1 Introduction

1.1 Shenzhen River

The Shenzhen River originates from the Ngai Mai Ling of the Ng Tung Mountain and flows from the northeast to the southwest and discharges into the Shenzhen Bay (Deep Bay). The Shenzhen River estuary is on the east side of the shenzhen Bay.

The Shenzhen River flows through Man Kam To, Lo Wu and Huanggang Border Crossings, receiving water from its main tributaries including the Sha Wan River and the Buji River on the Shenzhen side and the Ping Yuen River (River Ganges) and the Ng Tung River (River Indus) on the Hong Kong side, with a total length of 37 km. The water system of the Shenzhen River shows a dendritic shape with a catchment area of 312.5 km^2, of which 60% are in Shenzhen and 40% in the Northwest New Territories of Hong Kong.

The Shenzhen River is divided into three reaches. The reach above Sha Wan is the upper stream, which flows on low hilly land zone with a riverbed gradient of 3—4‰, where strath and gorges are located. The middle reach is between the Sha Wan River and San Pan Rivers with wide valley bottom and steep slope, where the River flows through the low hilly land area with a gradient of 2‰. Below the San Pan River mouth is the lower reach, where the river meanders on the alluvial plain with larger bends and less gradient of 0.5‰. The riverbed gradient below the Yunong Village is only 0.2‰. The tributaries have higher gradient of 10.9‰ for the Liantang River, 5.6‰ for Futian River, and 5～8‰ for the upper and middle reaches of the Buji River.

The Sha Wan River above the San Pan River is a mountain stream with narrow riverbed, and the river width is less than 20 m, which gradually becomes wider towards downstream. Due to urbanisation of shenzhen City, the average width of the Shenzher River upstream of Lo Wu Border Crossing is less than 20 m. The river width is 40 m — 45 m between the Lo Wu and Huanggang Border Crossings, and 65 m — 75 m between Huanggang Border Crossing. The Shenzhen River mouth has a maximum width of 230 m.

The trunk stream in the lower reach is tidal . The river mouth can be as wide as 4 km

in low tide while become submerged during high tide period. Tide wave changes after coming into the river mouth. Tide rises steeply and falls slowly with high tidal level, which prolong the time for slack water. With little effect of upstream runoff, the tidal stand time at Yunong Village has been prolonged for 30—60 minutes. The tide difference is 10—30 cm during flood tide and 50—100 cm during ebb tide as compared with the bay water level. Besides, the tide duration is 1 hour shorter for flood tide and 1 hour longer for ebb tide than the bay tides.

The Shenzhen River discharges into the Shenzhen Bay, which is also the outlet of the Yuen Long River and the Dashahe. The Shenzhen Bay connects the Lingding Yang and is influenced by discharges from the Pearl River. With an area of 115 km^2, the Shenzhen Bay is a semi-closed shallow bay with an average depth of 2. 9 m and a total volume of 0. 33 billion m^3. There is a deep channel south of the bay, which extends to the inner bay of the Shenzhen Bay along the direction of ENE. Affected by the channel, the topography of the seabed is deep outside and shallow inside, deep in south and shallow in north, which forms a rather complex hydrological condition. The annual mean tide difference in the Shenzhen Bay is 1. 37 m. The tide current belongs to reciprocated type due to the influence of irregular semi-day mixing tide in the South China Sea.

The Shenzhen Reservoir controls the water from the Sha Wan River. Thus the Shenzhen River water mainly comes from the Buji River, the Liantang River and the Ng Tung River (River Indus), etc. With respect to the existing conditions, main concerned area are flooding, low shipping capacity and serious water pollution.

Located in tropical seafront, the Shenzhen River basin belongs to south semi-tropical oceanic monsoon climate with a distinct feature of dry and wet season. From statistics, the yearly mean precipitation is about 1,900 mm and is mainly concentrated in wet season (April to October), accounting to 90% of yearly total, while only 10% in dry season (November to March in the next year). Heavy rain, typhoon rain and terrain rain are the main types of precipitation, featured with heavy storm and high intensity. Among them, typhoon is the most hazardous weather in the River basin. Typhoon can bring precipitation of as much as 300mm — 500 mm, along with heavy wind and sea water intrusion, causing severe flooding.

