KOWLOON-CANTON RAILWAY CORPORATION

East Rail Extensions -
Sheung Shui to Lok Ma Chau Spur Line

Construction Phase

Environmental Monitoring and Audit Manual

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Report Authorized For Issue By:	..... For and on Behalf of Black & Veatch Hong Kong Limited

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CONTENTS

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CONTENTS
(cont'd)

CONTENTS
(cont'd)

CONTENTS
(cont'd)

FIGURES

APPENDICES

1. INTRODUCTION

1.1 Policy

1.1.1 The Engineer's Representative (i.e. resident engineer) and the Contractor shall adopt the Environmental Policy Statements, as promulgated by the Kowloon Canton Railway Corporation (KCRC) East Rail Extensions (ERE) for the construction of the Sheung Shui to Lok Ma Chau Spur Line (Spur Line) in order to the foster a sound EM&A programme to protect the environment in accordance with Environmental Impact Assessment (EIA) study recommendations and Environmental Permit (EP) conditions set out in Section 1.4 below and included in Appendix B of this Manual.

1.2 Purpose of the Construction Phase EM&A Manual

1.2.1 The purpose of the Construction Phase Environmental Monitoring and Audit (EM&A) Manual is to guide the setup of an EM&A programme during a project's construction phase to ensure compliance with the Environmental Permit conditions, Environmental Impact Assessment (EIA) study recommendations, relevant environmental protection, and pollution prevention and control legislation. The Construction Phase EM&A Manual will be used to assess the effectiveness of, *inter alia,* the implementation of the recommended environmental impact mitigation measures and to identify the need for any additional mitigation measures or remedial action.

1.2.2 The Construction Phase EM&A Manual outlines the monitoring and audit programme to be undertaken for the construction of the development project. It aims to provide systematic procedures for the minimization and amelioration of environmental impacts associated with the construction works, the effective monitoring and audit of such impacts and the assessment of performance of any mitigation measures.

1.2.3 The Environmental Permit (EP-129/2002/A) conditions, findings, recommendations and requirements of the endorsed EIA, the Technical Memorandum and guidelines of all environmentally related legislation comprise the environmental standards and guideline to be used in the preparation of this Construction Phase EM&A Manual.

1.2.4 This Construction Phase EM&A Manual contains the following:

(a) duties of the Environmental Team (ET) Leader, the Independent Checker (Environment) (ICE), Engineer's Representative and Contractor, in relation to the project's environmental monitoring and audit requirements during construction;

(b) information on the project organisation and programming of construction activities;

(c) the project construction schedule and the necessary environmental monitoring and audit programme to track the environmental impacts;

(d) requirements for the review of pollution sources and working procedures in the event of non-compliance of the project's environmental performance criteria and the requirement to report regularly all recommendations made by the Environmental Committee;

(e) environmental monitoring protocols and their technical requirements including the latest information on the EM&A programme for hydrological monitoring at Long Valley and the ecological monitoring requirement for enhancement of fishponds at Lok Ma Chau.;

(f) environmental auditing procedures;

(g) requirements for the documentation of environmental monitoring and audit data, and appropriate reporting procedures; and

(h) complaint resolution procedures.

[For the purpose of the Construction Phase EM&A Manual, the "Architect/Engineer" shall refer to the Architect/Engineer as defined in the Contract and the Architect/Engineer's Representative (A/ER), in cases where the Architect/Engineer's powers have been delegated to the A/ER, in accordance with the Contract.]

1.2.5 A flow chart of the general Construction Phase EM&A activities is shown in Figure 1.1.

1.3 Background

Overview

1.3.1 The project site is shown in Figure 1.2. The Spur Line is proposed in order to alleviate the over-crowding conditions at Lo Wu on peak days and provide an alternative entry point to Shenzhen. It is expected that the passengers of North West New Territories and Kwu Tung will utilise the Spur Line rather than traveling to Lo Wu.

1.3.2 The Spur Line will involve the construction and operation of approximately 3.7 km of railway in tunnel and 1.6 km on a viaduct, a terminus at Lok Ma Chau and provision for a station at Kwu Tung in the future. The following sections describe the alignment of the Spur Line in detail.

Alignment

1.3.3 The Spur Line is an extension to the northern end of the existing East Rail system. Figure 1.2 shows the proposed horizontal alignment and the Study Area for the Environmental Impact Assessment (EIA) Study. Also shown are the works areas, emergency access points (EAPs), the sections of ramp, cut and cover tunnel, bored tunnel and viaduct, and the outline of the proposed Lok Ma Chau Station.

1.3.4 The proposed vertical alignment will descend from the at grade level at the existing Sheung Shui Station after diverting from the existing East Rail, onto two single track ramps. The southbound and northbound Spur Line track connections to the existing East Rail are staggered, the northbound track branching off before the southbound. This allows the northbound track to locate vertically below the southbound track, thus minimising the horizontal separation of the existing East Rail lines. The two tracks will enter the Eastern Portal at Chainages 30+420 (northbound track) and 30+762 (southbound track). The Eastern Ventilation Building will be located over the cut and cover section of the alignment. From Chainage 31+125 to 34+655, the two tracks enter twin 7.6m internal diameter (8.4m external diameter) bored tunnels located up to 30m below the existing ground level. Along the tunnel route, five emergency access points will be located, one east of the River Sutlej; one west of the River Beas, one at the east end of the future Kwu Tung station, one east of Pak Shek Au Road and one at the west end of the tunnel. Cross passages will be constructed at regular intervals between the twin bored tunnels to meet safety requirements.

1.3.5 The Tunnel Boring Machine (TBM) will be driven from the launching shaft at Sheung Shui, through to Chau Tau where, at Chainage 34+885, the western ventilation building will be constructed. In the area of the proposed Kwu Tung North NDA the shell of the future station will be constructed. The last section of the tunnel will be constructed using cut and cover techniques up to the western portal at Chainage 34+885. The tracks will then rise on an open ramp section to the viaduct abutment at 35+420. From this point, the viaduct rises to a top level of around 15mPD at which it continues to Lok Ma Chau station.

1.3.6 A number of works areas will be located along the alignment. These are also indicated on Figure 1.2. These areas will be used for storage of materials, stockpiling of material removed from the tunnel (if disposal is delayed), a water treatment plant, and general works activities.

Project Time Table

1.3.7 It is assumed that the necessary land will be available for this to start in the third quarter of 2002. The remaining land will be available by January 2003 for works on the East Rail diversion, tunnel approach sections, EAPs, Kwu Tung station box, viaduct construction and Lok Ma Chau station. Access to the uptrack will be available by April 2006, enabling rail systems installation completion by July 2007 when the Spur Line is planned to open.

Table 1.2
Sheung Shui to Lok Ma Chau Spur Line Construction Contracts to be Implemented by KCRC ERE

Contract No.	Civil, Structural and Environmentally Related Construction Works Under This Contract	Duration of Implementation	Monitoring Stations Which Fall Within the Boundary of This Contract
LDB 201	Up track tunnelling	September 2003 to September 2004	Noise Sensitive Receivers: NSRs 1, 3, 5, 8, 9, 11, 14, 16, 18, 19, 20 Air Quality Sensitive Receivers: ASRs: 5, 20 Water Quality Sensitive Receivers: WSRs: RB1, URB, LVS1, LVS2, LVW1, LVW2, LVW3, LVW4, LVW5, LVW6
	Down track tunnelling	December 2003 to November 2005	
	Western Approach Tunnel	January 2003 to September 2005	
	Eastern Approach Tunnel	January 2004 to December 2005	
	Construction of cross passages.	December 2005 to April 2006	
	Kwu Tung Station box construction	January 2003 to July 2005	
	Emergency Access Points with facilities for train control and access to track for emergency services in the event of an incident during operation, ventilation buildings;	January 2003 to April 2007	
	Diversion and modification of utility, drainage and sewerage services affected by the Works;	January 2003 to September 2005	
	Settlement, noise, pollution and environmental monitoring of the Site and adjacent areas; Landscaping including tree felling, tree transplantation and tree protection;	January 2003 to December 2005	
	All works and measures as specified in the Environmental Permit, including Floating Slab Track for sections of tunnel below existing or future populated areas.	January 2003 to December 2005	

Contract No.	Civil, Structural and Environmentally Related Construction Works Under This Contract	Duration of Implementation	Monitoring Stations Which Fall Within the Boundary of This Contract
LCC 202	1.4 km long twin track viaduct from the abutment at Chau Tau to the west of the future San Tin Eastern Drainage Channel the future San Tin Eastern Drainage Channel Two 0.15 km long single track viaducts from the San Tin Eastern Drainage Channel to the Lok Ma Chau Terminus A 0.2km long ramp up to the viaduct abutment Construction of walkway, central plenum, parapets, cable containment, lighting and OHL masts along the track way on viaduct and on the ramp section; An Emergency Access Point with facilities for train control and access to track for emergency services in the event of an incident during operation; Diversion and modification of utility, drainage and sewerage services affected by the Works; Settlement, noise, pollution and environmental monitoring of the Site and adjacent areas; Landscaping including tree felling, tree transplantation and tree protection; All works and measures as specified in the Environmental Permit.	December 2002 to June 2005	Noise Sensitive Receivers: NSRs 24, 25, 27 Air Quality Sensitive Receivers: ASRs: 27 Water Quality Sensitive Receivers: WSRs: CTC1, UCTC, STR1, USTR

Contract No.	Civil, Structural and Environmentally Related Construction Works Under This Contract	Duration of Implementation	Monitoring Stations Which Fall Within the Boundary of This Contract
LCC 206	Diaphragm wall for the Tunnel Boring Machine (TBM) launching shaft	July 2002 to May 2003	Noise Sensitive Receivers: NSR 4 Air Quality Sensitive Receivers: ASR: 4 Water Quality Sensitive Receivers: WSRs: RS1, URS
LCC 300	Lok Ma Chau Terminus and Huanggang Footbridge	September 2002 to June 2006	Noise Sensitive Receivers: Not Applicable Air Quality Sensitive Receivers: Not Applicable Water Quality Sensitive Receivers: WSRs: FP1, FP2, FP3
LFCC 007	Procurement and growth of nursery plants, and subsequent planting on the Site; Placing additional fill to create marsh areas; Modification of pond bunds to install water control systems, provide access, and create a habitat for birds; Detailed design, procurement and installation of a system to pump water between the ponds; Management of the ponds to stock, rear and net fish in accordance with the Habitat Creation and Management Plan (HCMP) included in PS Appendix E; and Management of the area generally to meet the requirements of the HCMP.		Noise Sensitive Receivers: Not Applicable Air Sensitive Receivers: Not Applicable Water Sensitive Receivers: Not Applicable

Operation

1.3.8 Only a passenger train service will be operated on the Spur Line. Upon opening in 2007, the train frequency will be 6 trains per hour in each direction. This will gradually increase to the ultimate train frequency of 12 trains per hour in each direction in 2016. When the Spur Line is completed, trains to Lo Wu and Lok Ma Chau will be operated as a split service direct from the existing Hung Hom station. The maximum speed of the trains operating on the Spur Line is 120 km/h. The Lok Ma Chau Boundary Crossing Point is assumed to be open from 0630 to 2330 hours. To accommodate the Boundary Crossing Point opening hours, the daily train service of the Spur Line will be provided between 0600 and one hour following the close of the Crossing Point.

1.4 Mitigation Measures listed in the Environmental Impact Assessment Report

1.4.1 Mitigation measures to be implemented during construction phase for air quality, noise, water quality, waste management, ecology, visual and landscape impact hydrology, and the Contamination Assessment Plan (CAP) are included in separate Chapters of this EM&A Manual. The implementation schedule for the full list of mitigation measures proposed under the EIA is included in Appendix A of the Manual.

1.5 Project Organization

1.5.1 The project organisation and lines of communication with respect to environmental protection works are shown in Figures 1.3a and b respectively.

The Client

1.5.2 The Client who may be the Environmental Manager (EM) of KCRC shall be responsible for:

(a) the broad supervision of the EM&A Study Programme, its members and the timely production and quality of the outputs;
(b) managing the Independent Environmental Checker and providing guidance to KCRC personnel in dealings with the Contractor's Environmental Team;
(c) meeting the agreed objectives and deadlines as set out in this Manual; and
(d) ensuring the quality of the deliverables.

1.5.3 The Client shall also provide appropriate information to the monthly EM&A reports such as:

- any design changes

- public consultation and liaison meetings involving the District Councils, area committees, interest groups, etc.

Contractor

1.5.4 Each Contractor shall be responsible for:

(a) employ an Environmental Team (ET) to undertake monitoring, laboratory analysis and reporting of environmental monitoring and audit;

(b) implementing environmental controls and mitigation as set out in this manual as well as any additional measures necessary for compliance with the environmental control standards;

(c) following any reasonable directions and corrective actions given by the Engineer or the ER(s) particularly as the result of the implementation of event/action plan and co-operate with the environmental performance review undertaken by the IEC;

(d) each Contractor shall comply with and observe all Ordinances, bye-laws, regulations and rules for the time being in force in Hong Kong governing the control of any form of pollution, including air, noise, water and waste pollution, and shall implement environmental controls and mitigation as set out in this manual as well as any additional measures necessary for compliance with the environmental control standards;

(e) each Contractor shall carry out all works in such a manner as to cause as little impact as possible to environs and the Contractor shall be held responsible for any claims which may arise from such impacts; and

(f) operate and strictly adhere to the guidelines of the Environmental Management Plan (EMP) developed by the Contractor.

The Engineer

1.5.5 The Engineer will be responsible for:

(a) ensuring that the EM&A programme is fully implemented in accordance with the Environmental Permit No. EP-129/2002 and this EM&A Manual;

(b) ensuring that the Contractor is implementing environmental controls and mitigation as set out in the contract specifications, Environmental Permit No. EP-129/2002 and this EM&A Manual as well as any additional measures necessary for compliance with the environmental control standards;

(c) ensuring that the Contractor is implementing and enforcing event/action plans when exceedances of Action and Limit (AL) levels or complaints occur;

(d) reviewing the monitoring and audit reports submitted by the Contractor's ET leader;

(e) implementing a `stop work' action if repeated exceedance of target levels justifies this action;

(f) follow up and close out corrective actions in accordance with the event/action plans; and

(g) investigating and auditing the Contractor's equipment and work methodologies with respect to pollution control and environmental mitigation, and to anticipate environmental issues that may require mitigation before the problem arises.

1.5.6 The division of the responsibilities under the Engineer are given in the following paragraphs.

The Engineer's Representative (ER(s))

1.5.7 The ER(s) have a key role to play with the EM&A programme, undertaking:

(a) an engineering audit of environmental reports;

(b) site liaison;

(c) implementing and enforcing event/action plans under the Contract when exceedances of AL levels or complaints occur; and

(d) ensuring that measures to protect the environment are sufficient, properly and regularly maintained under the Contract.

The Contractor's Environmental Team (Contractor's ET)

1.5.8 The Contractor's ET led by Contractor's ET leader will hold a key position with the EM&A programme.

1.5.9 Appropriate staff shall be included in the Contractor's ET to fulfil the following EM&A duties:

(a) environmental monitoring of various aspects such as noise, air quality and water quality as required by this EM&A Manual and using the procedures outlined in this EM&A Manual;

(b) recording activities or operations taking place at the site before or during the monitoring period;

(c) recording factors such as weather conditions at the time of sampling or data collection;

(d) undertaking regular maintenance and calibration of equipment so that accurate data are collected with precision;

(e) reporting to the Contractor's ET leader any abnormality in monitoring process and any difficulties encountered; and

(f) ensuring that monitoring results are sent to both the ER and the ET leader within the time frame as agreed by the ER.

Contractor's Environmental Team Leader (Contractor's ET Leader)

1.5.10 The Contractor's ET leader shall have relevant professional qualifications, or have sufficient relevant EM&A experience subject to approval of the Engineer. The Contractor's ET leader will be responsible for:

(a) reviewing the EIA final report and the detailed designs to ensure that the EIA recommendations and any other measures identified during the reviews are incorporated into the designs;

(b) ensuring that the contracts, licences and detailed designs of the Spur Line incorporate the measures recommended in the EIA report;

(c) checking that timely implementation of mitigation measures identified in the EIA final report occurs;

(d) examining Contractors' rolling works programmes, method statements, licence application and other relevant documentation so as to ensure the best practice would be implemented to generate no unacceptable impacts to the established guidelines/standards;

(e) identifying any potential unanticipated or greater than expected impacts;

(f) formulating any necessary preventative or remedial measures to be actioned for these potential impacts;

(g) liaising with the Engineer(s), and Contractors on environmental considerations both regularly and as necessary;

(h) undertaking environmental site inspection and audit both regularly and on ad-hoc basis at a frequency appropriate to the intensity of the works;

(i) approval of the appointment and the direction of the ET and supervising the ET;

(j) reviewing the monitoring data produced taking into account any factors which may influence these data;

(k) interpreting the reviewed data with reference to AL levels and baseline and control data;

(l) A contemporaneous log-book of each and every instance or circumstance or change of circumstances which may affect the EIA, and each and every non-compliance with recommendation of the EIA report (AEIAR-052/2002) or the Environmental Permit. The log-book shall be kept readily available for inspections by all persons assisting in supervision of the implementation of the EIA Report recommendations and the Environmental Permit or by the Director of his authorized officers.

(m) ascertaining whether any extraneous activities, unrelated to the construction work on the site, may have influenced the data. Cumulative impacts from nearby construction works should be considered;

(n) implementing event/action plans when exceedances of AL levels or complaints occur;

(o) liaising and consulting with all relevant parties during the implementation of action plans;

(p) establishing the A/L levels of water quality and Action Level of air quality;

(q) reviewing the EM&A programme after the collection and analysis of the baseline data. Modifying the EM&A programme in terms of parameters, sites, sample sizes, frequency etc. if appropriate in consultation with the Independent Environmental Checker (IEC), Engineer, EPD and Client;

(r) modifying the EM&A programme in consultation with the ER(s), EPD and AFCD if necessary throughout the period of Works;

(s) producing and circulating reports:

- on a regular basis as required in Section 11 of this Manual;
- when action plans are implemented;
- when responding to public complaints; and

(t) implementing the complaints procedures.

Independent Environmental Checker (IEC)

1.5.11 The Client shall employ an IEC before the commencement of construction of the Spur Line. The IEC shall have at least 7 years experience in EM&A or environmental management.

1.5.12 The IEC shall audit the overall EM&A programme including the implementation of all environmental mitigation measures, submissions relating to EM&A, and any other submission required under the Environmental Permit.

