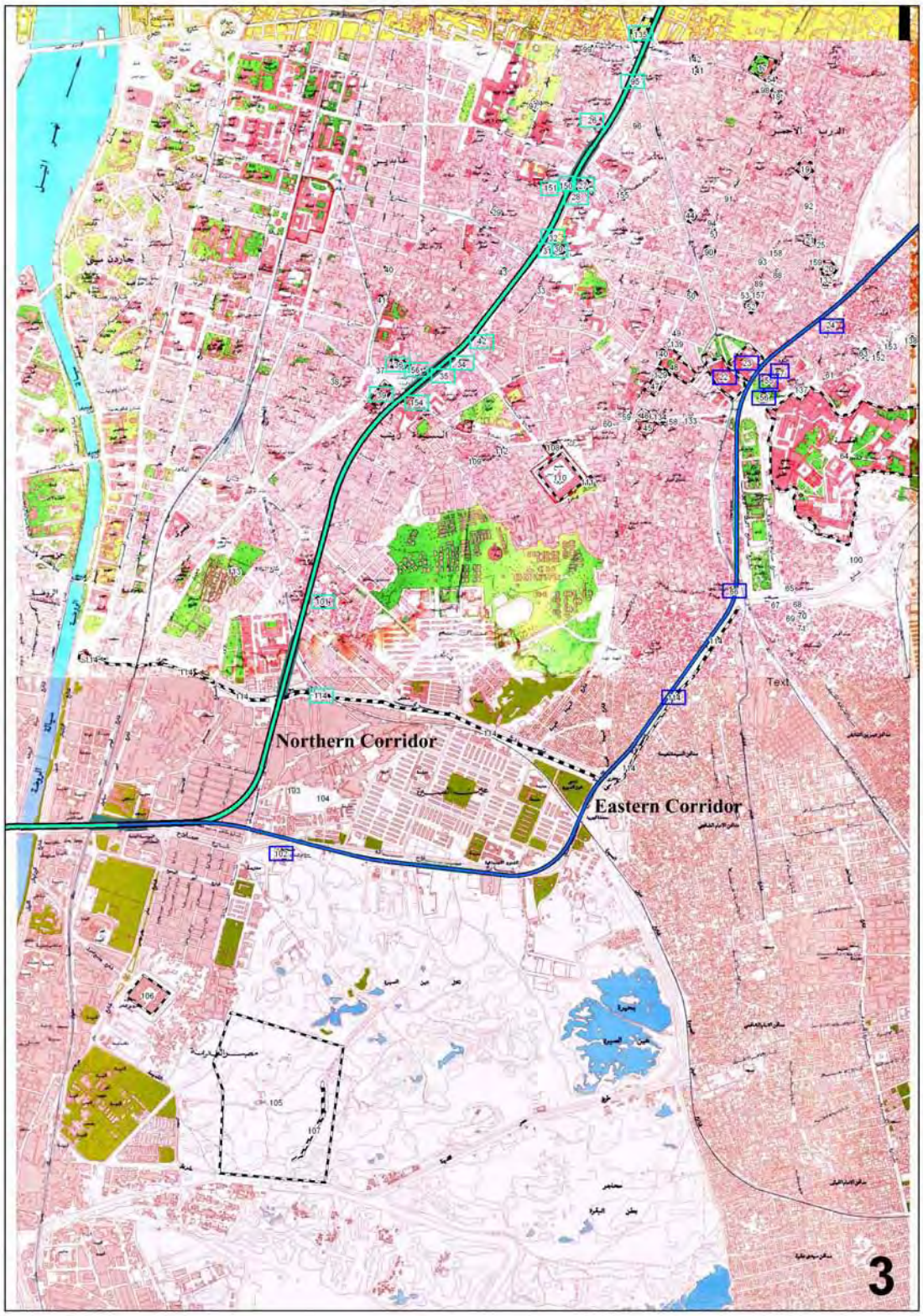
GIS No. 23: Ar-Rifa'i mosque
Location: Beside the route, to the west
Description: The construction of this mosque started in AD 1869 on the initiative of Princess Khushyar, and to the design of Husayn Pasha Fahmy, an architect and the Minister of Endowments. It was completed in 1911. The style of the mosque can best be described as hybrid neo-Mamluk. The building contains many royal tombs of the nineteenth and twentieth centuries.

GIS No. 56: Al-Mahmudiyyah mosque
Location: Beside the route, to the east
Description: The founder of this mosque, Mahmud al-Maqtul, was a famously harsh Ottoman governor of Cairo, who was ultimately assassinated. The mosque contains the only mausoleum built by an Ottoman governor for himself. The most curious feature is that the east façade formally imitates the arrangement of the rear façade of the adjacent madrasa of Sultan Hasan and is Mamluk in style, with the exception of the Ottoman minaret. The four separate painted wood ceilings around the perimeter are probably original; a deep, painted wood inscription band runs beneath them. The perimeter walls of the prayer space are pierced by many windows, which give the interior a great sense of openness.

GIS No. 55: Qanibay Amir Akhur mosque
Location: Beside the route, to the east
Description: Qanibay, ‘the Master of the Horse’, was originally a mamluk of Sultan Qaytbay whose career continued past the Ottoman conquest of Egypt. The site of the building is a steep slope, used to great effect in the placement of the complex’s architectural elements. The dome has maximum visual impact, which is a fine example of the Qaytbay-period masonry dome, carved with arabesques. At least half of the southern façade is a Comité reconstruction.

GIS No. 57: Ali Labib house
Location: Beside the route, to the east
Description: This is an Ottoman merchant's house (18th century AD), with a plastered façade adorned by mashrabiya windows. The small door is surrounded by ornate stone moldings. The interior spaces are grouped around two small courtyards, densely overhung with mashrabiya. The interior was remodelled in the late 19th and early 20th centuries. In more recent times, the top floor of the house served as the studio of the famous Egyptian architect Hassan Fathy.

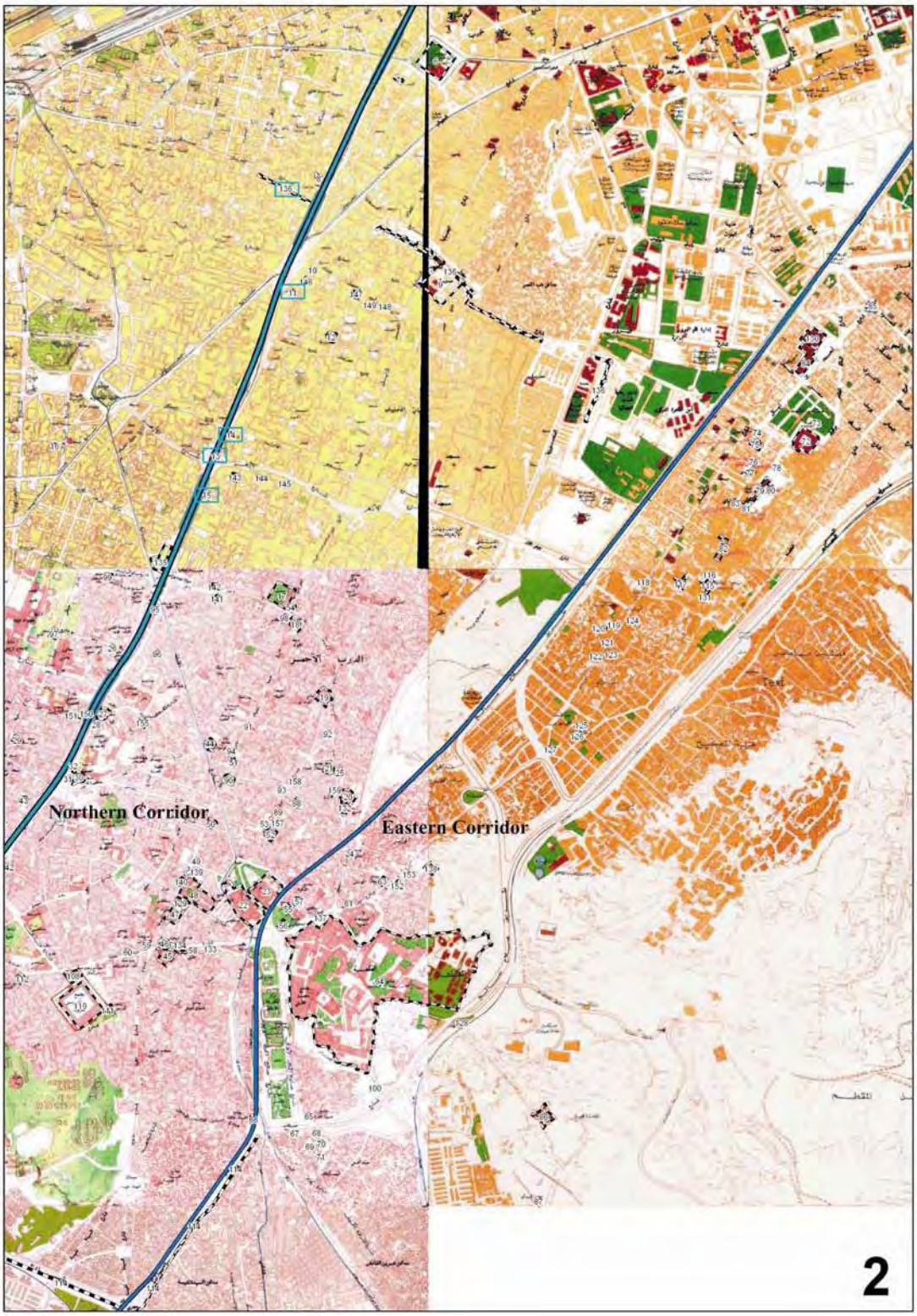
GIS No. 24: Aytumush al-Bagasi mosque
Location: Beside the route, to the east
Description: Aytumush was an amir of Sultan Barquq who subsequently became the regent for Barquq's son Farag. He fled Cairo and was killed in Damascus in AD 1400. His empty tomb chamber in this mosque has a distinctive spiral-ribbed brick-and-plaster dome with an inscription at its base. The main façade has a high-level inscription band. The sabil has a fine inscription and cup blazon on its wooden lintel. The Comité restored the stonework on the northern façade and introduced steel ties into the main façade to counteract its outward inclination. The interior is plain, with a newly tiled mihrab, a damaged painted wood ceiling over the main iwan, and a roof with lantern over the sahn.



Source: SCA-GIS Center

Figure 11-8 SCA-GIS Map Showing Standing Properties in Historic Cairo Area

(Square marks point properties along the route)



Source: SCA-GIS Center

Figure 11-9 SCA-GIS Map Showing Standing Properties in Historic Cairo Area

(Square marks point properties along the route)

11.4.4 Phase 2: Matariya Area

On the northern route of Phase 2, the area is quite important for archaeological asset. With the result of site reconnaissance with Adel Al-Sadani, General Director of Matariya Inspectorate, the distribution of archaeological remains and the current excavations in this area are reported here.

Called *Heliopolis* in Greek, the area covering Matariya and Ain Shams was one of the three main cities and religious centre of Sun cult in ancient Egypt. Despite the city's importance, no spectacular monuments could be seen in the area nowadays, except an obelisk of Senwosert I standing in the small concession area of SCA. Because it is close to Cairo, most of them were reused for the architectural materials and buried underground of modern houses and cultivation. However, according to records, there was a 'temenos' of God Ra-Aten and at least 10 temples surrounded by massive mud-brick walls, the scale of which is estimated to measure some 1.2 km by 1 km at this place (Figure 11-10). Some parts of the walls have been uncovered, and recent excavations revealed architectural remains at a depth of 2.0 m beyond the area of SCA (Figure 11-11), which indicates the archaeological remains spread across wider area.

With confirmations from previous researches (Figure 11-10), tombs of the 6th Dynasty have been found 550 m southeast of the obelisk, some 950 m to the same direction were tombs of the Late Period, about 1.3 km northeast of the obelisk was Mnevis Bulls' tomb[12]. In addition, recent excavations uncovered high-official tombs such as Panehsy and Waja-Hor from the 26th Dynasty, some kilometres east of the obelisk[13], and some parts of a sun temple precinct mainly belonging to Ramesses II about 60 m west of the obelisk[14]. Adel Al-Sadani said that around this area the stratum with artifacts starts from 2-3 m below ground surface to 8.0 m at most.

The planned route directing to El-Sawaha Square runs along the Port Said Street beside the Ismailiya Nile branch, which is the western end of Matariya district. Figure 11-10 shows that the sites are clustered in the eastern side, and according to Adel Al-Sadani, no archaeological evidence has so far been uncovered in the west. However, the German mission working on the sun temple of Ramesses II assumes that the temple of Heliopolis was connected to the Nile branch by a canal, and had a large gate and sphinx avenue to the west. Hence, there is a possibility that archaeological properties are also buried around the western area.

[12] J. Baines and J. Malek, 1980, *Atlas of Ancient Egypt*, Oxford; A. Dodson, 2005, " Bull Cults", in S. Ikram (ed.), *Divine Creatures: Animal Mummies in Ancient Egypt*, Cairo and New York: 72-105.
[13] N. El-Aref, 2006, "Empire of the sun", *Al-Ahram Weekly* 784, 2-8 March.
[14] SCA, 2006, *Antiquities of Egypt: SCA's Monthly Letter* 1: 5; Deutsches Archäologisches Institut, 2006, *Rundbrief* 2006: 21-24.

Source: JICA Study Team

Figure 11-10 Site Distribution Map in the Matariya Area (based on Dodson 2005: Fig.4.5)

Source: JICA Study Team

Figure 11-11 Pavements Uncovered Outside of SCA's Concession

11.5 Soil Observation on the Sample from Boreholes

11.5.1 Aim

As mentioned above, boring research is very useful for identifying the existence of buried archaeological properties. Moreover, in the Geological Survey, line of the boreholes is set in west-east direction along the Pyramid Street, which is the first and largest survey in the Giza area and should provide valuable information even for the archaeological study.

11.5.2 Observation Items

The soil observation is carried out according to the following items:

- Soil description of layers in the profile
- Identification of artifact
- Depth of the layer including the artifact
- Analysis on the artifact (date, type, etc.)

11.5.3 Results

The observation was carried out on soil samples from boreholes, which were so far completed as of December 2009 (Borehole Nos. 1-16, 23, 24[15]). As a result, six potsherds were retrieved from Borehole Nos. 23 and 24, both of which are located around El Malek El Saleh Station, Station 1 (Figure 11-12).

The artifact descriptions are as follows, which were confirmed by Ashraf Senussi who is the most prominent ceramist among the SCA Egyptologist and was in charge of publication of the AMBRIC rescue excavation at Giza.

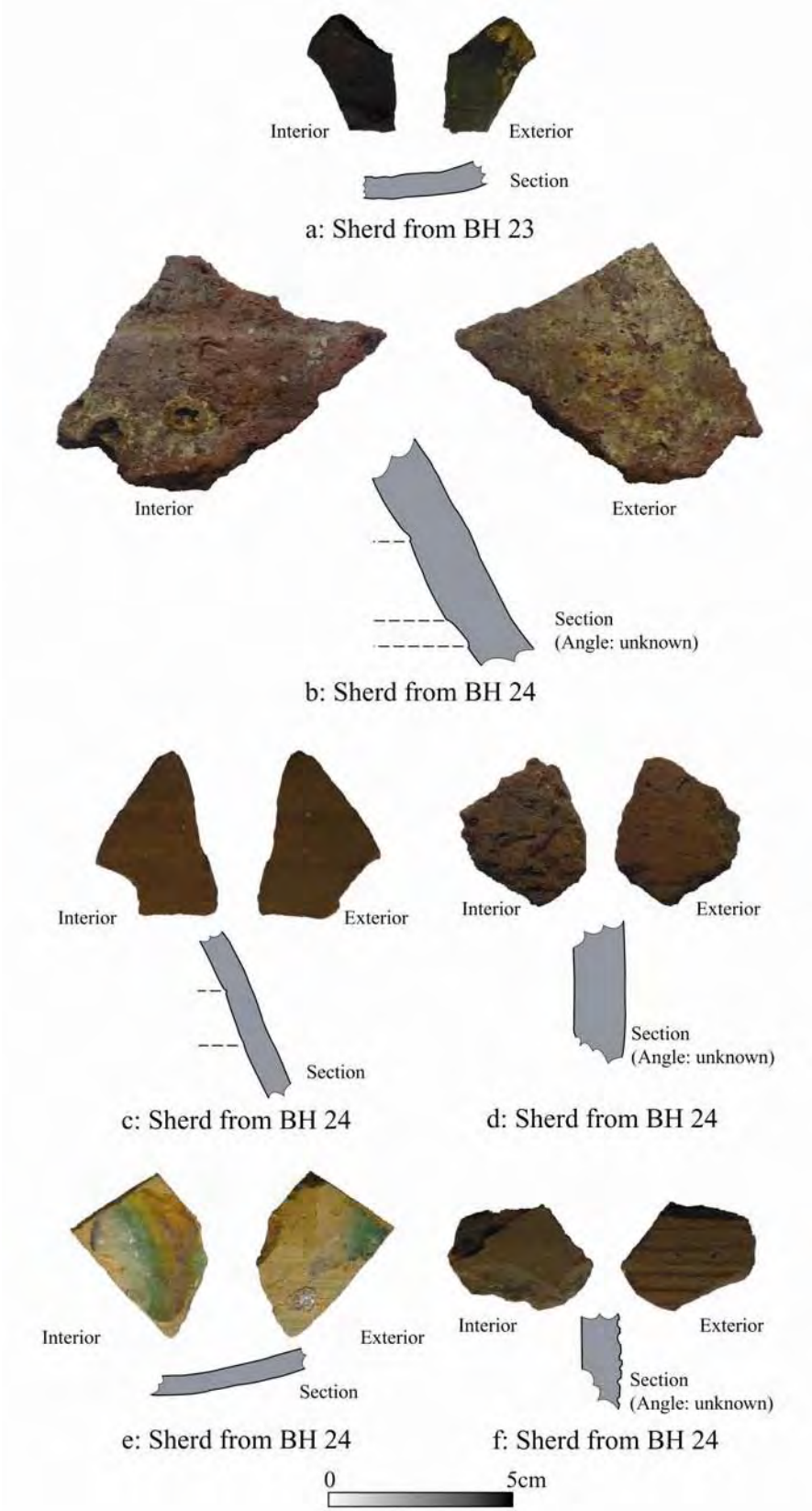
No.	*Fig.*	*Bore No.*	*Depth and Soil*	*Part*	*Colors*	*Fabric*	*Period*
1	11-12a	BH23	7.5 m Fill: clay and sand	Base of bowl	Ext: Black (7.5Y 2/1) Int: Black (7.5Y 2/1) Break: Brownish Black	Nile Silt	[Late Islamic] This black sherd is not common in ancient and also in modern times.
2	11-12b	BH24	0.6-1.5 m Fill: surface layer	Shoulder of large jar	Ext: Dark reddish brown (2.5YR 3/6) Int: Dark reddish brown (2.5YR 3/6) Break: Dark reddish brown (2.5YR 3/6)	Nile Silt with straw and sand	[Late Islamic]

[15] The soil samples were stored and analyzed at Ardaman-ACE, Shehab Street where I observed samples.

3	11-12c	BH24	0.6-1.5 m Fill surface layer	Shoulder of jar	Ext: Bright reddish brown (2.5YR 5/6) Int: Bright reddish brown (2.5YR 5/6) Break: Reddish brown (2.5YR 4/6)	Nile Silt with small amount of calcite, grit and Mica	[Islamic] Mica in fabric is not included among modern pots because Nile flood already ended.
4	11-12d	BH24	0.6-1.5 m Fill surface layer	Unknown	Ext: Dark red (7.5R 3/6) Int: Brown (7.5YR 4/6) Break: Brown (7.5YR 4/6)	Nile Silt with large amount of straw and sand	[Ancient] This rough ware is typical of Meat or Beer jar during the Old-New Kingdom.
5	11-12e	BH24	0.6-1.5 m Fill surface layer	Base of plate or bowl with glazed surface decoration	Ext: Light yellow (7.5Y 7/4) Int: Light yellow (7.5Y 7/4) Break: Orange (7.5YR 6/6)	Calcareous Marl Clay	[Late Islamic] Although the glazed surface is also common in modern, the fabric is higher quality than modern one.
6	11-12f	BH24	3.9 m Fill: Clay and Sand	Part of Amphora	Ext: bright brown (7.5YR 5/6) Int: Red (10R 4/6) Break: Grayish yellow brown (10YR 5/2)	Nile Silt with small amount of calcite and mica	[Late Roman] The thick sherd with horizontal lines on the exterior is a feature of Late Roman Amphora.

Based on the fabric and surface features, all collected potsherds could belong not to the Modern, but to the Ancient, Roman and Islamic pottery. This, however, does not directly mean the existence of buried archaeological properties. Borehole No. 24 near the El Malek El Saleh Station, where most potsherds were retrieved, is located in the Historical Cairo area, and the depth of the sherds is very close to the surface (mainly 0.6-1.5 m). Although it is not certain through the fragmental information, it is possible that these artifacts came from just dumped layer. This assumption is supported by the different periods of the collected potsherds.

There is low chance that archaeological layers are buried around the El Malek El Saleh Station. However, a preliminary research such as test trench excavation should be carried out on this area before the construction stage.



Source: JICA Study Team

Figure 11-12 Sherds Retrieved from Borehole Soils

11.6 Risk Assessment

11.6.1 Criteria for Risk Assessment

Based on the literature study and interviews with SCA staff, the buried archaeological properties could be categorized into three levels, which are evaluated according to the criteria such as size, historical importance and location. This evaluation is to be revalidated by SCA.

- Level A is a substantial property which encompasses immovable architectural remains such as temple, settlement or cemetery and movable artifacts spread over large area.
- Level B is a scattered property which has part of immovable architectural remains and movable artifacts in a limited area.
- Level C is a scattered property with only movable artifacts in a limited area.

