Guangfo Connecting Road, Guangzhou
Environmental Management Plan
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LIST OF CONTRIBUTORS TO THE ENVIRONMENTAL ASSESSMENT

Constructor:
Guangzhou Public Utilities Bureau

Author:
Guangzhou Environmental Scientific Research Institute

Director:
H. Gong

Chief Engineer:
X. Cui

Project Manager:
G. P. Xu

Contributors:
G. P Xu
H. Yu
J. H. Zhang
J. Shi
X. S. Huang
X. A. Gu
L. peng
Guangfo Connecting Road, Guangzhou
ENVIRONMENTAL MANAGEMENT PLAN

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ENVIRONMENTAL MANAGEMENT PLAN
For Guangzhou to Foshan (Guangfo) Road Project

1.0 INTRODUCTION

1.1 Project Background

Guangzhou’s inner ring road and the affiliated roads development are a key project in the Guangzhou Urban Center Traffic Improvement Plan (the Plan) to alleviate the highly congested urban center area. The project is to meet the demands of the rapid economic development in Guangzhou and will serve as a part of the traffic congestion solution for the downtown area by providing an undisrupted, high capacity flow for the through traffic. According to the Plan, the outer ring expressway is to connect Guangzhou with cities in the surrounding area and long distance inter-city traffic, while inner ring road is to provide pathways for the through traffic within the city of Guangzhou. The outer and inner ring roads are to be connected using seven “radial” roads in different directions to form an integrated fast road transport network surrounding the city.

The proposed Guangzhou to Foshan (Guangfo) road is one of the seven radial roads connecting the inner and outer ring roads and urban Guangzhou area with Foshan to the west. Located west of the city toward the west ring expressway, the proposed Guangfo road will be one of the major trunk roads in the high speed road network in the Guangzhou area and Pearl River delta. The locations of the inner and outer ring roads and the seven radial connecting roads including Guangfo, are shown in Figure 1-1.

The preparation for all seven radial roads was completed in 1998. During that process, an environmental impact assessment (EIA) for all component roads including Guangfo road had been finished as a single project by Guangzhou Environmental Scientific Research Institute (GESRI), in accordance with the “Environmental Impact Assessment Technical Guide” (HJ/T2.1-2.3-93). The EIA had been reviewed and approved by Guangzhou Environmental Protection Bureau (GEPB) which is the regulatory approval agency for this project in 1998. Over the past four years, three out of the seven radial roads have been constructed and opened for traffic. However, Guangfo road has not been ready for construction until now. The project proponent, Guangzhou City Center Transport Project Office, is seeking World Bank financing to start the construction of Guangfo road as soon as possible.

Clearly, many of the data and assessment in the 1998 EIA report may now be out-dated. In addition, the EIA must also comply and satisfy with relevant World Bank requirements, in particular, OP4.01 which took effective in 1999 and other safeguards policies. The original Terms of Reference (TOR) for EA, which was first prepared by GESRI and approved by GEPB in July 1998, has been updated to reflect the comments from GEPB.
Figure 1-1 Location of Guangfo Road and the Two Ring Roads and Radial Roads
Guangfo Road Environmental Management Plan

as well as World Bank safeguards requirements. The English version of the TOR has been submitted to the World Bank in April, 2002.

According to the revised TOR, additional EA tasks have been conducted since 2001, including the following:

- Field investigation along the project area to understand changes since the last EIA, particularly changes of sensitive receptors;
- Additional environmental baseline monitoring for ambient air, noise and water at selected representative sites along the project area to update the baseline information;
- Collection and review baseline and forecast data including traffic counts and forecast, motor vehicle fleet, etc.;
- Re-run the emission, dispersion and noise models using the updated data;
- Conduct public consultation; and
- Revise the EA documentation including the revision of EIA report.

This EIA report is prepared based on the original report as well as the findings of the above tasks with updated information and additional assessment for Guangfo road. This English version EIA is the translation of the original Chinese report which has been re-submitted to GEPB for reference (no review and approval are necessary as it has been approved in 1998).

On this basis, this Environmental Management Plan (EMP) is developed as an integral part of the EA documentation for Guangfo project.

1.2 Project Overview

Guangfo road is 5.6 km long starting from Zhongshan Balu interchange on the west inner ring road, extends west bound in parallel with the existing road and a railway line (Guangsan railway), intersecting with planned Datansha road, Fangcun boulevard, and ends at the Huangqi interchange on the west outer ring expressway. When completed, it be a quick speed connecting road between two ring roads with controlled access, no same level intersections with other roads.

Guangfo road will be built mostly on elevated viaducts. Starting its east end, Guangfo road will be constructed as two separate, parallel viaducts, one on each side of the existing road and railway. The two lines, Line A and B, will each have three motor vehicle lane in one direction. The two lines will be merged and form a single elevated viaduct at Guocun residential area, approximately two third of the total length from the east end. The design motor vehicle speed on Guangfo road is 80 km/hr.

Guangfo road will intersect with the inner ring road, proposed Datansha road, Fangcun boulevard and the outer ring expressway, with an interchange in each of these intersections. The Zhongshan Balu interchange at the inner ring road and Huangqi interchange at the outer ring expressway have mostly constructed with engineering and structural provisions reserved for Guangfo road connections.
The World Bank financing will be applied to fund the Guangfo road section within the Guangzhou city area, up to the Fangcun boulevard. The other section toward the outer ring expressway, located within the Nanhai city area, will be funded from different sources and possibly constructed in a different stage from the Guangzhou section. However, the EA, with the same standards and requirements, applies to the entire Guangfo road including the both Guangzhou and Nanhai sections. This EMP is also developed for mitigation of the impacts for the whole project area.

1.3 Objectives of EMP

Road construction is a major infrastructure development with profound impacts to social, economic and natural environments. The project EA has identified and assessed major impacts and the EMMP is to develop measures to minimize impacts during the design, construction and operation stages and provide a framework for the implementation of mitigation measures and environmental management and monitoring during project implementation. More specifically, the objectives of EMP are to:

- Identify site specific mitigation measures through field investigation at each of the sensitive receptors and proposed appropriate site specific engineering and management mitigation measures;
- Provide a single source information during project implementation to project proponents, contractors, construction supervision and others associated with the project during construction and operation;
- Identify institutional roles and responsibilities, as well as proposed lines of communications and reporting; and
- Outline environmental monitoring during construction and operation phases to ensure the effectiveness of mitigation measures and to respond to unanticipated environmental issues at an early stage and to determine the accuracy of impact predictions.

1.4 Applicable Regulations and Basis

The EA is conducted based on the following regulations, as well as technical guidelines and policies of state, provincial and municipal governments and the World Bank:

- Environmental Protection Law of PRC;
- Air Pollution Prevention Law of PRC;
- Water Pollution Prevention Law of PRC;
- Noise Pollution Prevention Regulations of PRC;
- Environmental Protection Management for Construction Projects, State Council, November 1998;
- Environmental Protection Guidelines for Construction Projects in Guangdong, Guangdong People’s Congress, No.57, 1994;
- Environmental Protection Guidelines in Guangzhou, Standing Committee of Guangzhou People’s Congress, June 1997;
• Air Pollution Prevention Regulations in Guangzhou, Standing Committee of Guangzhou People’s Congress, April, 1997;
• Noise Pollution Prevention Regulations in Guangzhou, Standing Committee of Guangzhou People’s Congress, April 1997;
• Motor Vehicle Emission Prevention and Control Regulations in Guangzhou, Standing Committee of Guangzhou People’s Congress, No.84, December 1997;
• Air quality zoning of Guangzhou urban area according to functional uses, Guangzhou Municipal Government, No.23, 1999;
• Guangzhou drinking water sources pollution prevention guidelines, Standing Committee of Guangzhou People’s Congress, No.59, April 1997;
• Interim Guangdong surface water zoning according to environmental functions, Guangdong provincial government, No.553, 1999;
• Management Regulation of Guangzhou Green Area, Standing Committee of Guangzhou People’s Congress, December 1996;
• Environmental Protection Management for Construction Projects, Decree No. 253, State Council, November 1998;
• Guangzhou City Master Plan (1991-2010); Guangzhou Municipal Government;
• Guangzhou City Transportation Plan, Guangzhou Planning Bureau;
• Informing to Enhance the EIA Management of Projects Loaded by International Banking Organisations, HJ (1993) No.324;
• The World Bank Operational Policies - Environmental Assessment (OP 4.01);
• Other World Bank safeguards policies, where applicable; and
• Feasibility study report for the Guangfo Project.

1.5 Function Zoning

The environmental zoning is based on the functions of the project as determined by the Guangzhou Municipal Government, based on relevant state and local environmental regulations. The functional zoning, which will be the basis for selection environmental standards for this assessment, is as follows:

• The project area will be Class II zone for ambient air quality;
• The project area is located in Guangzhou’s drinking water protection area which will be the basis for surface water quality standard;
• With regard to noise zoning, areas with schools will be regarded in this EA as Category I noise zone, and residential areas will be classified as Category II noise zone (mixed residential/commercial zone); other areas which are essentially industrial and commercial facilities located immediately adjacent to a busy railway line, is classified as Category IV noise zone (urban trunk road side zone), which is defined as 30 m from the railway and trunk roads.