1.5.13 In addition, the IEC shall be responsible for verifying the environmental acceptability of permanent and temporary works, relevant design plans, contemporaneous log-book and submissions under the Environmental Permit.

1.5.14 Appropriate resources shall also be allocated under the ER to fulfil their duties specified in this manual.

1.5.15 Implement and maintain the Electronic Environmental Management System (EEMS) to all contract packages.

1.5.16 Arrange and conduct monthly general site inspections of the different works areas along the Spur Line alignment.

1.5.17 Ensure that impact monitoring is conducted at the correct locations at the correct frequency as identified in this Manual.

1.5.18 Report the findings of the site inspections and other environmental performance reviews to the Client and the EPD.

1.5.19 The IEC shall also prepare the following information for inclusion into the monthly EM&A reports:

(a) summary of site audit observations and results
(b) comments and/or recommendations
(c) areas of concern
(d) verification and certification of the report

1.6 Environmental Permit

1.6.1 All parties described in Section 1.5 are required to comply with all the Environmental Permit (EP) (No. EP-129/2002) Conditions. A copy of the EP is enclosed in Appendix B of this Manual.

2. AIR QUALITY

2.1 Introduction

2.1.1 The EIA concluded that while potential air quality impacts may arise as a result of transporting dusty materials over haul roads during construction phase, suitable mitigation and preventive measures will minimize these impacts. The sections describe the requirements and methodology for the baseline and construction phase air quality monitoring for the audit of the performance of the proposed mitigation and preventive measures.

2.2 Air Quality Parameters

2.2.1 1-hour and 24-hour TSP levels shall be measured by following the standard high volume sampling (HVS) method as set out in the Title 40 of the Code of Federal Regulations, Chapter 1 (Part 50), Appendix B. Upon approval of the ER, 1-hour TSP levels, that indicate short event impacts, can be measured by direct reading methods which are capable of producing comparable results to that taken by the high volume sampling method.

2.2.2 All relevant data including temperature, pressure, weather conditions, elapsed-time meter reading for the start and stop of the sampler, identification and weight of the filter paper, and other special phenomena and work progress of the concerned site etc. shall be recorded in detail. A sample data sheet is shown in Figure 2.1.

2.3 Monitoring Equipment

2.3.1 High volume samplers (HVS) in compliance with the following specifications shall be used for carrying out the TSP monitoring:

(a) 0.6-1.7 m^3/min (20-60 SCFM) adjustable flow range;

(b) equipped with a timing/control device with +/- 5 minutes accuracy for 24 hours operation;

(c) installed with elapsed-time meter with +/- 2 minutes accuracy for 24 hours operation;

(d) capable of providing a minimum exposed area of 406 cm^2 (63 in^2);

(e) flow control accuracy: +/- 2.5% deviation over 24-hr sampling period;

(f) equipped with a shelter to protect the filter and sampler;

(g) incorporated with an electronic mass flow rate controller or other equivalent devices;

(h) equipped with a flow recorder for continuous monitoring;

(i) provided with a peaked roof inlet;

(j) incorporated with a manometer;

(k) able to hold and seal the filter paper to the sampler housing at horizontal position;

(l) easy to change the filter; and

(m) capable of operating continuously for 24-hr period.

2.3.2 The Contractor's ET leader is responsible for provision of the monitoring equipment. He shall ensure that sufficient number of HVSs with an appropriate calibration kit are available for carrying out any baseline checks, regular impact monitoring and ad hoc monitoring. The HVSs shall be equipped with an electronic mass flow controller and be calibrated against a traceable standard at regular intervals. All the equipment, calibration kit, filter papers, etc. shall be clearly labelled.

2.3.3 Initial calibration of dust monitoring equipment shall be conducted upon installation and thereafter at bi-monthly intervals. The transfer standard shall be traceable to the internationally recognised primary standard and be calibrated annually. The calibration data shall be properly documented for future reference. All the data should be converted into standard temperature and pressure condition.

2.3.4 The flow-rate of the sampler before and after the sampling exercise with the filter in position shall be verified to be constant and be recorded down in a data sheet as shown in Figure 2.1.

2.3.5 If the Contractor's ET leader proposes to use a direct reading dust meter to measure 1-hr TSP levels, he shall submit sufficient information to the ER to prove that the instrument is capable of achieving a comparable result as that the HVS and may be used for the 1-hr sampling. The instrument should also be calibrated regularly, and the 1-hr sampling shall be determined periodically by HVS to check the validity and accuracy of the results measured by direct reading method.

2.3.6 Wind data monitoring equipment shall also be provided and set up at conspicuous locations for logging wind speed and wind direction near to the dust monitoring locations. The equipment installation location shall be proposed by the Contractor's ET leader and agreed with the ER. For installation and operation of wind data monitoring equipment, the following points shall be observed:

(a) the wind sensors should be installed on masts at an elevated level 10m above ground so that they are clear of obstructions or turbulence caused by the buildings;

(b) the wind data should be captured by a data logger and be downloaded for processing at least once a month;

(c) the wind data monitoring equipment should be re-calibrated at least once every six months; and

(d) wind direction should be divided into 16 sectors of 22.5 degrees each.

2.3.7 In exceptional situations, the Contractor's ET leader may propose alternative methods to obtain representative wind data upon approval from the ER and agreement from the ER and agreement from the IEC.

2.4 Laboratory Measurement/Analysis

2.4.1 A clean laboratory with constant temperature and humidity control, and equipped with necessary measuring and conditioning instruments, to handle the dust samples collected, shall be available for sample analysis, and equipment calibration and maintenance. The laboratory should be HOKLAS accredited or other internationally accredited laboratory.

2.4.2 If a site laboratory is set up or a non-HOKLAS accredited laboratory is hired for carrying out the laboratory analysis, the laboratory equipment shall be approved by the ER and in consultation with the IEC. Measurement performed by the laboratory shall be demonstrated to the satisfaction of the ER and the IEC. The IEC shall conduct regular audit to the measurement performed by the laboratory to ensure the accuracy of measurement results. The Contractor's ET leader shall provide the ER with one copy of the Title 40 of the Code of Federal Regulations, Chapter 1 (Part 50), Appendix B for his reference.

2.4.3 Filter paper of size 8"x10" shall be labelled before sampling. It shall be a clean filter paper with no pin holes, and shall be conditioned in a humidity controlled chamber for over 24-hr and be pre-weighed before use for the sampling.

2.4.4 After sampling, the filter paper loaded with dust shall be kept in a clean and tightly sealed plastic bag. The filter paper is then returned to the laboratory for reconditioning in the humidity controlled chamber followed by accurate weighing by an electronic balance with a readout down to 0.1 mg. The balance shall be regularly calibrated against a traceable standard.

2.4.5 All the collected samples shall be kept in a good condition for 6 months before disposal.

2.5 Monitoring Locations

2.5.1 The dust monitoring locations are shown in Table 2.1 and Figure 3.2. The status and locations of dust sensitive receivers may change after issuing this manual. If such cases exist, the Contractor's ET leader shall propose updated monitoring locations and seek approval from ER and agreement from the IEC.

Table 2.1
Air Quality Monitoring Stations

Air Quality Sensitive Receiver in EIA	Description
AM1	Village House, Long Valley
AM2	Village House, Kwu Tung
AM3	Village House, Chau Tau
AM4	Village House, Ha Wan Tsuen, Lok Ma Chau

2.5.2 When alternative monitoring locations are proposed, the following criteria, as far as practicable, should be followed:

(a) at the site boundary or such locations close to the major dust emission source;

(b) close to the sensitive receptors; and

(c) take into account the prevailing meteorological conditions.

2.5.3 The Contractor's ET leader shall agree with the ER on the position of the HVS for installation of the monitoring equipment. When positioning the samplers, the following points shall be noted:

(a) a horizontal platform with appropriate support to secure the samplers against gusty wind should be provided;

(b) no two samplers should be placed less than 2 metres apart;

(c) the distance between the sampler and an obstacle, such as buildings, must be at least twice the height that the obstacle protrudes above the sampler;

(d) a minimum of 2 metres separation from walls, parapets and penthouses is required for rooftop samplers;

(e) a minimum of 2 metres separation from any supporting structure, measured horizontally is required;

(f) no furnace or incinerator flue is nearby;

(g) airflow around the sampler is unrestricted;

(h) the sampler is more than 20 metres from the dripline;

(i) any wire fence and gate, to protect the sampler, should not cause any obstruction during monitoring;

(j) permission must be obtained to set up the samplers and to obtain access to the monitoring stations; and

(k) a secured supply of electricity is needed to operate the samplers.

2.6 Baseline Monitoring

2.6.1 Baseline monitoring shall be carried out at all of the designated monitoring locations for at least 14 consecutive days prior to the commissioning of the construction works to obtain daily 24-hr TSP samples. 1-hr sampling shall also be done at least 3 times per day while the highest dust impact is expected. Before commencing the baseline monitoring, the ET leader shall inform the IEC of the baseline monitoring programme such that the IEC can conduct an on-site audit to ensure accuracy of the baseline monitoring results. Table 2.2 summarises the parameters, frequency and duration for baseline monitoring.

2.6.2 During the baseline monitoring, there should not be any construction or dust generation activities in the vicinity of the monitoring stations.

2.6.3 In case the baseline monitoring cannot be carried out at the designated monitoring locations during the baseline monitoring period, it should be carried out at alternative locations which can effectively represent the baseline conditions at the impact monitoring locations. The alternative baseline monitoring locations shall be approved with the ER and with the IEC.

2.6.4 In exceptional cases, when insufficient baseline monitoring data or questionable results are obtained, agreement with EPD should be sought on an appropriate set of data to be used as a baseline reference and submit to ER for approval.

Table 2.2
Air Quality Monitoring Locations, Parameters, Frequency and Duration for Baseline

Location	Parameters	Frequency	Duration
AM1	24-hour TSP	Daily	Two consecutive week (total 14 days)
AM2	(All Locations)		
AM3	1-hour TSP	Three times daily during time of peak dust levels	
AM4	(All Locations)		

The locations are shown in Figure 2.2 (Sheets 1 to 5).

2.6.5 Ambient conditions may vary seasonally and shall be reviewed at three monthly intervals. If the ER or Contractor's ET leader considers that the ambient conditions have changed and a repeat of the baseline monitoring is required to be carried out for obtaining updated baseline levels, the monitoring should be at times when the contractor's activities are not generating dust, at least in the proximity of the monitoring stations. Should a change in ambient conditions be determined, the baseline levels and, in turn, the air quality criteria, should be revised. The revised baseline levels and air quality criteria should be agreed with the IEC and EPD.

2.7 Impact Monitoring

2.7.1 The Contractor's ET leader shall carry out impact monitoring during the course of the Works. For regular impact monitoring, the sampling frequency of once in every six-days shall be performed at all designated monitoring stations for 24-hr TSP monitoring. For 1-hr TSP monitoring, the sampling frequency of three times in every six-days should be undertaken when the highest dust impact occurs. Before commencing the baseline monitoring, the ET leader shall inform the IEC of the impact monitoring programme such that the IEC can conduct on-site audit to ensure accuracy of the impact monitoring results. All the locations listed in Table 2.1 shall be monitored.

2.7.2 The specific time to start and stop the 24-hr TSP monitoring shall be clearly defined for each location and be strictly followed by the operator.

2.7.3 In case of non-compliance with the air quality criteria, more frequent monitoring exercise, as specified in the Action Plan in Section 2.8, shall be conducted within 24 hours after the result is obtained. This additional monitoring shall be continued until the excessive dust emission or the deterioration in air quality is rectified.

2.8 Event and Action Plan for Air Quality

2.8.1 The baseline monitoring results form the basis for determining the air quality criteria for the impact monitoring. The Contractor's ET leader shall compare the impact monitoring results with air quality criteria set up for 24-hour TSP and 1-hour TSP. Table 2.3 shows the air quality criteria and Action and Limit levels to be used. Should non-compliance of the air quality criteria occurs, the Contractor's ET, the ER and the Contractor shall undertake the relevant action in accordance with the Action Plan in Table 2.4. Appendix D presents the calculated action and limit levels based on baseline monitoring data issued in August 2002.

Table 2.3
Action and Limit Levels for Air Quality

Parameters	Action	Limit
	Criteria	
24-Hour TSP Level in $\mu g/m^3$	For baseline level < 108 $\mu g/m^3$, Action level = average of baseline level plus 30% and Limit level For baseline level > 108 $\mu g/m^3$ and baseline level < 154 $\mu g/m^3$, Action level = 200 $\mu g/m^3$ For baseline level > 154 $\mu g/m^3$, Action level = 130% of baseline level	260
1-Hour TSP Level in $\mu g/m^3$	For baseline level < 154 $\mu g/m^3$, Action level = average of baseline level plus 30% and Limit level For baseline level > 154 $\mu g/m^3$ and baseline level < 269 $\mu g/m^3$, Action level = 350 $\mu g/m^3$ For baseline level > 269 $\mu g/m^3$, Action level = 130% of baseline level	500

Table 2.4
Event/Action Plan for Air Quality

EVENT	ACTION			
	Contractor's ET leader	IEC	ER	Contractor
ACTION LEVEL				
1. Exceedance for one sample	1. Identify source 2. Inform IEC, ER and Contractor 3. Repeat measurement to confirm findings 4. Increase monitoring frequency to daily	1. Check monitoring data submitted by Contractor's ET leader 2. Check Contractor's working method	1. Notify Contractor	1. Rectify any unacceptable practice 2. Amend working methods if appropriate
2. Exceedance for two or more consecutive samples	1. Identify source 2. Inform IEC, ER and Contractor 3. Repeat measurement to confirm findings 4. Increase monitoring frequency to daily 5. Discuss with IEC, Contractor and ER on remedial actions required 6. If exceedance continue, arrange meeting with IEC, ER and Contractor 7. If exceedance stops, cease additional monitoring	1. Checking monitoring data submitted by Contractor's ET leader. 2. Check Contractor's working method 3. Discuss with Contractor's ET leader and Contractor on possible remedial measures 4. Advise the ER on the effectiveness of the proposed remedial measures 5. Supervise implementation of remedial measures	1. Confirm receipt of notification of failure in writing 2. Notify Contractor 3. Ensure remedial measures properly implemented	1. Submit proposals for remedial actions to IEC and ER within 3 working days of notification 2. Implement the agreed proposals 3. Amend proposal if appropriate
LIMIT LEVEL				
1. Exceedance for one sample	1. Identify source 2. Inform IEC, ER, EPD and Contractor 3. Repeat measurement to confirm findings 4. Increase monitoring frequency to daily 5. Assess effectiveness of Contractor's remedial actions and kept IEC, EPD and ER informed of the results	1. Check monitoring data submitted by Contractor's ET leader 2. Check Contractor's working method 3. Discuss with Contractor's ET leader and Contractor on possible remedial measures 4. Advise the ER on the effectiveness of the proposed remedial measures 5. Audit implementation of remedial measures	1. Confirm receipt of notification of failure in writing 2. Notify Contractor 3. Ensure remedial measures properly implemented	1. Take immediate action to avoid for the exceedance 2. Submit proposals for remedial actions to IEC and ER within 3 working days of notification 3. Amend proposal if appropriate
2. Exceedance for two or more consecutive samples	1. Notify IEC, ER, Contractor and EPD 2. Identify source 3. Repeat measurement to confirm findings 4. Increase monitoring frequency to daily 5. Carry out analysis of Contractor's working procedures to determine possible mitigation to be implemented 6. Arrange meeting with IEC, Contractor and ER to discuss the remedial actions to be taken 7. Assess effectiveness of Contractor's remedial actions and keep IEC, EPD and ER informed of the results 8. If exceedance stops, cease additional monitoring	1. Discuss amongst ER, Contractor's ET leader and Contractor on the potential remedial actions 2. Review Contractor's remedial actions whenever necessary to assure their effectiveness and advise the ER accordingly 3. Audit the implementation of remedial measures	1. Confirm receipt of notification of failure in writing 2. Notify Contractor 3. In consultation with IEC, agree with the Contractor on the remedial measures to be implemented 4. Ensure remedial measures properly implemented 5. If exceedance continues, consider what portion of the work is responsible and instruct the Contractor to stop that portion of work until the exceedance is abated.	1. Take immediate action to avoid for the exceedance 2. Submit proposals for remedial actions to IEC and ER within 3 working days of notification 3. Implement the agreed proposals 4. Resubmit proposals if problem still not under control 5. Stop the relevant portion of works as determined by the ER until the exceedance is abate.

2.9 Dust Mitigation Measures

2.9.1 The EIA report has recommended dust control and mitigation measures. The Contractor shall be responsible for the design and implementation of these measures. The suggested dust control/mitigation measures are described below.

2.9.2 The following dust control measures as part of good construction site practice should be incorporated in the Contract Specification and implemented to minimize dust nuisance arising from the works to within acceptable levels:

(i) The Contractor shall undertake at all times to prevent dust nuisance as a result of his activities. Effective dust suppression measures, as necessary, should be installed to minimize air quality impacts, at the boundary of the site and at any sensitive receivers.

(ii) The Contractor shall frequently clean and water the site to minimize fugitive dust emissions.

(iii) Effective water sprays shall be used during the delivery and handling of all raw sand, aggregate and other similar materials, when dust is likely to be created, to dampen all stored materials during dry and windy weather.

(iv) Watering of exposed surfaces shall be conducted as often as possible depending on the circumstances.

(v) Areas within the site where there is a regular movement of vehicles shall have an approved hard surface, be kept clear of loose surface materials and / or regularly watered.

(vi) Where dusty materials are being discharged to vehicle from a conveying system at fixed transfer point, a three-sided roofed enclosure with a flexible curtain across the entry shall be provided. Exhaust fans shall be provided for this enclosure and vented to a suitable fabric filter system.

(vii) The Contractor shall confine haulage and delivery vehicles to designated roadways inside the site. If in the opinion of the Engineer, any motorised vehicle is causing dust nuisance, the Engineer may require that the vehicle be restricted to a maximum speed of 15 km per hour while within the site area.

(viii) Wheel cleaning facilities shall be installed and used by all vehicles leaving the site. No earth, mud, debris, dust and the like shall be deposited on public roads. Water in the wheel cleaning facility shall be changed at frequent intervals and sediments shall be removed regularly. The Contractor shall submit details of proposals for the wheel cleaning facilities to the Engineer prior to construction of the facility. Such wheel cleaning facilities shall be usable prior to any earthwork excavation activity on site. The Contractor shall provide a hard-surfaced road between any cleaning facility and the public road.

(ix) Any stockpile of dusty material shall be either: a) covered entirely by impervious sheeting; b) placed in an area sheltered on the top and the three sides; or c) sprayed with water or a dust suppression chemical so as to maintain the entire surface wet.