Table 11-2 Level and the Criteria of Buried Archaeological Properties

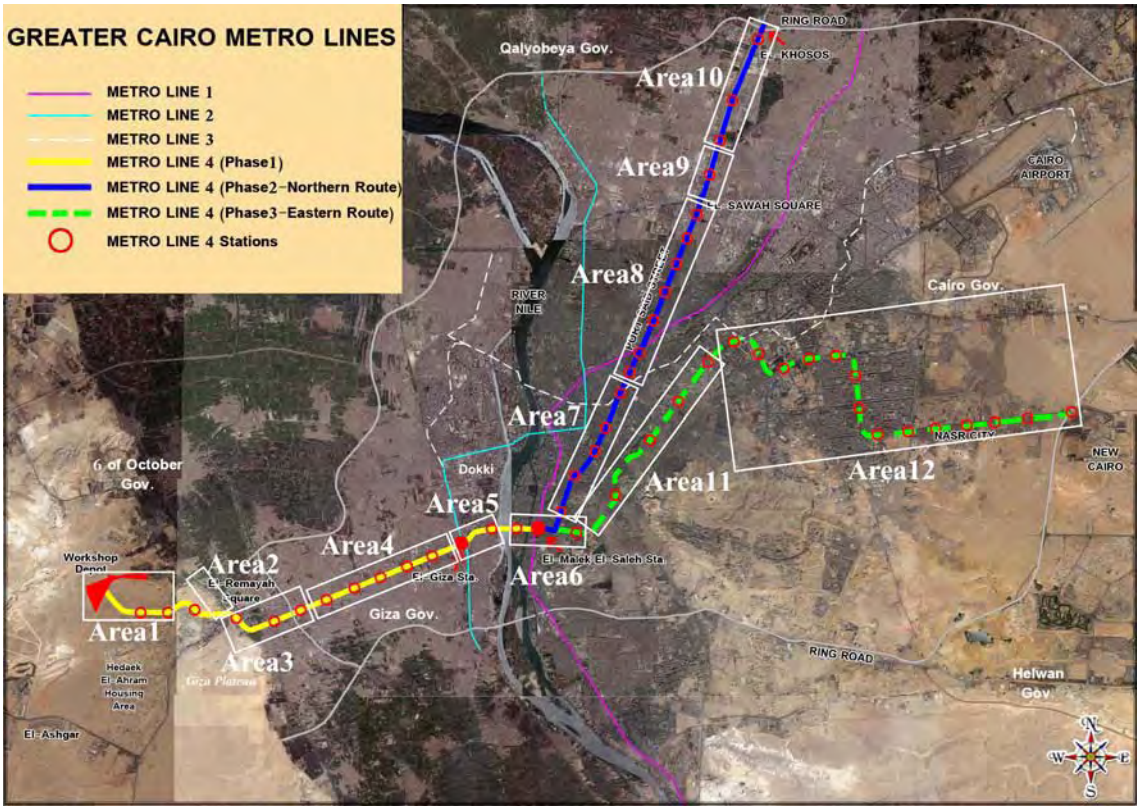
Level	Criteria (Characters of Properties)
A	Substantial property with immovable architectural remains such as temple or settlement/cemetery
B	Scattered property with part of immovable architectural remains and movable artifacts
C	Scattered property with only movable artifacts

Source: JICA Study Team

11.6.2 Risk Assessment on the Study Area

(1) For Buried Archaeological Property

According to the baseline information, possibility of existence of the buried property and the level for Risk Assessment are suggested as follows:



Source: JICA Study Team

Table 11-3 Risk Assessment on Study Area

Area	Area Name	Station	Possibility	Level
1	Desert near Depot		Low	-----
2	Desert fringe near GEM		Middle	B-C
3	Al Remayah Sq. to Marrioutia Canal		High	B-C
4	Pyramid Street		Low	-----
5	El Giza Station		Middle	C
6	El Malek El Saleh Station		Middle	B-C
7	Historic Cairo (North Corridor)		Middle	C
8	North of Ghamra Station		Low	-----
9	Matariya		Middle	B-C
10	South of El Khosos		Low	-----
11	Historic Cairo (South Corridor)		Middle	B-C
12	Nasr City		Low	-----

Source: JICA Study Team

Area 1: Possibly no buried properties according to the previous studies and site reconnaissance in this area.

Area 2: Although no archaeological remains have been reported in this area, ancient settlements were ordinarily occupied on the border between desert and alluvial terrains. This is supported by discoveries of settlements east of the Giza Plateau and near Ausim located 13 km north of Giza Plateau where part of the Old Kingdom settlement was discovered during the Greater Cairo Waste Water Project[16].

Area 3: As mentioned in the baseline information, there have been buried properties at the area from Al Remayah Square to the Marrioutia Canal by trench excavation and boreholes. There is a possibility that buried properties exist in this area. The level of risk assessment would be B-C based on previous researches.

Area 4: Along the Pyramid Street to the east from the Marrioutia Canal, archaeological remains have not yet been found. However, the final remark should await the borehole observation.

Area 5: Around El Giza station on the Pyramid Street, no archaeological remains have been found yet. However, given the cases at Dokki, there is a possibility that these remains will be found.

Area 6: No archaeological remains have been reported at the El Malek El Saleh Station. However, given that there are archaeological and historic properties to the south of the station, there is a possibility that these remains will be found, which is supported by the results of the borehole survey.

Area 7: Along the Port Said Street (North Corridor) in the Historic Cairo area, there are no reports of buried archaeological remains. However, considering that this street was an ancient canal, as well as this segment is inside the Historic Cairo, there is a possibility to find debris of archaeological property.

Area 8: Along the Port Said Street (North Corridor) to the north of Ghamra Station, there is possibly no buried property according to the previous studies.

Area 9: In Matariya, famous for the Ancient town Heliopolis, archaeological sites are distributed over the eastern side. The route in this segment runs beside Ismailiya Nile branch, which is far west of the ancient area. However, there is also a possibility that part of the temple precinct is buried around the western side.

Area 10: Along the Port Said Street (North Corridor) to the south of El Khosos, there is possibly no buried property according to the previous studies.

Area 11: Along the east corridor in a segment of the Historic Cairo area, there is no report of buried archaeological remains. However, given that this area has a long history and houses densely-distributed monuments, there is a possibility to find remains or deposits such as architectural foundation.

Area 12: There is possibly no buried property according to the precious studies in the Nasr City area.

[16] M. Jones, 1995, “A New Old Kingdom Settlement near Ausim”, *MDAIK* 51:85-98.

(2) For Existing Historical Property

As far as the baseline information shows, there is no existing archaeological property on the limited area along the Phase 1 of Metro Line 4. However, in the historic Cairo Area of the Phase 2, there are historical properties on and beside the proposed routes; especially around al-Sayyidah Zaynab mosque, and the intersection of Port Said and Ratib streets in the northern corridor, and around al-Sultan Hasan mosque in the eastern corridor. Consequently, the risk on these areas should be higher.

11.7 Countermeasure

In spite of their scale and character, all archaeological properties possess universal value to be preserved as precious cultural resources. However, in the case when archaeological remains are found during a construction work, it is sometimes necessary to remove or transfer them by salvage or rescue operations. Based on reviews of previous cases of possible findings, countermeasure to be applied for each Level of Risk Assessment is discussed, which has been confirmed with archaeological experts from the SCA Committee.

11.7.1 Previous Cases

(1) Case for Level A

Regarding previous countermeasures, several interviews with SCA Staff identified that if highly important architectural remains such as a temple or large cemetery are found, they should be preserved on site. In fact, there was such case in Greater Cairo. In 1995, a group of tombs were found at the fringe of desert 3.0 km south from Giza Plateau which is very close to a half-built highway of the Ring Road planned to link with Alexandria and Fayoum Desert Roads. After UNESCO complained that the highway violated a world cultural heritage convention, SCA sent their staff to excavate and realized that the tombs were probably part of a large cemetery dating from 600 BC. Since the cemetery stands on the area listed as a UNESCO World Heritage, SCA and UNESCO committees requested the Egyptian authorities to halt the construction and to use alternative route well outside the protected area[17]. As a result, the highway route was changed to use the Marrioutia Canal Road that runs parallel to the desert.

(2) Case for Level B

Except for the case of the ring road, however, there has been no precedent case of preserving buried archaeological remains with cessation of construction works in Greater Cairo. Only individual tombs and scattered remains such as parts of pavements and pothsards have been found during construction works. These findings have been removed and transferred after full data recovery by mapping, drawing and photographs. For example, in Matariya, tombs of the 26th Dynasty were accidentally discovered underground in the course of the demolition of houses with the recent urban expansion (for the detail, see

[17] This information was collected from the interviews from SCA staff and the article of *Reuter,* 8 Feb. 1995.

below). To protect the burial chambers from further damage, after investigation and restoration, SCA dismantled and relocated them to the open-air Museum in Heliopolis[18]. In addition, in the case of Nazelet el-Samman area where parts of the causeway and valley temple of Khufu and the Old Kingdom settlement were revealed, the remains were investigated by archaeologist and some parts were transferred to a Museum after completion of the full recording.

(3) Case for Level C

There have been more cases of Level C which is scattered property with only movable artifacts. As discussed above, potsherds and other human activity deposits were found at Giza area during the Greater Cairo Waste Water Project. In these cases, after full archaeological research, SCA removed artifacts and stored them at the magazine.

(4) Case for Standing Historical Property

As shown in the GIS map, there are some standing historical properties located along the supposed routes of Metro Line No. 4 in the Historical Cairo, UNESCO area. According to SCA experts in this area, these properties are not permitted to be dismantled and transferred to other places, and are only restored on site. Therefore, a suitable construction method to protect these properties should be considered.

11.7.2 Countermeasure Applied for Each Level

The following table shows the conceivable countermeasures and actions, based from previous cases and interviews with SCA.

Table 11-4 Countermeasure and the Action

Level	Countermeasure	Action	Following work Item
A	To be saved *in situ*	Alteration of undertaking	-Full archaeological investigation -Scientific report
B	To be transferred	Data recovery and rescue	-Borehole or trench to fix extent -Rescue excavation -Recording -Restoration on site -Transfer -Restoration on storeroom -Scientific report
C	To be removed	Data recovery and rescue	-Rescue excavation -Recording -Remove to storeroom -Scientific report

Source: JICA Study Team

11.7.3 Preliminary Survey in BD Stage

[18] *Al-Ahram Weekly* 26, May - 1 June, 2005.

The results of risk assessment suppose that there are some areas where archaeological properties could be buried underground. Among them, it is most likely to be found at areas around El Remayah Square (Area 3), which is ranked Level B-C.

To confirm this suggestion and make further plans appropriately, it is proposed that a preliminary survey should be carried out before construction. Taking for example the El Remayah Square, the work schedule of the preliminary survey is estimated here.

(1) Work Items

- Geophysical Exploration:
  For the area covered by asphalt road, the Electromagnetic Radiation method is effective. Firstly, this exploration is conducted on the proposed line and the buffer zone, which cover approximately 0.1 km wide, to examine the existence of buried property as well as its extent and depth. The result is shown as a map with anomaly.
- Borehole:
  This is carried out to confirm the anomaly of geophysical exploration. It is better to use a wider bore than that used in the geological survey and to set boreholes on the anomaly area at 5.0 m interval. The retrieved soil samples are examined at a laboratory to detect artificial contents and observe the depth and soil condition.
- Trench Excavation:
  The trench area is selected based on the borehole survey. First trench is 5 m x 3 m, and then, if archaeological deposit spreads wider, it would be expanded. Full recording of measurement and photographs is carried out in this work.
- Report Making:
  Putting all data together, a scientific report will be made.

(2) Schedules

In Area 3 of El Remayah Square, the supposed route line runs approximately 2.5 km on the road of the Cairo-Alexandria and Pyramids Street. To survey on this area, a schedule plan is tentatively proposed below.

The works on site (geophysical, borehole and trench) would take about nine weeks, and the following report work would take another six weeks. However, the number of the trench excavation depends on the result of the borehole survey, and it may require more weeks.

Table 11-5 Schedule of Preliminary Survey

	Period (week)														
Work Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Geophysical Exploration	2 weeks														
Borehole (including lab work)			4 weeks												
Trench Excavation							4 weeks								
Report Making												6 weeks			

Source: JICA Study Team

CHAPTER 12
DRAFT ENVIRONMENTAL CHECKLIST OF EX-JBIC GUIDELINES

CHAPTER 12 DRAFT ENVIRONMENTAL CHECKLIST OF EX-JBIC GUIDELINES

In this F/S, various environmental and social considerations were examined and incorporated into the plan and design of the project. EIA and RAP framework studies especially for Phase 1 have been also conducted in line with the project planning and design.

The key points obtained In the course of environmental and social studies as of F/S stage for Phase 1 of the project are summarized in Table 12-1, by using the format of Environmental Checklists No. 15 for Roads and Railways, defined by ex-JBIC Guidelines for confirmation of environmental and social considerations (April, 2002).

Table 12-1 Environmental Checklists for Phase 1 by ex-JBIC Guidelines (No. 15 Roads and Railways)

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
1 Permits and Explanation	(1) EIA and Environmental Permits	① Have EIA reports been officially completed? ② Have EIA reports been approved by authorities of the host country's government? ③ Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? ④ In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	① EIA reports are being finalized for the purpose of official submission to EEAA as of February, 2010. ② Official approval of EIA is expected to be obtained in a few months after submission of final EIA report to EEAA. ③ EIA reports are going to be submited and approved. It is unknown whether or not EIA would be approved unconditionally as of February, 2010. ④ There is no additional approval to be obtained by the project proponent.
	(2) Explanation to the Public	① Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public? ② Are proper responses made to comments from the public and regulatory authorities?	① According to the Egyptian regulation on EIA, explanation of project description is already completed at the scoping stage. Information disclosure to public at the draft EIA report stage was also arranged through the 2nd stakeholder meeting held on 28th December 2009, and potential impacts with proposed mitigation measures ware explained with plain expression. ② Various opinions and suggestions were exchanged at the 2nd stakeholder meeting. Comments raised at the meeting were integrated in the final EIA reports as well as project design accordingly.
2 Mitigation Measures	(1) Air Quality	① Is there a possibility that air pollutants emitted from various sources, such as vehicle traffic will affect ambient air quality? Does ambient air quality comply with the country's ambient air quality standards? ② Where industrial areas already exist near the route, is there a possibility that the project will make air pollution worse?	① Ambient air quality in and aroung the Project area is currently exceeding the standards in general. Although the impact by the Project will be limited and temporal in construction stage, the possibility of air pollution is expected due to operation of heavy equipment and vehicles. Mitigation measures to reduce the impact likely caused by the construction activities are proposed. It is not expected during OM stage to induce significant impacts on air quality directly caused by the Project. ② There is no industrial areas to be taken into considerations near the Project area.
	(2) Water Quality	① Is there a possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? ② Is there a possibility that surface runoff from roads will contaminate water sources, such as groundwater? ③ Do effluents from various facilities, such as stations and parking areas/service areas comply with the country's effluent standards and ambient water quality standards? Is there a possibility that the effluents will cause areas that do not comply with the country's ambient water quality standards?	① There is some possibility of water pollution during constrcution stage due to turbid water generated by such works as shielding (TBM), although all of the construction works will be done underground. Treatment plants for turbid water will be installed as countermeasures similary to Metro Line 3 project to reduce likely impacts. ② There is some possiblity of groundwater pollution during the constrcution stage due to accidental spillage of such chemicals as oil. Proper management of constrcution sites will be made to reduce such risks. ③ The effluents from such facilities as stations and depot will be treated according to the requirements of Egyptian legislation. Therefore no or negligible impacts are expected.
	(3) Noise and Vibration	① Do noise and vibrations from vehicle and train traffic comply with the country's standards?	① No or negligible impacts of noise and vibrations in OM stage of the Project, since tracks and stations will be constructed underground with enough depth from ground.

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
3 Natural Environment	(1) Protected Areas	① Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	① The Project area does not include protected areas, and does not locate close to protected area. There is no possibility to affect the protected area due to Project.
	(2) Ecosystem	① Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? ② Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? ③ If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? ④ Are adequate protection measures taken to prevent impacts, such as disruption of migration routes, habitat fragmentation, and traffic accident of wildlife and livestock? ⑤ Is there a possibility that installation of roads will cause impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystems due to introduction of exotic (non-native invasive) species and pests? Are adequate measures for preventing such impacts considered? ⑥ In cases where the project site is located at undeveloped areas, is there a possibility that the new development will result in extensive loss of natural environments?	①②③④⑤⑥ The Project area is located in metropolitan city with highly urbanization. Therefore, there are no issues on ecosystem to be cautioned.
	(3) Hydrology	① Is there a possibility that alteration of topographic features and installation of structures, such as tunnels will adversely affect surface water and groundwater flows?	① There is no possibility of alternation of topographic features due to the Project. However, sheilding works (TBM) underground during construction stage might cause lowering of groundwater level, although the duration will be limited and temporal. Monitoring of groundwater level is proposed at the existing wells near the Project area.
	(4) Topography and Geology	① Is there a soft ground on the route that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed? ② Is there a possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides? ③ Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	①② Existence of a soft ground is not reported along the Project route. And constrcution works of major facilities such as tracks and stations will be made underground. Therefore, no posibility of causing slope failures or landslides is expected. ③ The surface areas where cut and cover method will be applied are limited to the stations' construction, therefore the possibility of soil runoff due to constrcution work will be negligible. Slurry generated by sheilding works (TBM) will be treated at the treatment plants, whereas surplus soil will be disposed of according to the related legislation in Egypt, in order to prevent the impacts due to soil runoff.

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
4 Social Environment	(1) Resettlement	① Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? ② Is adequate explanation on relocation and compensation given to affected persons prior to resettlement? ③ Is the resettlement plan, including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? ④ Does the resettlement plan pay particular attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? ⑤ Are agreements with the affected persons obtained prior to resettlement? ⑥ Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? ⑦ Is a plan developed to monitor the impacts of resettlement?	① It is expected that small-scale resettlement is caused due to Project implementation. Necessary efforts to minimize the impacts due to resettlement has been made in the Project design. ② At the 2nd stakeholder meeting at disclosure stage of draft EIA report heled on 28th December 2009, overall explanation was provided on resettlement and compensation. Moreover, necessary consultation with affected persons will be held prior to resettlement by referring previous experience of resettleemnt in Egypt. ③ Policies for resettlement and compensation is prepared in the feasibility study stage, and it will be developed at the time of the basic study stage. ④ Policies for resettleent and compensation prepared during the feasiliby study pays necessary attention to socially vulenrable groups. ⑤ Agreement with affected persons will be obtained through consultation and negotiation prior to resettlement in the stage before constrcution commencement.. ⑥ The organizational framework for the project is establised based on the Egyptian regulation. Responsible parties for resettlement is considered as capable to implement, and budget will be prepared in advance according to the Egyptian regulation. ⑦ Monitoring plan for resettlement implementaiton is considered in the policies, which will be further developed at the basic design stage.
	(2) Living and Livelihood	① Where roads or railways are newly installed, is there a possibility that the project will affect the existing means of transportation and the associated workers? Is there a possibility that the project will cause significant impacts, such as extensive alteration of existing land uses, changes in sources of livelihood, or unemployment? Are adequate measures considered for preventing these impacts? ② Is there a possibility that the project will adversely affect the living conditions of inhabitants other than the affected inhabitants? Are adequate measures considered to reduce the impacts, if necessary? ③ Is there a possibility that diseases, including communicable diseases, such as HIV will be introduced due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? ④ Is there a possibility that the project will adversely affect road traffic in the surrounding areas (e.g., by causing increases in traffic congestion and traffic accidents)? ⑤ Is there a possibility that roads and railways will cause impede the movement of inhabitants? ⑥ Is there a possibility that structures associated with roads (such as bridges) will cause a sun shading and radio interference?	① Based on the fndings of stakeholder meetings, there is negligible possibility to affect negatively the existing traffic means such as taxi and minibus along the Project route, since these means are expected also to be beneficiaries through the increment of business opportunities promoted by the Project. Some possibility of uncontrolled land use change is expected due to the new stations of the Project, although this change is considered as secondary one. Close coordination with such authorities as local governorates is proposed for proper land use planning and development near the new stations. ② The possibility of inconvenient conditions on inhabitants due to the stations constrcution where the cut and cover method will be applied, although the duration of impacts will be limited. Proper management for stations' construction sites will be prepared such as a temporary pedestrian path to reduce the inconvenience of inhabitants. No impact is expected in OM stage of the Project. ③ The health care system including prevention of communicable diseases will be planned for workers' camps by contractor(s) based on the recommendations of EIA. ④ There will be possibility to affect the road traffic near the constrcution sites of stations where cut and cover method will be applied during the construction stage. Road decking at the constrcution sites of stations will be applied to reduce the negative impacts on traffic conditions. No impact is expected in OM stage of the Project. ⑤ The possibility expected during the constrcution stage is same as ②. There is no possibility to cause the negative impacts of inhabitants' movement during OM stage. ⑥ Since major facilities such as tracks and stations will be constructed underground, no possibility of sun shading or radio interferance is expected.

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
4 Social Environment	(3) Heritage	① Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's laws?	① No damege is expected on local archeological, historical, cultural and religious heritage sites by the Project, because the stations will be designed to avoid suth valuable sites. However, buried cultural assets might be damaged due to the constrcution works (tracks and stations), if undiscovered assets exist underground along the route. Investigation such methods as non-destructive survey and boring are proposed to be done in the basic design stage for reducing the risk of unexpected discovery of buried assets during construction stage.
	(4) Landscape	① Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	① Negligible impact on landscape is expected due to the Project, since the major facilities such as tracks and stations will be constructed underground.
	(5) Ethnic Minorities and Indigenous Peoples	① Where ethnic minorities and indigenous peoples are living in the rights-of-way, are considerations given to reduce the impacts on culture and lifestyle of ethnic minorities and indigenous peoples? ② Does the project comply with the country's laws for rights of ethnic minorities and indigenous peoples?	① Egypt is said to be no category of ethnic minorities as well as indigenous people. However, there is a high possiblity that socially vulnerable groups such as the poor lives in the righs-of-way. Necessary considration for socially vulnerable groups is taken to reduce impact to them. ② There are no laws for the rights of ethnic minorities and indigenous people in Egypt. However, special consideration for socially vulnerable groups is taken.
5 Others	(1) Impacts during Construction	① Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? ② If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? ③ If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? ④ If necessary, is health and safety education (e.g., traffic safety, public health) provided for project personnel, including workers?	① Adequate measures will be planned and provided to reduce the negative impacts of environmental pollution during constrcution stage, such as proper maintenance of heavy equipment and vehicles, water spraying, management of construction waste, etc. according to legislation and recommendations of EIA. ② The Project area is located in metropolitan city with high urbanization. Therefore, there are no issues of ecosystem to be cautioned on construction activities. ③ Adequate measures will be planned and provided to reduce the negative impacts of social environment during constrcution stage, such as road decking to reduce traffic jam at stations' construction sites, temporary pedestrian paths, etc. ④ It is proposed to provide primary health check, first aid kit, instrution of health and taraffic safety, etc. for the workers by a contractor during the constrcution stage.
	(2) Monitoring	① Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? ② Are the items, methods and frequencies included in the monitoring program judged to be appropriate? ③ Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? ④ Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	① Environmental monitoring plan is proposed for pre-construction, construction and OM stages of the Project, based on the impact prediction and mitigation measures proposed. ② Parameters, methods, and frequency in the monitoring plan are considered to be enough for identifying the effectiveness of mitigation measures and/or unforseen impacts in the course of Projet implementation. ③ Institutional arrangement to carry out the monitoring plan is proposed including entities concerned and roles of each entity. ④ There are no regulatory requirements in Egypt such as reporting system of monitoring results, except the inspection system to industrial sector being carried out by environmental authorities

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
6 Note	Reference to Checklist of Other Sectors	① Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects including large areas of deforestation). ② Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of power transmission lines and/or electric distribution facilities).	① The project does not have relevance to forest or foresty since the project locates in the urban area where any primal nature is not observed. ② The project includes power transmission and installation of power transmission line, but these are planned to be constructed undergournd. Therefore potential impacts are considered to be minimal.
	Note on Using Environmental Checklist	① If necessary, the impacts to transboundary or global issues should be confirmed, if necessary (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	① No impacts are expected on transboundary or global issues, ocnsidering the project characteristics and scale.