The functional zoning of the project area applied in this EA, is summarized in Table 1-1.
Table 1-1 Functional Zoning for Project Area

<table>
<thead>
<tr>
<th>No.</th>
<th>Items</th>
<th>Functional Zoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Surface water environment</td>
<td>Drinking water protection zone</td>
</tr>
<tr>
<td>2</td>
<td>Ambient air quality</td>
<td>Category II zone</td>
</tr>
<tr>
<td>3</td>
<td>Noise</td>
<td>Category I for schools and II for residential areas and IV for others</td>
</tr>
<tr>
<td>4</td>
<td>Any agricultural protection zone</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>Scenery protection zone</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>Other land zoning</td>
<td>Gas pipelines, etc.</td>
</tr>
</tbody>
</table>

1.6 Environmental Control Standards

Air

The Class II of the ambient air quality standards of the Environmental Air Quality Standards (GB3095-1006), are applied in the EA according to relevant regulations. The specifics of the Class II standards are presented in Table 1-2.

Table 1-2 Air Quality Standards  unit: mg/Nm³

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
</tr>
<tr>
<td>Yearly average</td>
<td>0.08</td>
</tr>
<tr>
<td>Seasonal average</td>
<td></td>
</tr>
<tr>
<td>Daily average</td>
<td>4.00</td>
</tr>
<tr>
<td>Hourly average</td>
<td>10.00</td>
</tr>
</tbody>
</table>

Vehicle emissions

Table 1-3 Vehicle Emission Standards

<table>
<thead>
<tr>
<th>Type of vehicle</th>
<th>Standard</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO (%)</td>
<td>HC (ppm)</td>
</tr>
<tr>
<td>Gasoline vehicle</td>
<td>New</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>in-use</td>
<td>5.0</td>
</tr>
<tr>
<td>Diesel vehicle</td>
<td></td>
<td>4.5-5 (FSN)</td>
</tr>
</tbody>
</table>

Noise

Based on Zoning of Guangzhou Urban Area According to ‘Standard of Environmental Noise in Urban Area’ the project area includes both Class IV and Class II zones. Basically area immediately adjacent to trunk roads and railways are zoned as Class IV while the mixed residential, education and commercial areas are zoned as Class II, and the corresponding noise standards will be applied to this zones accordingly. Earlier environmental assessment has identified seven sensitive receptors including schools and residential areas some of which are located on the trunk road and railway side. However, to better protect the sensitive receptors, all schools and residential facilities, regardless
which zones they are located, will all apply Class II noise standards, which are the more stringent standards. The standards are listed in Table 1-4. The construction site noise standards are listed in Table 1-5.

<table>
<thead>
<tr>
<th>Class</th>
<th>Scope</th>
<th>Day</th>
<th>Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Schools and hospitals zone</td>
<td>55</td>
<td>45</td>
</tr>
<tr>
<td>II</td>
<td>Residential, commercial and education zones</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>IV</td>
<td>Trunk road and railway side</td>
<td>70</td>
<td>55</td>
</tr>
</tbody>
</table>

Table 1-5 Standards for Noise at Border of Construction Site  unit: dB(A)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Main Noise Source</th>
<th>Day</th>
<th>Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth and stone</td>
<td>Bulldozer, excavator, fork-lift truck</td>
<td>75</td>
<td>55</td>
</tr>
<tr>
<td>Pile Driving</td>
<td>Pile driver</td>
<td>85</td>
<td>use prohibited</td>
</tr>
<tr>
<td>Structure</td>
<td>Concrete mixer, vibration pile driver, electric saw</td>
<td>70</td>
<td>55</td>
</tr>
<tr>
<td>Set up</td>
<td>Crane, elevator</td>
<td>65</td>
<td>55</td>
</tr>
</tbody>
</table>

Water

Based on the relevant state and Guangzhou environmental regulations and the location of the project as well as water bodies likely to be directly affected by the project, applicable standards are Class II in the Surface Water Quality Standards (GHZB1-1999), as shown in Table 1-6.

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>PH</th>
<th>CODcr</th>
<th>BOD5</th>
<th>Oil</th>
<th>Pb</th>
<th>P</th>
<th>DO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>6.5-8.5</td>
<td>20</td>
<td>4</td>
<td>0.05</td>
<td>0.05</td>
<td>0.1</td>
<td>&gt;5</td>
</tr>
</tbody>
</table>

Wastewater discharge will apply Class II in the Integrated Wastewater Discharge Standards, shown in Table 1-7.

Table 1-7 Standard of Wastewater Discharge

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Standard (mg/l, except pH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CODcr</td>
<td>60</td>
</tr>
<tr>
<td>BOD5</td>
<td>20</td>
</tr>
<tr>
<td>SS</td>
<td>20</td>
</tr>
<tr>
<td>Mineral oil and grease</td>
<td>5</td>
</tr>
<tr>
<td>Plant and animal oil and grease</td>
<td>10</td>
</tr>
<tr>
<td>Ammonia nitrogen</td>
<td>10</td>
</tr>
<tr>
<td>Total phosphorus</td>
<td>0.5</td>
</tr>
<tr>
<td>PH</td>
<td>6-9</td>
</tr>
</tbody>
</table>
Sunshine

Sunshine standards are presented in Table 1-8.

<table>
<thead>
<tr>
<th>Class</th>
<th>Applications</th>
<th>Standards (hrs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Nursery, kindergarten, sanitarium, greenhouses</td>
<td>5-6</td>
</tr>
<tr>
<td>II</td>
<td>Teaching building, office, public building, general workshop</td>
<td>3-4</td>
</tr>
<tr>
<td>III</td>
<td>Residential building, office, public building, recreation units</td>
<td>1-2 or full window sunshine at noon</td>
</tr>
</tbody>
</table>

1.7 Primary Environmental Protection Target

The primary protection targets in the project area are sensitive to environmental impacts, or known as sensitive receptors. Typically in urban or suburb areas, sensitive receptors include schools, hospitals, kindergartens, residential areas, government and professional institutions, drinking water sources, scenery and cultural relics or historical sites.

In this EA, all sensitive receptors along the project will first be identified through site investigation and determined as to the nature of these facilities and what types of impacts they are sensitive to at when. These sensitive receptors will then be a focus throughout the environmental baseline evaluation and impact assessment. Furthermore, the sensitive receptors will also be the primary targets for which preventive and mitigation measures will be developed. An objective of the EA is to protect these sensitive receptors from unacceptable adverse impacts from project activities in both the construction and operation phases.
2.0 SUMMARY OF ENVIRONMENTAL IMPACTS

2.1 Environmental Baseline

An ambient air quality monitoring program shows that NO\textsubscript{2} in the monitored area are mostly within 0.037-0.342 mg/m\textsuperscript{3} range, parts of which exceed the standard at 0.24 mg/m\textsuperscript{3}. The higher than the standard concentrations were monitored at the Zhongshan Balu interchange at the Guangzhou end, with monitored data in other areas all within the standard. The monitored CO concentrations, ranged from 0.34-8.69 mg/m\textsuperscript{3}, for hourly average and 0.57-7.05 for daily average, met the applicable standards. The monitored TSP ranged from 0.191-0.438 mg/m\textsuperscript{3}, with the exceedance over the standard occurring only at Zhongshan Balu interchange. PM\textsubscript{10} exceeded the standard at all monitored locations. The monitoring data show that the existing air quality is poor at the Guangzhou end and becomes towards the suburb. This is consistent with the gradually decreased urban activities such as motor vehicle traffic, etc. from urban area to suburb.

The project area acoustic environment mostly meets the Category II standards. When there is no trains passing, all monitored locations can meet Category II standards both during the day time and at night, except Jiangzhou primary school, Shuangqiao middle school and Guangdong Commerce College, where the day time noise exceeded the standard by up to 6 dB(A) (the applicable standard is Category I because of higher sensitivity). When there is passing trains, however, all monitored locations near the railway are significantly affected by the train noise. For example, at the Jiaobiao primary school, the instant noise levels from passing trains could reach 87.4 dB(A), even to 91.4 dB(A) when the trains blow their whistles at this location. Therefore, the acoustic environment is considered generally good except the impact from passing trains.

The water quality monitoring programs carried out in the EA that the Pearl river section near the project show that the existing water quality exceeded the Class III surface water quality for COD and petroleum based oils. But heavy metal parameters were all within the standards. This indicates that the pollution sources causing the existing water quality deterioration in the Pearl river are primarily domestic based.

There are two well landscaped community and one city parks in the immediately adjacent area of Guangfo road. Along the project alignment, there are trees, bushes and lawns, mostly typical species of urban vegetation. Towards the west end of Guangfo road, there are agricultural land with flower nurseries, pleasure fish, and vegetable gardens.

The site survey indicates there are several receptors which will be highly sensitive to the construction and operation of Guangfo road. These sensitive receptors include Jiangzhou primary school, Shuangqiao middle school, Guangdong commerce college, Fangcun Guocun residential area, Fangcun New World residential area, Jiaobiao village, Jiaobiao primary school, Li's Family Shrine, and Hengjiao village. Most of these sensitive receptors are located at the northwest side of the road and about 10-150 m to
Guangfo road. Because of their proximity to the roads and nature, they will be sensitive to the noise and motor vehicle exhaust pipe emissions.