(x) Chemical wetting agents shall only be used on completed cuts and fills to reduce wind erosion.

(xi) All site vehicular exhausts should be directed vertically upwards or directed away from ground to minimize dust nuisance.

(xii) Ventilation system, equipped with proprietary filters, should be provided to ensure the safe working environment inside the tunnel. Particular attention should be paid to the location and direction of the ventilation exhausts. The exhausts should not be allowed to face any sensitive receivers directly. Consideration should also be given to the location of windows, doors and direction of prevailing winds in relation to the nearby sensitive receivers.

2.9.3 In addition, based on the *Air Pollution Control (Construction Dust) Regulation*, any works involved regulatory and notifiable works, such as stockpiling, loading and unloading of dusty materials, shall take precautions to suppress dust nuisance. Examples of dust suppression methods are:

- The working area of any excavation or earthmoving operation shall be sprayed with water or a dust suppression chemical immediately before, during and immediately after the operation so as to maintain the entire surface wet.

- Exposed earth shall be properly treated by compaction, turfing, hydroseeding, vegetation planting or sealing with latex, vinyl, bitumen or other suitable surface stabiliser within six months after the last construction activity on the construction site or part of the construction site where the exposed earth lies.

- Any stockpile of dusty materials shall be either covered entirely by impervious sheeting or placed in an area sheltered on the top and three sides; and sprayed with water or a dust suppression chemical so as to maintain the entire surface wet.

- Other suitable dust control measures as stipulated in the Air Pollution Control (Construction Dust). Regulation, where appropriate, should be adopted.

2.9.4 If the above measures are not sufficient to restore the air quality to acceptable levels upon the advice of Contractor's ET leader, the Contractor shall liaise with the Contractor's ET leader on some other mitigation measures, endorsed by IEC and propose to ER for approval, and implement the mitigation measures.

3. NOISE

3.1 Introduction

3.1.1 Noise impact is likely to arise from some of the construction activities of the Spur Line. The EIA recommended a number of administrative and technical preventive and mitigation measures that should be implemented to reduce potential impacts to acceptable limits. A monitoring programme is recommended for baseline conditions and during the construction phase to evaluate the performance of the proposed measures.

3.1.2 This section of the Manual lists all the recommended mitigative and preventive measures in the EIA and EP 129/2002 for the control of construction noise, and the up to date requirements for baseline and construction phase noise monitoring. The Contractor is required to implement these listed measures and to undertake noise monitoring as specified in this section, in addition to complying with all noise control related legislation of HKSAR.

3.2 Noise Parameters

3.2.1 The construction noise level shall be measured in terms of the A-weighted equivalent continuous sound pressure level (Leq). Leq(30 min) as six consecutive Leq (5 min) shall be used as the monitoring parameter for the time period between 0700-1900 hours on normal weekdays. For all other time periods, Leq(15 min) as three consecutive Leq(5 min) results shall be employed for comparison with the NCO criteria.

3.2.2 As supplementary information for data auditing, statistical results such as L_{10}, L_{90} and L_{max} shall also be obtained for reference. L_{max} levels are only measured during operation/maintenance monitoring. A sample data record sheet is shown in Figure 3.1 for reference.

3.3 Monitoring Equipment

3.3.1 As referred to in the Technical Memorandum (TM) issued under the Noise Control Ordinance (NCO), sound level meters in compliance with the International Electrotechnical Commission Publications 651: 1979 (Type 1) and 804: 1985 (Type 1) specifications shall be used for carrying out the noise monitoring. Immediately prior to and following each noise measurement, the accuracy of the sound level meter shall be checked using an acoustic calibrator generating a known sound pressure level at a known frequency. Measurements may be accepted as valid only if the calibration level from before and after the noise measurement agree to within 1.0 dB.

3.3.2 Noise measurements should not be made in the presence of fog, rain, wind with a steady speed exceeding $5ms^{-1}$ or wind with gusts exceeding $10ms^{-1}$. The wind speed shall be checked with a portable wind speed meter capable of measuring the wind speed in m/s. Standard acoustical principles and practices should be observed during monitoring.

3.3.3 The Contractor's ET leader is responsible for the provision of the monitoring equipment. He shall ensure that sufficient noise measuring equipment and associated instrumentation are available for carrying out the baseline monitoring, regular impact monitoring and ad hoc monitoring. All the equipment and associated instrumentation shall be clearly labelled.

3.4 Monitoring Locations

3.4.1 The locations of noise monitoring stations are shown in Table 3.1 and Figure 3.2. In case works is required for restricted hours, monitoring locations may also include those relevant to the application of Construction Noise Permit (CNPs) as advised by EPD.

3.4.2 The status and locations of noise sensitive receivers may change after issuing this manual. In this case, the Contractor's ET leader shall propose updated monitoring stations and seek approval from ER and agreement from the ICE and EPD of the proposal.

Table 3.1
Construction Noise Monitoring Stations

Noise Monitoring Stations	Equivalent RNSRs in EIA	Timing
NM1	1	During any construction works between Sheung Shui Station and the launching shaft
NM2	3	During any construction works between Sheung Shui Station and the launching shaft
NM3	4	During any construction works on works area around launching shaft
NM4	5	Construction of east EAP
NM5	8	During any works in the Kwu Tung Area
NM6	9	During any works in the Kwu Tung Area
NM7	11	During any works in the Kwu Tung Area
NM8	14	During any works in the Kwu Tung Area

Noise Monitoring Stations	Equivalent RNSRs in EIA	Timing
NM9	16	Construction of west EAP
NM10	18	During any construction works around the west approach
NM11	19	During any construction works around the west approach
NM12	20	During any construction works around the west approach
NM13	24	During any construction works on CH+875 to CH+2000 on Lok Ma Chau Road
NM14	25	During any construction works on CH+875 to CH+2000 on Lok Ma Chau Road
NM15	27	During any construction works for Spur Line alignment CH36+350 to CH36+450

3.4.3 When alternative monitoring stations are proposed, the monitoring locations should be chosen based on the following criteria:

(a) at locations close to the major site activities which are likely to have noise impacts;

(b) close to the noise sensitive receivers (N.B. For the purposes of this section, any domestic premises, hotel, hostel, temporary housing accommodation, hospital, medical clinic, educational institution, place of public worship, library, court of law, performing art centre should be considered as noise sensitive receiver); and

(c) for monitoring locations located in the vicinity of the sensitive receivers, care should be taken to cause minimal disturbance to the occupants during monitoring.

3.4.4 The monitoring station shall normally be at a point 1m from the exterior of the sensitive receivers building facade and be at a position 1.2m above the ground. If there is problem with access to the normal monitoring position, an alternative position may be chosen, and a correction to the measurements shall be made. For reference, a correction of +3dB(A) shall be made to the free field measurements.

3.4.5 The Contractor's ET leader shall agree with the ER on the monitoring position and the corrections adopted. Once the positions for the monitoring stations are chosen, the baseline monitoring and the impact monitoring shall be carried out at the same positions.

3.4.6 In case the monitoring location's windows are normally closed and operate their air condition units, or has fixed windows and operate air conditioning units, alternative locations shall be sought, bearing in mind the criteria listed in Section 3.4.3.

3.4.7 Where examinations take place at Ku Tung Oi Wah Public School, care shall be taken to cause minimal disturbance to the school during monitoring. The headmaster or headmistress should be notified in advance of monitoring programme.

3.5 Baseline Monitoring

3.5.1 At each location, baseline noise levels should be measured prior to the construction of the project, Leq(30 min) measurement for hours between 0700-1900, and Leq(15 min) measurement, between 1900 – 0700 shall be taken over seven consecutive calendar days. The measurements should be computed from consecutive Leq(5 min) readings taken throughout each 24 hour period.

3.5.2 The survey period should be selected prior to the commencement of construction activities in order to avoid other atypical noise sources. The proper functioning of the logger shall be ensured during the monitoring period, and as a minimum, the equipment shall be inspected for a period of not less that one hour every two days to ensure its continued operation and to detail specific noise sources audible at the monitoring location. The calibration of the logger kit shall be as recommended by the manufacturer. Measurements shall be recorded to the nearest 0.1 dB.

3.5.3 There shall not be any construction activities in the vicinity of the stations during the baseline monitoring.

3.6 Impact Monitoring

3.6.1 Impact monitoring shall be carried out at all the designated monitoring station in Table 3.1 during the construction phase of the project. The monitoring frequency for each station on a basis of each calendar week when noise generating activities are underway is as follows:

- one set of Leq (30min) as six consecutive Leq (5min) between 0700-1900 hours on normal weekdays.

3.6.2 General Construction work carried out during restricted hours is controlled by CNP system under the Noise Control Ordinance (NCO). If a school exists near the construction activity, noise monitoring shall be carried out at the monitoring

stations for the schools during the examination periods. The ET Leader shall liaise with the school's personnel and the Examination Authority to ascertain the exact dates and times of all examination periods during the course of the contract.

3.6.3 The Action and Limit Levels for Regular Monitoring are given in Table 3.2 and the Event/Action Plan in Table 3.3.

3.7 Event and Action Plan for Construction Noise

3.7.1 In case of non-compliance with the construction noise criteria, more frequent monitoring as specified in the Action Plan in Table 3.3 shall be carried out. This additional monitoring shall be continued until the recorded noise levels are rectified or proved to be irrelevant to the construction activities. The contractor's ET shall provide full documentation of his investigation on the cause of the non-compliance and whether it can be traced to activities other than those caused by the project, to the satisfaction of the ER and the IEC.

Table 3.2
Action and Limit Levels for Construction Noise

	Time Period	Action	Limit
Normal hours	0700-1900 hrs on normal weekdays	When one documented complaint is received	75* dB(A)

* *Reduced to 70 dB(A) for schools and 65 dB(A) during school examination periods.*

3.8 Construction Noise Mitigation Measures

3.8.1 To mitigate construction noise impacts, gap-free noise barriers made of material at least 10 kg/m² shall be installed at locations as indicated in Figure 3.2 (sheet 1 of 5) shall be maintained throughout the construction period.

3.8.2 No movement of spoil to any areas other than the works areas indicated in the layout plans shall be carried out during restricted hours. These layout plans in Scale 1:1000 will contain the works boundary, works areas, the railway, and the tunnel alignment of this Project. They will be submitted not more than one month before the commencement of construction of the Project to EPD in triplicate. These plans shall be certified by the ET leader and verified by the IEC that they conform to the contents of the EIA Report.

Table 3.3 Event/Action Plan for Construction Noise Monitoring

EVENT	ACTION			
	Contractor's ET Leader	**IEC**	**ER**	**Contractor**
Action Level	1. Notify IEC, Contractor and ER 2. Carry out investigation 3. Report the results of investigation to the IEC, Contractor and ER 4. Discuss with the Contractor and formulate remedial measures 5. Double monitoring frequency 6. Check compliance to Action/Limit Levels after application of mitigation measures	1. Review the analysed results submitted by the Contract's ET leader 2. Review the proposed remedial measures by the Contractor and advise the ER accordingly 3. Review the implementation of remedial measures	1. Confirm receipt of notification of complaint in writing 2. Notify Contractor 3. Require Contractor to propose remedial measures for the analysed noise problem 4. Ensure remedial measures are properly implemented	1. Submit noise mitigation proposals to ER and IEC 2. Implement noise mitigation proposals
Limit Level	1. Notify IEC, ER, EPD and Contractor 2. Identify Source 3. Repeat measurement to confirm findings 4. Increase monitoring frequency 5. Carry out analysis of Contractor's working procedures to determine possible mitigation to be implemented 6. Inform IEC, ER and EPD the causes & actions taken for the exceedances 7. Assess effectiveness of Contractor's remedial actions and keep IEC, EPD and ER informed of the results 8. If exceedance stops, cease additional monitoring	1. Discuss amongst ER, Contractor's ET leader and Contractor on the potential remedial actions 2. Review Contractor's remedial actions whenever necessary to assure their effectiveness and advise the ER accordingly 3. Audit the implementation of remedial measures	1. Confirm receipt of notification of failure in writing 2. Notify Contractor 3. Require Contractor to propose remedial measures for the analysed noise problem 4. Ensure remedial measures are properly implemented 5. If exceedance continues, consider what portion of the work is responsible and instruct the Contractor to stop that portion of work until the exceedance is abated	1. Take immediate action to avoid further exceedance 2. Submit proposals for remedial actions to within 3 working days of notification 3. Implement the agreed proposals 4. Resubmit proposals if problem still not under control 5. Stop the relevant portion of works as determined by the ER until the exceedance is abated

4. WATER QUALITY

4.1 Introduction

4.1.1 The EIA identified activities and locations during the construction of the railway that may have potential impacts on water quality. Potential impacts include runoff from the construction of surface structures such as the emergency access points, ventilation buildings, Kwu Tung station box excavation, tunnel boring machine excavation and retrieval shafts, and the cut and cover areas at either end of the tunnel, that may lead to water quality impacts in nearby rivers, fishponds and wells.

4.1.2 The EIA recommended a number of administrative and technical preventive and mitigative measures that should be implemented to control the potential impacts to within acceptable limits. A monitoring programme is recommended for baseline conditions and during the construction phase to assess and ensure the performance of the proposed measures.

4.1.3 This section of the Manual lists all the recommended mitigative and preventive measures in the EIA and EP 129/2002 for the protection of water quality during construction phase, and the up to date requirements for baseline and construction phase water quality monitoring. The Contractor is required to implement these listed measures and to undertake water quality monitoring as specified in this section, in addition to complying with all the water quality related legislation of HKSAR.

4.2 Water Quality Parameters

4.2.1 The selection of water quality monitoring parameters shall be based on the recommendations in the EIA report. The monitoring shall be carried out by the ET to ensure that any deteriorating water quality can be readily detected and action be taken in time to rectify the situation.

4.2.2 In association with the water quality parameters, selected relevant data shall also be measured, such as monitoring location/position, time, water depth, water temperature, salinity, DO saturation, weather conditions, tidal stage, and any special phenomena and work underway at the construction site.

4.2.3 The data format of the water quality monitoring record and a sample monitoring record sheet are shown in Figures 4.1 and 4.2 for reference.

4.3 Sampling Procedures and Monitoring Equipment

4.3.1 Water samples for all monitoring parameters shall be collected, stored, preserved and analysis according to the Standard Methods, APHA 17 ed. and/or methods agreed by the Director of Environmental Protection. *In-situ* measurements at monitoring locations including DO, turbidity, salinity and water depth shall be collected using equipment with the characteristics and functions listed in the following sections.

4.3.2 Dissolved oxygen and temperature measuring equipment

(a) The instrument shall be a portable, weatherproof dissolved oxygen measuring instrument complete with cable, sensor, comprehensive operation manuals, and with the us of a DC power source. (e.g. YSI model 59 meter, YSI 5739 probe, YSI 5795A submersible stirrer with reel and cable or an approved similar instrument). It shall be capable of measuring:-

- a dissolved oxygen level in the range of 0-20 mg/l and 0-200% saturation; and
- a temperature of 0-45 degree Celsius.

(b) It shall have a membrane electrode with automatic temperature compensation complete with a cable. Sufficient stocks of spare electrodes and cables shall be available for replacement where necessary.

(c) Should salinity compensation not be built-in to the DO equipment, in-situ salinity shall be measured to calibrate the DO equipment prior to each DO measurement.

4.3.3 Turbidity Measurement Instrument

The instrument shall be a portable, weatherproof turbidity-measuring instrument complete with comprehensive operation manual. The equipment shall use a DC power source. It shall have a photoelectric sensor capable of measuring turbidity between 0-1000 NTU (e.g. Hach model 2100P or an approved similar instrument).

4.3.4 Suspended Solids

(a) Sampling shall be carried out using a water sampler which comprises a transparent PVC cylinder, with a capacity of not less than 2 litres, and can be effectively sealed with latex cups at both ends. The sampler shall have a positive latching system to keep it open and prevent premature closure until released by a messenger when the sampler is at the selected water depth (e.g. Kahlsico Water Sampler or an approved similar instrument).

(b) Water samples for suspended solids measurement shall be collected in high density polythene bottles, packed in ice (cooled to 4°C without being frozen), and delivered to the laboratory as soon as possible after collection.

4.3.5 Water Depth Detector

A portable, battery-operated echo sounder shall be used for the determination of water depth at each designated monitoring station. This unit can either be handheld or affixed to the bottom of the work boat, if the same vessel is to be used throughout the monitoring programme.

Salinity

4.3.6 A portable salinometer capable of measuring salinity in the range of 0-40 ppt shall be provided for measuring salinity of the water at each monitoring location.

4.3.7 If necessary a hand-held or boat-fixed type digital Global Positioning System (GPS) with way point bearing indication or other equivalent instrument of similar accuracy shall be provided and used during monitoring to ensure the monitoring vessel is at the correct location before taking measurements.

4.3.8 All in-situ monitoring instrument shall be checked, calibrated and certified by a laboratory accredited under HOKLAS or any other international accreditation scheme before use, and subsequently re-calibrated at 3 monthly intervals throughout all stages of the water quality monitoring. Responses of sensors and electrodes shall be checked with certified standard solutions before each use. Wet bulb calibration for a DO meter shall be carried out before measurement at each monitoring location.

4.3.9 For the on-site calibration of field equipment, the BS 1427:1993," Guide to Field and on-site test methods for the analysis of waters" shall be observed.

4.3.10 Sufficient stocks of spare parts shall be maintained for replacements when necessary. Backup monitoring equipment shall also be made available so that monitoring can proceed uninterrupted even when some equipment is under maintenance, calibration, etc.

4.4 Laboratory Measurement/Analysis

4.4.1 Analysis of suspended solids, oil an grease, BOD_5, TOC, total nitrogen, Ammonia-N, and total phosphates shall be carried out in a HOKLAS or other international accredited laboratory. Water samples of about 1000ml shall be collected at the monitoring stations for carrying out the laboratory SS determination. The detection limit shall be 1 mg/L or better. The SS determination work shall start within 24 hours after collection of the water samples. The SS determination shall follow APHA 17ed 2540D or equivalent methods subject to approval of EPD.

4.4.2 If a site laboratory is set up or a non-HOKLAS and non-international accredited laboratory is hired for carrying out the laboratory analysis, the laboratory equipment, analytical procedures, and quality control shall be approved by the EPD. All the analysis shall be witnessed by the ET. The ET Leader shall provide the ER with one copy of the relevant chapters of the "Standard Methods for the Examination of Water and Wastewater" updated edition and any other relevant document for his reference.