1) Regarding the term “Country’s Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are made, if necessary.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan' experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Source: JICA Study Team, referrence to ex-JBIC guidelines

CHAPTER 13
ECONOMIC AND FINANCIAL ANALYSIS

CHAPTER 13 ECONOMIC AND FINANCIAL ANALYSIS

13.1 Introduction

This chapter presents the methodology, assumptions and results of economic and financial appraisals of the Cairo Metro Line 4 construction project. These appraisals were undertaken both for the case of Phase 1 route only (i.e. without the addition of the second phase route) and for the case of an entire metro route comprising both the Phase 1 and Phase 2 route components.

These appraisals are intended to demonstrate the economic and financial viability of the project under varying assumptions as to the level of ridership demand, road traffic impacts, capital costs, O&M costs and fares. In addition, the financial appraisal considers the effect of different financing sources and conditions on the financial returns available from the project.

The chapter first reviews estimates of the project capital and O&M costs, which provide a common base for both economic and financial appraisals, before presenting individually the methodology, assumptions and results of these two appraisals.

13.2 Project Costs

Estimates of the initial capital and operating and maintenance (O&M) costs of the project are fully described in Chapter 7 (please see Sections 7.1 and 7.2, respectively).

These estimates are valued in financial terms and are suitable as bases for the financial appraisal. For the economic appraisal, however, all project costs and benefits must reflect values relevant to the wider economy. Often these values are referred to as “resource values” and their main characteristic is that they exclude government taxes, charges, and transfer payments, as well as the effect of any distortions of prices from market determined values. They may be estimated by adjusting financial costs by shadow pricing factors (SPFs), which exclude the non-economic cost elements. An example of the calculation of SPF for the capital cost of *station civil works* is given in Figure 13-1 below.

Figure 13-1 Example of SPF Calculation (Station Civil Works Cost)

Cost component	Estimated distribution in total station civil works cost (%)	Tax proportion assumed to apply to cost component (%)	Weighted average tax proportion
Labour	15	10	0.015
Material			
- Concrete	35	10	0.035
- Steel	20	25	0.050
Equipment	30	25	0.075
Total (all components)	100		0.175*

*** SPF = 1 – 0.175 = 0.825**
Source: JICA Study Team

The SPF estimated for the project's construction capital costs, comprising civil works and E&M system costs, is 0.82 and for the cost of rolling stock purchases, 0.75, giving an overall factor for the project capital cost of 0.81.

The O&M costs of the project comprise the costs of staff, electricity consumption, and materials and spare parts. SPFs estimated for these components are respectively 0.90, 1.30 and 0.75, giving a weighted average for consolidated O&M costs of 0.86. In the case of electricity consumption, the SPF reflects an adjustment to remove the government electricity subsidy, which is estimated at 30%.[1]

13.2.1 Summary of Costs Used for Financial and Economic Appraisals

(i) Capital Costs

Table 13-1 provides a summary of the financial estimates of *initial capital costs* of the project, which are discussed in detail in Chapter 7. These costs have been separated into four main components: namely tunnelling costs; civil works costs (including station, depot and track work construction costs); electrical and mechanical (E&M) system costs; and rolling stock costs. It is assumed that these costs would be disbursed over the construction periods assumed for Phase 1 (2012-2019) and Phase 2 (2017-2022), in accordance with a schedule developed by the JICA Study Team. An alternative schedule was developed for the project, assuming that it would be financed by a Normal ODA Loan. In this instance, Basic Design of the project would be undertaken and financed by the Egyptian government under a tender let in accordance with International Competitive Bidding methods, and for this reason would be implemented over a longer time frame than if the project was financed by a STEP Loan. The summary of initial capital costs disbursed under Normal ODA Loan conditions is given in Table 13-2.

The SPFs for the major capital cost components (derived by the procedure shown in Table 13-1) were applied to these financial cost estimates for the STEP Loan case to calculate the economic cost estimates as input for the economic appraisal. The resulting estimates are given in Table 13-3.

In addition, the capital cost stream used for both economic and financial appraisals includes future rolling stock investments, including new equipment purchases to satisfy future demand, half-life refurbishments after 15 years in service, and new purchases to replace life-expired stock. These costs in financial values are given in Table 13-4 and in economic values in Table 13-5.

(ii) O&M costs

Detailed calculations of the project O&M costs, in financial values, are given in Chapter 7 of this report (see Section 7.2). These costs and their conversion to economic values are summarized for specified reference years in Table 13-6.

[1] Information obtained from the Ministry of Finance website shows that a subsidy of L.E. 2.0 billion was paid to electric power producers in 2007/08, in order to compensate them for the increased cost of CNG inputs and allow them to maintain electricity prices at current levels. Based on total electricity consumption of about 98.9 billion Kwh, this subsidy was equivalent to L.E. 0.0202 per Kwh. When compared with the price of L.E. 0.068 per Kwh quoted by the electricity supply company for the supply of electricity to the metro, the rate of subsidy is about 30%.

Table 13-1 Summary of Initial Capital Costs used as Input for the Discounted Cash Flow (DCF) Analysis (STEP Loan)

Capital cost component	Year												Phase totals	*Project totals (Phases 1+2)*
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022		
Civil works - tunnelling														
Phase 1	0.0	20.7	279.7	518.1	497.3	238.2	0.0	0.0	0.0	0.0	0.0	0.0	1,554.1	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	56.5	313.3	342.4	143.8	0.0	855.9	*2,410.0*
Civil works (except tunnelling)														
Phase 1	0.0	373.9	1,183.7	1,496.2	1,434.8	625.4	333.9	0.0	0.0	0.0	0.0	0.0	5,447.9	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	342.5	1,127.8	1,417.9	1,183.9	694.0	0.0	4,766.2	*10,214.1*
E&M equipment														
Phase 1	0.0	0.0	0.0	248.0	547.0	893.7	1,112.3	665.5	0.0	0.0	0.0	0.0	3,466.5	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	103.4	951.2	1,197.7	1,198.4	3,450.7	*6,917.3*
Total construction capital costs														
Phase 1	0.0	394.6	1,463.5	2,262.3	2,479.1	1,757.3	1,446.2	665.5	0.0	0.0	0.0	0.0	10,468.5	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	342.5	1,184.3	1,834.5	2,477.5	2,035.6	1,198.4	9,072.8	*19,541.4*
Rolling stock														
Phase 1	0.0	0.0	0.0	0.0	0.0	562.7	562.7	562.7	562.7	112.5	0.0	0.0	2,363.2	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5,064.0	5,064.0	*7,427.3*
Total construction & rolling stock														
Phase 1	0.0	394.6	1,463.5	2,262.3	2,479.1	2,320.0	2,008.9	1,228.2	562.7	112.5	0.0	0.0	12,831.8	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	342.5	1,184.3	1,834.5	2,477.5	2,035.6	6,262.5	14,136.9	*26,968.6*
GC Service fee (7%)														
Phase 1	0.0	27.6	102.4	158.4	173.5	162.4	140.6	86.0	39.4	7.9	0.0	0.0	898.2	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	24.0	82.9	128.4	173.4	142.5	438.4	989.6	*1,887.8*
Sub-total														
Phase 1	0.0	422.2	1565.9	2420.7	2652.6	2482.4	2149.5	1314.2	602.1	120.4	0.0	0.0	13,730.0	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	366.5	1267.2	1962.9	2650.9	2178.1	6700.9	15,126.4	*28,856.4*
Land Acquisition and re-settlement														
Phase 1	113.9	56.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	170.0	
Phase 2	0.0	0.0	0.0	0.0	47.5	95.0	47.5	0.0	0.0	0.0	0.0	0.0	190.0	*360.0*
Public utility relocation														
Phase 1	115.3	115.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	230.6	
Phase 2	0.0	0.0	0.0	0.0	0.0	69.3	69.3	0.0	0.0	0.0	0.0	0.0	138.6	*369.2*
TOTAL PROJECT CAPITAL COST														
Phase 1	***229.2***	***593.6***	***1565.9***	***2420.7***	***2652.6***	***2482.4***	***2149.5***	***1314.2***	***602.1***	***120.4***	***0.0***	***0.0***	***14,130.5***	
Phase 2	***0.0***	***0.0***	***0.0***	***0.0***	***47.5***	***164.3***	***483.3***	***1267.2***	***1962.9***	***2650.9***	***2178.1***	***6700.9***	***15,455.0***	*29,585.6*

Source: JICA Study Team

Table 13-2 Summary of initial capital costs used as input for the Discounted Cash Flow (DCF) analysis (Normal Loan)

Capital cost component	Year												Phase totals	*Project totals (Phases 1+2)*
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022		
Civil works - tunnelling														
Phase 1	0.0	0.0	0.0	20.7	279.7	518.1	497.3	238.2	0.0	0.0	0.0	0.0	1,554.1	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	198.6	342.4	285.9	29.1	855.9	*2,410.0*
Civil works (except tunnelling)														
Phase 1	0.0	0.0	0.0	373.9	1,183.7	1,496.2	1,434.8	625.4	333.9	0.0	0.0	0.0	5,447.9	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	697.8	1,473.0	1,417.8	828.7	348.9	4,766.2	*10,214.1*
E&M equipment														
Phase 1	0.0	0.0	0.0	0.0	0.0	248.0	547.0	893.7	1,112.3	665.5	0.0	0.0	3,466.5	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	551.2	868.6	868.6	2,288.4	*5,754.9*
Total construction capital costs														
Phase 1	0.0	0.0	0.0	394.6	1,463.5	2,262.3	2,479.1	1,757.3	1,446.2	665.5	0.0	0.0	10,468.5	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	697.8	1,671.5	2,311.4	1,983.2	1,246.6	7,910.5	*18,379.0*
Rolling stock														
Phase 1	0.0	0.0	0.0	0.0	0.0	562.7	562.7	562.7	562.7	112.5	0.0	0.0	2,363.2	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5,064.0	5,064.0	*7,427.3*
Total construction & rolling stock														
Phase 1	0.0	0.0	0.0	394.6	1,463.5	2,825.0	3,041.8	2,320.0	2,008.9	778.1	0.0	0.0	12,831.8	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	697.8	1,671.5	2,311.4	1,983.2	6,310.6	12,974.5	*25,806.3*
GC Service fee (7%)														
Phase 1	0.0	0.0	0.0	27.6	102.4	197.7	212.9	162.4	140.6	54.5	0.0	0.0	898.2	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.8	117.0	161.8	138.8	441.7	908.2	*1,806.4*
Sub-total														
Phase 1	0.0	0.0	0.0	422.2	1565.9	3022.7	3254.7	2482.4	2149.5	832.5	0.0	0.0	13,730.0	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	746.6	1788.5	2473.2	2122.0	6752.4	13,882.7	*27,612.7*
Land Acquisition and re-settlement														
Phase 1	0.0	0.0	116.3	57.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	173.5	
Phase 2	0.0	0.0	0.0	0.0	23.7	95.0	71.2	0.0	0.0	0.0	0.0	0.0	190.0	*363.5*
Public utility relocation														
Phase 1	0.0	0.0	115.3	115.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	230.6	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	138.6	0.0	0.0	0.0	0.0	0.0	138.6	*369.2*
BD and TD														
Phase 1	0.0	0.0	55.1	55.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	110.2	
Phase 2	0.0	0.0	0.0	0.0	0.0	0.0	110.2	0.0	0.0	0.0	0.0	0.0	110.2	*220.5*
TOTAL PROJECT CAPITAL COST														
Phase 1	***0.0***	***0.0***	***286.7***	***649.9***	***1565.9***	***3022.7***	***3254.7***	***2482.4***	***2149.5***	***832.5***	***0.0***	***0.0***	***14,244.3***	
Phase 2	***0.0***	***0.0***	***0.0***	***0.0***	***23.7***	***95.0***	***320.1***	***746.6***	***1788.5***	***2473.2***	***2122.0***	***6752.4***	***14,321.5***	*28,565.9*

Table 13-3 Summary of Initial Capital Costs used as Input for the Economic Flow Analysis

Capital Cost Component	SPF	Year												Phase totals	*Project totals (Phases 1+2)*
		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022		
Civil works - tunnelling	0.83														
Phase 1		0.0	17.1	230.8	427.5	410.3	196.5	0.0	0.0	0.0	0.0	0.0	0.0	1,282.1	
Phase 2		0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.6	258.4	282.4	118.6	0.0	706.1	*1,988.2*
Civil works (except tunnelling)	0.84														
Phase 1		0.0	314.0	993.0	1,256.2	1,205.6	526.9	280.5	0.0	0.0	0.0	0.0	0.0	4,576.1	
Phase 2		0.0	0.0	0.0	0.0	0.0	0.0	288.2	947.2	1,192.2	995.4	583.7	0.0	4,006.6	*8,582.7*
E&M equipment	0.79														
Phase 1		0.0	0.0	0.0	195.9	432.1	706.8	877.2	523.9	0.0	0.0	0.0	0.0	2,736.0	
Phase 2		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.8	752.1	946.6	942.9	2,723.4	*5,459.4*
Total construction capital costs	0.81														
Phase 1		0.0	331.0	1,223.8	1,879.6	2,048.0	1,430.2	1,157.7	523.9	0.0	0.0	0.0	0.0	8,594.2	
Phase 2		0.0	0.0	0.0	0.0	0.0	0.0	288.2	993.8	1,532.4	2,030.0	1,648.9	942.9	7,436.2	*16,030.4*
Rolling stock	0.75														
Phase 1		0.0	0.0	0.0	0.0	0.0	422.0	422.0	422.0	422.0	84.4	0.0	0.0	1,772.4	
Phase 2		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3,798.0	3,798.0	*5,570.4*
Total construction & rolling stock															
Phase 1		0.0	331.0	1,223.8	1,879.6	2,048.0	1,852.2	1,579.7	945.9	422.0	84.4	0.0	0.0	10,366.6	
Phase 2		0.0	0.0	0.0	0.0	0.0	0.0	288.2	993.8	1,532.4	2,030.0	1,648.9	4,740.9	11,234.2	*21,600.8*
GC Service fee (7%)															
Phase 1		0.0	23.2	85.7	131.6	143.4	129.7	110.6	66.2	29.5	5.9	0.0	0.0	725.7	
Phase 2		0.0	0.0	0.0	0.0	0.0	0.0	20.2	69.6	107.3	142.1	115.4	331.9	786.4	*1,512.1*
Sub-total															
Phase 1		0.0	354.2	1309.4	2011.2	2191.4	1981.9	1690.3	1012.1	451.5	90.3	0.0	0.0	11,092.3	
Phase 2		0.0	0.0	0.0	0.0	0.0	0.0	308.3	1063.4	1639.7	2172.1	1764.3	5072.8	12,020.6	*23,112.9*
Land Acquisition and re-settlement	1.0														
Phase 1		113.9	56.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	170.0	
Phase 2		0.0	0.0	0.0	0.0	47.5	95.0	47.5	0.0	0.0	0.0	0.0	0.0	190.0	*360.0*
Public utility relocation	1.0														
Phase 1		115.3	115.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	230.6	
Phase 2		0.0	0.0	0.0	0.0	0.0	69.3	69.3	0.0	0.0	0.0	0.0	0.0	138.6	*369.2*
TOTAL PROJECT CAPITAL COST															
Phase 1		***229.2***	***525.6***	***1309.4***	***2011.2***	***2191.4***	***1981.9***	***1690.3***	***1012.1***	***451.5***	***90.3***	***0.0***	***0.0***	***11,492.9***	
Phase 2		***0.0***	***0.0***	***0.0***	***0.0***	***47.5***	***164.3***	***425.1***	***1063.4***	***1639.7***	***2172.1***	***1764.3***	***5072.8***	***12,349.2***	*23,842.0*

Source: JICA Study Team

Table 13-4 Summary of Rolling Stock Investment Costs used for DCF Analysis

(i) Phase 1 Only – Financial Costs

Year	Purchase schedule (No. cars)	Disbursement -init.purchase unit price: 14.07 L.E. mill.	Half-life refurbishment schedule (No. cars)	Disbursement - refurbishmer unit price: 9.85 L.E. mill.	Rolling stock replacements unit price: 14.07 L.E. mill.	Total rolling stock capital disbursements L.E. mill.
2011						
2012						
2013						
2014						
2015						
2016	40	562.67				562.67
2017	40	562.67				562.67
2018	40	562.67				562.67
2019	40	562.67				562.67
2020	8	112.53				112.53
2021	0	0.00				0.00
2022	0	0.00				0.00
2023	0	0.00				0.00
2024	8	112.53				112.53
2025	8	112.53				112.53
2026	8	112.53				112.53
2027	0	0.00				0.00
2028	0	0.00				0.00
2029	8	112.53				112.53
2030	0	0.00				0.00
2031	8	112.53				112.53
2032	0	0.00				0.00
2033	0	0.00				0.00
2034	16	225.07	160	1,575.48		1,800.55
2035	0	0.00	8	78.77		78.77
2036	0	0.00	0	0.00		0.00
2037	8	112.53	0	0.00		112.53
2038	0	0.00	0	0.00		0.00
2039	0	0.00	8	78.77		78.77
2040	8	112.53	8	78.77		191.31
2041	0	0.00	8	78.77		78.77
2042	0	0.00	0	0.00		0.00
2043	8	112.53	0	0.00		112.53
2044	0	0.00	8	78.77		78.77
2045	0	0.00	0	0.00		0.00
2046	8	112.53	8	78.77		191.31
2047	0	0.00	0	0.00		0.00
2048	0	0.00	0	0.00		0.00
2049	8	112.53	16	157.55	2,250.69	2,520.77
2050	0	0.00	0	0.00	112.53	112.53
Residual value		-300.09		-330.85	-2,213.18	-2,844.12
Totals	*264*	***3,413.54***	*224*	***1,874.82***	***150.05***	***5,438.41***

Source: JICA Study Team

(ii) Entire Project (Phases 1 and 2) –Financial Costs

Year	Purchase schedule (No. cars)	Disbursement -init.purchase unit price: 14.07 L.E. mill.	Half-life refurbishment schedule (No. cars)	Disbursement - refurbishment unit price: 9.85 L.E. mill.	Rolling stock replacements unit price: 14.07 L.E. mill.	Total rolling stock capital disbursements L.E. mill.
2011						
2012						
2013						
2014						
2015						
2016	40	562.67				562.67
2017	40	562.67				562.67
2018	40	562.67				562.67
2019	40	562.67				562.67
2020	8	112.53				112.53
2021	0	0.00				0.00
2022	360	5054.05				5,054.05
2023	0					0.00
2024	16	225.07				225.07
2025	0					0.00
2026	0					0.00
2027	0					0.00
2028	0					0.00
2029	0					0.00
2030	0					0.00
2031	0					0.00
2032	16	225.07				225.07
2033	0					0.00
2034	0		160	1,575.48		1,575.48
2035	0		8	78.77		78.77
2036	0					0.00
2037	0		360	3,544.83		3,544.83
2038	0					0.00
2039	0		16	157.55		157.55
2040	0					0.00
2041	0					0.00
2042	0					0.00
2043	0					0.00
2044	0					0.00
2045	0					0.00
2046	0					0.00
2047	0		16	157.55		157.55
2048	0					0.00
2049	0				2,250.69	2,250.69
2050	0				112.53	112.53
Residual value				-640.70	-2,213.18	-2,853.87
Totals	***560***	***7,877.48***	***560***	***4,673.49***	***150.05***	***12,699.94***

Source: JICA Study Team

Table 13-5 Summary of Rolling Stock Investment Costs used for Economic Flow Analysis

(i) Phase 1 Only – Economic Costs

Year	Purchase schedule (No. cars)	Disbursement -Init.purchase unit price: 10.55 L.E. mill.	Half-life refurbishment schedule (No. cars)	Disbursement - refurbishment unit price: 7.39 L.E. mill.	Rolling stock replacements unit price: 10.55 L.E. mill.	Total rolling stock capital disbursements L.E. mill.
2011						
2012						
2013						
2014						
2015						
2016	40	422.00				422.00
2017	40	422.00				422.00
2018	40	422.00				422.00
2019	40	422.00	0			422.00
2020	8	84.40	0			84.40
2021	0	0.00	0			0.00
2022	0	0.00	0			0.00
2023	0	0.00	0			0.00
2024	8	84.40	0			84.40
2025	8	84.40	0			84.40
2026	8	84.40	0			84.40
2027	0	0.00	0			0.00
2028	0	0.00	0			0.00
2029	8	84.40	0			84.40
2030	0	0.00	0			0.00
2031	8	84.40	0			84.40
2032	0	0.00	0			0.00
2033	0	0.00	0			0.00
2034	16	168.80	160	1,181.61		1,350.41
2035	0	0.00	8	59.08		59.08
2036	0	0.00	0	0.00		0.00
2037	8	84.40	0	0.00		84.40
2038	0	0.00	0	0.00		0.00
2039	0	0.00	8	59.08		59.08
2040	8	84.40	8	59.08		143.48
2041	0	0.00	8	59.08		59.08
2042	0	0.00	0	0.00		0.00
2043	8	84.40	0	0.00		84.40
2044	0	0.00	8	59.08		59.08
2045	0	0.00	0	0.00		0.00
2046	8	84.40	8	59.08		143.48
2047	0	0.00	0	0.00		0.00
2048	0	0.00	0	0.00		0.00
2049	8	84.40	16	118.16	1,688.02	1,890.58
2050	0	0.00	0	0.00	84.40	84.40
Residual value		-225.07		-248.14	-1,659.88	-2,133.09
Totals	364	3,566.16	224	1,486.12	112.53	4,678.81

Source: JICA Study Team

(ii) Entire project (Phases 1 and 2) – Economic Costs

Year	Purchase schedule (No. cars)	Disbursement -Init.purchase unit price: 10.55 L.E. mill.	Half-life refurbishment schedule (No. cars)	Disbursement - refurbishment unit price: 7.39 L.E. mill.	Rolling stock replacements unit price: 10.55 L.E. mill.	Total rolling stock capital disbursements L.E. mill.
2011						
2012						
2013						
2014						
2015						
2016	40	422.00				422.00
2017	40	422.00				422.00
2018	40	422.00				422.00
2019	40	422.00				422.00
2020	8	84.40				84.40
2021	0	0.00				0.00
2022	360	3798.03				3,798.03
2023	0					0.00
2024	16	168.80				168.80
2025	0					0.00
2026	0					0.00
2027	0					0.00
2028	0					0.00
2029	0					0.00
2030	0					0.00
2031	0					0.00
2032	16	168.80				168.80
2033	0					0.00
2034	0		160	1,181.61		1,181.61
2035	0		8	59.08		59.08
2036	0					0.00
2037	0		360	2,658.62		2,658.62
2038	0					0.00
2039	0		16	118.16		118.16
2040	0					0.00
2041	0					0.00
2042	0					0.00
2043	0					0.00
2044	0					0.00
2045	0					0.00
2046	0					0.00
2047	0		16	118.16		118.16
2048	0					0.00
2049	0				1,688.02	1,688.02
2050	0				84.40	84.40
Residual value				-480.62	-1,659.88	-2,140.40
Totals	560	5,966.05	560	3,855.12	112.53	9,675.70

Source: JICA Study Team

Table 13-6 O&M Costs – Financial and Economic (LE million)

(i) Phase 1 only - Financial

Year	Personnel	Parts and materials	Power consumption	Security and other	Total
2020	35.245	50.693	13.534	9.546	**109.018**
2023	34.069	52.381	13.959	9.568	**109.977**
2027	17.234	57.445	14.666	9.620	**98.965**
2050	19.298	72.637	16.522	9.768	**118.226**

(ii) Phase 1 only - Economic

Year	Personnel	Parts and materials	Power consumption	Security and other	Total
2020	33.889	38.020	17.560	8.592	**98.061**
2023	32.692	39.286	18.112	8.611	**98.701**
2027	15.511	43.084	19.029	8.658	**86.281**
2050	17.368	54.478	21.438	8.791	**102.075**

(iii) Entire route (Phases 1 and 2 combined) - Financial

Year	Personnel	Parts and materials	Power consumption	Security and other	Total
2020	35.245	50.693	13.534	9.546	**109.018**
2023	55.225	142.728	32.397	19.191	**249.542**
2027	37.396	146.104	32.789	19.265	**235.555**
2050	37.924	149.480	33.299	19.297	**240.000**

(iv) Entire route (Phases 1 and 2 combined) - Economic

Year	Personnel	Parts and materials	Power consumption	Security and other	Total
2020	33.889	38.020	17.560	8.592	**98.061**
2023	52.325	107.046	42.036	17.272	**218.678**
2027	33.656	109.578	42.544	17.339	**203.118**
2050	34.132	112.110	43.206	17.367	**206.815**

Source: JICA Study Team

13.2.2 Other Common Assumptions related to the Economic and Financial Appraisals of Line 4

(i) *Evaluation Period*

The evaluation period assumed for the appraisal of both the Phase 1 route section and the entire route (Phase 1 and 2) starts in 2011, when land must be acquired and compensation to affected persons paid to allow construction to proceed, and ends in 2050, which is the last year of the demand forecast. The construction period (2012-2019 in the case of Phase 1 and 2017-2023 in the case of Phase 2) forms part of the evaluation period, as does the operating period (2020-2050 in case of the Phase 1 only project and 2023-2050 in the case of the combined Phase 1 and 2 project).