2.2 Construction Phase Impacts

Guangfo road project will have large scale activities, with a long construction period, mostly within urban and built up areas with a high population density and congested traffic on the existing roads. Therefore, construction activities in such areas will impact the surrounding natural and socio-economic environment. More specifically, the impacts will include:

- Noise generated from construction activities is expected to exceed both the day and night time standard limits in the “Construction Site Boundary Noise Standards” (GB12523-90). Such noise levels will impact the area within the 50 m zone and any facilities particularly sensitive receptors will be impacted by construction noise. About 10 residential households and three schools are in these zones which will be most affected.
- Bridge construction and other construction activities construction equipment and vehicle machinery washing, surface runoff from the disturbed soil, etc. near water bodies particularly Pearl river, could result in increased suspended solid and in some cases oils in the receiving water.
- Many construction activities such as demolition, loading/unloading, site cleanup and preparation, vehicle movements, etc. will cause air-borne dust which will affect the surrounding areas especially those in the leeward direction. Once again, the households and schools closest to the construction site will be most affected by the air borne dust.
- The construction will result in a large quantity of spoil and solid waste including demolition waste, excessive soil and other waste from construction activities. The storage of the waste on site could pollute the surrounding environment and disturb the communities. The transportation of the waste, if not properly handled could result in pollution of the transportation routes. Finally, the disposal of the waste will occupy land and impact the areas surrounding the disposal sites.
- Construction activities such as materials storage, loading/unloading, truck movement and parking, etc will occupy a portion of the existing roads causing traffic jams near the construction sites. Since the roads near the sites are the major gate ways to the western Guangzhou area and towards the Foshan municipality (as this connects the bridge on the Pearl river), and they are narrow and very busy, the occupation of the roads, even temporarily could cause serious traffic problems.

2.3 Operation Phase Impacts

Air Quality Impact

Based on modeling prediction, on the climate conditions of average wind speed of 1.9 m/s and D atmospheric stability (normal climate conditions), the hourly average NO$_2$ concentrations at the pedestrian roads (about 10 m to the motor vehicles lanes) will be
ranged between 0.103-0.242 mg/m$^3$ for the short term, 0.106-0.251 mg/m$^3$ for the mid term and 0.189-0.414 mg/m$^3$ over the long term. Under worse climate conditions, i.e., slower wind speed or calm and E atmospheric stability, the NO$_2$ concentrations will be ranged between 0.190-0.762 mg/m$^3$ up to 80% higher than the standard, according to the modeling prediction.

Another important air pollutant which can be related to motor vehicle emission, CO, is predicted to be always below 6 mg/m$^3$, within the applicable standard (10 mg/m$^3$). Even under the worst case conditions (1 m/s wind stability and E atmospheric conditions), the CO concentrations at predicted to be below 9 mg/m$^3$ will still be below the standard.

It is noted that the modeling results show that predicted concentrations of both CO and NO$_2$ will increase over time, indicating the increase in motor vehicle fleet and traffic volume on Guangfo road will offset the decrease in individual motor vehicle emission from the implementation of more stringent emission standards to new motor vehicles. According to relevant national and local policies, more stringent motor vehicle emission standards will be enforced to new motor vehicles in Guangzhou, as well as in the rest of the country, without which the impact of Guangfo road to ambient air quality would be much higher than currently predicted.

During the operation stage, at various sensitive receptors average hourly NO$_2$ concentrations are expected to be in the range of 0.101-0.206 mg/m$^3$. Compared with the applicable standard of 0.24 mg/m$^3$, the predicted concentration is below the standard indicating insignificant impacts. Under the worst climate conditions, however, the NO$_2$ concentrations at these locations will be 0.173-0.412 mg/m$^3$, up to 71% above the standard. Among the sensitive receptors, Jiaobiao village and Jiaobiao primary school will be worst affected as both are very closely located to the project road. The highest concentrations are predicted at these locations.

In general, CO is not going to be a major affecting pollutant even under the worst case climate conditions, according to the air quality modeling simulation results which show a maximum CO concentration in the sensitive receptors of 7.439 mg/m$^3$ under the worst case conditions over the long term which is well below the 10 mg/m$^3$ standard. NO$_2$ on the other hand will be the primary air pollutant which will impact the project surrounding area and sensitive receptors, particularly during the slow wind speed and stable climate conditions.

Noise

According the noise modeling results, at 30 m from the road, the combined road and railway noise will be 75.8-76.1 dB(A) for day time and 73.5-76.4 dB(A) for the night, significantly exceeding the applicable noise standards for the both time frames. Within this distance, there are Jiaobiao primary school and residential housing from Jiaobiao village. Compared the applicable standards for these sensitive receptors of 55 (day) 45 (night) dB(A) and 60 (day) and 55 (night) dB(A), respectively, the predicted noise levels exceed the standards by up to 22 dB(A), indicating very serious noise impacts on these
sensitive receptors. At these noise levels, the school will be able to carry classes properly and the residents sleep and rest will be seriously affected.

Other sensitive receptors which are located outside the 40 m areas include Songjiang middle school, Jiangzhou primary school, Guangdong commerce school, and New World residential development. The predicted combined railway and road noise levels will be 70 to 71 dB(A) for day time, exceeding the applicable standards by up to 11 dB(A) for day time. Jiangzhou primary school, however is expected not to be affected as there is building between the school and the proposed road which will act as a very effective noise barrier reducing the noise by 15-25 dB(A).

Water Impact

At the operation stage, the pollutants such as dust, oil, etc. accumulated on the road surface, could be carried away by the “first flush” of rain water. The contaminated surface runoff, when drained into the receiving water, could affect the receiving water quality. The modeling results indicate that at the point where the surface runoff will be drained into the surface water bodies, COD and oil could increase slightly, up to 0.263 and 0.0006 mg/L, respectively. The affected area is mostly limited within a narrow bend of 1000 m by 15 m along the river bank. The sensitive points, the water intake for Xicun Water Purification Plant located 4.7 km up stream from the east bridge on Pearl river, will not be affected by the road operation. Traffic accidents involving tank trucks containing hazardous materials over the bridges could seriously affect water quality in project area. However, the chance of such accident occurrence is extremely small. According to the estimate, an accident resulting in release of hazardous materials into Pearl river from Guangfo road occurs about once every 236 years.
3.0 IMPACT MITIGATION

A series measures have been designed to mitigate, reduce and minimize potential adverse impacts of Guangfo road to the natural and socio-economic environment. These measures are to be taken during the design, construction and operation stages.

3.1 Design Stage

Mitigation measures at the design stage are those which are considered during and/or incorporated into the design.

Selection of Alternatives

Many of the adverse impacts of project can be best avoided through the selection of alignments/designs with the least adverse environmental and socio-economic impacts during the feasibility study and design stage. In this project, alternative alignments and alternative design (i.e., elevated viaduct versus ground level roads) have been proposed and evaluated in terms of potential environmental impacts, as well as transportation, engineering and cost considerations, before an optimal option is selected for the design of the project.

Three alternative in alignments for Guangfo road have been proposed and considered during project feasibility study and design stage. The alternative are (Figure 3-1):

- **Alternative I**: The road will be divided into two elevated viaducts, i.e., Line A and B lines, one on each side of the existing east and west Pearl river bridges; the two lines continue towards Fangcun boulevard and merged into one line at about the Guocun residential area; the single line extends towards southwest and connects with the outer ring expressway at Huangqi interchange;

- **Alternative II**: The road will be single elevated viaduct with six motor vehicle lane in both directions, to be built on the north side of the existing roads/bridges; after crossing the Pearl river west bridge, the road extends straightly west bound and finally connects with the outer ring expressway at Surounding interchange north of Huangqi; and

- **Alternative III**: The alignment prior to Wuyangqiao residential area is basically identical to Alternative I, i.e. twin elevated viaducts one on each side of the existing roads/bridges. At about the Guocun, Line A continues along the same alignment as in Alternative I but only has three lanes and remains as an one way viaduct. Line B extends around the south side of the Hengjiao village and the two lines are merged in the open field east of Quangqi interchange before connects with the outer ring expressway at Huangqi.

The advantages and disadvantages of both alignments/layout are compared in Table 3-1.
Table 3-1 Comparison of the Alternative Alignments/Layouts

<table>
<thead>
<tr>
<th>Item</th>
<th>Alternative I</th>
<th>Alternative II</th>
<th>Alternative II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resettlement</td>
<td>Less</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Traffic interruption</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Land occupied</td>
<td>Mostly on land for road development; occupy part of Shuangqiao park</td>
<td>Occupies green field land on the west end</td>
<td>More farm land</td>
</tr>
<tr>
<td>Impacts to residents</td>
<td>Low, mostly to shops and industries</td>
<td>Low</td>
<td>On both sides Guocun residential area with high impacts</td>
</tr>
<tr>
<td>Impacts to school</td>
<td>Low</td>
<td>High; schools are all on the north side of the existing roads</td>
<td>Low</td>
</tr>
<tr>
<td>Project difficulties</td>
<td>Affect railway upgrading</td>
<td>Difficult in Datansha section</td>
<td>Less complex</td>
</tr>
<tr>
<td>Water impacts</td>
<td>Construction of two bridges in pearl river</td>
<td>Construction one bridge on Pearl river</td>
<td>Construction of two bridges on Pearl river</td>
</tr>
<tr>
<td>Cost</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

The impacts of the three alternatives are mixed, each of which has its advantages and disadvantages in terms of environmental impacts. However on the balance, with all factors considered, Alternative I in both sections appear to have less environmental and socio-economic impacts and other engineering and cost advantages. Thus Alternative I are selected as preferred alignment for Guangfo road project.