4.4.3 For the testing methods of other parameters as recommended by EIA or required by EPD, detailed testing methods, pre-treatment procedures, instrument use, Quality Assurance/Quality Control (QA/QC) details (such as blank, spike recovery, number of duplicate samples per batch, etc.), detection limits and accuracy shall be submitted to EPD for approval prior to the commencement of monitoring programme. The QA/QC shall be in accordance with the requirement of HOKLAS or international accredited scheme. The QA/QC results shall be reported. EPD may also request the laboratory to carry out analysis of known standards provided by EPD for quality assurance. Additional duplicate samples may be required by EPD for inter laboratory calibration. Remaining samples after analysis shall be kept by the laboratory for 3 months in case repeat analysis is required. If in-house or non-standard methods are proposed, details of the method verification may also be required to submit to EPD. In any circumstance, the sample testing shall have comprehensive quality assurance and quality control programmes. The laboratory shall prepare to demonstrate the programmes to EPD or his representatives when requested.

4.5 Monitoring Locations

4.5.1 Locations of the sites to be monitored during baseline and impact monitoring are shown in Table 4.1 and Figures 4.3 and 4.4 . The status and locations of water quality sensitive receivers may change after issuing this manual. In such a case, the ET Leader shall propose updated monitoring locations and seek approval from the IEC and EPD.

Table 4.1
Proposed Monitoring Locations for Water Quality during Construction of Spur Line

Location Code	Description	Grid Co-ordinates*	
		Easting	Northing
RS1	River Sutlej – downstream of Spur Line	830 274	840 731
URS	River Sutlej – upstream of Spur Line	830 127	841 085
RB1	River Beas – downstream of Spur Line	829 296	840 766
URB	River Beas – upstream of Spur Line	829 374	841 022
FP1	Selected fishponds to be monitored when works is close to this area. These locations will be modified depending on the works location.	826 750	840 486
FP2		826 380	840 578
FP3		825 392	841 571
STR1	San Tin River – downstream of Spur Line	825 371	841 754
USTR	San Tin River – upstream of Spur Line	825 903	841 078
CTC1	Chau Tau Channel – downstream of Spur Line	825 877	841 320
UCTC	Chau Tau Channel – upstream of Spur Line	825 144	841 658
LVS1	Two streams within Long Valley, one upstream, one downstream of alignment.	829 986	840 958
LVS2		829 836	840 914
LVW1	Six well locations bordering the tunnel alignment, to be used for water quality monitoring.	829 752	840 980
LVW2		829 757	840 936
LVW3		829 643	840 930
LVW4		829 591	840 866
LVW5		829 995	840 853
LVW6		829 697	840 884

* Hong Kong Grid Version 98-01

4.5.2 When alternative monitoring locations are proposed, they shall be chosen based on the following criteria:

(a) at locations close to and preferably at the boundary of the mixing zone of the major site activities as indicated in the EIA final report, which are likely to have water quality impacts;

(b) close to the sensitive receptors which are directly or likely to be affected;

(c) for monitoring locations located in the vicinity of the sensitive receptors, care shall be taken to cause minimal disturbance during monitoring;

(d) two or more control stations which shall be at locations representative of the project site in its undisturbed condition. Control station shall be located, as far as is practicable, both upstream and down stream of the works area.

4.5.3 Control stations are necessary to compare the water quality from potentially impacted sites with the ambient water quality. Control stations shall be located within the same body of water as the impact monitoring stations but shall be outside the area of influence of the works and, as far as practicable, not affected by any other works.

4.5.4 Measurements shall be taken at 3 water depths, namely, 1m below water surface, mid-depth and 1m above stream or sea bed, except where the water depth less than 6m, the mid-depth station may be omitted. Should the water depth be less than 3m, only the mid-depth station will be monitored.

4.5.5 Replicates *-in-situ* measurements and samples collected from each independent sampling event are required for all parameters to ensure a robust statistically interpretable dataset.

4.6 Baseline Monitoring

4.6.1 Baseline conditions for water quality shall be established and agreed with EPD prior to the commencement of works. The purpose of the baseline monitoring is to establish ambient conditions prior to the commencement of the works and to demonstrate the suitability of the proposed impact, control and reference monitoring stations. The baseline conditions shall be established by measuring the water quality parameters specified in Table 4.2. For tidal areas, the measurements shall be taken at all designated monitoring stations including control stations, 3 days per week, at mid-flood and mid-ebb tides, for at least four weeks prior to the commencement of marine works. For non-tidal areas, which include the fish ponds an non-tidal streams, flood and ebb conditions do not apply, and water quality should only be monitored once a week.

4.6.2 There shall not be any construction activities in the vicinity of the stations during the baseline monitoring.

4.6.3 In exceptional cases when insufficient baseline monitoring data or questionable results are obtained, the ET Leader shall seek approval from the IEC and EPD on an appropriate set of data to be used as baseline reference.

4.6.4 Baseline monitoring schedule shall be faxed to EPD 1 week prior to the commencement of baseline monitoring. The interval between 2 sets of monitoring shall not be less than 36 hours.

Table 4.2
Water Quality Monitoring Locations, Parameter, Frequency and Duration for Baseline

Locations	Parameters	Frequency	Duration
RS1 URS RB1 URB FP1 FP2 FP3 STR1 USTR UCTC CTC1	DO, pH, turbidity, temperature, suspended solids, oil & grease	For tidal areas, 3 days per week at mid-flood an mid-ebb tides. For non-tidal areas (including fish ponds and non tidal streams), once per week.	Four weeks
LVS1 LVS2 LVW1 LVW2 LVW3 LVW4	DO, pH, turbidity, temperature, suspended solids, oil & grease	Non-tidal. Once per week	Four weeks
LVW5 LVW6	BOD_5 TOC Total Nitrogen Ammonia-N Total Phosphate	Non-tidal. Once per week	Four weeks

The locations are shown in Figures 4.3 and 4.4.

4.7 Impact Monitoring

4.7.1 During the course of the construction works, monitoring shall be undertaken according to the parameters, frequencies, and duration described in Table 4.3. The interval between two sets of monitoring shall not be less than 36 hours except where there are exceedances of AL levels, in which case the monitoring frequency will be increased.

Table 4.3

Locations, Parameters, Frequencies and Durations during Construction Phases

Parameter	Locations	Frequency
DO/pH/Temperature/Turbidity	RS1, URS, RB1, URB, FP1, FP2, FP3, STR1, USTR, CTC1, CTC1, UCTC	Twice a week in-situ monitoring, at mid flood and mid ebb tides during each day monitored.
SS		Weekly, at mid-flood and mid ebb.
Oil & Grease		Biweekly/monthly depending on the type of waters, at mid flood and mid ebb.
DO, pH, Temperature, Turbidity, SS	LVS1, LVS2, LVW1, LVW2, LVW3, LVW4, LVW5, LVW6	Three times per week. These waters are non-tidal.
BOD_5 TOC Total Nitrogen Ammonia-N Total Phosphate, Oil and Grease	LVS1, LVS2, LVW1, LVW2, LVW3, LVW4, LVW5, LVW6	Weekly/biweekly depending on works being undertaken. When TBM is approaching within 50m of the location, weekly. After passing the location, biweekly for the following month. These waters are non-tidal.

4.7.2 The proposed water quality monitoring schedule shall be faxed to IEC and EPD on or before the first day of the monitoring month. EPD shall also be notified immediately for any changes in schedule by fax.

4.8 Event and Action Plan for Water Quality

4.8.1 There are two established ways to set the water quality assessment criteria for a monitoring programme. The consultants shall seek advice from the EPD on setting the assessment criteria and the design of the project specific Action Plan.

4.8.2 Approach One:

The water quality assessment criteria, namely Action and Limit levels are based on the results of baseline monitoring and WQO of the Deep Bay water control zone (Table 4.4) and inland rivers. Should the monitoring results of the water quality parameters at any designated monitoring stations indicate that the water quality assessment criteria are exceeded, the actions in accordance with the Action Plan in Table 4.5 shall be carried out.

4.8.3 Approach Two:

The water quality assessment criteria shall be based on the results of statistical analysis on the different between impact monitoring results and 30% above control, and/or specific levels defined during the EIA stage for the sensitive receivers. A project specific Action Plan shall be designed according to the monitoring programme and approval from the EPD shall be sought.

Table 4.4
Typical Action and Limit Levels for Water Quality

Parameters	Action	Limit
DO in mg/l (Surface, Middle & Bottom)	Surface & Middle 5%-ile of baseline data for surface and middle layer Room 5%-ile of baseline data for bottom layer.	Surface & Middle 4mg/l except 5mg/l for FCZ or 1%-ile of baseline data for surface and middle layer Bottom 2mg/l or 1%-ile of baseline data for bottom layer
SS in mg/l (depth-averaged)	95%-ile of baseline data or 120% of upstream control station's SS at the same tide of the same day	99%-ile of baseline or 130% of upstream control station's SS at the same tide of the same day and specific sensitive receiver water quality requirements (e.g. required suspended solids level for concerned sea water intakes)
Turbidity (Tby) in NTU (depth-averaged)	95%-ile of baseline data or 120% of upstream control station's Tby at the same tide of the same day	99%-ile of baseline or 130% of upstream control station's Tby at the same tide of the same day

Notes:
- For DO, non-compliance of the water quality limits occurs when monitoring result is lower than the limits.
- For SS and Tby, non-compliance of the water quality limits occurs when monitoring result is higher than the limits.
- All the figures given in the table are used for reference only and the EPD may amend the figures whenever it is considered as necessary

Table 4.5 Typical Event and Action Plan for Water Quality

Event	ET Leader	IEC	ER	Contractor
Action level being exceeded by one sampling day	Repeat in-site measurement to confirm findings; Identify Source(s) of impact; Inform IEC an Contractor; Check monitoring data, all plant, equipment and Contractor's working methods; Discuss mitigation measures with IEC and Contractor; Repeat measurement on next day of exceedance	Discuss with ET and Contractor on the mitigation measures Review proposals on mitigation measures submitted by Contractor and advise the ER accordingly Assess the effectiveness of the implemented mitigation measures.	Discuss with IEC on the proposed mitigation measures; Make agreement on the mitigation measures to be implemented;	Inform the ER and confirm notification of the non-compliance in writing; Rectify unacceptable practice; Check al plant and equipment; Consider changes of working methods; Discuss with ET and IEC and propose mitigation measures to IEC and ER; Implement the agreed mitigation measures.
Action level being exceeded by more than one consecutive sampling days	Repeat in-situ measurement to confirm findings; Identify source(s) of impact; Inform IEC and Contractor; Check monitoring data, all plant, equipment and Contractor's working methods; Discuss mitigation measures with IEC and Contractor; Ensure mitigation measures are implemented; Prepare to increase the monitoring frequency to daily; Repeat measurement on next day of exceedance.	Discuss with ET and Contractor on the mitigation measures Review proposals on mitigation measures submitted by Contractor and advise the ER accordingly Assess the effectiveness of the implemented mitigation measures.	Discuss with IEC on the proposed mitigation measures; Made agreement on the mitigation measures to be implemented; Assess the effectiveness of the implemented mitigation measures.	Inform the Engineer and confirm notification of the non-compliance in writing; Rectify unacceptable practice; Check all plant and equipment; Consider changes of working methods; Discuss with ET and IEC and propose mitigation measures to IEC and ER within 3 working days; Implement the agreed mitigation measures.
Limit level being exceeded by one sampling day	Repeat in-situ measurement to confirm findings; Identify source(s) of impact; Inform IEC, contractor and EPD; Check monitoring data, all plant, equipment and Contractor's working methods; Discuss mitigation measures with IEC, ER and Contractor; Ensure mitigation measures are implemented; Increase the monitoring frequency to daily until no exceedance of Limit level.	Discuss with ET and Contractor on the mitigation measures Review proposals on mitigation measures submitted by Contractor and advise the R accordingly Assess the effectiveness of the implemented mitigation measures.	Discuss with IEC, ET and Contractor on the proposed mitigation measures; Request Contract to critically review the working methods; Made agreement on the mitigation measures to be implemented; Assess the effectiveness of the implemented mitigation measures.	Inform the Engineer and confirm notification of the non-compliance in writing; Rectify unacceptable practice; Check all plant and equipment; consider changes of working methods; Discuss with ET, IEC and ER and propose mitigation measures to IEC and ER within 3 working days; Implement the agreed mitigation measures/
Limit level being exceeded by more than one consecutive sampling days	Repeat in-situ measurement to confirm fundings; Identify source(s) of impact; Inform IEC, contractor and EPD; Check monitoring data, all plant, equipment and Contractor's working methods; Discuss mitigation measures with IEC, ER and Contractor; Ensure mitigation measures are implemented; Increase the Monitoring frequency to daily until no exceedance of Limit level for two consecutive days.	Discuss with ET and Contractor on the mitigation measures Review proposals on mitigation measures submitted by Contractor and advise the ER accordingly Assess the effectiveness of the implemented mitigation measures.	Discuss with IEC, ET and Contractor on the proposed mitigation measures; Request Contractor to critically review the working methods; Make agreement on the mitigation measures to be implemented; Assess the effectiveness of the implemented mitigation measures; Consider and instruct, if necessary, the Contractor to slow down or to stop all or part of the marine work until no exceedance of Limit level.	Inform the ER and confirm notification of the non-compliance in writing; Rectify unacceptable practice; Check all plant and equipment; Consider changes of working methods; Discuss with ET, IEC and ER and propose mitigation measures to IEC and ER within 3 working days; Implement the agreed mitigation measures; As directed by the Engineer, to slow down or to stop all or part of the marine work or construction activities.

4.9 Monitoring of Reedbed Performance

4.9.1 In order to comply with the Zero Discharge Policy for the operation of the sewage treatment plant at Lok Ma Chau Terminus, a reedbed will be constructed and used to polish RBC effluent and treat water from San Tin Channel to offset pollution loads to Deep Bay. After construction of the reedbed according to the EIA, the EP-129/2002 and the Contract Specification, and establishment of the vegetation for at least 6 months, the performance of the reedbed in terms of pollution removal capability should be determined.

4.9.2 The monitoring programme for the reedbed requires that the percentage removal of BOD_5 be ascertained under different conditions of incoming water quality and flowrates, so that a programme of pumping water from the future San Tin Channel can be established to meet EPD's Zero Discharge Policy.

4.9.3 The monitoring programme should be carried out after installation and commissioning of the pumping system to transport water from the San Tin Channel into the storage ponds and subsequently to the reedbed.

Monitoring Locations

4.9.4 Monitoring should be carried out at the equalisation tank/desilting tank at the inlet to the reedbed and at a point in the open channel at the exit of the reedbed. In order to monitor individual bed performance samples could be obtained at the outlet of reedbed 1 and 3. These locations are shown on Figure 4.5.

Water Quality Parameters and Monitoring Frequency

4.9.5 The water quality parameters to be monitored and the frequency of monitoring will vary depending on the operating schedule of the reedbed (pump flowrates and river water quality). Table 4.6 describes the proposed operating regime during the monitoring period, which is assumed to take place in the second six months of the establishment period. It is assumed that the reedbed planting will take place early in the wet season and the first 6 months of establishment will be from May to October. During the wet season rainfall will irrigate reeds during their establishment. If rainfall is insufficient water will be provided by the Contractor, as specified in the Contract, to supplement water supply. Following completion of the establishment period, monthly monitoring should continue with an annual review to determine need for increased or decreased monitoring parameters and frequencies.

4.9.6 The monitoring programme is therefore assumed to take place between November and April. During this period, the quality of water in the river is expected to range from moderate to poor as evidenced from monthly data collected during the reedbed detailed design period. In the table below, indicative BOD_5 values have been assumed to demonstrate the environmental conditions under which monitoring should be carried out.

Table 4.6
Proposed Operating Regime and Monitoring Programme to determine Reedbed Performance

Monitoring Period	Expected BOD_5** concentration (mg/l)	Seasonal Flow Rates	Monitoring parameters for all tests	Frequency of monitoring	Length of monitoring programme
October*	50-75	Flowrate of $100m^3$/day	Flowrate DO, Temperature, pH, Turbidity BOD_5, TOC	Weekly	3 weeks
November to December	75 –100	Flowrate of $500m^3$/day	Flowrate DO, Temperature, pH, Turbidity TSS, BOD_5, TOC, Orthophosphate, NH_3-N, NO_3-N+NO_2-N and TIN	Daily Daily for 1st week, twice a week for 2nd and subsequent weeks.	3 weeks
January to February	150 –200	Flowrate of $250m^3$/day			3 weeks
March to April	50 -100	Flowrate of $650m^3$/day			2 weeks

* This period of pumping is to enable the reedbed to become acclimatised to the San Tin river water. The water quality during October is expected to be better than during the latter part of the dry season and will therefore enable a better 'start-up" for the reedbed prior to the commencement of the monitoring programme.

** Based on analysis of water samples.

4.9.7 Monitoring of all parameters should be carried out daily in the first week of each monitoring period. As BOD_5 takes 5 days to measure, TOC is also suggested as a more immediate measure of biodegradation within the reedbed. A removal rate of at least 50% BOD_5 and TOC is expected within the first week of the performance testing. If this level of pollutant removal is not achieved then the Action Plan shown in Table 4.7 should be implemented.

Table 4.7
Action Plan for Reedbed Operation and Monitoring Programme if Criteria for Reedbed Performance are not obtained

Monitoring Period	Criterion for monitoring	Action
All times	DO < 2.0 at inlet	Stop pumping until pumped river water DO increases to >2.0.
	pH of incoming water is >8.5 or <6	Stop pumping until pumped river water pH is between 6.0 and 8.5.
	TOC of incoming water > 200mg/l	Stop pumping until pumped river water TOC is <200.

Monitoring Period	Criterion for monitoring	Action
For all monitoring programmes	DO < 4.0 at outlet monitoring point	Reduce pumping by 50% and continue pumping daily until DO at outlet >4.0. If DO does not record >4.0 within 5 days, reduce pump rate by 50% and continue monitoring daily. If DO of outlet is still <4.0 after 5 days, stop pumping river water, investigate plant health, inlet water quality, determine cause of poor performance before restarting monitoring programme.
	Turbidity at outlet > Turbidity at inlet	Reduce pumping by 50% for 5 days. If condition still exists, stop pumping and investigate cause of turbidity.
	BOD_5 or TOC removal < 50% after second week of monitoring programme	Reduce flowrate by 30% and monitor daily for 5 days. If removal rate is still <50%, reduce by another 30% and monitor daily. If condition continues, stop pumping and investigate cause of poor performance.
	NH_3 removal <25% after second week of monitoring programme	Reduce flowrate by 30% and monitor daily for 5 days. If removal rate is still <25% reduce by another 30% and monitor daily. If condition continues, stop pumping river water and investigate cause of poor performance.