As most of the Shenzhen River water comes from precipitation, its flow is closely re-

lated to the precipitation. Flow variation within the year coincides with the rain season, Statistics showed that the runoff in wet season accounts for 87% of the yearly total.

Because of the short length of the tributaries and steep upper section of the river, the high flood peak is often formed within a short period of time, and the flood water level rises and drops sharply. Usually the flood peak can reach Shenzhen City in a few hours after the start of a storm. In the lower reach affecting by tide, however, as the zigzagging river channels are narrow with low gradient, plus flat topography on both sides of the river, floods often could not discharge expeditely. The discharge capacity of the existing river is only several hundreds cubic meters per second, which represents a discharge of two-year return period flood. As a result, flood damage has often occurred to both sides of the River.

On the north bank of the River, about 15 km^2 area along the river in the Lo Wu and Futian districts often suffer from flood damage, with an average of 1—2 times every year. Each flood event lasts for 1—3 days. Due to rapid development over the last 20 years in Shenzhen City, the two districts have become densely populated with modern commercial sectors. Great economic losses are resulted in each flood event. In the NW New Territory, on the south bank of the Shenzhen River, flooding will result in inundation of ponds, farmland and houses. The damage is high.

Due to rapid development on both sides of the River, the deficiency of the river capacity to combat flood causes serious concern, The deficiency of river capacity convey to flood flow that leading to severe flood damage for years, has caused great impact on the social economy and environment, and has greatly restricted the sustainable development and social stability in the region.

Stage Ⅰ and Ⅱ of the Shenzhen River Regulation Project will be completed by the end of year 2000. By then, the flood carrying capacity downstream of Lo Wu will be greatly improved to resist the flood of 50-year return period. However, it is anticipated that the upper reach area in the east of Lo Wu along the Shenzhen River will not be able to release the flood water. Once flood occurs, the operation of the two bridges and other facilities in Man Kam To Border Crossing would be seriously affected. The Dongshen Water Supply Pumping Station on the Shenzhen side and Muk Wu Pumping Station on the Hong Kong side would also be flooded and the normal function will be

disrupted. In addition, the losses caused by flooding in the Ping Yuen River (River Ganges) basin would be inevitable.

1.2 Objective of the Shenzhen River Regulation Project

In order to improve the living environment along the river side and the safety of the public and property, and promote the sustainable development of the regional economy, the governments of both Shenzhen Special Economic Zone and Hong Kong Special Administrative Region have jointly commissioned the Shenzhen River Regulation Project with the main objective of flood prevention, while pollution control and navigation improvement are the associated benefits.

In the early establishment of the Shenzhen Economical Special Zone, detailed survey, investigation and hydrological calculation were conducted for urban flood control in combination with the overall city planning. In 1982, both the Shenzhen and Hong Kong governments jointly launched a successful cooperation program and completed the *Report of Flood Control for the Shenzhen River and Planning Report for the Shenzhen River Regulation Project*. In these reports the regulation scheme of the Shenzhen River is discussed, and the three stages scheme of the Shenzhen River Regulation Project is determined with a feasibility report of the Project.

The construction of Stage I of the Project has already been completed, and the construction of Stage II is underway and Stage III has been in preparation. The main task of Stage III Project is to improve the flood control capacity in North New Territory of Hong Kong and part of Shenzhen City in the upper reach of Lo Wu, reduce the losses caused by flooding, and regulate the river course from the upper reach of the meander in Liu Pok to the mouth of the River Ganges (Ping Yuen River).

Layout of the Shenzhen River regulation project is shown in Figure 1.1

1.3 Scope of EIA

The EIA mainly aims at Stage Ⅲ of the Shenzhen River Regulation Project (called as Stage Ⅲ Project below in this report), the scope of the EIA study covers from the upper reach of the meander in Liu Pok to the mouth of River Ganges. The potential impacts on air quality, noise, hydrology, sediment and water quality, spoil, ecology, water and soil erosion, landscape, vision, cultural heritage, and public health etc. affected by the Project are to be studied in the EIA.