With regard to project design, an alternative to the elevated viaduct design is to upgrade or construct new road at the ground level. The comparison of the two alternatives is presented in Table 3-2.

Table 3-2 Comparison of Elevated Viaduct vs Surface Road

<table>
<thead>
<tr>
<th>Item</th>
<th>Elevated viaduct</th>
<th>Surface road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resettlement</td>
<td>9500 m²</td>
<td>14,000 m²</td>
</tr>
<tr>
<td>Land acquisition</td>
<td>12,700 mu</td>
<td>18,000 mu</td>
</tr>
<tr>
<td>Impact to Li’s Family Shrine</td>
<td>Low</td>
<td>Dismantling part of it</td>
</tr>
<tr>
<td>Community severance</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Traffic flow capacity</td>
<td>High (surface road continue to use)</td>
<td>Low</td>
</tr>
<tr>
<td>Engineering difficulty</td>
<td>Elevated structure</td>
<td>Soft foundation treatment</td>
</tr>
<tr>
<td>Impacts during construction</td>
<td>Relatively low (no occupation of existing roads)</td>
<td>High (part or all existing roads need to close)</td>
</tr>
<tr>
<td>Impacts to local roads</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Construction period</td>
<td>Short</td>
<td>Long</td>
</tr>
<tr>
<td>Visual impacts</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Cost</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

The table shows that although the surface road design would have low engineering cost and low visual impacts compared with the elevated viaduct option, in virtually all other
aspects, the elevated viaduct design will have lower impacts to the natural and socio-
economic environment. With all factors considered, elevated viaduct design is selected
for Guangfo road project.

Noise

The noise standards are established with the consideration of noise impacts on human
health (effects on headaches, annoyance, cardiovascular diseases, etc.) and life activities
(sleeping, reading, listening, etc.), and specially sensitive activities (conducting classes,
concentration on learning, patients recovery, etc.). Noise levels in areas where different
activities are located should meet the applicable standards to protect the environmental
quality required for the activities. As the noise levels of Guangfo road is predicted to
exceed the standards, mitigation measures are needed to reduce or control the noise levels
to meet with the standards.

In addition to the understanding of the general features of major mitigation measures, the
EA team has included the lessens learnt from noise mitigation measures in the inner ring
road project into considerations in designing noise mitigation measures for Guangfo road.
The objective is to capitalize the previous experience, to avoid any mistakes made before
and to ensure the mitigation measures are effective for Guangfo road.

Overview of noise mitigation measures. Table 3-3 lists the commonly used noise
mitigation measures for roads in urban areas, including the effectiveness,
advantages/disadvantages, and estimated costs.
### Table 3-3 Comparison of Common Road Noise Mitigation Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Noise reduction</th>
<th>Advantage/disadvantage</th>
<th>Estimated cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorbent noise barrier</td>
<td>2-20 dB(A)</td>
<td>- Effective in open area&lt;br&gt;- Minimum noise reflection&lt;br&gt;- Potential sunlight and visual impacts&lt;br&gt;- Effective only to certain heights&lt;br&gt;- Limited effectiveness for multiple layer roads</td>
<td>RMB800-1000 per m²</td>
</tr>
<tr>
<td>Reflective noise barrier</td>
<td>5-20 dB(A)</td>
<td>- Lower sunlight impact&lt;br&gt;- Potentially increase noise intensity due to the reflection&lt;br&gt;- Effective only to certain heights&lt;br&gt;- Limited effectiveness for multiple layer roads</td>
<td>RMB850 per m²</td>
</tr>
<tr>
<td>Semi-closed light structure noise barrier</td>
<td>&gt;20 dB(A)</td>
<td>- Effective noise reduction&lt;br&gt;- Limited impact on road natural light&lt;br&gt;- Low noise reflection&lt;br&gt;- Relatively expensive and complex structure</td>
<td>RMB1000 per m²</td>
</tr>
<tr>
<td>Closed light structure noise barrier</td>
<td>&gt;25 dB(A)</td>
<td>- Very effective noise reduction&lt;br&gt;- Low noise reflection&lt;br&gt;- Expensive and complex structure&lt;br&gt;- Not good for motor vehicle exhaust emission dispersion</td>
<td></td>
</tr>
<tr>
<td>Absorbent road surface</td>
<td>5 dB(A)</td>
<td>- Most effective for high speed vehicles on flat terrain&lt;br&gt;- Easy to wear out&lt;br&gt;- Not suitable for heavy duty trucks</td>
<td>RMB240 per m²</td>
</tr>
<tr>
<td>Special asphalt surface</td>
<td>3 dB(A)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double glazed windows</td>
<td>&gt;20 dB(A)</td>
<td>- Very effective for indoor noise control&lt;br&gt;- Require ventilation&lt;br&gt;- Difficult to implement as it will involve individual households or building owners</td>
<td>RMB2800 per household</td>
</tr>
</tbody>
</table>

**Overview of mitigation measures for the inner ring road project.** The World Bank financed inner ring road project has been completed and operational since January 2000 and noise mitigation measures have been gradually implemented along the ring road. The original Environmental Action Plan (EAP) requires installation of 3.8 km of noise in 6 sections, which have been completed. In fact, the actual noise barrier length is about 12 km, over 3 times of the original requirements. The additional noise barrier has been installed in response to the strong public reaction on the increased noise from the inner ring road. The other important noise mitigation measure, installation of double glazed windows in sensitive receptors, has been gradually implemented.
A study was conducted in March 2002 to monitor the effectiveness of the noise mitigation measures. Six locations were selected to determine the noise reduction effect of noise barrier and two were selected for double glazed windows.

In general, the noise barriers are most effective to three to six floors of the buildings targeted for protection, with average noise reduction of about 2 to 4.7 dB(A). Higher floors are generally beyond the noise barrier protected area and have no measurable noise reduction. The lower floors on the other hand, are mostly impacted by the noise from the ground level traffic for which the noise barriers mounted on the elevated viaduct have no effect.

Double glazed windows have been installed in a hospital and a school. The monitoring program at the two locations show that noise can be reduced by 26-27 dB(A) at the hospital (with a vacuum lawyer between two pieces of glasses) and 17-22 dB(A) at the school (ordinary design with two layers of windows put together) when the windows are closed. When the windows are open, the reduction is about 6-10 dB(A) compared with the noise levels one meter outside the same windows.

The lessons learnt from the inner ring road noise mitigation, which will be included into the consideration of mitigation measure planning and design for Guangfo road include:

- For multi stories buildings, the noise barriers should be higher. A noise barrier 5-7 m tall as originally designed, compared with the current height of 3 m, would significantly increased the protected area;
- The lack of seal of noise barriers at the structural expansion joints and the poor design in aluminum frame of the noise barriers are to blame for the less than desired effectiveness of noise barriers;
- The noise barrier installation are not well planned. In some areas noise barriers are installed where is no sensitive receptors to protect. Such waste of effort should be avoided and the location of noise barriers should be carefully planned through site investigation and acoustic study; and
- Double glazed windows prove to be a very effective measures for noise attenuation for indoor environment. It seems that to meet the noise standards at the sensitive receptors, the windows are required to be closed; therefore, the ventilation must be resolved to ensure the effectiveness of double glazed window as a noise control measure.

Noise barriers. In the following section of Guangfo road, noise barrier will be built to protect the sensitive receptors nearby:

- North side at Jiaobiao and Hengjiao villages for 400 m long; on the southeast side, 450 m long. The noise barrier will be 3.5 m high using absorbent materials, considering the fact there is no high rises in the directly impacted area. As the buildings in the villages are mostly two stories high at about 10 m to the road for the closest houses. To this height, the noise barrier will be most effective in noise
reduction, particularly this part of the road will be single elevated viaduct only with no roads on the ground level. It is expected that the noise level equivalent at the houses will be reduced from the originally predicted levels by about 15-20 dB(A). The residual impacts at the village houses following the noise barriers will be about 60 dB(A) during the day time and about 58 dB(A) at night, which meet or slightly above the applicable Category II standards.

- Based on the lessons learnt from the inner ring project, the noise barrier to be installed will be carefully designed using quality materials. In particular, the aluminum frame of each panel, between panels and between the structural expansion joints will be well sealed to enhance the noise reduction function.

**Noise absorbent road surface.** Guangfo road will use bitumen based noise absorbent material for its surface in the entire 5.6 km of road. According to experience overseas, such road surface materials will reduce the noise to the surrounding areas by about 5 dB(A), compared with the concrete road surface.

**Double glazed windows.** The experience gained from noise mitigation of the inner ring road project has showed that noise barrier alone may not be adequate in terms of noise reduction to the acceptable levels while installation of double glazed windows at the sensitive receptors is the most effective measure to protect indoor environment from noise impact. Guangfo road will take such measure to noise mitigation at the most sensitive receptors.

- The Shuangqiao middle school is about 85 m from the proposed road, with a 4 stories classroom building. The first and second floor of the building is behind a factory shop and as such the noise impact is mostly towards the classrooms on the third and fourth floor. There are a total of 10 classrooms on these two floors with a total window area of 120 m².

- Jiangzhou primary school, although located only 65 m from the proposed, is completed behind a factory shop of the same height. The noise level is expected to be able to meet the applicable standards. No further mitigation is needed.