Note: The performance of the reedbed during the acclimatisation period should be satisfactory (at least 50% BOD_5 removal) before the monitoring programme commences. The criteria in this table should be met at the end of each monitoring programme before the next monitoring programme commences.

Methods and Equipment for Monitoring

4.9.8 Sampling and analytical methods for monitoring the performance of the reedbed should be as described in this section for general water quality monitoring during the construction phase.

Reporting on Reedbed Performance

4.9.9 Data on reedbed performance should be passed on a daily basis to the Engineer for distribution to the appropriate personnel for review. It is proposed that a monthly report is prepared summarising data and actions taken during the month. An annual report should also be produced that, in addition to presenting monitoring data, identifies compliance with the Zero Discharge Policy for Deep Bay and reviews the programme to determine the need for increase or decrease in monitoring parameters and frequencies. The data will be used to determine the long term programme of pumping to meet the requirements for compliance with EPD's Zero Discharge Policy.

4.10 Water Quality Mitigation Measures

4.10.1 The EIA report has recommended water quality control and mitigation measures during construction. The Contractor shall be responsible for the design and implementation of these measures.

4.10.2 Prior to the operation of the sewage treatment plant at the Lok Ma Chau station, the contractor shall establish not less than 5 hectares of reedbed/marsh area at the location indicated in Figure 4.5 and as described in the Contract drawings for the reedbed design. The reedbed/marsh area shall include at least 2 hectares of reedbed for wastewater polishing purpose. The implementation of measures for the establishment of the reedbed/marsh area shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the EIA report.

4.10.3 To prevent contamination of groundwater, biodegradable and non-toxic foam agents shall be used throughout the tunnel construction of the Project.

4.10.4 No later than one month before the commencement of construction of tunnel section of the Project, the Contractor shall submit to the EPD for approval information on the foaming agent or any chemicals to be used in the tunnel boring operation. The information shall include the chemical composition of the foaming agent or any chemicals to be used. Before submission to EPD, the information shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the EIA Report.

4.10.5 Works in River Sutlej and for diversion of Chau Tau Channel shall be carried out in the dry season (from November to March) only.

4.10.6 The Contractor shall, within one month after the commencement of construction of relevant part of the Project, submit to the EPD for approval 3 sets of the drainage system layout and management plan for the relevant part of the works areas. The submission shall include details of the facilities and measures to manage pollution arising from surface runoff from the works areas and to reduce surface runoff sediments and pollutants entering the watercourses. Before submission to the EPD, the drainage layouts and management plan shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the EIA Report. All measures as recommended in the approved drainage plan(s) shall be fully and properly implemented by the Contractor and any contractor working on the Project in accordance with the details set out in the submission throughout the construction period.

4.10.7 To mitigate environmental impacts due to site runoff and other potential water pollution caused by construction activities, all mitigation measures as recommended in the approved drainage layouts and management plan shall be fully and properly implemented throughout the construction period.

4.10.8 The main potential impacts arising from construction site activities include an increase in the level of suspended solids (SS), pH value and oil & grease content. Table 4.8 summarises the mitigation measures proposed in the EIA to minimise impacts on watercourses during specific construction activities. Full details of the mitigation measures are described in the EIA Report (BV January 2002).

Mitigation for Excavation Works

4.10.9 Potential run-off from excavation activities at the Sheung Shui end of the alignment and at Kwu Tung to create the station box must be minimised to avoid impacts on adjacent watercourses. Under the *Water Pollution Control Ordinance* (WPCO), turbid water from construction sites must be treated to minimize the solids content before being discharged into storm drains. The suspended solids load can be reduced by directing the runoff into temporary sand traps or other silt-removal facilities and other good and appropriate site management practices. Advice on the handling and disposal of construction site discharge is provided in the ProPECC Paper (PN 1/94) on *Construction Site Drainage.*

4.10.10 Five main works areas are proposed at the present time, one at each of Sheung Shui (for eastern Ventilation Building and TBM Launching Shaft), Kwu Tung (for Station Box and western Ventilation Building), Chau Tau (for recovery shaft), Lok Ma Chau Road area (for viaduct and Lok Ma Chau Road widening) and Lok Ma Chau Station.

4.10.11 A drainage system layout should be prepared by the Contractor for each of these Works Areas, detailing the facilities and measures to manage pollution arising from surface runoff from works areas. The drainage layout and an associated management plan to reduce surface runoff sediments and pollutants entering watercourses, should be submitted to the Engineer for approval and to EPD for agreement. The system should be capable of handling stormwater from the site and directing it to sediment removal facilities before discharge. If oil and grease is used on the site or brought to the site, the stormwater should pass through oil interceptors before discharge. The interceptors should have a bypass to prevent washout in heavy storms. The following paragraphs detail measures to be incorporated into this drainage system.

4.10.12A temporary channel system or earth bunds or sand barriers should be provided in works areas on site to direct stormwater to silt-removal facilities. Stockpiled materials susceptible to erosion of rain or wind should be covered as far as practical especially during the wet season. The presence of flat, exposed areas of permeable soil surface can be formed into pits and used effectively as infiltration areas, into which runoff flows, minimizing the amount of runoff into local watercourses. The success of this measure will depend to a large extent on the permeability of the ground, and the site topography. In Kwu Tung and Chau Tau, the lower water table (relative to the surroundings) will allow implementation of this measure more effectively. Where the ground is insufficiently permeable, sedimentation areas may be used. To allow for the intensive rainstorms in Hong Kong, overflow from these sedimentation areas should pass through silt traps to provide additional pollution removal before discharge.

4.10.13The largest Works Area will be located alongside the TBM launching shaft at Sheung Shui. Details of the equipment proposed for treating the water which is removed from the spoil are given in the section below, Mitigation for Bored Tunnel Operation.

4.10.14Along parts of the alignment, particularly at the Lok Ma Chau end of the alignment, abandoned fishponds within the works area may act as a sedimentation containment area to receive turbid run-off from the construction areas. Minor modification works such as elevating peripheral earth bunds and maintaining silt removal facilities will contribute to reduction of potentially polluting impacts. The area used for sedimentation should be within the Works Area for the contract. It is proposed that the ponds to the east of the Lok Ma Chau Station can be used initially, while ponds are being filled in the platform area. These ponds cover an area of between 3 to 5 ha, which is considered adequate for setting runoff during pond filling. Selected sections of pond bunds within the overall drainage area should be lowered to ensure a steady flow of runoff in the right direction. The pond water should be tested for turbidity before discharge to make sure the appropriate standard is reached. If discharged is to Shenzhen River, a discharge licence will be required from EPD (LCO).

Mitigation for Diaphragm Walling

4.10.15Diaphragm walling at each end of the tunnel, Kwu Tung station box construction, viaduct foundation/pier construction and Lok Ma Chau station construction all involve the placing of concrete and have the potential to impact the aquatic environment.

4.10.16 The highly alkaline lime content in cement increases the pH level in water and may endanger aquatic life if it is washed into natural water bodies. Where concrete work is undertaken, concrete washings should be carefully channeled to prevent concrete-contaminated drainage from entering watercourses. Where pH levels are above 8.5, the concrete washings should be channeled to a treatment facility to reduce pH to below 8.5 before discharge. Where ammonia levels are already high under baseline conditions, monitoring of pH levels downstream of concreting work should be carried out to ensure ecotoxic conditions are avoided. The pH levels of surface run-off are particularly important in relation to the active fishponds adjacent to works areas.

Mitigation for Concrete Batching Plant

4.10.17 The use of on-site concrete batching plants should be minimized through casting of viaduct units elsewhere and transporting to the site. If a batching plant is necessary, the drainage system should be carefully designed to minimize the likelihood of concrete washings flowing off-site. Sedimentation or infiltration areas should be established to receive concrete contaminated runoff and works areas covered to minimize runoff from areas of concrete production. In the launching shaft area, the drainage should be designed to enable concrete contaminated wastewaters to be treated to meet the required discharge standard.

4.10.18 Where concreting work is required within a watercourse or fishpond, as in the construction of the viaduct supporting column, the new station and culverting of streams, a dam should be constructed and the water pumped out to an area where solids can be settled out, before sediment removal or concreting works is initiated. Where possible, the concrete washings should be diverted to abandoned fishponds nearby to settle out solids. Adjustment of pH can be achieved by adding an acidic additive or other suitable neutralizing reagents to the waste water prior to discharge. Re-use of the supernatant from sediment pits for washing out concrete lorries, should be practiced wherever possible. Re-instatement work on the sedimentation pond will be required after the construction works are complete. Regular maintenance is required for all drainage systems to enable the pollutant control devices to function properly. Supernatant from settled concrete washings should be tested to determine its contamination status before discharge to a suitable location for treatment.

Mitigation for Bored Tunnel Operation

4.10.19 The bored tunnel operation has been designed to minimise impacts on water quality. Only water and a non-toxic, biodegradable foam will be used at the cutter face to form a wet paste which will be excavated and passed by conveyor back to the launching area where it will be settled in soil basins. The conveyor belt and soil basins should be covered to avoid washout during wet conditions.

4.10.20 The biodegradable foam added to the spoil at the cutter head is a tensoactive and a polymer, in an aqueous solution. It is non-toxic and biodegradable, properties which eliminate any potentially harmful impact on the environment. The material to be used for the Spur Line tunneling will be determined based on the required properties for the material to be excavated. A number of suitable materials are available and details will be submitted by the Contractor for approval before use. As an example of such as agent, the foaming agent used on the West Rail Contract DB320, Product Name CLB F4AD, is a water-soluble alkaline material which fully biodegrades after 15 days and is not considered harmful to the environment (information taken from Material Safety Data Sheet from supplier, Condat). An appropriate and equivalent material for Spur Line tunnel construction will be selected by the Contractor.

4.10.21 The foam is injected with water behind the TBM machine. Approximately 100 litres of tensoactive is added to 5000 litres of water to form a foam solution. Air is pumped into the system as the foam solution and passes down the line to the cutter head, where a foam is formed which is injected at the cutter head. A volume of foam agent (0.1 m^3) is required for excavation of approximately 108 m^3 ground. Being biodegradable and non-toxic, no adverse impacts are expected during use of the foaming agent.

4.10.22 Excess water from the soil basins will be transferred to the water treatment plant where the addition of flocculants will assist in settlement of solids. The treatment plant to be used in the Spur Line project will be similar to that used on Contract DB320 on West Rail (Kwai Tsing to Chau Tau Tunnels). For illustration, a description of this plant is given below. However, it should be emphasized that the detailed design of the treatment plant is not complete and the DB320 treatment system is provided for example only. The treatment plant proposed for treating the wastewater arising from the bored tunnel operation on Contract DB320 comprised a series of units with different functions as described below.

(i) Pre-sedimentation Tank and Oil Trap

Two pre-treatment tanks with a volume of approximately 20 m^3 were used to remove coarse particles and floating matter such as soil.

(ii) Desander
Desanding was carried out in a cyclone and a sand checker screen.

(iii) Flocculant dosing
Flocculant dosing equipment to add flocculant depending on the sediment load.

(iv) Settlement tanks
Two circular settlement tanks with conical bases approximately 6 m diameter and 5.5 m high. Collected sludge can be drawn off from the base and sent to the spoil handling basin or sent for further treatment.

(v) Cake plant
Settled sludge may be passed to the filter press to produce cakes. The extracted water is returned to the beginning of the treatment unit for treatment. The cake is disposed of with the TBM spoil.

4.10.23 Data was obtained from the water treatment system during the EM&A programme for DB320. The results indicate that for the majority of the time, the discharge standard of 25 mg/l suspended solids was achieved. The wastewater discharge from the plant at Sheung Shui for Spur Line will also be subject to a discharge licence.

4.10.24 As stated above, the treatment plant at Sheung Shui TBM Launching Shaft is likely to be similar to the DB320 treatment plant but will be specifically designed for the conditions of the area and the nature of wastewater expected. Measures must be incorporated into the monitoring require for the plant to evaluate the performance against discharge standards.

4.10.25 The volume of wastewater produced daily will depend on the volume and type of excavation carried out. In Contract DB 320 for West Rail, the average volume of wastewater produced (which was included in the discharge licence) was around 900 m^3. The material being excavated included both rock and soft ground. In Spur Line, the average tunnel drive will excavate around 500 m^3 per day. As this is mainly soft material, the water volume of the material may be around 80% water, and the discharge volume will therefore be of the order of 400 m^3 per day. Additional water will be required for the foaming agent. At this stage, the exact volumes likely to be produced are uncertain, however, this will be included in the discharge license for the treatment plant. The settleability of the material is also likely to vary and the flocculent addition must be optimised to deal with this.

4.10.26 The addition of flocculants to the wastewater treatment plant should be optimized for the wastewater being treated and regular inspection and monitoring should be undertaken to ensure the discharge meets license standards. The water treatment plant should be regularly maintained, solids removed and dried in a filter press before disposal. The use of bentonite during manned interventions will require careful handling and disposal to landfill following excavation. All discharges from the treatment plant are subject to control under the WPCO.

Hydrological Impacts during Construction

4.10.27 Potential impacts on groundwater levels, particularly in Long Valley, will be avoided through the operation of the TBM in Earth Pressure Balance Mode (EPBM). This mechanism is designed to balance the groundwater pressure at the face with an equal pressure from the TBM machine. In uniform soils, operational problems are unlikely. However, monitoring of groundwater and settlement of the ground above must be conducted during and after a TBM passby.

4.10.28 Contingency plans must be prepared by the Contractor in the case of maloperation of the EPB mode. If operation cannot be carried out in this mode, there is a potential risk of ground blowout or cave in. Anticipation of potential problems will minimise residual impacts on water quality or hydrology from this operation. A detailed assessment of potential impacts and required mitigation is provided in Chapter 3, Hydrology, of the EIA.

Mitigation for Formation of Cross passages

4.10.29 Jet grouting should be carried out under dry conditions as far as possible. Where water addition is required, or the works are carried out in wet conditions, the works area should be bunded to prevent run-off entering adjacent watercourses. In particular, spillage from the grouting production equipment or from other activities, should be contained until the drilling operation is compete. Water should be pumped out of the area and treated (if necessary) before discharge.

4.10.30 Where drilling is carried out near to potentially contaminated land, special care should be taken to avoid run-off contacting contaminated material and entering adjacent watercourses. Settlement areas should be constructed and a local drainage system implemented to contain the water generated. Water should not be discharged from site but pumped out and treated to reduce turbidity and remove contaminants (if present) before discharge.

Mitigation for Works in River Sutlej

4.10.31 Works in the River Sutlej should be conducted in dry season only to avoid washout of the works in the wet season, in compliance with DSD's requirements. The low flow channel must be suitably relocated and protected to avoid overflow into the excavation or washing of concrete or grout into the channel. Spilt concrete washings should be contained during the works and removed from the channel area as rapidly as possible. A sump or drainage area near the works area should be provided to allow settlement of solids before water is pumped out.

Mitigation for Hydrological Impacts

4.10.32 *M*itigation for possible impacts on the underground alluvial phase groundwater flow can be achieved through increasing the permeability of the concrete or grouted mass placed below the River Sutlej before tunnel boring begins. Positioning of suitable sized pipes through the concrete or grout mass and addition of a granular layer either side of the mass, will enable groundwater flow through the structure as before. This measure can be carried out relatively easily where excavation is followed by placement of a lean mix concrete box.

Mitigation for Draining works in Fishponds or Rivers

4.10.33 Avoidance of impacts during draining of water from Chau Tau Channel can be achieved through damming of the are in which works is carried out, using sandbags or other means. Measures should be taken to avoid the water coming into contact with water that has been polluted through the works activities. Any water that is impacted and becomes turbid should be confined locally. All work related to Chau Tau channel diversion should be undertaken and completed during the dry season.

4.10.34 Sand filling at Lok Ma Chau fishponds will require displacement of the water from the fishponds. To avoid this water becoming turbid and overflowing to watercourses and ultimately into Shenzhen River, a sedimentation area should be identified within the site and this area used as a stilling basin for water to gradually overflow into. A possible location for this purpose is the area to the east of the station that will be used in future as a reedbed and ecological mitigation area. This area occupies 3 to 5 ha, which should allow sufficient retention time for settlement of the solids in the fishpond water. Once settled, the water can be discharged (through overflow between ponds) into adjacent ponds within the future ecological mitigation area. Water quality should be checked to ensure the water turbidity is similar to the ponds into which water is being discharged. If the water quality is

still too turbid, treatment to reduce the turbidity will be required before the water can be discharged. Treatment may comprise a tank into which water can be pumped and flocculant added in a similar way to the treatment for spoil water at the TBM launching shaft. The treatment tank should be sized appropriately for the volume of water to be treated. Water should only be discharged after it meets the required standard.

4.10.35 In all circumstances drained pond mud or river sediment should be removed immediately or stored away from the watercourse. If stockpiled on site, the stockpile should be covered to prevent erosion. The quality of the mud in terms of contaminant concentration should be evaluated prior to removal. Any metal contaminated material, or large quantities of uncontaminated material, requires disposal in designated areas. Stockpiles should be surrounded by drains connected to a sediment trap or containment areas to make sure runoff is adequately treated before discharge. Wherever possible, in situ strengthening of the mud is recommended to minimize fill requirements. Pollutant measurements of sediment in abandoned ponds (Lok Ma Chau Boundary Crossing Expansion EIA, Binnie, 1999) has shown that nutrients are high in pond mud, however, metal levels are low and there is therefore minimal contamination risk.

Mitigation for Bored Piling

4.10.36 The use of bentonite during bore piling requires correct handling and disposal to avoid water impacts. Run-off from bore piling works should be settled in a sedimentation or infiltration pit until the supernatant is clear, after which it can be pumped to a drain, or it may be allowed to infiltrate into the ground.

4.10.37 In some locations along the alignment, abandoned fishponds within the works area may be used as a temporary infiltration or sedimentation pits for settlement of solids, concrete washings or bentonite washings. The pits should be regularly cleared of solids and covered in wet weather, to prevent turbid water from being washed over into storm drains during heavy storms. As described above for the ponds used to settle water around Lok Ma Chau station, the water should be settled to reduce turbidity or treated appropriately before discharge.