If the project would be financed by General Loan (rather than by a STEP Loan), construction would be delayed by two years owing to the need to appoint a consultant, through an International Competitive Bidding process, to undertake the BD. In this case,

the evaluation period would start in 2013 with the payment of land acquisition and resettlement costs, and end in 2050 (the last year of the demand forecast).

(ii) Asset Lives

The asset lives assumed for both the economic and financial appraisals are as follows:

- Tunnel structures: 100 years
- Other civil structures (including elevated structures, stations and depot/workshop), and track-work: 50 years
- Electrical and mechanical (E&M) equipment: 30 years
- Rolling-stock, new: 15 years
- Rolling stock, refurbished: 15 years

These asset lives were used as a basis for calculating residual values at the end of the evaluation period in the case of both the economic and financial appraisals, and depreciation allowances in the case of the financial appraisal.

(iii) Annualization Factor

The transport demand forecast on which the economic and financial appraisals of the project were based provides a projection of daily demand. These daily demand forecasts were used as basis for estimating the project's economic benefits and income from fare revenue. Converting these estimates from daily to annual value required derivation of a factor. This was done by assuming that same working day and holiday pattern of demand would apply to Line 4 as has recently been observed for Line 2. Traffic surveys taken for two weeks in May and July 2009 on Line 2 suggest that about 22% of ridership occurs during Friday and Saturday, with the remaining five days accounting for 78%. Pro-rating this ridership to 365 days gives 340 average traffic days per year (0.22 x 365 + 5*52). Thus, 340 was used as factor for expansion of daily revenue and economic benefits on an annual basis, for incorporation in the economic flow and discounted cash flow analyses of the project.

13.3 Economic Appraisal

This section describes the methodology, assumptions and results of economic appraisals undertaken in the case of the Phase 1 only section and of the entire route incorporating both Phases 1 and 2.

13.3.1 Methodology

This economic appraisal of the Cairo Metro Line 4 project conventionally measures the net economic benefits of the project to society (in this case the local economy) by comparing, over the life of the project, its economic benefits with its shadow-priced capital and operating costs.

The economic costs of the project have been identified and defined in the foregoing sections of this chapter.

The economic benefits of the project are measured by comparing the economic, or resource, costs of urban transport in the Greater Cairo Area, "with" and "without" the project. The presumption is that the project will reduce these costs, by reducing the volume of traffic circulation (measured in terms of vehicle-kilometres and vehicle-hours) on the urban road network. The reduction in the volume of road traffic circulation will save in vehicle operating costs (VOCs) and reduce air pollution costs and indirectly, through a reduction in traffic congestion and an increase in the average road traffic speed, save value of travel time (VOT).

The following sections describe the key assumptions and demand forecasts underlying the analysis of the project's economic benefits.

(i) Definition of the "With" and "Without" Project Cases

The "without" project case was established by determining what alternative transport modes and routes will operate, as part of the urban public transport network, in the absence of Cairo Metro Line 4. This case will therefore include all existing transport components of this network which are expected to continue operating, in addition to projects currently under construction; or for which funding has been, or is likely to be, committed to enable construction to be completed and operation to start, within the forecast period up until 2050.

The Greater Cairo transport network, which is assumed to operate in the absence of Line 4, was defined in Section 4.4.1 (2) of Feasibility Study Report 1. This network includes:

- The existing metro network, consisting of Lines 1 and 2, with the addition of Line 3 (currently under construction);
- The existing urban road network;
- The existing ENR suburban network and the Heliopolis tram;
- A total of sixteen urban road projects, which were identified in the SDMP report as being either under construction or under detailed planning in 2007; and

- A total of six additional urban transport projects identified by the General Office for Physical Planning (GOPP) [2] as in progress or committed and which are likely to have an impact on the demand for Cairo Metro Line 4. These include: the East Wing Railway of ENR; the Exclusive Busway system in the 26th July Corridor from Cairo University Metro Station to 6th October City (about 40 km); the Heliopolis Super Tram Project upgrading of Heliopolis Tram and extension to New Cairo (NUC); the Urban Tollway Project in East Cairo; and six road projects around the Grand Egyptian Museum and El Remayah Square aimed at relief of local traffic congestion.

The "with" project case then measures the traffic impact of the addition of the Cairo Metro Line 4 project to the Greater Cairo transport network operated in the "without" case.

(ii) Estimation and comparison of traffic circulation volumes associated with the "With" and "Without" project cases

The economic benefits of the project are measured by comparing the economic cost streams associated with the "with" and "without" project cases. These cost streams are in estimated based on the comparison of daily traffic circulation volumes for each case, expressed in terms of PCU-kilometres and PCU-hours.[3] In addition, the reduction in passenger-hours resulting from the reduced travel time for metro passengers, "with" the project, is also measured. These estimates have been produced as a by-product of the transport demand forecast, and are summarized in the case of traffic circulation in Greater Cairo in Table 13-7 and the case of reduced travel time for metro users in Table 13-8.

Table 13-7 Greater Cairo Daily Traffic Circulation "With" and "Without" the Project

(i) Phase 1 Project Only

Forecast Year	*PCU-km per day*			*PCU-hr per day*		
	"With" project	*"Without" project*	*Difference*	*"With" project*	*"Without" project*	*Difference*
2020	98,731,961	99,121,495	-389,534	4,282,355	4,325,890	-43,535
2023	110,374,324	110,822,126	-447,803	4,916,638	4,965,616	-48,978
2027	130,692,469	131,379,443	-686,974	6,046,580	6,115,575	-68,996
2050	246,472,181	247,710,296	-1,238,115	12,996,878	13,122,064	-125,186

(ii) Entire Route (Phase 1 and 2 Combined)

Forecast Year	*PCU-Km per day*			*PCU-Hours per day*		
	"With" project	*"Without" project*	*Difference*	*"With" project*	*"Without" project*	*Difference*
2020	98,731,961	99,121,495	-389,534	4,282,355	4,325,890	-43,535
2023	110,374,324	111,320,065	-945,741	4,916,638	4,993,470	-76,831
2027	130,692,469	131,680,555	-988,086	6,046,580	6,129,664	-83,084
2050	246,472,181	248,000,050	-1,527,870	12,996,878	13,145,552	-148,673

Source: JICA Study Team

[2] A division of the Ministry of Housing, Public Utilities and Urban Development.
[3] "PCU" means "Passenger Car Unit", a standard unit for measuring traffic volume, which results from expressing different vehicle types as in terms of an equivalent number of PCU, e.g. a large truck or a large bus is equivalent to 2.5 PCU, a motorcycle is equivalent to 0.3 PCU, and so on.

Table 13-8 Metro User Passenger Hours "With" and "Without" the Project

(i) Phase 1 Project Only

Forecast Year	Passenger-hours per day (Metro Line 4 passengers only)		
	"With" Project	"Without" Project	*Difference*
2020	241,501	334,515	-93,014
2023	244,520	354,206	-109,686
2027	324,583	479,574	-154,991
2050	436,573	716,239	-279,666

(ii) Entire Route (Phase 1 and 2 combined)

Forecast Year	Passenger-hours per day (Metro Line 4 passengers only)		
	"With" Project	"Without" Project	*Difference*
2020	241,501	334,515	-93,014
2023	452,608	656,991	-204,383
2027	479,894	710,147	-230,254
2050	568,729	934,969	-366,240

Source: JICA Study Team

Table 13-7 reflects the diversion of passengers from other urban transport modes to the metro system after the opening of Cairo Metro Line 4. The effect of this diversion will be to reduce the volume of traffic circulation (in PCU-km) on the Greater Cairo transport network, which in turn will allow average speeds for the remaining road users to increase and their average trip times to reduce. It will be noted that the overall effect of the project will be to reduce PCU-Km in Greater Cairo by only 0.4-0.6% and PCU-Hours by 1.0-1.1%. Nevertheless, the application of unit economic costs to the huge volume of traffic circulation in both the "with" and "without" project cases will still result in substantial economic benefits, except in the case of reduced vehicular emissions.

Table 13-8 reflects the reduction in travel time for metro passengers after commencement of metro operations. Thus, the comparison is between their travel times on the metro and on alternative modes of transport before the start of metro operations (assumed to be mostly bus and shared taxi services). By contrast, with its effects on travel times in the Greater Cairo Area, the metro project may have a marked effect on the travel times of metro users, with a reduction in travel time of 39-41%.

13.3.2 Estimation of Economic Benefits

Although an urban public transport project, such as Cairo Metro Line 4, can generate several types of economic benefit, it was considered that only three types were capable of practical measurement within the timeframe allowed for the F/S. These are: savings in vehicle operating costs, savings in the value of travel time, and reduction in air pollution costs. The approach used and the results obtained in the estimation of these benefits is given in the following sub-sections:

(i) Savings of vehicle operating costs (VOCs)

Unit VOC data, comprising the economic costs per vehicle-kilometre and per vehicle-hour for fuel, lubricants, tyres, maintenance labour, spare parts, crew (for buses and trucks), vehicle depreciation and insurance; is usually obtained as a by-product of a highway costing model, such as the World Bank's HDM-4. Unfortunately, such model is not applied

for the purposes of transport project evaluation in Egypt, so it was necessary to make estimates on the basis of information supplied by auto retailers, bus operating companies, truck operators, and insurance companies, as well as to review the VOC data generated in the SDMP study.

Fuel costs have been estimated separately from non-fuel VOCs, mainly because of the differences in the economic structure of fuel prices, as compared with the prices of other VOC components. Hence, the methods to be used must have conversion of VOCs in financial values to economic values. In addition, since the emissions of GHGs (Greenhouse Gases) and other pollutants are related to the volume of fuel consumed, it was necessary to make a separate calculation of fuel consumed in both the “with” and ”without” cases. This is done by applying to vehicle-kilometre in both cases, the typical fuel consumption rates of representative vehicles in each type category.

For the economic appraisal, fuel is valued at retail price, plus an allowance for the fuel price subsidies applied by the Egyptian Government. Although CNG is now widely used as an automotive fuel in Cairo, its overall volume as a share of the total volume of fuel consumed in the city is still quite small. Thus, it was assumed that, for all practical purposes, diesel and gasoline would account for nearly all of the fuel consumed in the Greater Cairo area.

The physical vehicle characteristics used as parameters for establishing unit VOCs are given in Table 13-9.

Table 13-9 Physical Characteristics of Vehicle Population

Item		Vehicle type:						
	Private cars	Taxis	Shared taxis (mini-buses)	Medium buses	Large buses	Light trucks	Medium trucks	Heavy trucks
Representative vehicle type	1600 CC sedan					Four wheel rigid	Six wheel rigid	Ten wheel rigid
Annual Km	20,000	80,000	100,000	75,000	75,000	50,000	75,000	75,000
Annual operating hours	400	3,433	4,286	4,737	4,737	1,300	1,950	1,950
Fuel consumption (litres/'000 km	96	100	138	160	300	160	250	357
Assumed life (yrs)	13	10	10	10	13	10	12	13
Deprec % dist.rel.	79%	81%	81%	89%	90%	88%	89%	89%
Deprec % time rel.	21%	19%	19%	11%	10%	12%	11%	11%
Tyre number	4	4	4	6	6	4	6	10
Average crew size	Not relevant	1	1	2	2	1	2	2
Average vehicle occupancy	1.9	2.0	11.0	15.0	47.0	Not relevant	Not relevant	Not relevant

Sources: SDMP study report; consultant’s estimates, based on enquiries to transport operators

For the purposes of revaluing unit VOCs from financial to economic values, it was necessary to establish appropriate conversion factors. Different factors were derived for different types of inputs.

Traded inputs, such as imported vehicles and tyres, are valued at border prices by excluding import duties and other taxes. For this purpose, a standard conversion factor developed for the SDMP study of 0.84 was used. This factor was derived as the ratio

between the value of imports and exports and with the addition of import duties and subtraction of export duties.[4]

The economic values for non-traded inputs, comprising services and locally manufactured goods, were established by eliminating the sales tax component from domestic prices, and in certain special cases (such as petroleum fuels) by eliminating subsidies. Since sales tax rates of 10% and 15% apply respectively to services and to most locally manufactured goods, economic values for these inputs were established through adjustment factors of 0.91 and 0.87 to domestic prices.

The rate of subsidy on petroleum fuels was the quotient the total amount of the subsidy in 2006/07 for gasoline and diesel fuel respectively by the total volume of these fuels consumed domestically in that particular year. This rate was reduced to reflect the expected reduction of LE15 billion in the level of the subsidy over the next three years, as shown in Table 13-10.

Table 13-10 Estimation of Petroleum Fuel Subsidies

Fuel type	Amount of subsidy in 2006/2007	Volume consumed domestically in 2006/2007	Estimated subsidy per litre	Estimated subsidy after reduction in 2008/2009
	(L.E. Million)	(Million Litres)	(L.E.)	(L.E.)
Diesel	10,360	11,670	0.89	0.74
Gasoline (all grades)	3,130	4,990	0.63	0.53
Average	13,490	16,660	0.81	0.71

Sources: (1) Ministry of Finance website (petroleum subsidies)
(2) American Chamber of Commerce: *Oil and Energy Profiles in Egypt,* 2008 (petroleum consumption)

Notes: Fuel prices in Egypt increased in May 2008 by an average of about 46 % per litre[5]. This was expected to lead to a reduction in the subsidy of about L.E. 15 billion over three years.

The subsidies identified in this table were added to the retail prices of diesel and gasoline to arrive at the economic prices for these fuels.

Unit economic values for each VOC component are given in Table 13-11, below. They were derived by the application of relevant conversion factors to financial estimates, which were obtained from inquiries with motor vehicle sales companies, transport operators, insurers and repair shops.

For vehicle maintenance costs, it was assumed that: (a) the cost of lubricants is included in the annual maintenance cost, and (b) that the cost for materials (including spare parts and lubricants) and the cost of maintenance labour would comprise 45% and 55%, respectively,

[4] *The Strategic Urban Development Master Plan Study for a Sustainable Development of the Greater Cairo Region in the Arab Republic of Egypt,* Final Report (Volume 4), page 8-3

[5] After the fuel price increase in May 2008, Egypt still had among the cheapest fuel prices in the world. For example the retail price of gasoline was only L.E. 1.85, or US$ 0.34 per litre, at a time when many developing countries had fuel prices which exceeded US$ 1.00 per litre. Removal of the subsidy would increase this price to L.E. 2.38, or US$ 0.43 per litre, still well below prevailing fuel prices in many countries of the world.

of the annual maintenance cost. Maintenance materials were assumed to be imported and their costs were converted to economic values by the application of a conversion factor of 0.84. Maintenance labour, as a service item, was assumed to carry sales tax of 10% and its cost was therefore converted to an economic value with a conversion factor of 0.91.

Based on information obtained from insurance companies, a standard insurance rate of 4.25% was assumed to apply to new purchases for all types of vehicles. The economic value of insurance was estimated with a conversion factor of 0.91 to the financial value of insurance premiums (to exclude the 10% sales tax).

Table 13-11 Unit Prices for VOC Components

Item	Vehicle type:							
	Private cars	Taxis	Shared taxis (mini-buses)	Small buses	Large buses	Light trucks	Medium trucks	Heavy trucks
New vehicle price								
SPF	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Financial (L.E.)	92,000	92,000	116,600	300,000	650,000	154,490	250,000	850,000
Economic (L.E.)	77,280	77,280	97,944	252,000	546,000	129,772	210,000	714,000
Tyre price								
SPF	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Financial (L,E.)	500	500	400	1,000	2,000	600	900	3,000
Economic (L.E.)	420	420	336	840	1,680	504	756	2,520
Fuel price per litre								
Diesel								
Subsidy			0.74	0.74	0.74	0.74	0.74	0.74
Financial (L,E.)			1.10	1.10	1.10	1.10	1.10	1.10
Economic (L.E.)			1.84	1.84	1.84	1.84	1.84	1.84
Fuel price per litre								
Gasoline 92 octane								
Subsidy	0.53	0.53						
Financial (L,E.)	1.85	1.85						
Economic (L.E.)	2.38	2.38						
Maintenance (annual cost per vehicle in L.E.)								
Financial	1,000	4,000	5,000	5,250	7,500	2,000	2,000	5,000
Economic	878	3,514	4,392	4,612	6,589	1,757	1,757	4,392
Crew cost – (annual wages in L.E.)								
Financial		18,000	18,000	24,000	323,783	18,000	24,000	30,000
Economic		14,400	14,400	109,595	259,026	14,400	19,200	24,000
Insurance cost (annual per vehicle in L.E.)								
SPF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Financial (4.25%)	3,910	3,910	4,956	12,750	27,625	6,566	10,625	36,125
Economic	3,558	3,558	4,510	11,603	25,139	5,975	9,669	32,874

Sources: SDMP study report; consultant's estimates, based on enquiries to motor vehicle sales companies, insurers and vehicle repair shops

Estimates of the unit VOCs per thousand vehicle-kilometre and per vehicle operating hour are given in Table 13-12. They are the result of applying unit input prices from Table 13-11 to the physical operating parameters of Table 13-9.

Fuel, tyre replacement and vehicle maintenance costs were assumed to be wholly distance dependent. Insurance and crew costs for all commercial vehicles were assumed to be

wholly time related. Vehicle depreciation was assumed to be 80-90% distance dependent and 10-20% time dependent.

Tyres were assumed to be replaced every two years for private cars and every year for all other vehicles.

Table 13-12 Estimated Unit Vehicle Operating Costs (VOCs)

Item	Vehicle type:							
	Private cars	Taxis	Shared taxis (mini-buses)	Medium buses	Large buses	Light trucks	Medium trucks	Heavy trucks
Distance related VOC (L.E. per thousand Km)								
Fuel cost	228.48	238.00	253.92	294.40	552.00	294.40	460.00	656.88
Tyre cost	42.00	42.00	26.88	38.64	84.00	40.32	60.48	336.00
Maintenance cost	43.90	43.93	43.92	61.49	87.85	35.14	23.43	58.56
Depreciation cost	236.07	78.43	79.46	199.07	276.99	227.76	206.65	650.25
Sub-total	550.45	402.35	404.18	593.60	1,000.84	597.62	750.56	1,701.69
Overhead rate		15%	15%	20%	20%	25%	35%	35%
Overhead cost	0	60.35	60.63	118.72	200.17	149.40	262.70	595.59
Total	550.45	462.71	464.81	712.32	1,201.01	747.02	1,013.25	2,297.28
Time related VOC (L.E. per hour)								
Crew cost		4.19	3.36	4.05	5.07	11.08	9.85	12.31
Insurance cost	8.90	1.04	1.05	1.63	2.92	4.60	4.96	16.86
Depreciation Cost	39.81	4.24	4.30	3.95	6.38	12.25	12.32	41.03
Sub-total	48.70	9.47	8.71	9.63	14.37	27.92	27.12	70.19
Overhead rate		15%	15%	20%	20%	25%	35%	35%
Overhead cost	-	1.42	1.31	1.93	2.87	6.98	9.49	24.57
Total	48.70	10.89	10.02	11.56	17.24	34.90	36.61	94.76
Annual Km	20,000	80,000	100,000	75,000	75,000	50,000	75,000	75,000
Annual Hours	400	3,433	4,286	4,737	4,737	1,300	1,950	1,950

Sources: SDMP study report; consultant's estimates

Since the transport demand forecasts used as a basis for economic benefit estimation are expressed in terms of PCU-kilometre and PCU-hour (see section 13.3.1), it was necessary to convert the vehicle operating costs in Table 13-12 to PCU-based rates. This was done by weighting costs by vehicle type in relation to both their distribution in the traffic population and to their PCU equivalence.

Table 13-13 and Table 13-14 give the resulting calculations for distance related and time related PCU, respectively.