- Guangdong Commerce School is about 85 m from the proposed Guangfo road. It has an 8 stories building with classrooms and administrative/teachers offices. The building side facing the road is 40 m wide. On this side, each floor has eight windows of 1.5 by 2 m giving a total window area of 24 m² per floor. Since the first three floors of the school are hided behind factory shops which act as very effective noise barrier themselves, the top five floors will be installed with double glazed windows, with a total area of 120 m².

### 3.2 Construction Stage

**Noise**

Construction noise cannot be avoided and will be generated whenever there are construction activities. However, it should be mitigated according to relevant regulations and requirements.
The construction boundary noise levels, as stipulated in the “Noise Limits at Construction Site Boundary” GB12523-90, will be enforced to minimize the impacts to the surrounding area. According to Article 23 of "Gaungzhou Environment Noise Pollution Prevention" of 1994, the operations of construction machinery used in the urban area which cause noise pollution to the surrounding environment will be limited to 7:00-12:00 and 14:00-22:00, which is the period for a after lunch nap for most residents in Guangzhou. Any operations extended beyond these timeframe as may be required by the construction needs must apply and receive approval from relevant authority. This requirement will be strictly enforced in the Guangfo road construction which will basically eliminate the noise impacts at night, as well as the after lunch nap time, when the standards exceedance would be worst.

According to the above assessment, Jiaobiao and Hengjiao villages and Jiaobiao primary will be the most seriously impacted sensitive receptors during construction. In fact, the later section of this report will show they are also the most significantly impacted by noise and motor vehicle exhaust emissions during the operation period of Guangfo road. Specific mitigation measures have been designed and will be taken at these locations for reduce or avoid the long term impacts during operation phase. These include relocating Jiaobiao primary school to an area not to be impacted by the project and install double-glazed windows to the first row of the residential housing in Jiaobiao and Hengjiao villages. To mitigate the noise impacts from construction activities, these measures will be implemented at the beginning of the construction phase. For example, Jiaobiao primary school will be relocate prior to the construction to completely avoid the impact. Double-glazed windows at the mostly affected houses will also be installed at the beginning of the construction for noise impact mitigation.

In addition, the following measures will be taken to further avoid or mitigate the construction noise impacts:

- Structural elements for bridges and elevated viaducts will be made in factories to avoid on-site concrete mixing and compacting;
- Low noise machinery will be selected where possible. High noise machinery such as power generators will not be allowed to sue at the site; but if they are necessary for construction work, noise temporary barriers or silencer will be installed;
- Appropriately schedule the construction activities to avoid sensitive time and/or sensitive locations where possible;
- Noise and vibratory activities will be arranged to be completed within the quickest time possible to reduce the impact length;
- Construction trucks movement will be arranged to avoid residential areas where possible;
- According to relevant laws and regulations, if the construction noise still exceeds applicable standards, especially night time construction, the contractors will apologize and compensate the affected residents, students in classrooms and dormitory, or others affected.
Night time construction

The past practices in Guangzhou urban road construction including inner ring road construction show that night time construction are in-avoidable because the government wishes to complete the construction in the shortest time possible in the busy and congested urban areas. In fact, some activities such as materials transportation will likely take place mostly at the night time to avoid the heavy traffic during the day time. Besides the general mitigation measures outlined above, the following mitigation measures will be taken specifically for night time construction:

- Public, particularly residents, in areas immediately adjacent to the construction sites will be consulted prior to the start of night time construction, to alert them the noisy activities at the night time, to explain the reasoning for night construction to obtain public understanding, and to solicit specific public concerns and suggestions for mitigation;
- Public billboards will be erected at the construction sites, listing construction activities, contact persons and telephone numbers for receiving public concerns, complaints, and suggestions on a constant basis;
- The most noisy activities such as piling will not conducted at night where possible;
- Temporary noise barriers may be erected at the most sensitive areas; Some of the stationary noise machinery such as generators will be located away from sensitive receptors and in enclosed structure for noise control;
- Dedicated and trained staff from contractors and construction supervision will be on site for traffic management and public safety during night time construction;
- Proper signage, fencing and lighting will be used to divert the traffic, alert the motor vehicle and pedestrian traffic of the safety hazards, particularly during the night construction; and
- Night time supervision by the environmental monitoring teams will be enhanced including on-site noise measurement and prompt incidents response.

Air Quality

The following measures will be taken during construction phase to mitigate the impact of air-borne dust and other air emissions:

- Excavation and demolition site will be water sprayed to maintain certain moisture levels, loosed earth and dry backfill materials will also be water sprayed to prevent or minimize dust from air borne; On dry days, water will be sprayed at least twice a day, once in the morning and once in the afternoon right after the noon break.
- Materials will be stored in appropriated places and will be compacted where possible; for bulk materials which cannot be compacted well, water spray or cover will be applied to minimize dust;
- All construction waste will be promptly removed from the sites, daily if possible;
- Earth and bulk materials transportation will be loaded in such a way they will not leak during transportation and will be covered.
- Before leaving construction sites, trucks wheels will be washed to clean the dirt which would otherwise be carried away to the streets;
Guangfo Road Environmental Management Plan

- Strictly prohibit burning of construction waste at the sites; and
- Asphalt and concrete mixing plants will be located in the area at least 500 m leeward from the nearest residential or other sensitive receptors to ensure that the emission from these facilities will impact the sensitive receptors. The asphalt plants will be required to equipped with effective emission control facilities to meet the emission standards in relevant state and provincial air emission standards. All these location and emission requirements will be included in the tendering documents distributed to the bidders for the pavement work and eventually in their contracts to become contractual obligations for the contractors working the Guangfo road project.

Water

The following measures will be taken during construction for water impact mitigation:

- The contaminated surface runoff and construction wastewater will not be allowed to discharge to the receiving water directly. Simple and temporary settling ponds will be constructed near the site to intercept the contaminated runoff or wastewater and remove suspended solid before allowing the wastewater to discharge;
- Where possible, domestic wastewater from construction comps will be discharged to municipal sanitary sewers. The construction sites will be in urban built area, well served by the municipal utilities throughout the area. Connecting to the municipal sewer should not limit locating construction camps for Guangfo road;
- Contractors, particularly those for in-water construction, will be trained for construction safety, leak/spill prevention and emergency response procedures in case of leaks and spills. In addition, environmental emergency response kits will be prepared in the in-water construction sites, which include perms for contain spilled oil, suction pumps, absorbent, etc., for use in emergency situations;
- All waste oil from construction machinery will be collected and stored properly and recycled via qualified vendors;
- Slurry from bridge construction sites will be treated through settling and filtration before discharge. Slurry drainage system, and temporary treatment facilities will be built near the river banks. It is a standard practice to install temporary settling ponds at the bridge site. Slurry from the bridge foundation will be pumped into the ponds first to allow separation of solids from liquids through sedimentation, before the supernatant will be allowed to discharge to the river. This practice will be re-enforced as contractual requirements to the contractors;
- Municipal and construction solid waste will be collected and disposed in designated disposal sites and dumping in waterways of any waste will be strictly prohibited;
- All river banks, dams and other flood control facilities will be well protected and any construction at these places must be reviewed and approved by hydrology and flood control authorities before construction.

Solid Waste

The following measures will be taken during construction to mitigate the impacts of solid waste to the environment:
• Contractors will be requested to comply strictly with “Interim Management Guides for Guangzhou Waste Spoil Storage and Disposal” and apply first to Guangzhou Waste Spoil Storage and Disposal Department, receive appropriate approval and permits and dispose the waste in designated areas;

• “Guangzhou Urban Appearance and Environmental Sanitation Administration Methods” stipulate that trucks loaded with bulk and loose materials and waste must be loaded properly, covered and washed of their exterior before allowed on the roads. Such trucks are not allowed to leak or cause air-borne of the materials loaded during transportation and the transportation can only be made within the designated time and along the designated routes.

• Waste materials which can be used again will be recycled;

• Temporary waste storage areas at the construction sites will be carefully selected to avoid water front or causing traffic congestion, inconvenience to the pedestrians, residents, and others in the nearby communities; and

• Transportation of construction waste will avoid peak hours, avoid sensitive areas, and will use approved routes.

Urban Ecology

The following measures will be taken to minimize the impacts:

• Where possible, plants including trees, flowers, and bushes will be relocated to other places or back to the project area following the completion of the construction, instead cut and wasted;

• The construction activities will be limited within the red line area and not to occupy farmland;

• Buildings under demolition will be surrounded with nylon cloth or metal sheets or wood boards to minimize the visual impacts to the communities as well as for dust and safety control;

• The project area will be landscaped and planted following the construction. The green area will be no less than 20% of the total project area. The landscaping plan will result in a net increase in green space in the project area.

Traffic Management

To mitigate impacts to the traffic on the existing roads, construction activities will be well planned in consultation with the local traffic police. The specific measures to be taken include the following:

• The most traffic affecting activities such as loading/unloading, beam lifting, and bulk materials transportation will be scheduled for the time when the traffic on the roads will be the lightest such as weekends, holidays mid-day around the noon time or evenings.

• No traffic affecting construction activities will be allowed during the rush hours in the morning and early evening;
• Public notices in the form of public boards at the construction sites will be provided to inform the road users of the time, length and type of traffic affecting construction activities and possible congestion.
• The public notice will also advise the road users of possible detoured roads identified by the traffic police as alternative routes to avoid the congestion on the roads affected by the project;
• No construction materials and debris will be allowed to store and pile on the roads or the pedestrian areas;
• Construction vehicles parking on the roads will not be allowed unless it is absolutely necessary. Such parking will be kept to the minimum and be removed as soon as it is possible; and
• During the loading/unloading, viaduct structural lifting and installation, the contractors will be requested to contact the traffic police to either have the police on site or have their own staff on-site to help direct the traffic, to minimize the traffic congestion and to ensure the safety.