Mitigation for the Footbridge between Lok Ma Chau station and Shenzhen

4.10.38 Foundation work for the footbridge will involve piling a cofferdam around the area of the proposed pier for purposes of piling, pile caps and column work. During creation of the piers, care should be taken to ensure no potentially polluting liquid or solid wastes fall into the river. This is essential to avoid impacts downstream in the ecologically sensitive area of Deep Bay and Mai Po marshes. The cofferdam should be constructed to minimize contact of the works area with the surrounding

waterbody. In order to avoid water quality impacts after the cofferdam is completed, any waste materials arising should be taken onto the attendant barge and removed for disposal. The pier to be constructed within the Hong Kong boundary is to be located within the alignment of the former riverbank extended for widening of Shenzhen River, and it is therefore unlikely that any of this material will be contaminated. The material can therefore be disposed of as uncontaminated sediment.

4.10.39 Adverse impacts on water quality from deck construction can be minimized by using pre-cast units constructed off site. Where concreting works is carried out on site, it is essential that a suitable mechanism is put in place to avoid concrete washings falling into the river. This may be done by incorporating a drain into the formwork design to catch washings and divert them back to the shore where they should be settled in a sedimentation pit and the supernatant treated before discharge. Any works area alongside the river should have appropriate drainage to remove sediment from surface run-off and incorporate oil and grease traps to capture run-off from the site. Vehicle washing areas should be provided and petrol/oil interceptors incorporated into the drainage. The interceptors should be regularly maintained. Regular maintenance of these pollution control devices is essential to ensure their efficient functioning.

4.10.40 The pier on the Shenzhen side of the river may be located in an area of potentially contaminated sediment. The sediment from the riverbed must first be tested to determine the level and type of contamination, and if necessary, disposed. The disposal site should be agreed with EPD and FMC. If the supernatant after settlement is contaminated, disposal via a suitable route will be required, either to sewer, local sewage treatment works, or, if highly contaminated, to an appropriate treatment location, as agreed with EPD.

4.10.41 These measures are designed to reduce the potential for adverse effects on the water quality and wildlife downstream in Deep Bay. Implemented properly, the potential for pollutants to enter the river will be minimized.

4.10.42 The contractor carrying out the works should submit a detailed Waste Management Plan, which should include a description of works methods and measures incorporated to minimize potential pollution from contaminated material during the construction process. This material may be sediment or contaminated land.

Mitigation for Potential Hydraulic Impacts

4.10.43 The construction of supports for the footbridge across the Shenzhen River has the potential to impact the hydraulic flow of the river. From the results of the DIA carried out for this scenario, the impact is likely to be small. The cross sectional area of the supports is a small proportion of the channel surface area, indicating that the change in the hydraulics of the river flows at this location will be minimal.

Mitigation for Jetties for Materials Transfer

4.10.44 Although impacts from the construction of the jetties are likely to be minimal, care should be taken to avoid waste materials falling into the water during both the construction and dismantling process. Transfer of material onto the barge at the sandfill location should be conducted carefully to allow the displaced water to be discharged slowly, thereby minimize impacts on water quality in the receiving waterbody. Where possible, displaced water should be discharged onto land, into a sedimentation pit where the solids can be allowed to settle or infiltrate into the ground before the clearer supernatant is discharged.

4.10.45 At the construction site, the transfer of materials onto the jetty should also be carried out with care to avoid sand falling into the river from the conveyor belt. The conveyor belt should not be overloaded and covering will assist in containing the sand material. Where stockpiles are set up on shore, they should be covered to prevent run-off entering the river during storm conditions. If water is required for washing purposes during the operation, then is should be pumped into a sedimentation area before clearer water is discharged into the waterbody. The barge should be regularly maintained to minimize the potential for fuel or other contaminants entering the waterbody. All waste generated by the workers onto the barge should be disposed of at allocated sites for waste disposal at the site of collection or delivery. Wastewater collected on the barge should similarly be carefully disposed of at suitable locations to avoid water quality impacts. These working practices and design of the transfer system will provide conditions that minimize impacts downstream in Deep Bay and associated ecologically sensitive mud flats.

4.10.46 Potential impacts from the presence of the jetties on the hydrological regime of the Shenzhen River have been shown to be minimal in the DIA carried out for the Lok Ma Chau station construction works. No mitigation is therefore required.

Mitigation for Site Workshop or Depot

4.10.47 Any contractor generating waste oil or other chemicals as a result of his activities should register as a chemical waste producer and provide a safe storage area for chemicals on site. Hard standing compounds should drain via an oil interceptor. Disposal of the waste oil should be done by a licensed collector. Oil interceptors need to be regularly inspected and cleaned to avoid wash-out of oil during storm conditions. A bypass should be provided to avoid overload of the interceptor's capacity. Good housekeeping practices are required to minimize careless spillage and keep the work space in a tidy and clean condition. Appropriate training including safety codes and relevant manuals should be given to the personnel who regularly handle the chemicals on site.

Mitigation for Additional Population (Workers) on Site

4.10.48 Sewage arising from the additional population of workers on site should be collected in a suitable storage facility, such as an underground septic tank or mobile toilet. Small scale on-site treatment plants should also be considered if the number of workers in one area indicates that this is more appropriate. The collected wastewater from sewage facilities and also from canteens or washing facilities must be disposed of properly, in accordance with the WPCO requirements. At Sheung Shui, connection to foul sewerage in Sheung Shui should be considered. In other areas, wastewater collected should be discharged into foul sewers or collected by licensed collectors and disposed of at government sewage treatment facilities.

4.11 Summary of Mitigation Measures

4.11.1 Table 4.8 shows the range of mitigation measures that should be implemented during Spur Line construction to avoid impacts on waterbodies in the vicinity of the works area.

Table 4.8
Summary of Mitigation Measures for Construction Impacts

Potential impact	Proposed Mitigation
Site Surface Runoff from Excavation Works	• Site management practices in accordance with guidelines in ProPECC PN 1/94. • Creation of suitable drainage system, using channels, sand bags or bunds. • Use of silt trap settlement or infiltration areas for solids settlement.

Potential impact	Proposed Mitigation
Diaphragm Walling/Concrete Batching	• Site run-off containing concrete washings should be settled in depressed area and supernatant reused where possible. • Concrete batching plant area should be covered and a suitable drainage system installed to separate concrete washings and clean surface water. Concrete washings to be treated via settlement and appropriate pH adjustment prior to discharge. • Adjustment of pH in concrete contaminated water before discharge.
Bored Tunnel Operation	• Material added to soil at the face should be harmless and biodegradable. • Provide treatment plant to treat wastewater arising from the spoil basin. Regular monitoring and maintenance of water treatment plant. • Monitoring of groundwater levels and settlement during TBM passby. • Preparation of contingency plans in case EPB mode fails.
Formation of Cross passages	• Bunds and drainage system to be installed to contain spillage and potential run-off. • Avoidance of contaminated areas and containment of water that passes over contaminated areas. The contained water should be treated prior to discharge.
Works in River Sutlej	• Works to be carried out in the dry season. • Contain concrete washings and remove from channel. • Relocate and protect low flow channel to avoid contamination of water or overflow into excavation. • Prepare contingency plans for rainfall during works. • Install suitably sized drainage pipes in impermeable box to avoid impacts on groundwater flow in alluvial phase.
Draining works in Fishponds or Rivers	• Undertake and complete diversion work related to Chau Tau channels within the dry season. • Contain any disturbed areas to avoid turbid water entering watercourse. • Minimise mud removal. If necessary, test and dispose of as required. • For fishpond filling, provide settlement areas for the displaced pond water. Use other fishponds as settlement areas if possible.
Bored Piling	• Recycle bentonite wherever possible. • Contain run-off containing bentonite and drain to settlement area.
Footbridge between Lok Ma Chau station and Shenzhen	• Avoid spillage of wastewater and materials into river. • Test sediment prior to dredging, adopt appropriate disposal means for the dredged sediment. • Minimise concrete production on site – use pre-cast units wherever possible. • Minimise stirring up of water, particularly where sediment may be contaminated. • Minimise hydraulic impacts through pier design.

Potential impact	Proposed Mitigation
Jetty for materials transfer	• Care should be taken when transferring materials to avoid spillage into river. • Water used for washings should be pumped into settlement area to allow settlement before surface water is discharged.
Site Workshop or Depot	• Chemicals and waste oils should be stored, handled and disposed of to avoid impacts on watercourses. • Oil interceptors should have a bypass installed and be regularly maintained.
Additional Population (Workers) on Site	• Wastewater from workers should be collected and discharged according to discharge license.
Hydrological Impacts during Construction	• Detailed monitoring of groundwater levels during passby of the TBM. • Settlement monitoring and proposed reinstatement to make good any observed decrease in land levels as TBM passes beneath Long Valley.

4.11.2 If the above measures are not sufficient to restore the water quality to an acceptable level upon the advice of the ET Leader, the Contractor shall liaise with the ET Leader on some other mitigation measures, propose to IEC and ER for approval, and implement the mitigation measures.

5. WASTE MANAGEMENT

5.1 The Contractor is responsible for waste control within the construction site, removal of the waste material produced from the Site and implementation of any mitigation measures to minimise waste or redress problems arising from waste generated on the Site. The waste material may include any sewage, waste water or effluent containing sand, cement, silt or any other suspended or dissolved material to flow form the Site onto any adjoining land, storm sewer, sanitary sewer, or any waste matter or refuse to be deposited anywhere within the Site or onto any adjoining land.

5.2 When handling the waste material, the following measures shall be undertaken:

5.2.1 The Contractor should incorporate recommendations into a comprehensive on-site Waste Management Plan (WMP), which is to be submitted to the EPD for approval within one month after commencement of construction. This should include all factors dependent on individual works sites including designation of areas for the segregation and temporary storage of materials for future use or recycling. Such provision cannot be specified at this stage. Contractors should follow the recommendations of WBTC No. 29/2000 for on-site separation of waste, and 21/2002 for trip-ticket system for disposal of construction and demolition material. The WMP shall also define clearly the hierarchy for waste management on and off-site as well as a complete list of mitigation measures for handling excavated works.

5.2.2 The Public Fill Committee reviews and co-ordinates the provision and operation of public filling facilities. Responsibilities for recycling, re-use or disposal of waste materials are divided between the contractors generating the waste, FEHD, and the management of the receiving public filling sites. These responsibilities are described below and summarised in Table 5.1.

5.2.3 Under present practices, contractors handle their own wastes, often without separating different types of waste resulting in incorrect disposal of wastes. Under the proposed scheme, contractors would be required to separate wastes to ensure maximum reuse of materials and minimise adverse impact on the environment.

Concrete

5.2.4 Waste concrete generated during construction will be reused as far as practicable at East Rail sites. Separation is essential to enable concrete to be processed, for example, by crushing at the disposal site, and used as fill at other sites.

Wood formwork and steel

5.2.5 Waste material will be reused or recycled wherever possible. Unusable material should be taken to landfill, either WENT or NENT depending on the origin of the waste material, only as a last resort. It should be separated from recyclable concrete. Contractors are responsible for storage of re-useable materials on site.

Chemical wastes and oil wastes

5.2.6 Contractors are responsible for registering as a chemical waste producer with EPD for the disposal of chemical and oil wastes. Chemical wastes should be collected by a licensed collector. A storage area should be designated as a pre-disposal containment area to prevent environmental impacts from spilt chemicals.

Wheel Wash Waste

5.2.7 Areas of sand for absorbing oily wash water should be set up by Contractors. Liaison with FEHD/EPD is essential for correct disposal.

5.2.8 While fulfilling the responsibilities described above, each contractor is required to maintain their works area in compliance with environmental requirements. The generation of dust and noise from concrete and other waste collection must be minimised in compliance with environmental objectives. Maintenance of a clean and tidy environment is essential to minimise adverse environmental and visual impact.

Table 5.1
Responsibilities for waste collection, recycling and Disposal during the Construction Phase

Waste type	*Responsibility for collection of waste*	*Responsibility for transport of waste off-site*	*Responsibility for recycling*	*Responsibility for disposal*
Fill material	Construction contractors required to stockpile excess fill for use elsewhere or disposal	Contractor	Recycled on site	Contractor
Unsuitable material (e.g. fishpond mud)	Construction Contractors required to collect for use elsewhere in the works	Contractor	Contractor responsible for transport from donor site to recipient site for re-use	Contractor

Waste type	*Responsibility for collection of waste*	*Responsibility for transport of waste off-site*	*Responsibility for recycling*	*Responsibility for disposal*
Concrete	Contractor – directly at source of waste generation	Contractor – in contractor's vehicles to public filling area	CED (Port Works) defines suitable dumpsites. Project proponent of public filling area is responsible	Contractor
	Separation of re-useable and waste concrete should be carried out at source by contractor	Disposal of re-useable and waste concrete in different areas of filling area as required	Project proponent to provide different areas for re-useable and waste concrete as required	
Wood formwork, fencing	Contractor – directly at source of waste generation where volumes are large	Contractor – transported in contractor's vehicles to public filling area	Contractor - at source	Contractor to Landfill
	Separation of waste wood and concrete should be carried out at source by contractor	(inert material) or landfill (non-inert material)		
Reinforcing steel, steel cable and shutters	Contractor – directly at source of waste generation where volumes are large	Contractor – transported in contractor's vehicles scrap/recycling	Contractor - at source	Contractor to scrap/recycling
	Separation of waste steel and concrete should be carried out at source by contractor			

5.3 The Contractor shall also pay attention to the Waste Disposal Ordinance, the Dumping at Sea Ordinance, the Public Health and Municipal Services Ordinance and the Water Pollution Control Ordinance, and carry out the appropriate waste management work. The relevant licence/permit, such as the effluent discharge licence, the chemical waste producer registration, etc. shall be obtained. The Contractor shall refer to the relevant booklets issued by EPD when applying for the licence/permit.

5.4 During the site inspections and the document review procedures as mentioned in Sections 11.6.1 and 11.6.2 of this manual, the ET Leader shall pay special attention to the issues relating to waste management, and check whether the Contractor has followed the relevant contract specifications and the procedures specified under the law of HKSAR.

6. ECOLOGY

6.1 Introduction

6.1.1 On 11th December 2002 the varied Environmental Permit (No. EP-129/2002/A) was issued for the Sheung Shui to Lok Ma Chau Spur Line under the terms of the Environmental Impact Assessment Ordinance, Cap. 499, Section 10(1). Condition 2.3 of the Environmental Permit stated that:

"No later than one month before the commencement of the Project, the Permit Holder shall submit to the Director for approval and EM&A Manual for the Project..."

6.1.2 Under the terms of the Technical Memorandum to the Environmental Impact Assessment Ordinance, the EM&A Manual must include, where ecological impacts have been identified in the Environmental Impact Assessment, an Ecological Monitoring and Audit (EcolM&A) Programme. The purposes of this ecological monitoring and audit are:

"(a) to verify the accuracy of the predictions of the ecological assessment study;

(b) to detect any unpredicted ecological impacts arising from the proposed development;

(c) to monitor the effectiveness of the mitigation measures; and

(d) to recommend action plans in response to unpredicted impacts, and / or failed mitigation."

6.1.3 Specifically, in respect of the Sheung Shui to Lok Ma Chau Spur Line project the EcolM&A Programme is required to cover the following items specified in the Environmental Permit:

- Appropriate cross-reference between this EM&A Manual and the Habitat Creation and Management Plan (HCMP) which provides the detailed specifications for the habitats and ecological functions to be provided in the "Initial Enhancement Areas" (IEA) and "Ecological Compensation Area" (ECA).

- Measures to minimise disturbance to a bat roost at Chau Tau during the construction of the project.

6.1.4 The HCMP is divided into two parts, covering the construction and operational phases of the project. Part A of the HCMP covers the construction stage and hence it is this part which is cross-referenced to this Part of the EM&A Manual. This Part A of the HCMP covers the Initial Enhancement Areas (IEA) referenced in paragraph 6.1.3 above. The requirement for the IEA is defined in Condition 3.22 of the Environmental Permit for the project which states the following:

"Not less than 15 hectares of fishponds in Lok Ma Chau (hereinafter be referred to as "initial enhancement areas").... shall be established as conforming to the criteria set out in the HCMP before the commencement of site formation works for the Lok Ma Chau station....These measures shall include, but not (be) limited to the following:-

(a) reprofiling of pond levels to create shallow feeding habitats;
(b) fish stocking; and
(c) management of water levels."

6.1.5 The IEA area is shown in Figure 6.1. It comprises an area of 15.5 ha of fishponds (meeting the area requirement specified in the Environmental Permit), together with bunds and a drainage channel. The IEA area currently consists of 11 existing fishponds. Two of these Ponds (6a and 6b) are already joined and Ponds 3a and 3b and 8a and 8b will be joined to create larger ponds (indicated by the suffixes a and b in Figure 6.1), such that there will be eight ponds the water levels of which can be manipulated independently (Ponds 1- 8 in Figure 6.1). The IEA area will be managed in order to compensate for habitat loss to the large waterbird species detailed in Table 6.1 during the Lok Ma Chau Station and railway construction period.

Table 6.1 Large waterbird species forming the primary target of habitat enhancement and management measures in the IEA

Common name	*Scientific name*	*Conservation status*
Great Cormorant	*Phalacrocorax carbo*	Regionally important
Grey Heron	*Ardea cinerea*	Regionally important
Great Egret	*Egretta alba*	Regionally important
Little Egret	*Egretta garzetta*	Regionally important
Chinese Pond Heron	*Ardeola bacchus*	Regionally important
Black-faced Spoonbill	*Platalea minor*	Globally threatened

6.1.6 Within the IEA it is required that the numbers of these waterbird species using the IEA should be at least twice that of commercial fishponds. The numbers of these target waterbird species using the IEA compared with those using representative control areas of commercial fishponds are therefore the primary measure of its success. These numbers, however, will be a reflection of habitat factors, such as water conditions, food availability and freedom of disturbance. Accordingly, targets have been set that reflect the habitat requirements of the target species. In addition, the EIA Report (BV 2002a) identified other animal species which are targets of the habitat provision and enhancement which will be undertaken in the ECA. Whilst there are not numerical targets for these species which must be achieved during the construction period to which this part of the EM&A Manual refers, nevertheless their numbers and distribution in the IEA require to be monitored during this period.

6.1.7 Accordingly, this part of the EcolM&A Manual defines the ecological monitoring and reporting requirements for the following:

- Numbers of the large waterbird species specified in Table 6.1 using the IEA and the commercial control areas;
- Numbers and distribution of other bird species (including all ECA target species) in the Lok Ma Chau area;
- Numbers and distribution of other target animal groups (mammals, herpetofauna, butterflies and dragonflies) in the IEA and the commercial control areas;
- Food availability in the IEA for target waterbird species (fish, aquatic invertebrates and benthic invertebrates)
- Habitat conditions (including water quality and pedology) in the IEA;
- Bat use of the Chau Tau roost and its environs.