Table 13-13 Conversion of VOC per Vehicle-km to per PCU-km

Type of vehicle	Actual vehicle distribution by type	PCU factor applicable to vehicle type	PCU distribution by vehicle type	Coefficient	VOC	
					VOC per vkm	Weighted av.VOC per PCU-Km
					L.E.	L.E.
Car	0.529	1	0.5290	0.4805	0.55	0.26
Taxi	0.172	1	0.1720	0.1562	0.46	0.0723
Shared Taxi	0.151	1.5	0.2265	0.2057	0.46	0.0956
Minibus						0.0000
Public Bus	0.019	2.5	0.0475	0.0431	1.99	0.0858
Private bus						0.0000
Pick-up	0.063	1	0.0630	0.0572	0.46	0.0266
2-Axle	0.018	2	0.0360	0.0327	0.75	0.0244
3-Axle					1.01	0.0000
>3-Axle	0.003	2.5	0.0075	0.0068	2.40	0.0164
Motor cycle	0.04	0.3	0.0120	0.0109		0.0000
Other	0.005	1.5	0.0075	0.0068		0.0000
Average per PCU-Km	1.000		1.1010	1.0000		0.5856

Sources: Cairo Metro Line 4 Traffic Survey 2009 (Vehicle Distribution); JICA Study Team estimates (VOC data).

Table 13-14 Conversion of VOC per Vehicle-hour to per PCU-hour

Type of vehicle	Actual vehicle distribution by type	PCU factor applicable to vehicle type	PCU distribution by vehicle type	Coefficient	VOC	
					VOC per v-hr	Weighted av.VOC per PCU-Hr
					L.E.	L.E.
Car	0.529	1	0.5290	0.4805	48.69	23.39
Taxi	0.172	1	0.1720	0.1562	10.89	1.7014
Shared Taxi	0.151	1.5	0.2265	0.2057	10.02	2.0620
Minibus						0.0000
Public Bus	0.019	2.5	0.0475	0.0431	85.91	3.7065
Private bus						0.0000
Pick-up	0.063	1	0.0630	0.0572	10.02	0.5735
2-Axle	0.018	2	0.0360	0.0327	34.90	1.1411
3-Axle					36.61	0.0000
>3-Axle	0.003	2.5	0.0075	0.0068	94.76	0.6455
Motor cycle	0.04	0.3	0.0120	0.0109		0.0000
Other	0.005	1.5	0.0075	0.0068		0.0000
Average per PCU-Hour	1.000		1.1010	1.0000		33.2248

Sources: Cairo Metro Line 4 Traffic Survey 2009 (Vehicle Distribution); JICA Study Team estimates (VOC data).

(ii) Travel time savings

Travel time savings typically represent a major economic benefit of mass transit projects. In this F/S, travel time savings have been estimated both for mass transit and remaining road users. The former receives a direct benefit as a result of much faster mass transit trip times and while latter receives an indirect benefit resulting from faster average road speeds the transfer of traffic from the roads to the mass transit system.

VOT savings is conventionally based on household income data with different rates on different categories of commuters. This reflects the likelihood that bus passengers will value time differently from private car occupants, while mass transit passengers will value their time differently from the other two groups of commuters.

Benefits resulting from the reduction of travel time will be estimated by applying travel time values to the difference between the person-hours estimated for urban transport network in the "with" and "without" project cases.

In this F/S, estimates of urban travel time values are based on household income estimates derived from a household opinion survey conducted by the SDMP study team between June and July 2007. The SDMP study extended base estimates of value of time up until 2027 at the rates of increase forecast for GDRP per Capita. For the purposes of the F/S, it was necessary to re-cast the SDMP estimates on the basis of revised per capita GDRP growth projections (as outlined in Section 3.1.4 of FS Report 1) and to extend the forecast to 2050.

The socio-economic framework used to forecast household income and the average income per worker in the study area is given in Table 13-15.

Table 13-15 Socio-Economic Framework in the Study Area

Indicator		Unit	2006	2007	2008	2009	2010	2011	2012	2020	2030	2040	2050
Population		1000	16,101	16,464	16,836	17,217	17,606	18,004	18,411	21,639	25,387	28,801	31,815
No.of Households		1000	4,007	4,097	4,190	4,284	4,381	4,480	4,582	5,385	6,318	7,168	7,918
Household Size		Persons/household	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02
Average age of HH members		Years	28.70	29.00	29.18	29.36	29.54	29.72	29.90	31.68	32.80	33.97	35.17
Labour force		1000	4,613	4,777	4,915	5,056	5,202	5,352	5,506	6,858	8,427	10,005	11,475
Unemployment		%	7%	6%	6%	6%	6%	6%	6%	5%	5%	4%	4%
No.of Workers	Primary	1000	260	266	275	283	288	296	306	380	463	551	627
	Secondary	1000	1,667	1,741	1,797	1,849	1,895	1,950	2,014	2,517	3,064	3,642	4,138
	Tertiary	1000	2,384	2,467	2,547	2,620	2,707	2,785	2,876	3,619	4,477	5,412	6,251
	Total	1000	4,310	4,475	4,620	4,753	4,890	5,031	5,196	6,515	8,006	9,605	11,016
GRDP		Million L.E.	148,648	159,202	170,665	178,344	187,083	196,812	208,620	372,070	731,918	1,310,753	2,135,078
GRDP per Capita		L.E. per capita	9,232	9,670	10,137	10,359	10,626	10,932	11,331	17,194	28,831	45,510	67,110
Household Income		L.E. per household	1,072	1,134	1,189	1,215	1,246	1,282	1,329	2,016	3,381	5,337	7,870
No.workers in household		worker/household	1.08	1.09	1.10	1.11	1.12	1.12	1.13	1.21	1.27	1.34	1.39
Worker's income		L.E. per worker	997	1,038	1,078	1,095	1,117	1,142	1,172	1,667	2,668	3,983	5,657

Sources: SDMP study; consultant's estimates

The survey-derived household income data on which average values of time were based are given in Table 13-16. The average number of working hours per month used to calculate the average monthly income for workers in area was assumed to be 176 (22 working days per month x 8 hours per day).

Table 13-16 Average Monthly and Hourly Income for Workers in the Study Area

Item		Unit	2007	2008	2009	2010	2011	2012	2020	2030	2040	2050
Household Income	Low and Middle Income Households	L.E./month	748	784	801	822	846	877	1330	2230	3520	5191
	High Income Household	L.E./month	2,985	3129	3198	3280	3375	3498	5308	8900	14049	20717
	High and Middle Income Households	L.E./month	1,322	1386	1416	1453	1495	1549	2351	3942	6222	9175
Workers in household		Workers/HH	1.09	1.10	1.11	1.12	1.12	1.13	1.21	1.27	1.34	1.39
Worker's Income	Low and Middle Income Workers	L.E./month	685	711	722	736	753	773	1,099	1,760	2,627	3,731
	High Income Workers	L.E./month	2,733	2,838	2,882	2,939	3,005	3,085	4,387	7,024	10,484	14,890
	High and Middle Income Workers	L.E./month	1,210	1,257	1,277	1,302	1,331	1,366	1,943	3,111	4,643	6,595
Working Hours per Month		Hours/month	176	176	176	176	176	176	176	176	176	176
Worker's Hourly Income	Low and Middle Income Workers	L.E./hour	3.89	4.04	4.10	4.18	4.28	4.39	6.25	10.00	14.93	21.20
	High Income Workers	L.E./hour	15.53	16.12	16.38	16.70	17.08	17.53	24.93	39.91	59.57	84.60
	High and Middle Income Workers	L.E./hour	6.88	7.14	7.25	7.40	7.56	7.76	11.04	17.67	26.38	37.47

Sources: SDMP study; consultant's estimates

Since it is likely that different categories of commuters will value their time differently, it is necessary to calculate a factor reflecting the weighted average distribution of commuter trips according to trip purpose, to convert hourly income into time values. This factor, which was derived from the SDMP demand survey, was found to be 75.5% (see Table 13-17). The factor was used with the hourly income data in the above table to calculate the average values of time for the three main commuter categories: public transport users, car users and taxi and shared taxi users.

Table 13-17 Weighted Distribution of Commuter Trips by Trip Purpose

Trip Purpose	Share (%)	Weight	Weighted Distribution (%)
Work	44.0	1.0	44.0
Business	7.0	1.0	7.0
Study	28.9	0.5	14.5
Private	20.1	0.5	10.1
Total	100.0	3.0	75.5

Source: SDMP study report
Note: The summation of the weighted shares of commuter trips by purpose (75.5%) represents the factor used for conversion of average worker income to average values of travel time.

The resulting time value estimates are given in Table 13-18. These estimates assume that:

- Public transport users are mostly from the middle and low income groups;
- Car users are predominantly from the high income group; and
- Taxi and shared taxi users (including air conditioned bus users) are mostly from the high and middle income groups

Table 13-18 Estimated Value of Travel Time, by Commuter Category, in the Study Area

Commuter category	Assumed income category	Unit	2007	2008	2009	2010	2011	2012	2017	2020	2022	2030	2040	2050
Public Transport Users	Middle and low	L.E./hour/person	2.94	3.05	3.10	3.16	3.23	3.32	4.13	4.72	5.182	7.55	11.27	16.01
Car Users	High	L.E./hour/person	11.72	12.17	12.37	12.61	12.89	13.23	16.5	18.82	20.68	30.13	44.98	63.88
Taxi and shared taxi users	High and middle	L.E./hour/person	5.19	5.39	5.48	5.58	5.71	5.86	7.3	8.34	9.158	13.34	19.92	28.29

Sources: SDMP study report; consultant's estimates.

To calculate the value of time savings for the remaining road users, it was necessary to convert the above unit values of time estimates to rates per PCU-hour. The same method was used for this purpose as was used with the conversion of VOC estimates. The resulting estimates of the weighted average value of travel time per PCU-hour in each of the forecast reference years are given in Table 13-19 below. These estimates were applied to the savings in PCU-hours to calculate the stream of travel time benefits for road users.

Table 13-19 Conversion of VOT per Person-Hour to per PCU-Hour (Remaining Road Users)

Type of vehicle	Actual vehicle distribution by type	PCU factor applicable to vehicle type	PCU distribution by vehicle type	Coefficient	Av. occupancy per vehicle (no.persons)	Av. occupancy per PCU (no.persons)	2010		2017		2022		2030		2040		2050	
							Value of time	Weighted av. value of time	Value of time	Weighted av. value of time per	Value of time	Weighted av. value of time	Value of time	Weighted av. value of time	Value of time	Weighted av. value of time	Value of time	Weighted av. value of
							L.E./pers.hr	L.E./pers.hr	L.E./pers.hr	L.E./pers.hr	L.E./pers.hr	L.E./pers.hr	L.E./pers.hr	L.E./pers.hr	L.E./pers.hr	L.E./pers.hr	L.E./pers.hr	L.E./pers.hr
Car	0.529	1	0.5290	0.4805	1.9	0.91	12.61	6.06	16.49	7.92	20.68	9.94	30.13	14.48	44.98	21.61	63.88	30.69
Taxi	0.172	1	0.1720	0.1562	2.0	0.31	5.58	0.87	7.30	1.14	9.16	1.43	13.34	2.08	19.92	3.11	28.29	4.42
Shared Taxi	0.151	1.5	0.2265	0.2057	11.0	2.26	5.58	1.15	7.30	1.50	9.16	1.88	13.34	2.75	19.92	4.10	28.29	5.82
Minibus						0.00												
Public Bus	0.019	2.5	0.0475	0.0431	55.0	2.37	3.16	0.14	4.13	0.18	5.18	0.22	7.55	0.33	11.27	0.49	16.01	0.69
Private bus						0.00												
Pick-up	0.063	1	0.0630	0.0572	1.0	0.06	3.16	0.18	4.13	0.24	5.18	0.30	7.55	0.43	11.27	0.64	16.01	0.92
2-Axle	0.018	2	0.0360	0.0327	1.0	0.03	3.16	0.10	4.13	0.14	5.18	0.17	7.55	0.25	11.27	0.37	16.01	0.52
3-Axle						0.00												
>3-Axle	0.003	2.5	0.0075	0.0068	2.0	0.01	3.16	0.02	4.13	0.03	5.18	0.04	7.55	0.05	11.27	0.08	16.01	0.11
Motor cycle	0.04	0.3	0.0120	0.0109	1.0	0.01	3.16	0.03	4.13	0.05	5.18	0.06	7.55	0.08	11.27	0.12	16.01	0.17
Other	0.005	1.5	0.0075	0.0068	1.0	0.01	3.16	0.02	4.13	0.03	5.18	0.04	7.55	0.05	11.27	0.08	16.01	0.11
Average per PCU	1.000		1.1010	1.0000		5.9824		8.5766		11.2185		14.0665		20.4963		30.5953		43.4524
						Weighted av. per PCU-hour		51.31		67.11		84.15		122.62		183.03		259.95

Sources: Cairo Metro Line 4 Traffic Survey 2009 (Vehicle Distribution); JICA Study Team (VOT data).

It was assumed that passengers would be attracted to the metro from cars, buses and shared taxis in proportion to the shares of these three modes in the forecasted passenger volume for Greater Cairo in the "without" project case. Thus, estimates of travel time savings for metro users were based on unit rates, derived as the weighted average of the time values for car, bus and shared taxi passengers in each of the forecast reference years. The resulting unit values are given in Table 13-20.

Table 13-20 Estimates of Value of Travel Time for Metro Users

Item	Forecast reference year			
	2020	2023	2027	2050
Demand forecasts - Greater Cairo (Without Project)				
Car passengers (no.)	7,323,339	8,310,657	9,586,006	19,275,792
Bus passengers (no.)	13,116,175	13,170,879	12,944,028	16,730,764
Shared taxi passengers (no.)	1,439,039	1,453,928	1,596,994	2,167,889
Total (no.)	21,878,553	22,935,464	24,127,028	38,174,445
Demand distribution - Greater Cairo				
Car passengers	33.5%	36.2%	39.7%	50.5%
Bus passengers	59.9%	57.4%	53.6%	43.8%
Shared taxi passengers	6.6%	6.3%	6.6%	5.7%
Total	100.0%	100.0%	100.0%	100.0%
Estimated value of travel time (L.E./hr)				
Car passengers	19.00	21.86	26.59	63.88
Bus passengers	4.76	5.48	6.66	16.01
Shared taxi passengers	8.42	9.68	11.77	28.29
Weighted average value of travel time (L.E./hr)				
Car passengers	6.36	7.92	10.56	32.25
Bus passengers	2.85	3.15	3.57	7.02
Shared taxi passengers	0.55	0.61	0.78	1.61
Total (assumed VOT for metro users)	***9.77***	***11.68***	***14.92***	***40.88***

Sources: Transport demand forecast of Metro Line 4 feasibility study; JICA Study Team

(iii) Reduced air pollution

Reduced emissions from road vehicles similarly represents a potentially significant economic benefit of mass transit system development, especially so in a city of the size and traffic density of Cairo.

This benefit is of two types:

- Savings from reduced vehicle emissions of GHGs, such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), which add to global warming; and

- Savings from reduced vehicle emissions of noxious gases and particulate matter, such as sulphur dioxide (SO_2), PM_{10}, nitrogen oxides (NO_x), carbon monoxide (CO) and Volatile Organic Hydrocarbons (VOH), which are harmful to health.

Both types of emissions are a product of fuel combustion and their tonnage can therefore be calculated at a rate per litre of fuel consumed (as is usual for GHG emissions), or at a rate per vehicle-km (as is usual for emissions of noxious gases and particulate matter).

a. Fuel savings attributed to the metro project

Savings in the consumption of hydrocarbon fuels, which may be directly attributed to the project, are reflected in both reduced vehicle operating costs and reduced atmospheric emission of GHGs, noxious gases and particulate matter. Estimates of the total quantity of

fuel saved by diversion of traffic from the urban road network to metro were made by applying a rate of fuel consumed per PCU-km to the forecasted saving in PCU-km. This in turn was calculated by comparison of traffic circulation volumes in “with” and “without” project cases.

The rate of fuel consumption per PCU-km used for the estimation of fuel savings was calculated as the weighted average of fuel consumption rates for the various vehicle types, as shown in Table 13-21.

Table 13-21 Calculation of Fuel Consumption per PCU-km

Type of vehicle	Actual vehicle distribution by type	PCU factor applicable to vehicle type	Fuel Type	PCU distribution by vehicle type	Coefficient	Fuel consumption	
						Actual rate	Weighted average rate
						(Litres/'000 km)	(Litres/'000 km)
Car	0.529	1	Gasoline	0.5292	0.4806	96	46.1355
Taxi	0.172	1	Gasoline	0.1717	0.1560	100	15.5962
Shared Taxi	0.151	1.5	Diesel	0.2262	0.2054	138	28.3472
Minibus							0.0000
Public Bus	0.019	2.5	Diesel	0.0468	0.0425	550	23.3906
Private bus							0.0000
Pick-up	0.063	1	Diesel	0.0632	0.0574	110	6.3149
2-Axle	0.018	2	Diesel	0.0368	0.0334	160	5.3497
3-Axle							0.0000
>3-Axle	0.003	2.5	Diesel	0.0081	0.0074	400	2.9509
Motor cycle	0.040	0.3	Gasoline	0.0120	0.0109	20	0.2178
Other	0.005	1.5	Diesel	0.0071	0.0064	160	1.0248
Average per PCU-km	1.000			1.1011	1.0000		129.3276

Sources: Cairo Metro Line 4 Traffic Survey 2009 (vehicle distribution); JICA Study Team (fuel consumption data).

It was earlier observed (see section 13.3.1) that the metro would reduce the volume of traffic circulation on the urban road network of Greater Cairo by only 0.4-0.6% over the forecast period. The fuel savings associated with this reduction are therefore estimated to represent a similar proportionate reduction in the total fuel consumed on the urban road network. In volume terms, traffic diversion to full scale metro is expected to result in a fuel saving rising from 17 million litres in 2020 to 67 million litres in 2050. It is estimated that this saving is split between diesel and gasoline in the ratio of 52%:48%.

a. Reduction of GHG emissions

Since the global warming effects of GHG emissions are widespread, it is not practical to measure concentrations of such emissions at specific locations. Instead, typical emission rates related to different fuel types are used as basis for estimating the overall reduction in GHG emissions over the forecast period; by applying the relevant rates to estimates of the volume of fuel saved (see above).

Recent studies suggest that a typical CO_2e (CO_2 equivalent) emission rate for a gasoline fuelled mid-size car is about 2.3-2.4 kg/l of fuel consumed and for diesel fuelled trucks and buses about 2.6-2.7 kg/l. For the purposes of this study, emission rates recorded in tail-pipe tests in Canada[6] have been used, these being 2.469 kg/l of gasoline and 2.793 kg/l of diesel fuel consumed.

As shown in Table 13-22, weighted average emission rate per litre for all vehicle types was calculated for application to the estimated fuel saving for Greater Cairo, to arrive at estimates of physical reduction in GHG emissions.

Table 13-22 Weighted Average Rate of GHG Emissions per Litre of Fuel Consumed

Type of vehicle	Actual vehicle distribution by type	PCU factor applicable to vehicle type	PCU distribution by vehicle type	Coefficient	Kg.CO2eq/litre	
					Emission rate (Kg/litre)	Weighted av. emissions rate (Kg/litre)
Car	0.529	1	0.5292	0.4806	2.469	1.1865
Taxi	0.172	1	0.1717	0.1560	2.469	0.3851
Shared Taxi	0.151	1.5	0.2262	0.2054	2.793	0.5737
Minibus					2.793	0.0000
Public Bus	0.019	2.5	0.0468	0.0425	2.793	0.1188
Private bus					2.793	0.0000
Pick-up	0.063	1	0.0632	0.0574	2.793	0.1603
2-Axle	0.018	2	0.0368	0.0334	2.793	0.0934
3-Axle						0.0000
>3-Axle	0.003	2.5	0.0081	0.0074	2.793	0.0206
Motor cycle	0.040	0.3	0.0120	0.0109	2.469	0.0269
Other	0.005	1.5	0.0071	0.0064	2.793	0.0179
Average rate per litre	1.000		1.1011	1.0000		2.5832

Sources: (1) Victoria Transport Policy Institute, *Climate Change Emission Valuation for Transportation Economic Analysis, 02 January 2009*
(2) http://www.environment.gov/au/settlements/transport/fuelguide/environment.html
Australian Department of the Environment, Water, Heritage and the Arts

The resulting estimate was that the full scale project would reduce GHG emissions ranging from 44,000 tonnes in 2020 to 174,000 tonnes in 2050. This estimate must be qualified in one very important sense. Normally, the reduction in emissions generated by a mass transit project should offset by the level of emissions attributable to the project's consumption of electricity from the regional or national grid. In this case, owing to the lack of any robust measurement of the emission rates of the electric power grid in Cairo, it was not possible to determine the likely size of such an offset.[7]

[6] As reported in Victoria Transport Policy Institute (VTPI): *Climate Change Emission Valuation for Transportation Economic Analysis,* 02 January 2009.

[7] A preliminary assessment undertaken for this feasibility study has shown that emission rates for power generation of between 0.5 and 0.7 kg of CO_2e per Kwh might apply to the CML 4 project, but these estimates cannot be used with a sufficient degree of confidence.

b. Reduction of Noxious Gas and Particulate Emissions

An estimate of reduction in emissions of noxious gases and particulate matter attributable to the Cairo Metro Line 4 project was obtained by application of a weighted average emission rate per PCU to the estimated reduction in PCU-km.

Unlike greenhouse gas emissions, the emission of noxious gases and particulate matter has a localized impact which may be measured at specific sites within the study area. Measurements of ambient air quality have been undertaken for this F/S (see Chapter 9 dealing with environmental and social considerations). However, more detailed studies are required if the objective is to determine the level of pollutant emissions by individual vehicle types.

Since such detailed assessments were beyond the scope of this F/S, estimates of emission rates were accessed from a JICA sponsored project on improvement of regional air pollution control and management in Egypt. As shown in Table 13-23, a selection of emission rates for different vehicle types, based on detailed studies conducted in various countries, was excerpted from a related study report. [8]

Table 13-23 Estimated Emission Factors in Grams per Kilometre

Type of Vehicle	Type of Pollutant		
	NO_x	SO_2[1]	PM_{10}
Car	1.600[4]	0.010	0.110[2]
Taxi	1.680[4]	0.012	0.116[2]
Shared Taxi	4.330[3]	0.027	1.408[2]
Mini	4.330[3]	0.027	1.408[4]
Public	4.763[3]	0.030	2.872[3]
2-Axle	19.327[3]	0.031	4.329[4]
3-Axle	20.206[3]	0.032	4.525[4]
> 3-Axle	21.084[3]	0.034	4.722[4]

Notes:
1. Sulphur content of gasoline is considered to be 50 wt.ppm and of diesel 150 wt.ppm.
2. Expert estimation based on emission factors for Iran, Malaysia, USEPA and spot data from South Africa.
3. Based on Chassis Dynamometer test, conducted in Malaysia.
4. Expert estimation based on emission factors of Malaysia.

Source: JICA Study Team

These emission rates were converted to rates per PCU-km, as shown in Table 13-24.

[8] JICA and EEAA: *Mobile Emission Sources Inventory Survey and Emission Loads, Vehicles in Delta Region,* September 2008 (Component 1), for Regional Air Pollution Control Management System Improvement Project.