Others

Other measures to be taken during the construction phase include:

• The contractor will be request to halt the all construction activities immediately if any archaeological or other cultural properties are found (chance finds) during excavation and to properly protect the site which such finds are uncovered. Cultural authority, as well as PO and EA team, will be noticed promptly. Only after a thorough investigation by the cultural authority and specialists and a clearance is provided, will the contractor be allowed to resume their construction activities at the site.
• The contractor will be request to provide safety shelters at the construction sites, particularly overhead construction sites, to protect the public from any safety accidents. Warning signs will be provided to alert the public of potential safety hazards at and around the construction sites.
• The PO recognizes that contractors working on the Guangfo road site will be a key in environmental management, pollution control and impact mitigation during construction. A number of measures will be taken to ensure that the contractors will be aware of their responsibilities and obligations in environmental protection. All contractors and construction supervision will be required to participate in a mandatory environmental training program prior to the start of construction onsite. The above mitigation measures will be, where appropriate, included in the tendering documents for contractors and eventually in the construction contracts so that they will be the contractual requirements for contractors working on Guangfo road.

3.3 Operation Stage

Air quality

During the implementation of the World Bank financed Guangzhou inner ring road project, a motor vehicle emission control strategy (MVECS) has been developed in
Guangzhou, involving numerous measures and programs to reduce and control the emissions. At the time this EA was prepared, many of the measures and programs are being implemented such as clean fuels and limited inspection and maintenance program, while others are in the preparation stage for implementation such as a motor vehicle emission monitoring and research center. Although no data are available to firmly link the inner ring road project and the various mitigation air quality impact measures/programs, the ambient air quality in Guangzhou has been improved over the last two years since the inner ring road has been in operation, compared with the previous years, according to the routine air quality monitoring data.

Together with the inner ring road, Guangfo road is part of the fast urban transport road network. Most of the air quality mitigation measures, by nature, require integrated effort city wide which involves multiple government agencies and non-government organizations. During the operation stage, Guangfo road will participate in and become part of the city wide MVECS to mitigate the adverse impacts to the surrounding areas, particularly the 200 m areas on both sides of the road. These mitigation measures/programs which are currently implemented or to be implemented in Guangzhou are:

**Pollution sources related mitigation measures.** The air pollution source in this project is motor vehicles on the road. Motor vehicles are mobile sources and are not limited to this road. Motor vehicle emissions control is a city wide or region wide systematic work. The mitigation measures for air pollution source control is closely related to the motor vehicles emission control strategies and programs of Guangzhou city, Guangdong province and the State. There are state and provincial programs for motor vehicles with a target to reduce emissions. In addition, the city of Guangzhou is developing a Motor Vehicle Emission Control Strategy (MVECS) through the World Bank financed Guangzhou Ring Road project. The Guangfo road project will be integrated with the MVECS and adopt the measures in the state, provincial and municipal programs, including:

- Setting up motor vehicle emission standards and ban the motor vehicles which exceed the standards. In 1995, China released “Light Motor Vehicle Pollutant Emission Standards (GBPBI-1999)”, which is based on the emission standards of Europe Council of Economics (ECE). The standards are equivalent to about 50-70% of the ECE’s motor vehicle emission limits in the 1970’s. Guangzhou has road side and annual inspection programs. Guangfo project will support such programs and ban motor vehicles which exceed the emission standards. In fact, Guangzhou’s air quality is seriously affected by the increasing motor vehicle emissions with increasing motor vehicle fleet size which is expected to continue expanding quickly in the coming years. The fundamental measure to control the total emission volumes and thus to maintain and improve air quality, is to apply more stringent standards and further reduce emissions from individual vehicles. Guangzhou will gradually adopt more stringent standards for new vehicles which will help mitigate the impacts on the Guangfo road area.
• Continue implement and upgrade the inspection and maintenance (I/M) programs in Guangzhou. Practical experience has shown that the amount of exhaust emissions is largely dependent upon the state of tuning of the motor vehicle engines. High levels of emissions from vehicles can be largely attributed to poor maintenance and ineffective repairs. Effective inspection and maintenance programs will be critical to encourage vehicle operators to properly maintain their vehicles, as well as discouraging unauthorized tampering with the engine settings and the unauthorized removal of catalytic converters after conversion to unleaded petroleum. The current I/M exhaust test program is an idle test, which although adequate for older vehicles, has been shown to be insufficient with more modern vehicles, and for more stringent emission standards. With implementation of more stringent emission standards and exhaust controls, it becomes imperative to improve the existing I/M programs to include a loaded transient driving cycle test as well as a test of the fuel evaporation control system.

• The installation of catalytic converters is necessary to control automotive pollution; however their introduction must be preceded or accompanied by the distribution of unleaded gasoline. Once this is achieved, emissions may be significantly reduced if vehicles are properly maintained and operated. The environmental component, Guangzhou City Center Transport Project, proposed five strategies for motor vehicle pollution control:
  - Introduction of unleaded fuel
  - Catalytic converters
  - Improvements to existing I/M program
  - I/M demonstration projects
  - Automatic monitoring stations

• The main source suspended particulate in the air from roads are the dust on the road surface. Control the dust on the roads will result in reduction in dust source intensity. To achieve such a control, Guangfo road will be water sprayed/washed daily by local environmental sanitary bureau.

Measures on Air Pollutant Dispersion. Studies have showed distance between the air emission sources and receptors would directly affect pollution concentrations at the receptors. Therefore, future plans for buildings along Guangfo road should consider increasing distance to the road, provide greater space for dilution and dispersion, and thus reduce pollutant concentrations at the receptors. The planning department should not approve any residential housing within 200 m from the road. Instead, the area may be used for shopping malls, office building, warehouses and other enclosed structures. The first row of building should retreat as much as possible to avoided the most impacted area. Particularly in areas near interchanges, the impacted area is larger and the peak air pollutant concentrations occur in the 50-150 m and there will be more open space near the interchanges.

Trees and vegetation have been proven to be able to intercept air dust, and to some extent, clean up other air pollutants. The plants along both sides of Guangfo road and in the open space of the interchanges will help mitigate impacts on air quality.
**Clean Fuels.** A proven fleet-wide strategy to reduce the negative environmental and health impacts of emissions from vehicles is the improvement in fuel quality. With respect to diesel fuel, the particulate or smoke emissions largely comprise sulphur compounds. Therefore reducing the sulfur content will contribute to a decrease in the amount of particulate emitted from diesel engines, while also allowing the introduction of more stringent standards for diesel engines and more modern engine technologies. Alternate fuels are also a means of reducing the negative environmental impact of vehicle emissions. These fuels, such as liquefied propane and compressed natural gas (CNG), comprise hydrocarbons which have a much lower toxicity than those of gasoline. Also, the engines may emit lower emissions of CO and NO\(_x\), if they are properly adjusted to take full advantage of the fuel. As an example, CNG fueled vehicles have the potential to emit 97% less CO, 72% less HC, and 39% less NO\(_x\), than conventional gasoline engines.

**Sensitive Facility Siting/Planning.** To prevent the impact of excessive levels of HC and NO\(_x\), the areas within 100m of the roadway may be assigned uses such as warehouses, shopping arcades, and office buildings instead of residential use. Under the most unfavorable weather conditions, pollutants may exceed the standard at distances of up to 500m. It is recommended that within 500m off the roadway there should be no new construction of sensitive receptors such as hospitals, schools and government offices.

**Noise**

Noise mitigation measures to be implemented during the operation stage include:

**Relocation.** Jiaobiao primary school would be immediately adjacent to Guangfo road. In fact, the road will occupy part of the teaching building and about a quarter of the campus. The noise level will be very high, predicted to be at 83 dB(A) which is 28 dB(A) above the applicable standard. Even double glazed windows would not be able to reduce the noise to the standard. As shown in the previous sections, Jiaobiao primary school will also be the most impacted receptor from motor vehicle exhaust emission with NO\(_2\) exceeding the standard even under normal climate conditions and would be by up to 264% under unfavorable climate conditions. Furthermore, as part of the school will be occupied and there is no room within its current location to expand, the school will be unable to function properly for its 760 students and teachers.

Therefore, the best mitigation for the noise, air pollution and campus occupation will be to relocate the school to a quiet location sufficiently away from Guangfo road. As from Fangcun interchange to the outer ring expressway will not be funded by the World Bank but by the Nanhai government and Jiaobiao primary school is located in this section. The relocation of the school as a mitigation measure and a condition for the project has been proposed to the Nanhai government and accepted. The relocation and resettlement of Jiaobiao primary school will be completed in its new location prior to the start of the Guangfo road construction to a new location within the village, which is about 600 m from the proposed Guangfo road at this location.
**Appropriate Land and Development Planning.** Along the project area (e.g., southwest of the Fangcun Interchange) there are still land parcels to be developed. During the zoning and planning process, the following measures/policies will be taken:

- The first row of the buildings will be controlled to be no less than 20 m to the red line of Guangfo road;
- New development will have landscaped area between the development and the road;
- The first row of the buildings will not have any noise sensitive facilities such as schools, hospitals, kindergartens, but rather non noise sensitive facilities such as parking garage, commercial complex, etc.
- The immediately adjacent land will not be used for residential development in general. If it is used for such purposes, the building should design the building configuration as much as possible to locate the kitchens, bathrooms, elevator wells, auxiliary facilities on the side facing the road. In addition, developers will be requested to include noise control and reduction into the building design through materials selection, window designs, etc.
- The first row of the buildings may be designed to be in parallel to the road which would be a noise barrier themselves to the buildings behind.