6.1.8 Since the Chau Tau bat roost is in a geographically distinct area to the other location of the other parameters which will be monitored, EcolM&A requirements for this are treated after those which relate to the Lok Ma Chau area (see Section 6.12).

6.1.9 It is conventional in EcolM&A Manuals to distinguish between "Baseline Monitoring" which details requirements for monitoring of habitats, vegetation and fauna prior to the commencement of a project and "Impact Monitoring", which details the monitoring of the effects on the habitats, flora and fauna of the project as it proceeds. "Impact Monitoring" also covers the progress and success of mitigation measures where these are undertaken prior to or in parallel with the project. The requirements of the Environmental Permit for the Spur Line project to meet habitat provision and numerical targets for large waterbird numbers in the IEA prior to and throughout the course of the construction phase of the project, together with the use of control areas as a "rolling baseline" as a measure of success, make such a distinction between Baseline and Impact Monitoring less clear-cut. Effectively, Baseline Monitoring will continue throughout the construction phase of the project in the shape of the monitoring of control areas, whilst Impact Monitoring will include, in addition to the monitoring of the Lok Ma Chau station site and its environs, the monitoring of the IEA.

6.1.10 Accordingly, to avoid confusion, the terms Baseline and Impact Monitoring are not used further in this EcolM&A Manual, rather monitoring is described in relation to the adaptive management objectives and the mitigation targets to which it relates.

6.2 Monitoring of Target Waterbird Species

Monitoring in the IEA

6.2.1 Monitoring methodology will follow that utilised in the IEA during winter 2001-2002 (BV 2002b), allowing results to be compared directly. Monitoring of the IEA will be conducted from a tower hide. Use of a hide will be required in order to ensure that the observer does not disturb any birds using the ponds, whilst a tower is necessary to monitor all of the IEA ponds from a single location. Tower hide position is shown in Figure 6.1. Monitoring will be conducted by a single observer, using a tripod-mounted telescope. During each monitoring visit the observer will keep the study ponds under observation from just after dawn to mid-morning (06.30 – 09.30) to coincide with the daytime periods during which most birds feed. During each survey visit the observer will conduct five sweeps during which all birds using the ponds are counted. Only birds actually using the ponds will be counted (i.e. flying birds are ignored). Birds using the ponds will be recorded are those which are feeding or loafing (for the purpose of this exercise the latter category includes sleeping, resting, preening etc.).

6.2.2 Monitoring will be conducted once per week, except for times when individual ponds are being manipulated in order to attract large waterbirds. At such times, five days' continuous observations will be conducted in order to ensure that numbers of large waterbirds are properly assessed. Manipulation (drain-down and / or stocking) will be conducted, on average once every two weeks during winter and once per month during summer.

Monitoring in the Control Areas

6.2.3 The target numbers of large waterbirds are to be compared with a baseline which should equate to the numbers of birds which would have continued to use the area were the Spur Line and Lok Ma Chau Station not to be constructed. However, the determination of such a baseline is problematical. Historical count data for the Lok Ma Chau / Mai Po San Tsuen / San Tin area exists in the form of Hong Kong Bird Watching Society (HKBWS) waterfowl counts; however only a part of the KCRC Lok Ma Chau site and the San Tin fishponds are covered by these counts (Carey 2002). Waterfowl counts were also conducted during the Baseline Study conducted during 2000-2001 which was included in the EIA Report (BV 2002a). However, this survey was conducted during the period when commercial fish farming activities had ceased and the ponds were abandoned. The data collected is not, therefore, typical of bird use of commercial fishponds in normal operation. Further, setting a baseline for bird use on a particular historical time period fails to take into account changes in bird numbers over time and may result in the setting of targets which become inappropriate as bird numbers change.

6.2.4 Accordingly, in order to assess the performance of the IEA in meeting targets, monitoring will be conducted at the two control areas of commercial fishponds at Pak Hok Chau and at San Tin shown in Figure 6.2. The control areas have been selected on the basis of the following criteria:

- In the same geographical area as the IEA so the broad pattern of the bird community and habitat conditions is likely to be similar;
- Ponds are of a similar size and configuration to those in the IEA;
- Ponds are managed in a similar way to previous practice in the IEA.

Because they possess similar characteristics to the ponds in the IEA prior to the implementation of habitat enhancement and management measures designed to benefit wildlife, they provide a realistic standard against which the performance of the IEA can be measured.

6.2.5 The monitoring methodology for the control areas will follow that at Lok Ma Chau and will be conducted from similar observation towers. Monitoring will be undertaken once per week. As far as possible, observations will be carried out at Lok Ma Chau and the two control areas simultaneously to make the findings directly comparable. Observations during drain-down will be undertaken, although this is likely to be restricted to the winter months when most commercial fishponds are drained.

Monitoring of numbers of Black-faced Spoonbill wintering in Hong Kong

6.2.6 In winter, Hong Kong supports globally significant numbers of this species which is listed as Globally Endangered by BirdLife International (2000). The use of the IEA by this species is therefore of particular importance. Regular counts will be conducted at Mai Po Nature Reserve where most of the spoonbills normally roost. Surveys will be conducted covering the whole of the Mai Po Nature Reserve, during which time all spoonbills present will be counted. The timing of the counts will coincide with the period when most spoonbills are present, which is generally during the middle part of the day and / or over the high tide period. The count times at Mai Po Nature Reserve are not intended to mirror the anticipated pattern of usage in the IEA. Rather, for this globally endangered species it is considered that it is invaluable to view the numbers using the IEA in a wider (Hong Kong) context

6.2.7 Counts will be conducted once per week from mid-October to the end of May.

6.3 Monitoring of Birds Within the Lok Ma Chau Study Area to Assess Populations of Other Target Bird Species

6.3.1 This monitoring is essential in order to determine and to interpret numbers of bird species using the IEA and, later, the ECA. The methodology follows that used within the Lok Ma Chau area in the Baseline Study and subsequently; this will assist in the interpretation of trends in bird numbers during the course of the Spur Line project.

6.3.2 Surveys will be undertaken once per week within 500 m of the Spur Line and the Lok Ma Chau Station as well as throughout the IEA (part of which is more than 500 m from the railway and station). The 500 m distance has been selected as it is the maximum referred to in the EIA at which it is predicted that there will be reduced densities of birds as a result of disturbance. During each survey visit, the surveyor will visit each pond in the study area and identify to species level all birds present. Counts will be made of all waterbirds, species of conservation importance (following Fellowes *et al.* 2002) and any other unusual bird species (the same methodology as was followed in the baseline survey). Where possible, each pond will be surveyed from one point, the most accessible on the transect route, to reduce disturbance and to reduce the risk of double counting. If required, the surveyor will adjust his position (if part of the pond is out of sight, or if closer views of a bird are required in order to confirm identification). If it is considered that birds have already been counted on other ponds, these will be ignored. If ponds contain large numbers of birds (e.g. foraging egrets) these will be surveyed at a distance to avoid disturbing birds and to further reduce the possibility of double counting. Where necessary, ponds that have been found to hold large numbers of birds earlier on a visit will be revisited if there is a suspicion that birds have moved within the study area during the course of the survey. In general, flying birds will not be recorded unless they are clearly foraging and associated with the habitat. An exception to this will be Black-faced Spoonbill, Greater Spotted Eagle *Aquila clanga* and Imperial Eagle *Aquila heliaca*; all individuals of these species will be recorded, although efforts to avoid double counting will be maintained.

6.3.3 In parallel with this bird survey, the broad physical characteristics of each pond will be recorded, including information on water levels, whether it is actively managed or not, and details of any drainage activity (not drained / being drained / drained). Details of any fish harvesting (where apparent) will also be noted. Partially drained ponds which have not been harvested will be identified on the basis of numbers of larger commercial fish. For partially or fully drained ponds the extent of the exposed bottom will be recorded to the nearest 25% of the total area of the pond; whether the exposed bottom is wet or dry will also be noted.

6.3.4 This background physical data will provide an important basis for the interpretation of patterns of bird use and will also permit direct comparison with HKBWS waterfowl count data which is collected using a similar survey protocol (Carey 2002).

6.4 Monitoring of Mammals (Especially Eurasian Otter *Lutra lutra*) Within the IEA and the Control Areas

6.4.1 Monitoring of mammals within the IEA and the Control Areas will focus on the use of the area by Eurasian Otter *Lutra lutra.* The monitoring technique will be camera-based and will represent an extension of the study conducted from December 2001 – April 2002 (BV 2002c), during which otters were successfully photographed. Five Trailmaster combined camera and infra-red monitor sets will be deployed. These will be set up in permanent positions at appropriate locations in the IEA and in (for security reasons) temporary positions in the Control Areas. The cameras will be fixed at an appropriate height so as to maximise chances of obtaining photographs of otters as well as other mammal species such as Leopard Cat *Felis bengalensis* and Small Asian Mongoose *Herpestes javanicus*. The infra-red monitors have an effective range of 5 – 8 m for animals within this size range. Fixed cameras in the IEA will be checked, and films changed, once per week; temporary cameras will be set up overnight for one night per week in each Control Area. When cameras are set, signs of fresh otter activity (such as spraints and paw prints) will be searched for and will be recorded as will any other signs of recent mammal activity. Any spraints found will be photographed, collected and analysed to determine dietary composition. Prints will be photographed and measured to determine the size and number of individuals.

6.5 Monitoring of Herpetofauna within the IEA and the Control Areas

6.5.1 Herpetofauna surveys within the IEA will focus on breeding amphibians and the reptile community. Four half day surveys will be conducted per month during the period from March to July. Two surveys will take place during 10.00 to 14.00 hours, the peak period for reptile activity, while the other two surveys will take place at night from 18.00 to 22.00 and will focus on the detection of vocalising amphibians. During the surveys the IEA will be walked following a fixed survey route. All reptiles and amphibians observed or heard will be identified, and their abundance estimated. Habitat use and breeding activity will be recorded.

6.5.2 Surveys of the Control Areas will take place using identical methodology and the same frequencies.

6.6 Monitoring of Dragonflies and Butterflies within the IEA and the Control Areas

6.6.1 Dragonflies and butterflies within the IEA will be surveyed two times per month during the period April to August. The surveys will be half a day in duration. Each month one survey will be conducted from 08.00 to 12.00 hours, and one will be conducted from 14.00 to 18.00 hours, to take account of the different daily activity patterns of different dragonfly species. During the surveys the IEA will be walked following a fixed survey route. All dragonfly and butterfly species observed will be identified and all individuals counted. Habitat use and breeding activity will be recorded, as well as evidence of dragonfly breeding success in the form of final instar larval exuviae, which will be collected and identified.

6.6.2 Surveys of the Control Areas will take place using identical methodology and the same frequencies.

6.7 Monitoring of Aquatic Invertebrates in the IEA

6.7.1 Sweep-netting will be used to sample aquatic species in the water column and clinging to vegetation at the water-bund interface. The sweep-net shall be a D-shaped net of 30 cm diameter with a 1 mm mesh. Each sample shall be taken by two 2-metre sweeps of the net from which all captured specimens are removed. The first sweep shall be carried out at the water surface and the second as close to the pond bed as possible. For each set of replicates each sweep shall be along the water-bund interface. Five randomly located replicate samples will be taken from each pond.

6.7.2 Samples shall be placed in labelled containers together with preservative for transporting to the laboratory. Once in the laboratory, specimens shall be rinsed in water, placed on a white sorting tray and sorted for identification to species level using a binocular microscope. Where partial body parts are identified, only heads will be counted.

6.7.3 The number of each macro-invertebrate species will be ascertained for each replicate sample of all taxa groups. A total dry weight biomass shall also be determined for each of the above groups.

6.7.4 The number and species of any fish captured incidentally during the sampling shall also be recorded.

6.7.5 Since the purpose of the monitoring of aquatic invertebrates is primarily to track their availability as food for waterbirds; aquatic invertebrate sampling should be adaptive to the fishpond management regime, as well as providing a baseline

dataset. Accordingly, aquatic invertebrates should be sampled in all ponds in the IEA twice per year: at the end of the dry season (March) and the end of the wet season (September). In addition, aquatic invertebrates should be sampled in ponds which are drained-down in the two week period prior to the commencement of drain-down and in the two week period after refilling. This will provide a measure of invertebrate availability to birds during drain-down and how much of the invertebrate biomass has been consumed by birds during the drain-down period. In addition, in ponds which are not drained-down during a season (i.e. they are maintained at either a high or a low level during either the wet season and / or the dry season), aquatic invertebrates should be sampled at two monthly intervals to provide a measure of changes in the aquatic invertebrate community in the absence of water level management.

6.8 Monitoring of Benthic Invertebrates in the IEA

6.8.1 Cylindrical benthic cores 10 cm in diameter and 10 cm depth will be taken from the substrate at the base of the ponds to obtain quantitative data on benthic invertebrate populations. Five randomly located replicate cores will be collected from each pond shallows. Core contents will be bagged and stored in a cooler for subsequent sorting. Samples will be analysed as for sweep netting

6.8.2 As with aquatic invertebrate sampling, since the purpose of the benthic invertebrate monitoring is primarily to track their availability as food for waterbirds; sampling should be adaptive to the fishpond management regime, as well as providing a baseline dataset. Accordingly, benthic invertebrates should be sampled in all ponds in the IEA twice per year: at the end of the dry season (March) and the end of the wet season (September). In addition, benthic invertebrates should be sampled in ponds which are drained-down in the two week period prior to the commencement of drain-down and in the two week period after refilling. This will provide a measure of invertebrate availability to birds during drain-down and how much of the invertebrate biomass has been consumed by birds during the drain-down period. In addition, in ponds which are maintained at a low level during either the wet season and / or the dry season), aquatic invertebrates should be sampled at two monthly intervals to provide a measure of changes in the benthic invertebrate community in the absence of water level management. (Benthic invertebrate sampling for ponds maintained at a high level during a season is not required as benthic invertebrates in these ponds will not be available as prey to waterbirds, hence the six-monthly samples will adequately provide a measure of seasonal changes in diversity and numbers.)

6.9 Methodology for Monitoring Freshwater Fish

6.9.1 Monitoring of fish numbers, species and size will be undertaken by throw-netting at each stocked pond. A fishing throw-net with a mesh size of 30 mm, a diameter of 4.22 m and a surface area of about 14 m^2 will be used to catch fish in fishponds. Five randomly-placed replicates will be conducted in each pond. Fish will be identified to species and their weight and length recorded and then released back into the pond.

6.9.2 Monitoring of fish stocks should be undertaken at all ponds every two months, unless a pond has been stocked within one month of the proposed sampling date.

6.9.3 During stocking, a random sample of 50 specimens of each species to be stocked will be wet-weighed and length will be measured prior to release into the pond.

6.10 Pedology Monitoring for Fishponds in the IEA

6.10.1 Pond sediment shall be monitored for the following parameters twice a year, at the end of the wet season (September) and the end of the dry season (March):

- % total organic content
- total organic carbon
- total nitrogen
- total phosphorus
- reactive phosphorus
- mean pH

6.10.2 Three samples will be collected from each pond including any ponds which are drained on the sampling date. Samples will be collected randomly from the pond floor using a core sampler. At least 1 kg of the pond sediment will be collected from the pond bottom sediment at each sampling location for chemical analysis. Samples collected will be properly contained, sealed, labelled and stored immediately at ice temperature upon collection.

6.10.3 Direct or indirect contact with potentially contaminated materials should be avoided through proper sample handling and storage. Special care should be taken to avoid cross contamination. Sampling equipment and sample containers should be made of suitable material (e.g. glass or plastics) and be thoroughly cleaned prior to use. Samplers should also be thoroughly cleaned between collection of each sample.

6.10.4 Collected samples should be sent to a HOKLAS accredited laboratory for analysis.

6.11 Water Quality and Hydrology Monitoring for Fishponds in the IEA

6.11.1 Water levels in all ponds in the IEA should be recorded on a weekly basis. Measurements will be taken from a fixed marker pole will be placed at the lowest point in each pond. In addition, water levels should be recorded after storm events likely to have deposited significant quantities of rainwater in the ponds (Red or Black Rainstorm Warnings or No. 3 or higher Typhoon Warnings issued by Hong Kong Observatory.

6.11.2 In-situ monitoring of water in each pond for the following parameters should be undertaken every two months or within two weeks of management measures designed to change water quality having been undertaken:

- pH
- turbidity
- salinity / conductivity
- dissolved oxygen
- temperature

6.11.3 Monitoring will be conducted using a proprietary Water Quality Checker. Sampling protocol recommended by the manufacturer should be followed. Water samples shall be taken at mid-depth of pond.

6.11.4 In addition, every two months water samples will be collected from each pond and sent to a HOKLAS accredited laboratory in order to measure the following:

- biochemical oxygen demand (BOD)
- ammonia
- total oxidised nitrogen
- total phosphorus
- orthophosphate

6.11.5 Water samples will be collected using a sampling container at the end of a pole. This will enable the samples to be collected away from the edge of the pond while allowing sampling from land to minimise water disturbance. Samples will be collected using clean containers and will be stored in the appropriate transportation containers as required by the testing laboratory.

6.12 Monitoring of Bats at Chau Tau

6.12.1 A group of Chinese Fan Palms *Livistona chinensis* at Chau Tau has been identified as the site of a roost of Short-nosed Fruit Bats *Cynopterus sphinx*. Another bat species, the Lesser Bamboo Bat *Tylonycteris pachypus* has also been recorded in this location and may also be using the fan palms as a roost (BV 2002d). Monitoring of the roost is required to confirm that construction noise barriers which are to be erected prior to the commencement of Spur Line construction in this location are successful (i.e. that the bats continue to occupy the roost) and to identify if any additional mitigation measures are required.

6.12.2 Monitoring shall take the form of monthly counts of bats leaving the roost. Counts will be timed to commence shortly before dusk (i.e. whilst the bats are still roosting) and will be continued after night-fall so that foraging behaviour can be observed.

6.12.3 During each visit the roost should be quietly approached before dark and the underside of the foliage should be scanned for roosting fruit bats. All bats present should be counted. Further counts of fruit bats should be taken as bats leave the roost as not all bats may be visible at roost due to their being obscured by leaves.

6.12.4 All Lesser Bamboo Bats and all other bat species present in the area should be counted and their activities noted. As it is suspected, but not confirmed, that Lesser Bamboo footed Bats are roosting in the fan palms, special efforts should be made to confirm the location of roosts of this species subject to the requirement to minimise disturbance to the bats.

6.13 Monitoring of Other Possible Adverse Effects of the Spur Line Construction Programme

6.13.1 In addition to the monitoring of impacts at Lok Ma Chau, the monitoring of the IEA, and the monitoring of the bat roost at Chau Tau detailed above, ecological monitoring should be conducted throughout the Spur Line alignment. This additional monitoring is intended to cover the unlikely event that significant unpredicted adverse ecological impacts arise as a consequence of the project.