Table 13-24 Conversion of Emission Factors per VKM to per PCU-Km - Noxious gases and Particulate Matter

Type of vehicle	Coefficient	NO_x		SO_2		PM_{10}	
		Emission rate (grams/km)	Weighted av. emissions rate (grams/km)	Emission rate (grams/km)	Weighted av. emissions rate (grams/km)	Emission rate (grams/km)	Weighted av. emissions rate (grams/km)
Car	0.4806	1.6004	0.769116575	0.010	0.0048058	0.110	0.0528635
Taxi	0.1560	1.6804	0.26207907	0.012	0.0018715	0.116	0.0180916
Shared Taxi	0.2054	4.3303	0.889505272	0.027	0.0055462	1.408	0.2892232
Minibus		4.3303		0.027		1.408	0.0000000
Public Bus	0.0425	4.7633	0.202575402	0.030	0.0012759	2.872	0.1221415
Private bus		4.547		0.028		1.478	0.0000000
Pick-up	0.0574	17.570	1.008666614	0.028	0.0016074	3.935	0.2259023
2-Axle	0.0334	19.327	0.64620465	0.031	0.0010365	4.329	0.1447415
3-Axle		20.206		0.032		4.525	0.0000000
>3-Axle	0.0074	21.0843	0.155544955	0.034	0.0002508	4.722	0.0348356
Motor cycle	0.0109	0.21	0.002287203	0.005	0.0000545	0.205	0.0022327
Other	0.0064	0.231	0.001479518	0.027	0.0001729	0.226	0.0014475
Average per PCU-Km	1.0000		3.93745926		0.0166215		0.8914795

Source: JICA and EEAA: *Mobile emission Sources Inventory Survey and Emission Loads,* September 2008 for Regional Air Pollution Control Management System Improvement Project.

It was estimated that the full scale project would reducein emissions of noxious gases and particulate matter in Greater Cairo of 642 tonnes in 2020, rising to 2,517 tonnes in 2050.

c. Valuation of Reduction in Atmospheric Emissions

While fairly robust indicators are available for the measurement of the physical volume of emissions, both of GHG and noxious gases from vehicles, the valuation of emissions presents a particular problem. This is especially so where a carbon trading market does not operate, or where there are no monetary measurements of the local damage from emissions of noxious gases in the country under study. Egypt does not have a carbon trading scheme, nor indeed is there any similar scheme operating in the Middle East, and, thus, there have been no studies of monetary consequences from atmospheric pollution in Cairo.

For these reasons, the valuation of road vehicle emissions in Cairo is based on the European Union Emissions Trading Scheme in the case of GHG emissions; and on data from a World Bank study on energy and environment in Egypt for emissions of noxious gases and particulate matter.[9]

The valuation of greenhouse gas emissions in line with the price of European carbon emission permits (or EUAs) is considered valid for two reasons. First, they represent the willingness to pay for the right to emit greenhouse gases and, thus, are an appropriate market measure of value. Second, since the effects of the GHG emissions are widespread, there will be a tendency for global carbon prices to converge towards the prices established in the European Carbon Trading Scheme, which is the largest and longest established of the world's carbon markets.

For the purposes of valuing the reduction in GHGs, which is attributed to the Cairo Metro Line 4 project, the December 2009 benchmark price of EUAs was used. This price was

[9] World Bank and EEAA: *The Energy-Environment Review,* 2002.

€14.75, equivalent to LE120.51, per tonne (Source: Carbon Positive (http://www.carbonpositive.net), Carbon Trading Prices 29/10/09).

The valuation of noxious gas and particulate emissions is more problematical, since the effects of noxious gas emissions are specifically related to the number of receptors (or exposed persons); the extent to which their health is impaired; and the extent to which their health impairment will be reflected in increased medical costs. Clearly, the measurement of these effects requires substantial amounts of time and resources, which may explain why no such studies have been conducted in Cairo to date.

This F/S makes use of the unit values of noxious gas and particulate emissions as estimated in the World Bank study of 2002. Estimates of the damage costs from emission of certain pollutants in Egypt were given in this study as shown in Table 13-25. These estimates were inflated to 2009 values based on the trend in per capita health expenditures in Egypt[10], as also shown in this table.

Table 13-25 Estimates of Air Pollution Damage Costs in Egypt

Pollutant	Value (L.E. per tonne) as at July 2002	Value (L.E. per tonne) as at July 2008
PM_{10}	16,000	**33,046**
NO_x	2,200	**4,544**
SO_2	6,800	**14,045**
CO	700	**1,446**
NMVOC's	1.80	**3.72**

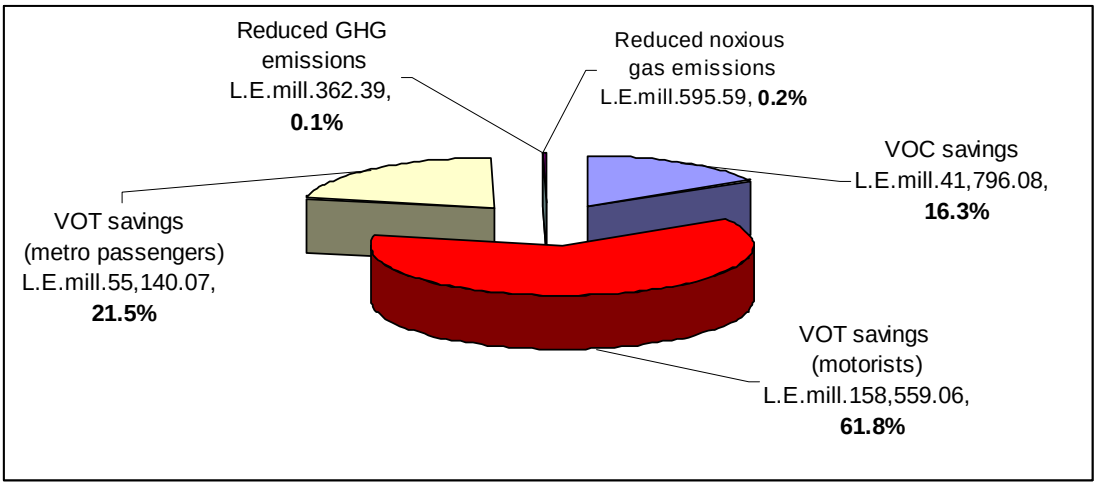
Sources: World Bank and EEAA: *The Energy-Environment Review 2002;* JICA Study Team's estimate

The benefits of reduced air pollution by the project were estimated by comparing and valuing the volumes of pollutants emitted by road traffic in the "with" and "without" project cases.

(iv) Summary and Significance of Economic Benefits

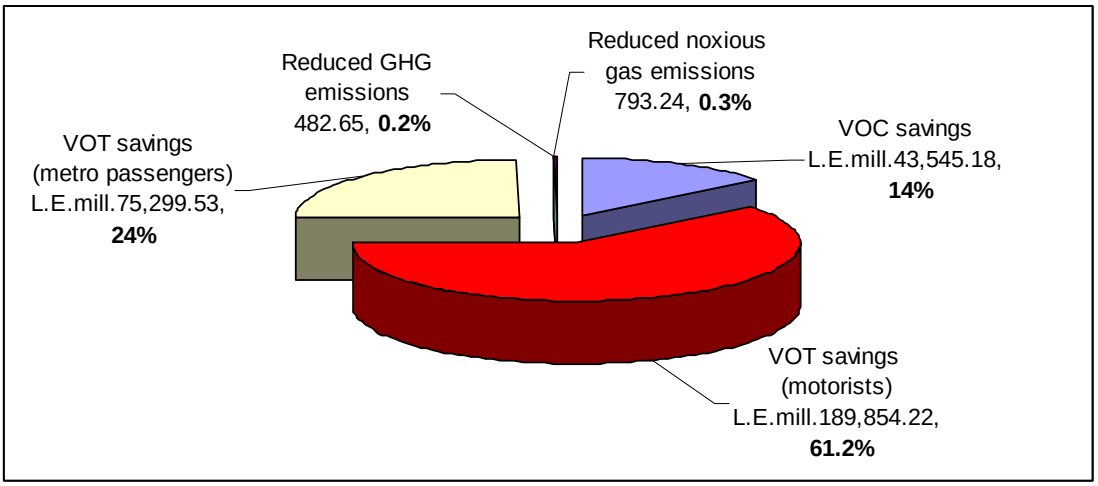
The estimated economic benefits of the Cairo Metro Line 4 projects are depicted respectively in Figure 13-2 and Figure 13-3 for the Phase 1 and combined Phases 1 and 2 route sections, respectively.

[10] Between 2002/03 and 2007/08, per capita Health Expenditures were estimated to have increased from L.E. 72.61 to L.E. 149.97, equivalent to a growth factor of 2.065.



Source: JICA Study Team

Figure 13-2 Distribution of Economic Benefits by Type (2020-2050) for Phase 1 Route Section Only



Source: JICA Study Team

Figure 13-3 Distribution of Economic Benefits by Type (2020-2050) for Phases 1 and 2 route

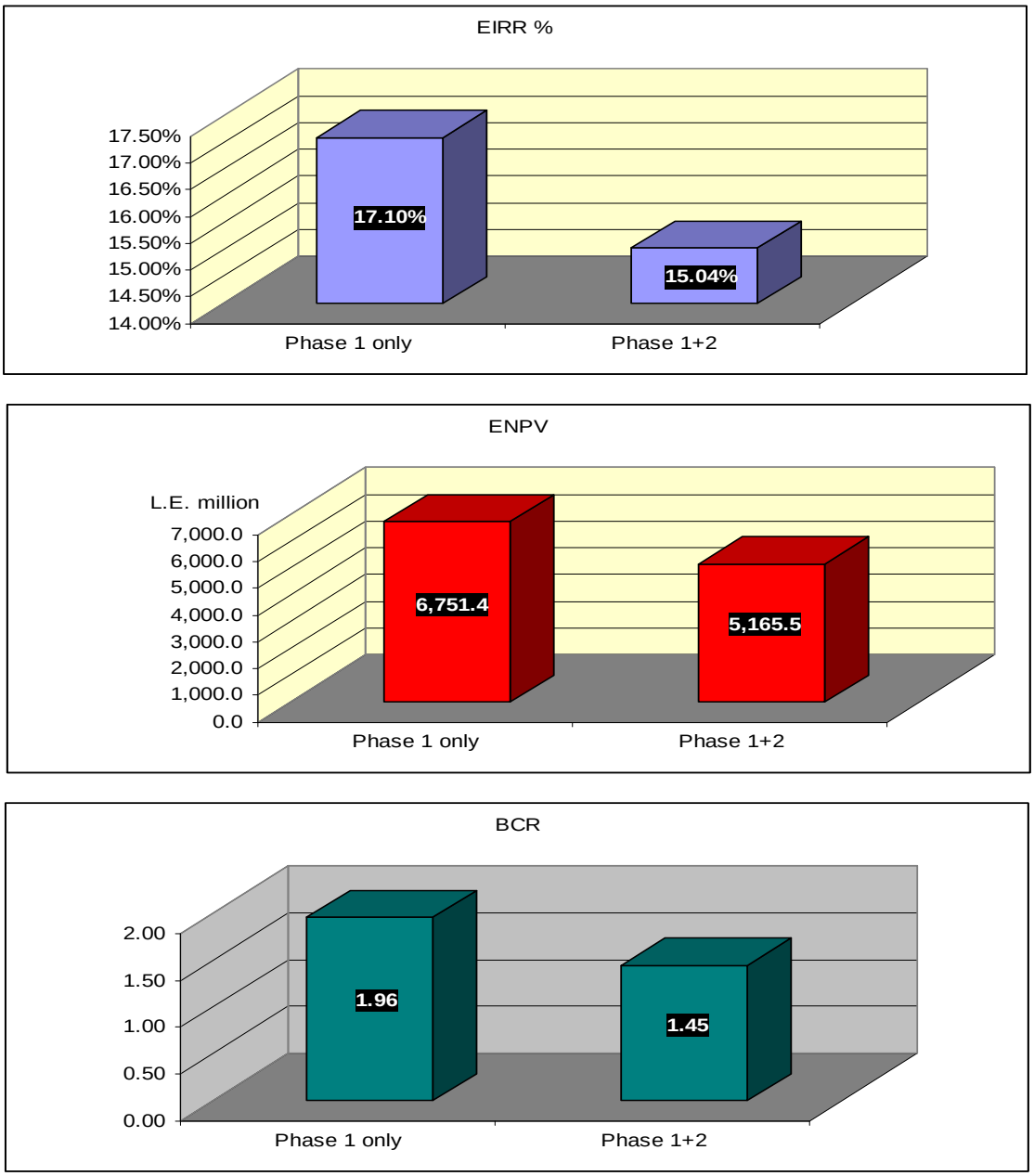
In both cases, VOT savings for motorists are estimated to account for by far the greatest share (more than 60%) of the project's consolidated economic benefits. In combination with savings in the VOT for metro passengers, this element is estimated to comprise 83-85% of the project's overall economic benefits. Project F/S conducted within the past 12 months in Bangkok and Panama City indicated that VOT savings comprise a similar proportion of total economic benefits. This was after allowing for the much higher cost of fuel in that particular year, which tended to inflate the share of VOC savings in the overall economic benefits of these projects.

Savings in VOCs from the Cairo Metro Line 4 project was estimated to account for a significantly smaller share (14-16%) of overall economic benefits than was the case for other recently evaluated projects, where VOC savings comprised 23-30%. This reflects of that fuel prices in Egypt are very cheap, which even after removal of subsidies are still substantially lower fuel prices than in most developing countries.

Finally, environmental benefits from reduced GHGs, noxious gas and particulate emissions are estimated to comprise an almost negligible share of total benefits. This is because the diversion of traffic from urban roads to the metro will have a very small impact on the reduction of road traffic circulation in Greater Cairo.

13.3.3 Results of Economic Appraisal

The results of the economic appraisal are given in detail for Phase 1 route section only in Table 13-26 and for Phases 1 and 2 routes combined in Table 13-27, while the key indicators, Economic Internal Rate of Return (EIRR), Economic Net Present Value (ENPV), and Benefit Cost Ratio, are depicted in Figure 13-4.



Source: JICA Study Team

Figure 13-4 Key Economic Indicators for Cairo Metro Line 4 Project

These results show that in both cases may generate robust economic returns, with EIRRs of at least 15% and positive ENPVs. These results are in line with economic returns which are typical of urban mass transit projects in many countries.

The results are stronger for the Phase 1 only than for the combined Phase 1 and Phase 2. The demand forecast for Phase 1 reflects stronger ridership attraction due to fewer transport alternatives than in Phase 2.

Table 13-26 Analysis of Net Economic Benefits – Phase 1 Route Section only

Year	Cost Flows (L.E.Million)											Benefit Flows (L.E. million)						
	Tunnel	Civil Works (except tunnel)	E&M	Rolling Stock -initial inv.	Rolling Stock -refurb.	Rolling Stock -replace	Land Acquisition & Resett.	Utility Relocation	Construction Supervision	O&M Costs	**Total Costs**	VOC Savings	VOT savings - motorists	VOT savings - metro pax.	Environmental savings GHG	Environmental savings Noxious gases & PM	**Total Benefits**	***Net Benefit***
2011	0.0	0.0	0.0	0.0	0.0	0.0	113.9	115.3	0.0		229.2						0.0	***-229.2***
2012	14.6	357.0	0.0	0.0	0.0	0.0	56.1	115.3	26.0		569.0						0.0	***-569.0***
2013	197.9	1113.1	0.0	0.0	0.0	0.0	0.0	0.0	91.8		1402.8						0.0	***-1402.8***
2014	366.6	1428.5	214.1	0.0	0.0	0.0			140.6		2149.9						0.0	***-2149.9***
2015	351.9	1387.0	472.2	0.0	0.0	0.0			154.8		2365.9						0.0	***-2365.9***
2016	168.6	631.4	704.1	443.1	0.0	0.0			136.3		2083.4						0.0	***-2083.4***
2017	0.0	263.5	723.3	443.1	0.0	0.0			100.1		1530.0						0.0	***-1530.0***
2018	0.0	0.0	371.3	443.1	0.0	0.0			57.0		871.5						0.0	***-871.5***
2019	0.0	0.0	0.0	443.1	0.0	0.0			31.0		474.1						0.0	***-474.1***
2020				84.4	0.0	0.0			0.0	98.9	183.3	569.3	1144.5	308.9	5.3	8.8	2036.8	***1853.5***
2021				0.0	0.0	0.0				92.8	92.8	593.6	1244.8	348.7	5.6	9.2	2201.9	***2109.1***
2022				0.0	0.0	0.0				94.3	94.3	618.0	1349.2	390.9	5.9	9.6	2373.6	***2279.3***
2023				0.0	0.0	0.0				99.5	99.5	956.9	1481.2	435.5	6.1	10.1	2889.8	***2790.3***
2024				84.4	0.0	0.0				94.3	178.7	986.5	1720.7	513.8	6.9	11.4	3239.4	***3060.7***
2025				84.4	0.0	0.0				83.0	167.4	1016.0	1976.7	598.3	7.8	12.8	3611.5	***3444.1***
2026				84.4	0.0	0.0				84.8	169.2	1045.6	2249.0	689.0	8.6	14.1	4006.3	***3837.1***
2027				0.0	0.0	0.0				86.6	86.6	1075.2	2537.6	785.9	9.4	15.5	4423.6	***4337.0***
2028				0.0	0.0	0.0				86.6	86.6	1112.1	2744.3	875.0	9.7	16.0	4757.1	***4670.5***
2029				84.4	0.0	0.0				86.6	171.0	1149.1	2958.9	968.2	10.1	16.5	5102.7	***4931.8***
2030				0.0	0.0	0.0				88.4	88.4	1186.1	3181.5	1065.5	10.4	17.1	5460.5	***5372.2***
2031				84.4	0.0	0.0				88.4	172.8	1223.1	3445.1	1167.0	10.7	17.6	5863.5	***5690.8***
2032				0.0	0.0	0.0				90.2	90.2	1260.1	3718.7	1272.7	11.0	18.1	6280.7	***6190.5***
2033				0.0	0.0	0.0				90.1	90.1	1297.0	4002.4	1382.5	11.4	18.7	6712.0	***6621.9***
2034				168.8	1181.6	0.0				90.1	1440.6	1334.0	4296.1	1496.5	11.7	19.2	7157.6	***5717.0***
2035				0.0	59.1	0.0				93.4	152.5	1371.0	4599.9	1614.7	12.0	19.8	7617.3	***7464.9***
2036				0.0	0.0	0.0				93.4	93.4	1408.0	4913.7	1737.0	12.4	20.3	8091.3	***7997.9***
2037				84.4	0.0	0.0				93.4	177.8	1445.0	5237.5	1863.5	12.7	20.8	8579.4	***8401.7***
2038				0.0	0.0	0.0				95.2	95.2	1481.9	5571.4	1994.1	13.0	21.4	9081.8	***8986.6***
2039				0.0	59.1	0.0				95.2	154.2	1518.9	5915.3	2128.9	13.3	21.9	9598.3	***9444.1***
2040				84.4	59.1	0.0				95.2	238.6	1555.9	6269.2	2267.8	13.7	22.5	10129.0	***9890.4***
2041				0.0	59.1	0.0				97.0	156.1	1592.9	6691.0	2410.9	14.0	23.0	10731.8	***10575.8***
2042				0.0	0.0	0.0				97.0	97.0	1629.9	7125.7	2558.2	14.3	23.5	11351.6	***11254.6***
2043				84.4	0.0	0.0				97.0	181.4	1666.8	7573.1	2709.6	14.6	24.1	11988.3	***11806.9***
2044			214.1	0.0	59.1	0.0				98.8	372.0	1703.8	8033.2	2865.2	15.0	24.6	12641.9	***12269.9***
2045			472.2	0.0	0.0	0.0				98.8	571.0	1740.8	8506.2	3025.0	15.3	25.2	13312.4	***12741.4***
2046			704.1	84.4	59.1	0.0				98.8	946.4	1777.8	8991.9	3188.9	15.6	25.7	13999.9	***13053.5***
2047			723.3	0.0	0.0	0.0				100.6	823.9	1814.7	9490.4	3357.0	16.0	26.2	14704.3	***13880.4***
2048			371.3	0.0	0.0	0.0				100.6	471.9	1851.7	10001.7	3529.2	16.3	26.8	15425.7	***14953.8***
2049			0.0	84.4	118.2	443.1				100.6	746.2	1888.7	10525.8	3705.6	16.6	27.3	16164.0	***15417.7***
2050	-708.3	-1482.8	-4970.2	-225.1	-248.1	-413.6	-170.0	-230.6	-737.6	102.4	-9083.9	1925.7	11062.6	3886.1	16.9	27.9	16919.2	***26003.1***
Totals	391.2	3697.7	0.0	2644.5	1406.1	29.5	0.0	0.0	0.0	2911.5	11080.5	41796.1	158559.1	55140.1	362.4	595.6	256453.2	***245372.7***
	1099.6	5180.5	2485.1	2278.8	0.0	0.0	170.0	230.6	737.6		12182.2							

Residual value, rolling stock - init pu (assumed life: 15 years)	225.1
Residual value, rolling stock - refurb (assumed life: 15 years)	248.1
Residual value, rolling stock - replac (assumed life: 15 years)	497.9595
Residual value, tunnel (assumed life: 100 years)	708.3
Residual value, civil works excluding tunnel (assumed life: 50 years)	1482.8
E&M equipment	4970.2

Indicators of economic worth

NPV (L.E.mill)	**6,751.4**
EIRR	**17.10%**
BCR	**1.96**
Cost flows disc.at 12% (L.E.mill.)	**7057.7**
Benefit flows disc.at 12% (L.E.mill.	**13809.1**