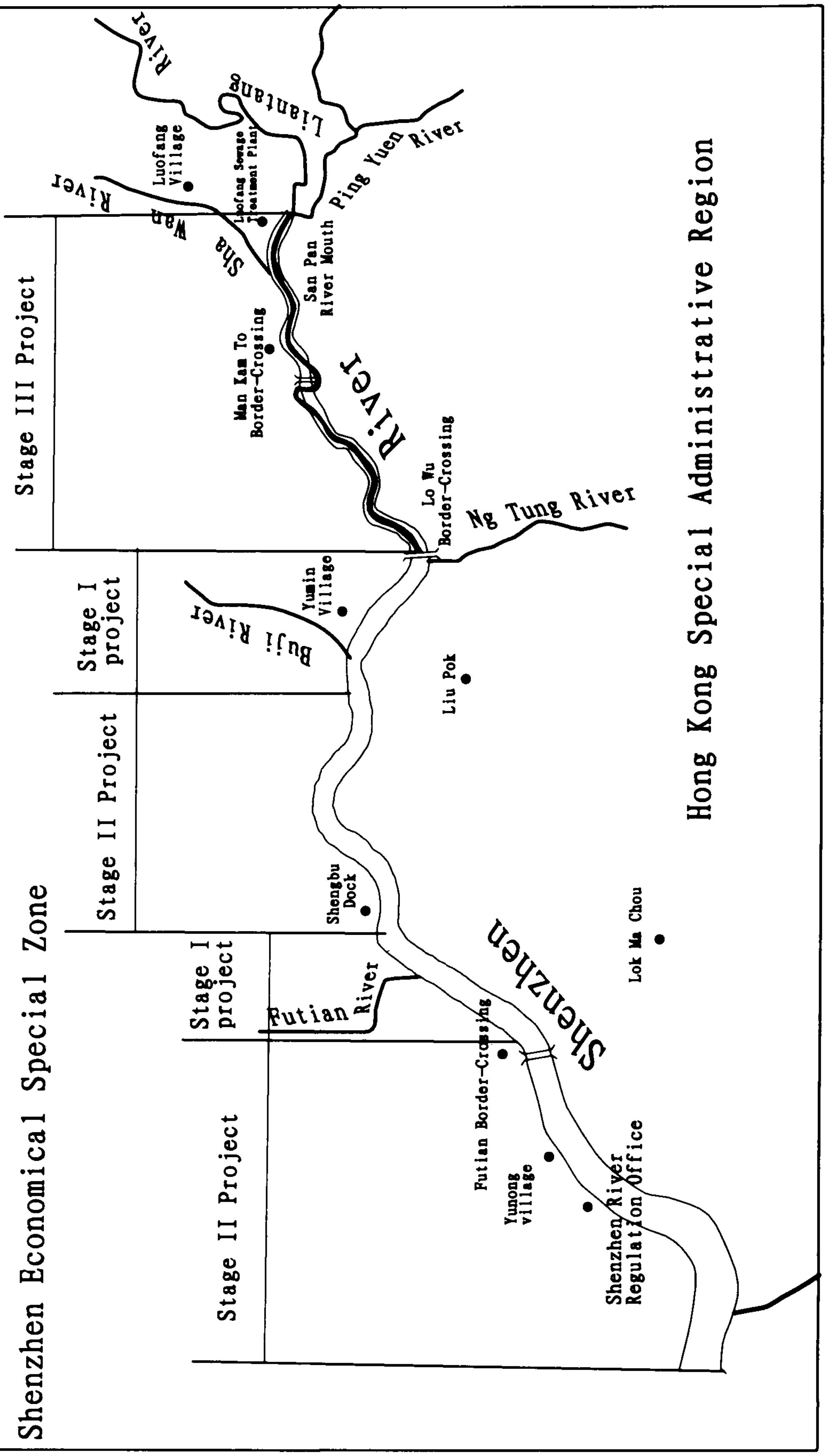

Figure1.1 Stage Sketch Map of the Shenzhen River Regulation Project

1.4 Purpose of EIA

The Project will greatly enhance the flood control capacity and improve river water quality, navigation conditions, as well as local landscape, which has significant social, economical and environmental benefits. However, there will also be some unavoidable environmental impacts associated with the Project. Therefore, it is essential to undertake an environmental impact assessment (EIA) to evaluate the nature and extent of the potential impacts, propose practical mitigation measures and assess the acceptability of the residual impact. Because the construction of Stage III Project may cause some adverse impacts on ecology, water quality, waste disposal, noise and air quality, environmental protection aspect of the Project is of great concern. After evaluation and discussion, the two local governments concluded that an EIA for Stage III Project must be conducted.