**Road structure and materials selection.** will include considerations for noise control and minimization. Such considerations will include:

- As discussed before, the entire Guangfo road surface will use high quality bitumen.
- The design will utilize no expansion joints and continuous large displacement and multiple span structure, so that the expansion joints can be minimized and thus the noise resulting from motor vehicle vibration when through the joints.
- The design will utilize flexible support such as board rubber supports and spherical rubber support to absorb structural vibration and the noise thus caused.

**Management measures** will be taken during Guangfo road operations, including:

- Gradually increase motor vehicle noise emission standards, implement vehicle inspection system and enforced maintenance for vehicles which exceed the standards. High noise, old model vehicles will be retired. Guangzhou will establish control plan and targets for motor vehicle noise. The reduction of noise from vehicles is the most directly and effective measures to control noise.
- Strictly enforce motor vehicle speed limits, particularly in the sections where there are sensitive receptors and at night.
- Guangfo road will be periodically and regularly maintained for good working conditions.

**Water impacts mitigation**

Although the probability of accidental release of hazardous materials into Pearl river is very low, it will be a high risk and major potential impacts of Guangfo road to the surface water quality with serious potential consequences. As such, mitigation measures are planned to minimize such risks. These measures are:
• Strictly enforce hazardous materials transportation permitting system – Guangzhou
Hazardous Materials Transportation Regulations stipulates that transportation of
hazardous materials must receive prior approval and receive permit from road
transportation authority. The permitting requirements that the trucks to be used for
such transportation must be in good conditions, equipped with fire extinguishers and
hazardous materials signage. Non-motor vehicles and motor cycles are banned for
hazardous materials transportation. Transportation of explosives and hazardous
chemicals will further require special permits from the public security (police)
authority. As part of the Guangzhou/Guangdong road network, Guangfo road will
implement these requirements during operation.

• The road management authority which will be Guangzhou Road Bureau in this
project will establish emergency response procedures and plans together with public
security and environmental protection bureau to respond promptly to any spills, leaks
and other accidents which involve hazardous materials. Necessary equipment and
materials will be available to deal with such accidents to contain the spills to the
maximum extent possible to protect the contamination of Pearl river as well as to
protect resident the communities and natural environment in the area.

• At the key and sensitive sections of Guangfo road, such as bridges and areas near the
bridges, warning signs will be erected to set speed limits to vehicles hazardous
materials. These trucks will be banned to use Guangfo road during rush hours.

• An emergency reporting system will be established. Any accidents involving spills of
hazardous materials and release of such materials to Pearl river will be required to
report to Guangzhou Environmental Protection Bureau immediately. Procedures will
be established to closed down the Xicun Water Purification Plant water intake
following such accidents. The intake can only be opened again following detailed
investigation and mitigation/remediation as may be necessary and with assurance
that the spills will not reach the intake and have any impacts to water quality at the
intake area.

Relocation of the stature, monument and pavilion

Guangfo road, as elevated viaduct, will run directly above these structure, not only cover
it completely under its shade but seriously affect its surrounding setting and locals’
feeling about them. As a mitigation measure, the stature, monument and pavilion will be
relocated to the southwest side of the Shrine to a small community park near the village
(see Figure 5-1 in the main Environmental Impact Assessment Report). The particular
new location was in fact suggested by the local villagers during the public consultation
and would maintain the harmony and connection of this group of structures.

Land Use Planning Measures

Proper land use planning would be very effective in preventing air, noise, access, visual
and other potentially adverse impacts to sensitive receptors, if properly implemented.
Land use mitigation measures need to be well coordinated among agencies but will be
primarily implemented by the Planning Bureau. The following principles will be applied
in future development along the Guangfo road area:
• Areas within 100 m of the roadway will not be approved for any new residential housing;
• These areas may be assigned uses such as warehouses, shopping arcades, office buildings and other enclosed structures;
• More open space will be created and well landscaped near the interchanges;
• The first row of the buildings will be controlled to be no less than 20 m to the red line of Guangfo road;
• New development will have landscaped area between the development and the road;
• The first row of the buildings will not have any noise sensitive facilities such as schools, hospitals, kindergartens, but less noise sensitive facilities such as parking garage, commercial complex, other closed structures, etc.;
• The immediately adjacent land will not be used for residential development in general. If it is used for such purposes, the building should design the building configuration as much as possible to locate the kitchens, bathrooms, elevator wells, auxiliary facilities on the side facing the road. In addition, developers will be requested to include noise control and reduction into the building design through materials selection, window designs, etc.; and
• The first row of the buildings may be designed to be in parallel to the road which would be a noise barrier themselves to the buildings behind.
4. ENVIRONMENTAL MANAGEMENT AND MONITORING

As discussed above, Guangfo road project will generate adverse environmental impacts in both construction and operation stages. The impacts during construction can be high and extend to a large area but it mostly limited to the relatively short construction period (up to two years). While during operation, the impacts will be long lasting. For both stages, environmental management system including environmental monitoring will be necessary to control the impacts to the minimum.

4.1 Environmental Management Organizations

The environmental management organizations involve in Guangfo road construction and operation, and their interrelation are presented in an organizational chart (Figure 4-1). The functions of each organizations are summarized in Table 4-1.

<table>
<thead>
<tr>
<th>Organizations</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guangzhou Construction Committee</td>
<td>• The ultimate decision making body for all matters related to Guangfo road including environmental management</td>
</tr>
</tbody>
</table>
| Guangzhou Environmental Protection Bureau  | • Law and regulations enforcement  
• Environmental policy/program implementation  
• Setting up and enforcing discharge standards  
• Provide guidance on environmental matters  
• Review environmental reports  
• Handling environmental emergency |
| Guangzhou Urban Center Transport Project Office (PO) | • Project proponent and executing agency  
• Day to day operation during construction including environmental matters  
• Will have two full time environmental specialists  
• Prepare contractual requirements and specification for environmental performance for contractors and construction supervision  
• Implement environmental mitigation measures  
• Review and respond with new mitigation as may be necessary to environmental monitoring reports. |
| Guangzhou Communication Bureau             | • Responsible for all matters once the road is constructed and open for traffic  
• Review and respond environmental monitoring reports  
• Responds to emergency situation including environmental accidents. |
Figure 4-1 Project Organization
As the project proponent, the PO will take the ultimate responsibility for environmental performance and environmental management during construction. During the inner ring road construction which was competed in 2001, the PO gained substantial experience with environmental management. The PO has dedicated environmental specialists on staff who manage the day to day environmental performance of the contractors, maintain liaison with regulatory agencies and communicate with the affected public including receiving public complaints.

The environmental staff are also responsible for ensuring the implementation of mitigation measures identified and designed by the EA. They will work closely with the design institute and contractors as may be necessary to modify and update the mitigation design and scale as needed by the actual conditions during project construction and implementation. An effective working system has been developed with the PO for environmental management through the ring road construction and such system, as well as the extensive experience gained during the inner ring road construction will be capitalized for Guangfo road implementation as well.

4.2 Environmental Management

Construction Stage

In order to effectively control and minimize environmental pollution resulting from construction activities, the construction site must be assured of an environmental management system including management people and full time environmental persons to ensure mitigation measures designed during EA stage are appropriately implemented. More specifically, the construction stage will:

- Include environmental protection requirements, mitigation plans and monitoring plan into the bid documents and eventually in the contract;
- Prepare environmental, sanitary measures by contractors and implemented other mitigation measures identified and described in the EA reports;
• Request construction supervision to have at least one full time environmental supervision engineer
• Request contractors to have full time environmental staff at the site;
• Explain to the affected residents potential impacts through public notice and information release; and
• Continue public consultation through hotline telephone, bill boards at the construction site.

Operation stage

Environmental management during operation is a long term effort, which requires well structured environmental management system, and on which to further build supervision, monitoring and management procedures. The environmental monitoring will be an effective tool to determine the environmental performance but preventive will also be needed such as proper maintenance. During the operation, the project operator (Guangzhou Communication Bureau) will work closely with Guangzhou EPB on city environmental programs such as motor vehicle emission control strategy, vehicle inspection and forced retirement plan etc.

Continued Public Consultation

It is very important that public consultation and communications will continue throughout the project construction stage. The objective is to inform the public of construction activities to gain their understanding and support, and to listen to any concerns they may have and suggestions for mitigation. For example, contractors will be requested to inform and discuss with affected communities prior to construction activities which could result in high noise. The public opinions and concerns will be taken to full considerations for properly scheduling noise construction activities.

A bill board will be erected in every construction site. This board will briefly explain the activities on this site, and indicates specifically that public concerns and opinions on the environment will be welcome. To ensure public concerns, if any, can be received properly and timely, the board will include specific contact information such as telephone numbers, email address where possible, and contact persons, which will be the head and environmental staff of the contractors on that particular site.

Public notice will also be issued in media during the operation stage to inform of the public with contact information so that they can express their concerns and opinions, if any, on environmental impacts of Guangfo road operations. Once again telephone numbers and contact persons will be provided. At this stage, the contact information will be those of that of the road operating company.