Source: JICA Study Team

Table 13-27 Analysis of Net Economic Benefits – Combined Phase 1 and 2 Routes

Year	Cost Flows (L.E.Million)											Benefit Flows (L.E. million)						
	Tunnel	Civil Works (except tunnel)	E&M	Rolling Stock -initial inv.	Rolling Stock -refurb.	Rolling Stock -replace	Land Acquisition & Resett.	Utility Relocation	Construction Supervision	O&M Costs	**Total Costs**	VOC Savings	VOT savings - motorists	VOT savings - metro pax.	Environmental savings GHG	Environmental savings Noxious gases & PM	**Total Benefits**	***Net Benefit***
2011	0.0	0.0	0.0	0.0	0.0	0.0	113.9	115.3	0.0		229.2						0.0	***-229.2***
2012	14.6	357.0	0.0	0.0	0.0	0.0	56.1	115.3	26.0		569.0						0.0	***-569.0***
2013	197.9	1113.1	0.0	0.0	0.0	0.0	0.0	0.0	91.8		1402.8						0.0	***-1402.8***
2014	366.6	1428.5	214.1	0.0	0.0	0.0	0.0	0.0	140.6		2149.9						0.0	***-2149.9***
2015	351.9	1387.0	472.2	0.0	0.0	0.0	47.5	0.0	154.8		2413.4						0.0	***-2413.4***
2016	168.6	631.4	704.1	443.1	0.0	0.0	95.0	69.3	136.3		2247.7						0.0	***-2247.7***
2017	0.0	593.9	723.3	443.1	0.0	0.0	47.5	69.3	123.2		2000.3						0.0	***-2000.3***
2018	61.1	1074.1	371.3	443.1	0.0	0.0	0.0	0.0	136.5		2086.2						0.0	***-2086.2***
2019	339.0	1361.3	70.1	1434.8	0.0	0.0	0.0	0.0	224.4		3429.6						0.0	***-3429.6***
2020	370.5	1136.7	690.5	991.7	0.0	0.0	0.0	0.0	223.3	98.9	3511.6	569.3	1144.5	308.9	5.3	8.8	2036.8	***-1474.8***
2021	155.6	710.9	859.5	991.7	0.0	0.0	0.0	0.0	190.2	92.8	3000.7	593.6	1244.8	348.7	5.6	9.2	2201.9	***-798.8***
2022	0.0	0.0	659.0	991.7	0.0	0.0	0.0	0.0	115.5	94.3	1860.5	618.0	1349.2	390.9	5.9	9.6	2373.6	***513.1***
2023				0.0	0.0	0.0			0.0	218.9	218.9	1056.0	2323.5	811.5	12.9	21.3	4225.3	***4006.4***
2024				168.8	0.0	0.0				213.7	382.5	1075.8	2498.9	895.2	13.1	21.5	4504.5	***4122.1***
2025				0.0	0.0	0.0				203.4	203.4	1095.6	2679.4	982.4	13.2	21.7	4792.4	***4589.0***
2026				0.0	0.0	0.0				203.4	203.4	1115.3	2865.1	1073.2	13.4	22.0	5089.0	***4885.6***
2027				0.0	0.0	0.0				203.4	203.4	1135.1	3055.8	1167.6	13.5	22.2	5394.2	***5190.9***
2028				0.0	0.0	0.0				203.5	203.5	1172.0	3301.2	1288.2	13.8	22.8	5797.9	***5594.4***
2029				0.0	0.0	0.0				203.5	203.5	1208.9	3555.8	1413.3	14.2	23.3	6215.4	***6012.0***
2030				0.0	0.0	0.0				203.5	203.5	1245.7	3819.8	1543.0	14.5	23.8	6646.8	***6443.4***
2031				0.0	0.0	0.0				203.5	203.5	1282.6	4132.8	1677.2	14.8	24.3	7131.7	***6928.2***
2032				168.8	0.0	0.0				203.8	372.6	1319.5	4457.4	1815.9	15.1	24.9	7632.8	***7260.3***
2033				0.0	0.0	0.0				207.1	207.1	1356.4	4793.8	1959.2	15.5	25.4	8150.2	***7943.2***
2034				0.0	1181.6	0.0				207.1	1388.7	1393.3	5141.9	2107.0	15.8	25.9	8683.8	***7295.2***
2035				0.0	59.1	0.0				207.1	266.1	1430.1	5501.7	2259.4	16.1	26.4	9233.7	***8967.6***
2036				0.0	0.0	0.0				207.1	207.1	1467.0	5873.2	2416.2	16.4	27.0	9799.9	***9592.8***
2037				0.0	2658.6	0.0				207.1	2865.7	1503.9	6256.4	2577.7	16.7	27.5	10382.2	***7516.6***
2038				0.0	0.0	0.0				207.1	207.1	1540.8	6651.3	2743.6	17.1	28.0	10980.9	***10773.8***
2039				0.0	118.2	0.0				207.1	325.2	1577.7	7058.0	2914.1	17.4	28.6	11595.7	***11270.5***
2040				0.0	0.0	0.0				207.1	207.1	1614.6	7476.4	3089.2	17.7	29.1	12226.9	***12019.8***
2041				0.0	0.0	0.0				207.1	207.1	1651.4	7975.4	3268.8	18.0	29.6	12943.3	***12736.2***
2042				0.0	0.0	0.0				207.1	207.1	1688.3	8489.4	3452.9	18.3	30.1	13679.1	***13472.0***
2043				0.0	0.0	0.0				207.1	207.1	1725.2	9018.3	3641.5	18.7	30.7	14434.4	***14227.3***
2044			214.1	0.0	0.0	0.0				207.1	421.1	1762.1	9562.1	3834.7	19.0	31.2	15209.1	***14788.0***
2045			472.2	0.0	0.0	0.0				207.1	679.3	1799.0	10120.9	4032.4	19.3	31.7	16003.3	***15324.0***
2046			704.1	0.0	0.0	0.0				207.1	911.2	1835.8	10694.5	4234.7	19.6	32.3	16816.9	***15905.7***
2047			723.3	0.0	118.2	0.0				207.1	1048.5	1872.7	11283.0	4441.5	19.9	32.8	17650.0	***16601.4***
2048			371.3	0.0	0.0	0.0				207.1	578.4	1909.6	11886.5	4652.8	20.3	33.3	18502.5	***17924.1***
2049			70.1	0.0	0.0	1434.8				207.1	1712.0	1946.5	12504.9	4868.7	20.6	33.8	19374.5	***17662.5***
2050	-1353.7	-3252.4	-7319.3	0.0	-480.5	-1339.1	-360.0	-369.2	-1562.6	207.1	-15829.8	1983.4	13138.2	5089.1	20.9	34.4	20265.9	***36095.7***
Totals	672.2	6541.5	0.0	6076.8	3655.1	95.7	0.0	0.0	0.0	6073.5	23114.8	43545.2	189854.2	75299.5	482.7	793.2	309974.8	***286860.1***
	2025.9	9793.9	4764.1	6076.8	0.0	0.0	360.0	369.2	1562.6		24952.5							

Residual value, rolling stock - init purch (assumed life: 15 years) 0.0

Residual value, rolling stock - refurb. (assumed life: 15 years) 480.5

Residual value, rolling stock - replace (assumed life: 15 years) 2330.8396

Residual value, tunnel (assumed life: 100 years) 1353.7

Residual value, civil works excluding tunnel (assumed life: 50 years) 3252.4

E&M equipment (assumed life: 30 years) 8009.8

Indicators of economic worth

NPV (L.E.mill)	**5,165.5**
EIRR	**15.04%**
BCR	**1.45**
Cost flows disc.at 12% (L.E.mill.)	**11558.7**
Benefit flows disc.at 12% (L.E.mill.)	**16724.2**

Source: JICA Study Team

13.3.4 Sensitivity Analysis

Table 13-28 and Table 13-29 present results of the sensitivity testing of the project economic results to changes in key cost and benefit variables for both project cases considered.

Five sensitivity tests were carried out for both cases, involving, respectively, an increase of 20 % in project capital costs; a decrease of 20 % in project benefits; a combined increase of 20 % in capital costs and a 20 % reduction in benefits; a variation in the discount rate from 12% to 8%; and a doubling of fuel prices.

Table 13-28 Sensitivity Analysis of Economic Results for Phase 1 only

Item	Base factor	New Factor	Change	NPV (L.E. Mill.)	EIRR (%)	Sensitivity Indicator		Switching Value (%)		Remarks
						NPV	EIRR	NPV	EIRR	
Base case				6,751.4	17.10%					
ST1: Investment cost + 20%	12,182.2	14,618.6	20%	5,393.7	15.65%	1.01	1.42	99%	70%	Increased investment cost
ST2: Benefits - 20%	256,453.2	205162.6	-20%	3,989.5	15.29%	2.05	1.77	49%	56%	Reduced total benefit stream
ST3: Investment cost + 20% AND Benefits - 20%	245,372.7	192,448.3	-22%	2,631.8	13.94%	2.83	2.87	35%	35%	Reduced net benefit stream
ST4: Discount rate of 8%	12.00%	8.00%	-33%	23,284.0	17.11%	7.35		14%		Reduced discount factor
ST5: Doubling of fuel prices	41,796.1	43,659.6	4%	6,877.8	17.19%	0.42	0.37	238%	270%	Increased VOC stream
Cut-off EIRR	**12.00%**									

Source: JICA Study Team's estimate

Table 13-29 Sensitivity Analysis of Economic Results for Phases 1 and 2 Combined

Item	Base factor	New Factor	Change	NPV (L.E.Mill.)	EIRR (%)	Sensitivity Indicator		Switching Value (%)		Remarks
						NPV	EIRR	NPV	EIRR	
Base case				5,165.5	15.04%					
ST1: Investment cost + 20%	24,952.5	29,943.0	20%	2,955.2	13.54%	2.14	2.46	47%	41%	Increased investment cost
ST2: Benefits - 20%	309,974.8	247979.9	-20%	1,820.6	13.16%	3.24	3.09	31%	32%	Reduced total benefit stream
ST3: Investment cost + 20% AND Benefits - 20%	286,860.1	221,456.8	-23%	-389.6	11.78%	4.72	4.70	21%	21%	Reduced net benefit stream
ST4: Discount rate of 8%	12.00%	8.00%	-33%	23,477.8	15.04%	10.64		9%		Increased NPV, BCR
ST5: Doubling of fuel prices	43,545.2	46,027.1	6%	5,345.2	15.13%	0.61	0.57	164%	175%	Increased VOC stream
Cut-off EIRR	**12.00%**									

Source: JICA Study Team

Both Sensitivity Indicators (SIs) and Switching Values (SVs) were used to indicate the sensitivity of the Base Case results to changes in the key variables.

In relation to the ENPV, SIs compare the percentage change in the ENPV with the percentage change in the relevant variable. SIs compare the percentage change in the EIRR, above the cut-off rate, with the percentage change in the relevant variable. The smaller the SI, the less the sensitivity of the indicator to changes in the relevant variable.

In relation to the ENPV, the SVs indicate the change required in the relevant variable to reduce the ENPV to zero (0). SVs indicate the percentage change required in the relevant

variable to equate EIRR with the cut-off rate (or discount rate). By contrast with SI, the higher the SV, the less the sensitivity of the indicator to changes in the relevant variable.

By definition, SV is the reciprocal of the SI. SIs and SVs calculated in relation to EIRR yield slightly different results when compared with SIs and SVs calculated in relation to the ENPV. This is because the IRR approach discounts all future net benefits at the IRR value and the NPV approach at the chosen discount rate.

Several significant observations may be made about the results of the sensitivity analysis:

(i) *In both cases, sensitivity tests revealed that EIRR results in particular were quite robust – in other words, the EIRR does not change significantly even when there are large changes in the key variables.*

(ii) *For Case 1 (construction of the Phase 1 section only), no sensitivity test resulted in EIRR dropping below the assumed cut-off rate of 12%. Only the third test (ST3) was the EIRR moderately sensitive to changes in the key variables.*

(iii) *For Case 2 (construction of the entire Phase 1 and 2 route), only the combined variation of project costs and benefits (in ST3) resulted in the EIRR falling below the cut-off rate of 12% and the ENPV negative.* This represents an extreme case which would have a small probability of occurrence.

(iv) *In both cases, the ENPV proved quite sensitive to reducing discount rate.*

(v) *In neither case was the EIRR sensitive to a doubling of fuel prices (and an associated increase in vehicle operating costs).* This result was expected given the cheap fuel prices in Egypt (with fuel currently accounting for less than 20% of VOC).

13.4 Financial Appraisal

This section describes the methodology, assumptions and results of financial appraisals undertaken in the case of the Phase 1 only section and of the entire route (incorporating both the Phase 1 and Phase 2 sections).

13.4.1 Methodology

A full financial appraisal of the Cairo Metro Line 4 project has been carried out. This appraisal comprises:

- *A detailed Discounted Cash Flow (DCF) analysis of the two project cases*, where Case 1 involves the construction of the Phase 1 route section only; and Case 2 covers the construction of the combined Phase 1 and Phase 2 sections. The DCF analysis involves a comparison between expected cash inflows (revenues) and cash outflows (costs) for both projects over the evaluation period from 2011-2050[11], to compute indicators of its financial worth. These indicators include the Financial Internal Rate of Return (FIRR), Net Present Value (NPV), and Return on Equity (ROE), otherwise known as Return on Investment.
- *Sensitivity tests* to assess the sensitivity of the project financial indicators to changes in the key cost and income variables, including (a) changes in the structure and level of fares; (b) addition of non-fare revenue; and (c) variations in project capital and O&M costs.

[11] 2013-2050 in the case where the project is financed by a Normal ODA Loan

The *base* DCF analysis undertaken for both project cases assumes that fares for Line 4 will be set at the current level of fares in force on the Cairo Metro and that the project would be financed by an ODA STEP Loan. These assumptions are relaxed to consider alternatives in the Sensitivity Analysis. In particular, comparative DCF analyses were undertaken of the Phase 1 project financed respectively by a STEP Loan and by an ODA General Loan, to determine which financing alternative will produce the most favourable results.

The positive cash flows of the project comprise fare box revenue (and for sensitivity testing purposes) income from alternative sources, such as property leasing and advertising.

The negative cash flows of the project comprise its capital, financing and O&M costs. The project's capital costs were estimated by the engineering specialists of JST following finalization of the route alignment, project specifications and construction schedule. The project's O&M costs were estimated as an output of the Train Operating Plan, which was prepared by the JST's operations specialist on the basis of transport demand forecast.

13.4.2 Assumptions Underlying the DCF Analysis

The principal assumptions underlying the DCF analysis include those related to the escalation of costs and revenues.

All project costs and revenues were initially estimated in November 2009 values and, for the purposes of the DCF analysis. were escalated over the project evaluation period at the rates shown in Table 13-30 below.

Table 13-30 Escalation Rates Assumed for DCF Analysis

Item	Applicable period	Assumed rate
Land value	Entire period (2011-2050)	5% p.a.
Capital cost (not including land)	First 5 years Next 7 years Thereafter	5% p.a. 4% p.a. 3% p.a.
O&M costs	First 2 years Next 4 years Next 9 years Thereafter	10% p.a. 7% p.a. 5% p.a. 4% p.a.
Exchange rate variation	First 3 years Next 5 years Next 2 years Thereafter	3% p.a. 2% p.a. 1% p.a. 0% p.a.
Revenue	Entire period (2011-2050)	12.5% every 3 years

Source: JICA Study Team

The level of domestic inflation provides a starting indicator of the rate of price escalation of the local cost component. In Egypt, domestic inflation rates have recently been very high, of the order of 10% per annum. High rates of domestic inflation are not consistent with a sustained high rate of economic growth. For this reason, it is considered that inflation rates will fall to around 5% per annum by the time construction starts (in 2012), and will further decline to 4% over the construction period. For the foreign cost component, rates of inflation in the exporting countries were assumed to provide indicators of cost escalation. Little information is available on these, but typically, they have been considerably lower than in Egypt (e.g. recently Japan has been experiencing *domestic deflation*, although this

is not reflected in the average value of its exports). Initially foreign price escalation was assumed to be about 5%, falling to 4% by 2023, and 3% thereafter.

In calculating the after tax cash flow from operations, a Business (or Corporate Profits) tax rate of 20% was used.[12]

13.4.3 Passenger Demand Forecasts used as Basis for Cost and Revenue Estimation

The passenger demand forecasts used as basis for cost and revenue estimation in this F/S have been described in detail in Chapter 2 of this report and are summarized respectively for the and combined Phase 1 and 2 projects in Table 13-31 and Table 13-32 below.

Table 13-31 Passenger Demand Forecasts for Phase 1 Only

Forecast reference year	Passenger no. per day	Passenger-km per day	Average trip distance (Km)	Max PPHPD*
2020	1,377,600	3,230,766	4.69	29,940
2023	1,402,800	3,308,806	4.72	30,350
2027	1,717,000	4,547,569	5.30	36,600
2050	2,151,500	6,504,522	6.05	52,560

Source: JICA Study Team
* Maximum Passengers Per Hour Per Direction

Table 13-32 Passenger Demand Forecasts for Phases 1 and 2 Combined

Forecast reference year	Passenger no.per day	Passenger-km per day	Average trip distance (Km)	Max PPHPD*
2020	1,377,600	3,230,766	4.69	29,940
2023	3,077,200	10,379,397	6.75	50,760
2027	3,501,600	15,256,998	8.71	53,470
2050	4,085,400	18,731,775	9.17	55,750

Source: JICA Study Team
* Maximum Passengers Per Hour Per Direction

13.4.4 Project Capital and O&M Cost Estimates

The capital and O&M costs forming the cash outflows of the project are summarized in Section 13.2.1 of this chapter. These outflows were assumed to apply in 2011, which is the first year of cost disbursement.

13.4.5 Project Revenue Estimates

For the base DCF analysis, cash inflows, representing only revenue from fares, were assumed to be generated by the project starting in 2020, which is the first year of operation. It was assumed that fares would be set at the current level for the Cairo metro, i.e. a flat fare of LE1.00 per passenger. Three other revenue alternatives were included in the sensitivity analysis of the project's financial results. These were: (a) application of a distance based fare; (b) addition of non-fare revenue; and (c) a combination of (a) and (b). The following sections describe the approach used for the estimation of revenue for the base and sensitivity cases:

[12] The new Tax Law 91/2005 sets the annual tax rate payable by normal companies on net profits at 20%. Exceptions are the Suez Canal Authority, the Public Petroleum Company and the Central Bank of Egypt which are required to pay profits tax at higher rates and a list of specified organizations, including government ministries and authorities, which are exempted.

(i) Structure and Level of Existing Metro Fares

The starting point for the analysis of fare alternatives is the current level of average fare revenue and the current structure and level of fares.

Revenue data provided to JST by the Egyptian Company for Metro (ECM) for the 2007/08 financial year are given in Table 13-33.

Table 13-33 Cairo Metro – Number of Passengers and Revenue for 2007/08

Item	Amount
Total revenue from daily ticket sales (million LE)	323.64
Revenue from quarterly ticket sales (million LE)	47.58
Revenue from yearly ticket sales (million LE)	10.32
Penalty revenue (million LE)	4.91
Total revenue (million LE)	*386.45*
Number of non-concessional passengers (Millions)	325.67 (45%)
Number of concessional passengers (Millions)	391.16 (55%)
Total number of passengers (Millions)	716.83
Average ticket value (normal), LE	0.994
Average ticket value (concessional), LE	0.148

Source: ECM

The key point for the distribution of total ticket sales by type of customer is that purchasers of normal (i.e. non-concessional) daily tickets represent only 45% of the total number of passengers. The remaining 55% travels at concessional fare levels. While the average fare revenue from normal ticket holders is just below one Egyptian pound, the average revenue from concessional ticket holders is less than 15 pilasters. Therefore, overall, the operating company collects average revenue of only 54 (53.77) pilasters per ticket.

Metro fares are varied infrequently. The last major variation was implemented on 14 July 2006, when normal daily ticket prices were increased by 33% from 75 to 100 pilasters. At the time of writing, current fares have been in force for more than three years.

Concessional fares are available to three separate commuter categories: public sector employees; Metro employees; and students, police, blind and other physically handicapped persons. These fares apply to the purchase of quarterly tickets at the current rates as indicated in Table 13-34.

Table 13-34 Cairo Metro – Quarterly Ticket Fare Concessions

No. of stations	Normal price	Concessional ticket holder categories		
		Public sector employees	Metro employees	Students, police, blind/handicapped
	LE	LE	LE	LE
25	107	64	30	22
34	140	84	36	27

Source: ECM
Note: Fares implemented by Decree No 4480 – 315 – 2006 on 14 July 2006.

Weekly and annual fares are also offered for annual tickets. Annual tickets are sold at concessional fare rates to four categories of commuter: private sector employees; public sector employees; press workers/military personnel/police personnel; and persons over 60 years of age. Fares range from LE160 (equivalent to 44 pilasters per day) for press

workers/military personnel/police personnel to LE386 (equivalent to LE1.06 per day) for private sector employees.

It is estimated that the current operating ratio, or the ratio of operating costs to revenue, of the Cairo Metro is approximately 60%[13]. However, while revenue is sufficient to cover O&M costs by a healthy margin, it is understood that it is not sufficient to cover both O&M and asset replacement costs.

For the base DCF analysis, it was assumed that the initial average fare revenue per passenger would be set at the present normal fare level of LE1.00 per passenger trip, to minimize the extent of government subsidy required to provide asset replacement. Nevertheless, if the government intends to maintain the present fare structure, it will be necessary to make up the shortfall between the normal fare level and present average fare of 54 pilasters per trip. This could do by providing a revenue supplement of 46 pilasters per trip.

(ii) Revenue Alternatives

The application of a distance based fare structure and the addition of non-fare revenue were assessed for the purpose of testing the sensitivity of financial results to revenue variations.

Distance-based fares were assumed to be set initially at a level which would equate to an average fare revenue of LE1.00 per passenger. For both project cases, a flat rate, or flag-all, of 50 pilasters per passenger and a distance rate of 21 pilasters per passenger-km would be required to achieve this result. However, with a distance based fare structure, the combined Phase 1 and 2 project has greater potential revenue over the evaluation period than the Phase 1 only project. This is due to the longer trip lengths achieved on average when Phase 2 enters service.

The metro has the potential to generate non-fare income through the leasing of properties near stations for retail activities and through granting advertising rights, as well as in metro cars. Recently, it was reported that a contract had been signed with an advertising agency for the use of metro facilities for advertising space.[14] The contract valued at LE256 million for 10 years, would yield additional revenue equivalent to about 6% of fare revenue. For the purposes of the Sensitivity Analysis ,it was assumed that additional revenue equivalent to 5% of fare revenue would be earned over the operating period from 2020 to 2050.

Table 13-35 and Table 13-36 summarize the annual revenue projections for the base and sensitivity cases in the forecast reference years.

Table 13-35 Revenue Projections – Phase 1 Only Project

Year	Base case fare revenue (flat fare of LE1.00 pax)	Sensitivity case fare revenue (distance based fare of LE0.50/0.21)	Sensitivity case, additional non-fare revenue
	LE million	LE million	LE million
2020	468.3	468.3	23.4

[13] O&M costs as advised by ECM for 2008/09 amounted to L.E. 230.590 million, which when offset against income of about L.E. 387 million would result in an operating ratio of 59%.

[14] Daily News Egypt: *On the right track: Cairo Metro developing under new management,* December 5-6, 2009.

2023	476.9	478.3	23.8
2027	583.7	621.4	29.2
2050	731.4	837.1	36.6

Source: JICA Study Team

Table 13-36 Revenue Projections – Combined Phases 1 and 2 Project

Year	Base case fare revenue (flat fare of LE1.00 pax)	Sensitivity case fare revenue (distance based fare of LE0.50/0.21)	Sensitivity case, additional non-fare revenue
	LE million	LE million	LE million
2020	468.3	468.3	23.4
2023	1,046.1	1,275.3	52.3
2027	1,190.4	1,701.0	59.5
2050	1,388.8	2,052.0	69.4

Source: JICA Study Team

13.4.6 Project Financing Alternatives

The financial appraisal of Cairo Metro Line 4 project includes consideration of alternatives for the financing of the project.