Objectives of the EIA

1) To describe the proposed project and associated works together with the requirements and environmental benefits of the proposed projects, as well as the reasons and objectives to conduct the project;

2) To identify and describe the elements of the community and environment likely to be affected by the proposed project, and likely to cause adverse impacts on the proposed project, including both the natural and man-made environment and the associated environmental constraints;

3) To identify and quantify the pollution sources and determine the significance of impacts on sensitive receivers and potential affected uses;

4) To identify and quantify any potential losses or damage caused to flora, fauna and natural habitats;

5) To identify any negative impacts on cultural heritage and to propose measures to mitigate the impacts;

6) To propose the provision of infrastructure or mitigation measures to minimize pollution, environmental disturbance and nuisance during construction and operation of the Project;

7) To investigate the feasibility, effectiveness and implications of the proposed mitigation measures;

8) To identify, predict and evaluate the residual environmental impacts and the cumulative effects expected to arise during the construction and operation phases of the Project in relation to the sensitive receivers and potential affected uses;

9) To identify, assess and specify methods, measures and standards, to be included in the detailed design, construction and operation of the Project, which are necessary to mitigate these residual environmental impacts and cumulative effects and reduce them to an acceptable level;

10) To design and specify the requirements for environmental monitoring and audit of the Project; and

11) To identify any additional studies necessary to implement the mitigation measures or monitoring and propose recommendations in the EIA report.

1.5 Content of the EIA

To fulfill the above objective, the final EIA report will cover the following aspects:

(1) Detail description of the Project, including:

1) General description of the project area, brief of the Project and its main benefit,

2) Planning, feasibility and design outline of the Project,

3) Programme and method of construction, and

4) Alternatives for design and construction, and of the Project.

(2) Existing environmental situation in the Project area and Project affected area, including:

1) Environmental baseline survey, and

2) Environmental trend and main environmental issues.

(3) Technical approach and methodology, including:

1) Basic procedures for environmental assessment;

2) Determination of the main environmental issues;

3) Details and method for study on environmental baseline and other special items; and

4) Details of prediction, basic assumption and selection of the model.

(4) Prediction and assessment of environmental impact, including:

1) Outline of the legal basis, standards and principals for assessment;

2) Qualitative or quantitative description of classification and characteristics of the potential impacts during construction, maintenance and operation;

3) Determination and description of the receivers and resources affected;

4) Prediction of environmental impact (including negative or positive, direct or indirect, short term or long term, reversible or irreversible, regional or trans-regional, cumulative or non-cumulative, etc.); and

5) Assessment of the predicted environmental impacts.

(5) Mitigation measures including:

1) Various mitigation measures for mitigating environmental impacts caused by the Project construction;

2) Screening and proposal on optimal mitigation measures;

3) Assessment of the feasibility and effectiveness of the mitigation measures; and

4) Identification and determination of the residual impact after taking mitigation measures.

(6) Requirement for monitoring and audit, including:

1) Need for and scope of the monitoring and audit;

2) Definition of environmental monitoring and audit requirements; and

3) Compilation of the environmental monitoring and audit manual.

(7) Conclusion and suggestion, including:

1) Outline of the environmental impacts of the Project and relevant mitigation measures to be conducted;

2) Description of the environmental feasibility of the Project; and

3) Suggestions to effectively control Project's environmental impacts, and other environmental issues, which need to be further studied.

1.6 Structure of the EIA Report

The EIA report consists of 14 Chapters.

Chapter 1 to chapter 2 of the EIA report will introduce the background of the EIA, objectives of the Shenzhen River Regulation Project, the programme of the Project and potential environmental impact likely caused by the Project.

Chapter 3 introduces the technical approach and methodology used in the EIA.

Chapter 4 to chapter 12 present the prediction and assessment of the environmental impacts including air quality, noise, hydrology, sediment, water quality, spoil, ecology, water and soil erosion, landscape, vision and cultural relics, public health, etc..

Chapter 13 presents public concern and participation for the Project's environmental impacts.

Chapter 14 presents the conclusion of the EIA for the Project.