4.3 Personnel Training

Personnel training will be provided in different stages of project implementation. At the construction stage, heads and environmental staff from winning contractors and
construction supervision companies will be requested to participated in a mandatory environmental training program. This request will be included the construction tendering documents to be issued to the pre-qualified bidders who will be invited to bid. This training program will include, but not limited to, the following contents:

- Relevant environmental regulations, policies, standards and programs;
- The main findings and recommendations of environmental impacts assessment;
- Relevant environmental control technologies, processes and procedures;
- Key contents of environmental management plan, particularly various mitigation measures for the construction stage and the implementation;
- Daily environmental monitoring requirements (see section below), methodology and procedures;
- Environmental reporting requirements; and
- Environmental emergency response and cleanup.

Regarding personnel training, the effort will be focused on the contractors who will conduct the construction, because other environmental training for project management, monitoring and other professional staff have been included in the Inner Ring Road (IRR) component. In total, 10 people from the contractors will be requested to participate in the environmental training for a total of eight days. Based on the unit cost of RMB4000 per person for the training, the total training budget for the Guangfo road will be RMB40,000.

For operation stage, environmental staff from the road operation company and relevant government organizations which oversee and supervise the road operations will be provided the training. The training programs will be primarily provided by professional environmental staff or in local universities.

### 4.4 Environmental Monitoring

The objective of the environmental monitoring plan is to verify the prediction of environmental impacts assessment and determine environmental performance and impacts to surrounding area. The monitoring plan will also provide a basis for project executing agency and road operator to prepare environmental policies, take additional actions for mitigation as may be necessary and minimize adverse impacts.

**Environmental monitoring plan**

Environmental monitoring will be carried out in both the construction and operation stages. In the construction stage, the monitoring will be done in two levels: daily and regular monitoring, to be carried out by contractors and construction supervision companies. Environmental staff will be trained prior to the start of construction for the monitoring which will include mostly visual monitoring of air borne dust, surface runoff, storage and disposal of construction waste, traffic impacts, and construction safety issues. Hand-hold noise meters will be used to monitor the noise levels at sensitive receptors.
during construction. The objective of this daily monitoring program is to identify environmental issues at the same time as the construction activities on these sites so that appropriate mitigation actions, if needed, can be initiated and implemented timely to minimize the impacts.

At the same time, in addition to the daily monitoring by contractors a formal environmental monitoring program will also be carried out during the construction, as well as operation phase. This programs will be conducted by professional environmental monitoring program with main objective to provide official records on environmental and regulatory compliance status.

The formal environmental monitoring plan for both construction and operation stages is presented in Table 4-2 and monitoring locations are shown in Figure 4-2.

<table>
<thead>
<tr>
<th>Environment</th>
<th>Item</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>Parameter</td>
<td>( \text{NO}<em>2, \text{CO}, \text{TSP, PM}</em>{10} )</td>
</tr>
<tr>
<td></td>
<td>Length</td>
<td>1 year for construction and first 2 years in operation</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
<td>Once a quarter and 5 consecutive days each time</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>6:00, 10:00, 14:00, 18:00 (TSP and ( \text{NO}_2 ))</td>
</tr>
<tr>
<td></td>
<td>Location</td>
<td>Datansha middle school, Guangdong Commerce School, Jiaobiao primary school</td>
</tr>
<tr>
<td>Noise</td>
<td>Parameter</td>
<td>Noise level equivalent (( \text{Leq} ))</td>
</tr>
<tr>
<td></td>
<td>Length</td>
<td>1 year for construction and first 2 years in operation</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
<td>Once a quarter and one day each time</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>One during the day and one at night</td>
</tr>
<tr>
<td></td>
<td>Location</td>
<td>Shuangqiao Middle School, Guangdong Commerce School, Guocun residential housing, Jiaobiao primary school and Hengjiao village</td>
</tr>
</tbody>
</table>

As the night time construction is unavoidable, night time construction activities will be closely monitored, besides other mitigation measures. Dedicated and well trained staff will be stationed at the night time construction sites to monitor the activities with regard to mitigation measure implementation, necessary actions for reduce excessive impacts particularly noise and traffic as well as to receive and respond to any public complaints.

**Reporting and data management**

Environmental monitoring data have high values in environmental management and pollution control. The data will demonstrate whether the actual environmental performance and environmental impacts will be as predicted by the EA which will also provide basis for appropriate and necessary actions. The reports and data will help create environmental data base for Guangfo road area.

More specifically, the environmental monitoring reports will contain:
Figure 4-2 Locations of Air and noise monitoring sites
- Raw data (coefficients, monitoring location, monitoring/sample collection time, statistics, environmental quality analysis and recommendations for further actions where needed;
- Reporting frequency: once every three months for a quarterly report and once a year for comprehensive reports;
- Reporting to: Guangzhou EPB and Guangzhou Urban Center Transport Projects Office (PO).

The reports will be reviewed by the environmental staff of the PO as well as the regulatory authorities and the World Bank. It is the PO’s responsibility to respond to the reports, particularly if the reports identify adverse impacts unexpected by the project EA or impacts which exceed acceptable levels. PO will take prompt actions including additional mitigation measures to address the newly identified issues.

**Estimated costs for monitoring plan**

The monitoring plan costs consist of fees for analysis, labor cost for the monitoring work as well as costs for reporting preparation and translation. The estimated costs for the monitoring plan are as follows:

**Air quality** which includes analytical cost (Table 4-3) and labor costs.

**Table 4-3 Air Quality Monitoring Analytical Costs (RMB)**

<table>
<thead>
<tr>
<th>Item</th>
<th>No. of monitoring points</th>
<th>Samples per day</th>
<th>Days per time</th>
<th>Times Per year</th>
<th>Unit cost</th>
<th>Total cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO₂</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>40</td>
<td>9600</td>
</tr>
<tr>
<td>CO</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>37</td>
<td>8880</td>
</tr>
<tr>
<td>PM₁₀₀</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>495</td>
<td>5940</td>
</tr>
<tr>
<td>TSP</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>495</td>
<td>5940</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30,360</td>
</tr>
</tbody>
</table>

For the one year monitoring for construction and two years for operation (the first two years), the total analytical costs for the air quality will be RMB91,080. In addition, the labor cost, based on two technical staff and one driver required for the program at RMB160/person for technical staff and RMB100/person for the driver, will be estimated to be RMB22,400 per year or RMB67,200 for three years (one construction and two operation years). Therefore, the total estimated costs for air quality monitoring program will be RMB158,280.

**Noise**, which includes primarily labor cost. Assuming one technical staff and one driver for the program for the five monitoring locations, two days per time and four times per year at RMB160 per person per day for technical staff and RMB100 per person per day, the annual labor cost will be RMB7680/year. For the three years monitoring program (one year for construction and two for operation), the total noise monitoring cost will be RMB23,040.

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Night time construction supervision which includes dedicated and well trained staff going through all construction sites during night time construction. It is estimated that there will be 90 days when night construction are necessary. At RMB160 per night, the total cost for night construction supervision will be RMB14,400.

Transportation. This is primarily the cost of using motor vehicle during conducting the monitoring program. The basic assumption is that one vehicle is needed for noise and air quality, respectively. At unit cost of RMB350 per vehicle per day, the annual cost will be RMB8400 or the total cost for the monitoring program will be RMB25,200 for the three years.

Reporting. The estimated cost for report production will be RMB20,000 per year and the total cost will be RMB60,000 for the three years. The total translation cost will be RMB45,000 for the three years. Therefore, the total estimated cost for report production and preparation is RMB105,000.

Adding all the estimated costs listed above, the total cost for the three years environmental monitoring program will be RMB325,920 covering one year for the construction phase (including night time supervision cost) and the first two years of the operation phase.

4.5 Estimated cost of mitigation measures

The various mitigation measures for Guangfo road project will be taken during different stages of project implementation. The costs for these measures are estimated and presented in Table 4-4.

<table>
<thead>
<tr>
<th>Item</th>
<th>Specific measures</th>
<th>Quantity</th>
<th>Estimated costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
<td>Barrier</td>
<td>850 m</td>
<td>2,550,000</td>
</tr>
<tr>
<td></td>
<td>Double glazed windows</td>
<td>240 m²</td>
<td>72,000</td>
</tr>
<tr>
<td></td>
<td>Noise absorbent pavement</td>
<td>16,667 m²</td>
<td>40,000,000*</td>
</tr>
<tr>
<td>Landscaping</td>
<td>Tree planting, lawns</td>
<td>10 m wide on both sides</td>
<td>798,000</td>
</tr>
<tr>
<td>Resettlement and relocation</td>
<td>Cash compensation, moving</td>
<td>Cost, lost incomes, etc.</td>
<td>388,126,728*</td>
</tr>
<tr>
<td>Environmental monitoring</td>
<td>Labor, materials, transportation reporting etc.</td>
<td>One year for construction and two for operation</td>
<td>325,920</td>
</tr>
<tr>
<td>Personnel training</td>
<td></td>
<td></td>
<td>40,000</td>
</tr>
<tr>
<td>Direct Total*</td>
<td></td>
<td></td>
<td>3,785,920</td>
</tr>
</tbody>
</table>

*Noise absorbent pavement is included in the engineering work and resettlement is implemented with the separate group and as such the direct environmental mitigation cost does not include these two items.