The benchmark for establishing financing alternatives for this project was the terms and conditions applying to Line 3. Details of the project financing terms and conditions applying to Line 3 were obtained from the Finance and Administration Department of the National Authority for Tunnels. These terms and conditions were compared with those likely to be applied to financing through Yen loans provided by the Government of Japan and to other loan instruments available from the African Development Bank and the International Bank for Reconstruction and Development (IBRD).

The terms and conditions applying to loan from these four sources are summarized in Table 13-37 and are described in greater detail in the following sections.

Table 13-37 Terms and Conditions of Loans for Cairo Metro Development

Type/category of loan	Allowable coverage of total project cost	Interest rate	Grace period (years)	Repay-ment period (years)	Conditions for procurement
Loans from France for Phase 1 of Line 3 project					
Low interest government-to-government	Up to €200 million (approx. 37% of project cost)	0.2%	6	18	Tied
Commercial Bank		5.1%	4	10	
Loans from France for Phase 2 of Line 3 project					
Low interest government-to-government	Up to €200 million	0.15%	5	20	Tied
Commercial Bank		Not yet finalized	4	10	
ODA loans from the Government of Japan					
General terms:					
Standard	Up to 85%	1.40%	10	30	Untied
Option 1	Up to 85%	0.80%	6	20	Untied
Option 2	Up to 85%	0.70%	5	15	Untied
STEP					
Standard	Up to 100%	0.20%	10	40	Tied
Option	Up to 100%	0.10%	10	30	Tied
African Development Bank					
Sovereign Guaranteed Loan for Public Sector – *Variable Spread Loans*	Not specified	USD: 0.961% EUR: 1.359% YEN: 0.916%	5	15	Untied
IBRD					
Flexible Loan - Fixed Spread (1)(2)	Not specified	USD: LIBOR + 1.05% EUR: LIBOR + 1.05% YEN: LIBOR + 0.95%	11.5	12.0	Untied

Sources: Finance and Administration Department of NAT; JICA, African Development Bank and IBRD websites.

Notes: (1) LIBOR = London Interbank Offered Rate. This is the floating interest rate at which banks can borrow unsecured funds from other banks in the London wholesale money market. The LIBOR 6 month rate as at 27 November 2009 was 0.484%. IBRD rates shown apply to loans with a maturity of more than 14 years. Lower rates apply to loans with shorter maturity periods.

(2) The Grace period and Repayment periods shown for the IBRD Flexible Loan are those which have recently been applied to a Loan for the Integrated Mass Transit System Development project in Colombia, but the nature of this type of loan is such these conditions may be varied by borrowers, provided that their loans meet the requirement for a weighted average maturity of 18 years.

(i) Conditions for Financing Line 3 Project by the Government of France

Finance for the construction of Line 3 is being provided by France through a low interest government-to-government loan and through commercial bank loans. The government-to-government loan is to be executed through protocols signed by the governments of Egypt and France for the allocation of loans in the amount of €200 million

to each of Phases 1 and 2 of the project. The loans will be applied to the funding of all project components, except rolling stock, which will be financed through an agreement with the Government of Japan, which is currently under negotiation.

Finance from French sources will cover about 54% of the total project cost of Phase 1[15], with the balance being provided by Japanese Yen Loan (for rolling stock procurement) and through equity funding by the Egyptian Government. Financing arrangements for Phase 2 of Line 3 are currently being finalized.

(ii) Terms and Conditions for Japanese ODA Loans

Details of the terms and conditions of potential Japanese Yen Loans are available from the JICA website.[16] Different terms and conditions are applied to different countries depending on the level of their Gross National Income per capita. Egypt falls within the category of "Lower–Middle Income Countries", with a GNI per capita in the range of US$ 936–1,785.

Among the ODA Loans, the categories that are relevant to the Metro Line 4 project are the General Loan with Standard Conditions and the STEP Loan.

General Loans incorporating Standard Conditions have an interest rate of 1.4% per annum, a grace period of 10 years and a loan repayment period of 30 years. In the case of loans of this type, there are no requirements for the project to utilize Japanese technology. .

Projects that are eligible for STEP Loans include projects within specified sectors and fields and for which Japanese technologies and equipment are substantially utilized. The specified sectors and fields include bridges, tunnels and urban mass transit systems. The standard form of loans for this type provides an interest rate of 0.2% per annum, a grace period of 10 years, and a repayment period of 40 years.

(iii) Terms and Conditions for Loans by the African Development Bank (AfDB)

The terms and conditions applying to loans by AfDB are available from its website.[17]

The principal loan instrument offered by AfDB relevant to the Cairo Metro Line 4 project is the Public Sector Sovereign Guaranteed Loan. Loans will qualify for this category if:

- They are made to a Regional Member Country; or
- They are supported by full faith and credit of the Member Country in whose territory the Borrower is domiciled; or
- In the case of loans to multinational institutions, they are guaranteed by a Member Country or by Member Countries in whose territory(ies) the Borrower will execute the project.

Egypt is currently one of fifteen regional member countries that are eligible for Public Sector Sovereign Guaranteed Loans. To date, however, it appears that Egypt has received AfDB

15 Estimated at about L.E. 4,000 million
16 Terms and conditions pertaining to ODA loans can be found at: http://www.jica.go.jp/english/operations/schemes/oda_loans/standard/
17 http://www.afdb.org/en/projects-operations/financial products/

financing mainly in the fields of water supply and sanitation, energy and power supply, and agricultural irrigation and drainage. In the field of transport, AfDB resources seem to have been concentrated on loans for rural road development.

After 21 January 2009, when certain changes were made to its offering of financial products, AfDB's standard product is a Variable Spread Loan, made up of cost of borrowing relative to the London Interbank Offered Rate (LIBOR) and a lending margin or spread. The lending rates shown for the AfDB in Table 13-37 reflect the floating LIBOR base rates as of 13 November 2009.

The AfDB website indicates that maturities on sovereign and non-sovereign guaranteed loans are 20 and 15 years, respectively, including a grace period of up to 5 years. There is no indication on this website on the limitations applicable to AfDB coverage of a project's total cost.

(iv) Terms and Conditions for Loans by the International Bank for Reconstruction and Development (IBRD)

The World Bank Treasury, through its IBRD subsidiary, offers a Flexible Loan, which is claimed to be more competitive and flexible for most public sector borrowers than other financing options available in international financial markets. The terms and conditions of the IBRD are given in the World Bank Treasury website.[18]

The Flexible Loan allows borrowers to customize their repayment terms, including grace period, repayment period, and amortization profile, to meet individual debt management needs. Final repayment can be received up to 30 years from loan commencement, as long as the weighted average repayment period does not exceed 18 years.

As is the case with AfDB finance, Flexible Loan interest rates are based on six month LIBOR rates for major currencies, plus a fixed or variable spread. However, unlike AfDB loans, IBRD Flexible Loans apply a different level of fixed spread above LIBOR depending on the length of maturity period. For example, for a loan in USD, spreads of 0.60%, 0.80% and 1.05% are applied respectively in the case of loan maturities of 10 years and less, greater than 10 years and up to 14 years, and greater than 14 years, respectively. In addition, a front end fee of 0.25% of the loan amount is applied at the beginning of the project.

The website provides no indication of the limitations which might apply to IBRD coverage of a project's total cost. The IBRD had wide experience in establishing loans for urban public transport projects, but it appears there were limitations on the extent of funds provided under Flexible Loan arrangement. Recently it provided a Fixed Spread loan for the second phase of the Integrated Mass Transit Sytems Project in Colombia, but its total commitment of funds for this project represented US$300 million, or 70% of the total project cost of US$429 million. [19]

(v) Evaluation and Selection of Financing Alternatives for Cairo Metro Line 4

[18] http://treasury.worldbank-org/bdm/htm/ibrd.html
[19] This project involves the development of Bus Rapid Transit systems in several Colombian cities.

The financial appraisal of the full scale Cairo Metro Line 4 project has established that the project FIRR, before financing, is likely to be around 2.1% (see following section containing the results of the financial appraisal). By contrast, the economic appraisal of the project shows that it is likely to realize an EIRR of at least 15%.

The poor financial returns of the project are consistent with results estimated for a majority of urban mass transit projects in developing countries, where governments typically constrain revenue generating capacity by imposing low fare levels.

However, the poor financial results of the Line 4 project are also a reflection of its high capital cost and its lengthy construction period. Services will not commence and revenue will not be generated on Line 4 until 7½ years after the first disbursement of loan funds. Repayment of loan amounts cannot therefore be contemplated until the 10th year, when the project is earning revenue. Similarly, financing at extremely low rates of interest, with loan repayments over an extended period, will be required to minimize the burden on the equity party, the Government of Egypt.

With the exception of Japanese ODA funding, the financing alternatives considered in the foregoing section generally suffer from the disadvantages of a low proportionate coverage of project costs, relatively high borrowing costs and short grace and repayment periods.

For these reasons, it is likely that only the terms and conditions under a Japanese ODA loan will provide a suitable basis for the financing of the Cairo Metro Line 4 project. The two candidate loan schemes for financing this project are a STEP Loan, which will effectively tie the borrower to the procurement of Japanese technologies and equipment, and a Normal Loan, which will allow untied procurement but will still offer the advantages of low borrowing costs and extended repayment period.

13.4.7 Financing Assumptions for the DCF Analysis

Accordingly, the financial appraisal has been undertaken on the basis of these two alternatives. A standard STEP Loan has been assumed for the base case assessment of the project's net financial worth and an ODA Normal Loan was assumed for the purpose of a comparative analysis of the financing alternatives, based on the Phase 1 project.

JICA has advised that its financing limit for STEP Loan will be ¥100 billion and for Normal Loan ¥30 billion. JICA has further advised that the balance of the finance for the project, after excluding local equity covering the purchase of land and re-location of public utilities, would be made up by a long term domestic loan, having an interest rate of 3.0% per annum while maintaining the same grace and maturity conditions as the ODA Loan. For Normal Loan, JICA has indicated that the Egyptian Government would cover the cost of BD as its equity contribution to the project capital cost, in addition to cost of land purchase and public utility relocation. As observed in Section 13.2.2, it would be necessary in this case to select a consultant through an International Competitive Bidding Process, to undertake the BD. This would delay the project construction and commencement of revenue services by 24 months, an outcome for which allowance had to be made in the DCF analysis.

In summary, the assumed loan conditions for base and comparative cases are given in Table 13-38.

Table 13-38 Assumed Loan Conditions for Cairo Metro Line 4 Project

Evaluated case	Financing source	Assumed Loan Conditions				
		Cost coverage %	Interest rate %	Grace period (years)	Repayment period (years)	Procurement conditions
Phase 1 project						
Base case	Standard STEP Loan	30.4 (Financing Limit ¥100 billion)	0.2	10	40	Tied
	Long Term Domestic Loan	67.4	3.0	10	40	Not applicable
	Egyptian Government Equity	2.2	Not applicable	Not applicable	Not applicable	Not applicable
Comparative case	Normal Loan, Standard Conditions	8.1 (Financing Limit, ¥30 billion)	1.4	10	30	Untied
	Long Term Domestic Loan	89.2	3.0	10	30	Not Applicable
	Egyptian Government Equity	2.7	Not applicable	Not applicable	Not applicable	Not applicable
Combined Phases 1 and 2 project						
Base case	Standard STEP Loan	37.5 (Financing Limit ¥200 billion)	0.2	10	40	Tied
	Long Term Domestic Loan	59.8	3.0	10	40	Not applicable
	Egyptian Government Equity	2.7	Not applicable	Not applicable	Not applicable	Not applicable

Sources: JICA Head Office and JICA Study Team

In accordance with JICA requirements, it was assumed that interest incurred during the construction phase would be paid during the grace period for all cases.

13.4.8 Results of Financial Appraisal

The net financial worth of the project was measured by the following six indicators, which were estimated both for the Phase 1 only and the combined Phases 1 and 2 projects:

- Project FIRR, before financing
- Project FIRR, after financing
- Return on Equity (ROE)
- NPV at 12% rate of discount, before financing
- NPV at 12% rate of discount, after financing
- NPV to Equity at 12% rate of discount

The project FIRR and NPV before financing measure the overall viability of the project before payment of interest during the construction period. The project FIRR and NPV after financing, on the other hand, measure of the overall viability of the project after payment of interest during the construction period. The ROE and NPV to Equity are measures of net returns to equity investment in the project and are computed from the net cash flow of the project after payment of interest and repayment of loan principal.

(i) Comparative DCF Results for Financing of Phase 1 Project (STEP vs.Normal)

The financial results of the comparison of the two project financing alternatives are given in Table 13-39.

Table 13-39 Comparison of Financial Results for STEP Loan vs. Normal Loan with Standard Conditions - Financing of Phase 1 project

Loan Type	Project FIRR	Project NPV (LE million)	ROE	NPV to Equity (mille million)
STEP Loan	2.85	-7,400	13.89%	163
Normal Loan	1.96	-8,502	Negative	9

Source: DCF Model of JICA Study Team

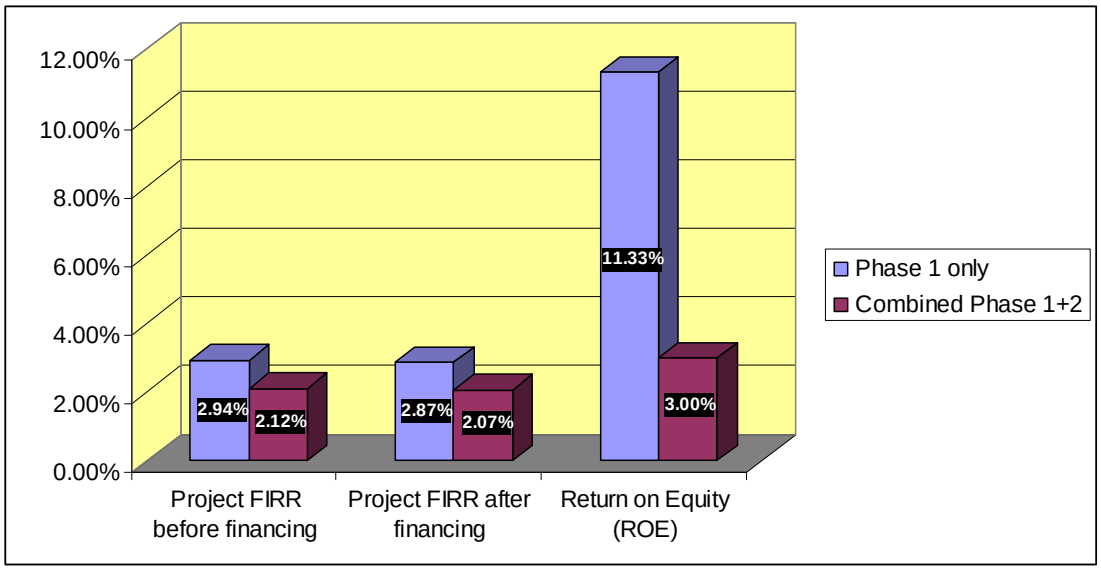
The results indicate a significant advantage of STEP Loan over Normal Loan for the financing of Phase 1 of the Cairo Metro Line 4 project. This advantage is particularly pronounced in terms of the return on equity (ROE and NPV to Equity).

For Normal Loan, the stream of the net cash flow to equity is heavily negative between the middle and end of the evaluation period, reflecting a net commitment of external funds to repay the loan within the specified period of 30 years. The project will not generate sufficient revenue to repay the loan within this period, so that the necessary funds must be provided by the Egyptian Government, which would be required to guarantee repayment of loan. This flow of funds represents a cash outflow to equity.

For STEP Loan, the project will generate sufficient revenue to repay the loan within the longer 40 year period specified for loan repayment.

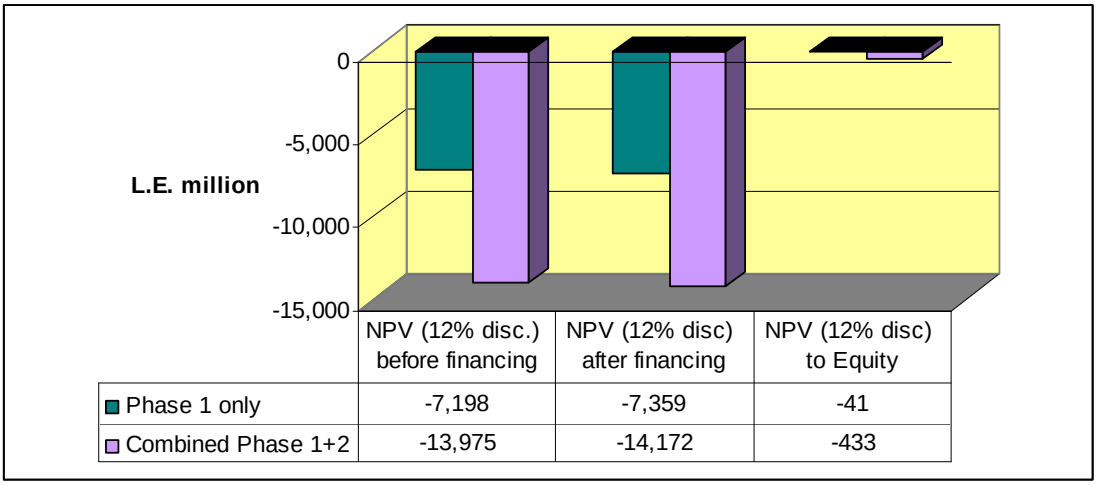
(ii) DCF Results for the Phase 1 Only and Combined Phases 1 and 2 Projects

The results of the financial evaluation of the Base Case in the two project cases are given in Source: JICA Study Team
Figure 13-5 and Source: JICA Study Team
Figure 13-6 below. This evaluation is based on the STEP Loan as the main financing instrument, with co-financing by a long term domestic loan.



Source: JICA Study Team

Figure 13-5 FIRR and ROE Results for Cairo Metro Line 4 Project



	NPV (12% disc.) before financing	NPV (12% disc) after financing	NPV (12% disc) to Equity
Phase 1 only	-7,198	-7,359	-41
Combined Phase 1+2	-13,975	-14,172	-433

Source: JICA Study Team

Figure 13-6 NPV Results for CML-4 Project

The financial appraisal shows that:

- Low FIRR results are likely to be achieved for both project cases, mainly as a result of high capital costs of the project and long time interval between first cost disbursement and receipt of revenue;
- Better FIRR, ROE and NPV results are likely to be achieved for the Phase 1 only project than the combined Phases 1 and 2. This is explained by the stronger ridership potential of the Phase 1 section as compared with the Phase 2 section, where commuters are presented with more choices for public transport;
- Stronger results for the Phase 1 only project raise the possibility that construction and operation of Phase 2 could be further delayed (i.e. beyond the proposed in-service date of 2023), to contain the initial investment in the project to a more manageable level.

13.4.9 Sensitivity Analysis

Table 13-40 and Table 13-41 present the results of the sensitivity testing of the project financial results to changes in key cost and benefit variables for both project cases considered.

In both cases eight sensitivity tests were carried out, involving:

- A 20% increase in project O&M expenditure;
- A 20% increase in project capital expenditure;
- A 20% reduction in project revenue;
- Revenue increase through introduction of distance based fare;
- Revenue increase through addition of non-fare revenue; and
- Revenue increase through distance based fare and addition of non fare revenue

Table 13-40 Sensitivity Analysis of Financial Results for Phase 1 Only

No.	Item	Base factor	New Factor	Change (%)	NPV (L.E.mill.) after finance	FIRR -Project after finance	Return on Equity (ROE)	Sensitivity Indicator		Switching Value (%)	
								NPV	FIRR	NPV	FIRR
	Base case (STEP 85% financing)				-7,358.81	2.87%	11.33%				
	Sensitivity cases *Cost increases and rev. reduction*										
ST 1	OPEX plus 20 %	3,325.78	3,990.93	20%	-7,501.91	2.58%	*Negative*	0.10	0.16	1029%	644%
ST 2	CAPEX plus 20%	23,144.45	27,806.95	20%	-9,372.71	1.79%	*Negative*	1.36	0.58	74%	171%
ST 3	REVENUE less 20%	19,262.38	15,409.91	-20%	-8,019.43	1.23%	*Negative*	0.45	0.89	223%	112%
	Revenue increases										
ST 4	DIST.BASED FARE	19262.38	21045.54	9%	-7,142.68	3.53%	12.70%	0.32	0.79	315%	127%
ST 5	PLUS NON-FARE REVENUE	19262.38	20225.50	5%	-7,193.66	3.23%	10.50%	0.45	0.79	223%	127%
ST 6	DIST.FARE + NON-FARE REV.	19262.38	22097.82	15%	-6,966.72	3.88%	12.65%	0.36	0.76	276%	132%
	Cut-off FIRR	**12.00%**									

Source: JICA Study Team estimate

Table 13-41 Sensitivity Analysis of Financial Results for Phases 1 and 2 Combined

No.	Item	Base factor	New Factor	Change (%)	NPV (L.E.mill.) after finance	FIRR -Project after finance	Return on Equity (ROE)	Sensitivity Indicator		Switching Value (%)	
								NPV	FIRR	NPV	FIRR
	Base case (STEP, JPY 300,000 mill financing)				-14,171.62	2.07%	3.00%				
	Sensitivity cases *Cost increases and rev.reduction*										
ST 1	OPEX plus 20 %	7,016.34	8,419.61	20%	-14,455.90	1.76%	*Negative*	0.10	0.16	997%	641%
ST 2	CAPEX plus 20%	42,720.75	51,327.79	20%	-17,922.17	1.06%	*Negative*	1.31	0.51	76%	197%
ST 3	REVENUE less 20%	35,390.60	28,312.48	-20%	-15,328.51	0.49%	*Negative*	0.41	0.80	245%	125%
	Revenue increases										
ST 6	DIST.BASED FARE	35390.60	50161.79	42%	-12,126.23	4.60%	12.27%	0.35	0.61	289%	164%
ST 7	PLUS NON-FARE REVENUE	35390.60	37229.58	5%	-13,868.48	2.43%	9.68%	0.41	0.70	243%	143%
ST 8	DIST.FARE + NON-FARE REV.	35390.60	52772.48	49%	-11,711.43	4.98%	12.97%	0.35	0.60	283%	168%
	Cut-off FIRR	**12.00%**									

Source: JICA Study Team estimate

The main conclusions drawn from the sensitivity analysis of both project cases are that:

(i) The FIRR, ROE and NPV are vulnerable to increase project capital expenditures and decrease project revenue, but are not so sensitive to increase O&M expenditures;

(ii) Revenue increases through fare restructuring and the addition of non-fare revenue have the potential to improve project returns substantially. With the introduction of a distance based fare. the project FIRR will more than double to 4.60% for project Case 2, but will increase more modestly for project Case 1. The difference between these results is explained by longer trip lengths in project Case 2. Fare restructuring, combined with the addition of non-fare revenue, will more than quadruple the ROE of Case 2 (to a level of 12.97%, which exceeds the target rate of 12%).