6.13.2 Weekly inspections will be conducted of ecological conditions throughout the Spur Line alignment and will focus on any habitat changes that may impact on ecologically sensitive areas, including the Lok Ma Chau station area, the ECA and IEA, habitats adjacent to Chau Tau and Long Valley. Overall monitoring will cover three main aspects, as follows:

- Progress with the construction and management of the IEA and ECA;

- Identification of any ecological impacts of other construction activities where these are within or adjacent to locations where Spur Line construction works are underway or are programmed;

- Ecological status of areas within the Spur Line resumption area not yet subject to construction activities or active land management measures.

6.14 Reporting and Staffing

6.14.1 Because this EcolM&A Manual covers both the monitoring of the ecological impacts of the Spur Line construction and the monitoring of the actively managed IEA, reporting must include the following:

- Ecological Monitoring;

- Review of Conditions in the IEA.

6.14.2 Both the results of the ecological monitoring and the review of conditions in the IEA will be reported on a monthly basis in an Ecological Monitoring and IEA Management Report. This will cover the EcolM&A reporting requirements under the following headings:

Ecological Monitoring

- Utilisation of the IEA and the Control Areas by target waterbird species, including their response to enhancement management measures such as stocking or drain-down;

- Results of all wildlife monitoring activities (including bird surveys for the Lok Ma Chau area, Black-faced Spoonbill roost counts, camera surveillance of Eurasian Otters and other mammals, amphibians, reptiles, dragonflies and butterflies of the IEA and control areas and Chau Tau bat surveys);

- Results of weekly inspections of ecological conditions throughout the Spur Line alignment and any habitat changes that may impact on ecologically sensitive areas and species of conservation importance.

IEA Management

- Report on the adaptive management activities (both recurrent and non-recurrent) during the previous month;
- Report on conditions in the IEA during the previous month, including water quality, fish and invertebrate[1] populations.
- Report on incidents requiring a management response or (potentially) affecting mitigation targets such as adverse weather, disturbance or water quality problems:
- Report on management measures initiated or to be initiated to maintain the IEA and to meet targets.

6.14.3 Monitoring and adaptive management activities will be reported on a yearly basis in an Annual Ecological Monitoring and IEA Management Report. This will summarise the data presented in the Monthly Reports and will include, in addition:

- Analysis of the year's monitoring data;
- Evaluation of success in meeting mitigation targets over the year;
- Review of adaptive management activities conducted over the year and outline of management activities proposed for the subsequent year.
- Cross-reference to the Habitat Creation and Management Plan (the latter to be reviewed and updated on a six-monthly basis.

6.14.4 The ecological monitoring programme is detailed in Table 6.2

Table 6.2
Ecological monitoring programme for the IEA

Ecological attribute	Number of measurements	Timing of measurements	Frequency of measurements	Reporting
Habitats in the IEA				
Percentage of the IEA consisting of wetland habitats	One	Wet season	Once per year	Annual

[1] Note that due to the time taken to process invertebrate samples, the results will be reported on approximately two months after samples are collected.

Ecological attribute	Number of measurements	Timing of measurements	Frequency of measurements	Reporting
Vegetation cover in the IEA				
Vegetation map	One	Wet season	Once per year	Annual
Vegetation cover on bunds, on bundsides and in ponds	Ten quadrats per pond *	Wet season	Once per year	Annual
Percentage of undesirable/exotic plant species	Ten quadrats per pond*	Wet season	Once per year	Annual
Plant community composition and structure in IEA				
Percentage of obligate or facultative wetland plants	Ten quadrats per pond *	Wet season	Once per year	Annual
Individual species frequency / cover	Ten quadrats per pond*	Wet season	Once per year	Annual
Mean maximum height of the vegetation	Ten quadrats per pond*	Wet season	Once per year	Annual
Variation in vegetation height	Ten quadrats per pond*	Wet season	Once per year	Annual
Target Bird Species in IEA and the Control Areas				
Numbers of target waterbird species	Four – five counts of all individuals of target waterbird species	All year (drain-down during dry season only)	Once per week except during drain-down when five day survey required	Monthly
Abundance / diversity of food for target waterbird species in IEA				
Species richness and diversity of aquatic invertebrates	Five samples per pond	Pre and post drain-down and once each during wet and dry seasons		Bi-annually (data) / annually (analysis)
Species richness and diversity of benthic invertebrates	Five samples per pond	Pre and post drain-down and once each during wet and dry seasons		Bi-annually (data) / annually (analysis)
Numbers and size of fish	Five throw-net samples per pond	All year	Every two months or prior to stocking	Bi-monthly

Ecological attribute	Number of measurements	Timing of measurements	Frequency of measurements	Reporting
Fauna and flora of the IEA and the Control Areas				
Species richness and diversity of dragonflies and butterflies	One transect	April to August	Fortnightly	Monthly
Species richness and diversity of mammals	Five infra-red cameras / one day-time transect	All year	Weekly	Monthly
Species richness and diversity of reptiles and amphibians	One day-time and one night-time transect	March to July	Fortnightly	Monthly
Species richness and diversity of secondary target fauna species	One transect	All year	Weekly	Monthly
Presence and abundance of additional flora or fauna Species of Conservation Importance	One transect	All year	Weekly	Monthly
Birds and environmental conditions in the Lak Ma Chau Area (within 500 m of the construction site boundary)				
Numbers and distribution of birds	One transect	All year	Weekly	Monthly
Water levels and status of ponds**	One transect	All year	Weekly	Monthly
Bat roost at Chau Tau				
Number and distribution of bats at roost	One count pre-dusk	All year	Monthly	Monthly
Pedology in the IEA				
Mean percentage organic versus mineral content.	Three samples per pond	Wet and dry seasons	Bi-annually	Bi-annually (data) / annually (analysis)
Change in nutrient composition.	Three samples per pond	Wet and dry seasons	Bi-annually	Bi-annually (data) / annually (analysis)
Mean pH.	Three samples per pond	Wet and dry seasons	Bi-annually	Bi-annually (data) / annually (analysis)
Hydrology in the IEA				
Per cent surface water	One per pond	All year	Weekly	Monthly

Ecological attribute	Number of measurements	Timing of measurements	Frequency of measurements	Reporting
Surface water level of ponds	One per pond	All year	Weekly	Monthly
Water chemistry in the IEA				
Mean salinity	One per pond	All year	Bi-monthly***	Bi-monthly
Mean pH	One per pond	All year	Bi-monthly***	Bi-monthly
Mean dissolved oxygen	One per pond	All year	Bi-monthly***	Bi-monthly
Biochemical oxygen demand	One per pond	All year	Bi-monthly***	Bi-monthly
Mean ammonia concentration	One per pond	All year	Bi-monthly***	Bi-monthly
Mean total oxidised nitrogen concentration	One per pond	All year	Bi-monthly***	Bi-monthly
Mean total phosphorus concentration.	One per pond	All year	Bi-monthly***	Bi-monthly
Mean orthophosphate concentration	One per pond	All year	Bi-monthly***	Bi-monthly

* Including bunds and bundsides.
** Water level, management activities (including drain-down and harvesting).
*** Or as required during when active management measures are in progress.

Staffing

6.14.5 Ecological monitoring will be conducted by ecologists with at least three years experience of surveying the relevant faunal groups. The ecological monitoring team will be supervised by an ecologist with at least seven years experience of ecological surveys and study team management.

6.15 Event and Action Plan for Ecology

6.15.1 An ecology event and action plan is detailed in Table 6.3. Because this ecology event and action plan relates to both ecological monitoring and monitoring of the adaptive management regime, this plan will be reviewed an updated on an annual basis as a part of the preparation process of the Annual Ecological Monitoring and IEA Management Report (see paragraph 6.14.3). Aspects of it may also be amended in the light of the six-monthly review of the HCMP. In this regard, it should be noted that where monitoring of attributes (and the rationale behind this) is not explicitly referred to in this EcolM&A Manual, monitoring falls under the adaptive management regime detailed in the HCMP. In such instances, further details can be found in the HCMP or in Section 6.16. In particular, it is

anticipated that action levels for habitat conditions will be updated as the project proceeds.

Table 6.3
Event and Action Plan for Ecology

Ecological attribute	Action Level	Limit	Action Plan / Contingency Plan (where appropriate)
Habitats in IEA			
Area of IEA	IEA area < 15.5 ha	As action level	Extend IEA to cover adjacent fishponds
Proportion of IEA consisting of wetland habitats	<90% with surface water, hydric soils and vegetation dominated by obligate or facultative wetland plants	<75% with surface water, hydric soils and vegetation dominated by obligate or facultative wetland plants	Adjust water management to increase wetland area / regrade to enlarge ponds area / add further ponds to IEA
Proportion of ponds under an active drain-down regime	< 70% of ponds under an active drain-down regime with conditions suitable for fish stocking	< 50% of ponds under an active drain-down regime with conditions suitable for fish stocking	Bring ponds into active management regime by manipulation of water levels and water quality and fish stocking
Proportion of shallow water in ponds	< 20% of the fishpond area (excluding bunds) consists of water < 50 cm depth	< 10% of the fishpond area (excluding bunds) consists consists of water < 50 cm depth	Lower water levels in short term / regrade bunds in long term
Vegetation cover in IEA			
Percentage of bunds with vegetation cover	< 20% of bunds with vegetation cover	< 10% of bunds with vegetation cover	Planting or hydro-seeding
	>30% of bunds with vegetation cover > 10 cm height	>50% of bunds with vegetation cover > 10 cm height	Cutting
Percentage of pondsides with vegetation cover	< 20% of pondsides with vegetation cover	< 10% of pondsides with vegetation cover	Planting or hydro-seeding
	> 30% of pondsides with vegetation cover	> 50% of pondsides with vegetation cover	Cutting
Percentage of ponds with vegetation cover	< 10% of pond area with vegetation cover	< 5% of pond area with vegetation cover	Planting or hydro-seeding
	> 20% of pond area with vegetation cover	> 30% of pond area with vegetation cover	Cutting
Percentage of undesirable / exotic plant species	> 10% of vegetation in ponds / on pondsides or on bunds	> 20% of vegetation in ponds / on pondsides or on bunds	Cutting
Plant community composition & structure in IEA			
Proportion of wetland plants	Monitor only in first year	Monitor only in first year	Review and amend vegetation management regime if appropriate

Ecological attribute	Action Level	Limit	Action Plan / Contingency Plan (where appropriate)
Individual species frequency / cover	Monitor only in first year	Monitor only in first year	Review and amend vegetation management regime if appropriate
Mean maximum height of the vegetation	Monitor only in first year	Monitor only in first year	Review and amend vegetation management regime if appropriate
Variation in vegetation height (all species)	Monitor only in first year	Monitor only in first year	Review and amend vegetation management regime if appropriate
Numbers of Target Bird Species in IEA			
Overall numbers of target waterbird species	Performance target for any species not met in any month	Performance target for any species not met in any twelve month period	Review adaptive management regime / accelerate attraction measures e.g. stocking / drain-down
Numbers of Great Cormorants / Grey Herons / Great Egrets / Black-faced Spoonbills	Numbers of any one of these species < target in any two successive months	Numbers of any one of these species < target in any four successive months	Review adaptive management regime / accelerate attraction measures e.g. stocking / drain-down
Numbers of Little Egrets / Chinese Pond Herons	Numbers of either of these species < target in any four successive months during October - March or any two successive months in April - September	Numbers of either of these species < target in any six successive months during October - March or any three successive months in April - September	Review adaptive management regime / adjust conditions for these relative to other target waterbird species

Ecological attribute	Action Level	Limit	Action Plan / Contingency Plan (where appropriate)
Abundance / diversity of food for target waterbird species in IEA			
Species richness and diversity of aquatic invertebrates	Monitor and set action level after two years of establishment	Monitor and set limit level after two years of establishment	Adjust water quality / vegetation cover / adjust drain-down regime
Species richness and diversity of benthic invertebrates	Monitor and set action level after two years of establishment	Monitor and set limit level after two years of establishment	Adjust water quality / adjust drain-down regime
Numbers and size of fish	Monitor and set action level after one year of establishment	Monitor and set limit level after two years of establishment	Adjust water quality / vegetation cover / adjust stocking regime
Fauna and flora of the IEA			
Species richness and diversity of dragonflies	Monitor and set action levels after two years of establishment	Monitor and set limit level after two years of establishment	Adjust water and vegetation management regime / use experience to adjust ECA design
Species richness and diversity of mammals	Monitor and set action levels after two years of establishment	Monitor and set limit level after two years of establishment	Adjust water and vegetation management regime / use experience to adjust ECA design
Species richness and diversity of reptiles and amphibians	Monitor and set action levels after two years of establishment	Monitor and set limit level after two years of establishment	Adjust water and vegetation management regime / use experience to adjust ECA design
Species richness and diversity of secondary target fauna species	Monitor and set action levels after two years of establishment	Monitor and set limit level after two years of establishment	Consider scope for enhancement management in later years of IEA / use experience to adjust ECA design
Presence and abundance of additional flora or fauna Species of Conservation Importance	Review information and if appropriate prepare contingency plan for appropriate management	To be set as a part of the contingency plan	Implement contingency measures if appropriate
Pedology in the IEA			
Mean percentage organic versus mineral content.	Surveillance only – no limits	Surveillance only – no limits	
Change in nutrient composition.	Surveillance only – no limits	Surveillance only – no limits	
Mean Redox potential	Surveillance only – no limits	Surveillance only – no limits	
Mean pH.	Surveillance only – no limits	Surveillance only – no limits	
Hydrology in the IEA			

Ecological attribute	Action Level	Limit	Action Plan / Contingency Plan (where appropriate)
Per cent surface water	Surface water is present over <90% of the pond area except during programmed drain-down periods	Surface water is present over <75% of the pond area except during programmed drain-down periods	Pumping to redistribute water / use of water tankers
Surface water level for Ponds 1, 2, 3a/3b, 6a/6b & 8	Level > 300 mm above or 1000 mm below target levels	Level > 500 mm above or 1500 mm below target levels	Pump water in or out; review causes of problem, prepare and implement contingency plan if problem persists
Surface water level for Ponds 4 and 7	Level > 200 mm above or 200 mm below target levels	Level > 400 mm above or 400 mm below target levels	Pump water in or out; review causes of problem, prepare and implement contingency plan if problem persists
Water Chemistry in the IEA			
Mean salinity	Salinity > 1 pp thousand	Salinity > 3 pp thousand	Water mixing / drain and refill; review causes of problem, prepare and implement contingency plan if problem persists
Mean pH	pH outside range 5.5 – 7.5	pH outside range 4.0 – 8.5	Lime/ Add peanut residue / mix water / drain and lime
Mean dissolved oxygen	Dissolved oxygen < 1.0 mg/l	Dissolved oxygen < 0.5 mg/l	Amend fertilisation and stocking regime / pump & mix water / aeration
Mean ammonia concentration	Surveillance only in first year – no limits	Surveillance only in first year – no limits	
Mean total oxidised nitrogen concentration	Surveillance only in first year – no limits	Surveillance only in first year – no limits	
Mean total phosphorus concentration.	Surveillance only in first year – no limits	Surveillance only in first year – no limits	
Mean orthophosphate concentration	Surveillance only in first year – no limits	Surveillance only in first year – no limits	

6.16 Ecological Mitigation Measures

6.16.1 The objective of the ecological mitigation measures to be undertaken in the IEA is to ensure that there is no net decrease in the numbers of large waterbirds using the area during the construction period. These large waterbird species are the species for which the Lok Ma Chau area is considered to be of greatest conservation importance (in both a Hong Kong and international context) and which are most vulnerable to direct and indirect habitat loss (the latter through

disturbance) during the station construction period. These target large waterbird species are listed in Table 6.1.

6.16.2 Habitat and habitat management requirements for the target large waterbird species are detailed below.

Great Cormorant Phalacrocorax carbo

6.16.3 Great Cormorants are winter visitors to Hong Kong and are economically important as a proportion of the large numbers of this fish-eating species which occur in Deep Bay feed in commercial fishponds. Studies of the wintering ecology of Great Cormorants and measures to reduce their impact on commercial fisheries including diversionary feeding and wiring ponds to prevent cormorant access are being carried out by AFCD.

6.16.4 Great Cormorants in Hong Kong roost communally. There are currently two roosts in the Deep Bay area: at Mai Po NR and at Nam Sang Wai. Cormorants disperse to feed; either in Deep Bay itself or on fishponds. They use both active and inactive ponds, but avoid small ponds, especially those surrounded by trees or adjacent to sources of human activity. They readily take advantage of fish concentrations, including the provision of "trash fish" (usually tilapia) in ponds at Mai Po NR to divert feeding pressure from commercial ponds.

6.16.5 Unlike the other target species, Great Cormorants feed by catching fish whilst swimming (usually underwater). Accordingly, they will utilise ponds when they are full or partly full of water. During the day, when not feeding some birds return to the nighttime roosts whilst others use daytime loafing sites; usually isolated trees or tree lines or bare bunds or banks, especially those which isolated from disturbance and ground predators by being surrounded by water.

6.16.6 Management of ponds at Lok Ma Chau during winter 2001-2002 demonstrated that Great Cormorants could readily be attracted to ponds in the IEA when these were stocked with fish. Stocked ponds attracted this species both when they were left at their normal depth (c. 1.5 m) and when they were partially drained to c. 50 cm water depth.

Grey Heron Ardea cinerea

6.16.7 Grey Herons have bred in Hong Kong, but this species is primarily a winter visitor (Young and Cha 1995). Habitat utilisation has been studied in Hong Kong by Young (1994) who noted that this species is predominantly a crepuscular feeder in Hong Kong and primarily uses *gei wai* as a daytime roost; but also utilises fish ponds for feeding. Grey Herons usually feed by wading for fish,

preferentially selecting those 10 – 16 cm in length (Cramp and Simmons 1977). As one of the larger target species they can wade in water up to c. 70 cm depth.

6.16.8 Management of ponds at Lok Ma Chau during winter 2001-2002 demonstrated that Grey Herons could readily be attracted to ponds in the IEA. Stocking alone attracted birds; attraction increased when ponds were partially drained or maintained at a low level which permitted birds to wade over most of the pond. In addition, birds regularly took advantage of bunds which were largely cleared of vegetation as daytime roosting and loafing sites.

Great Egret Egretta alba

6.16.9 Great Egrets are one of the scarcer breeding Ardeids in Hong Kong, but numbers are much greater in winter (Young and Cha 1995). Habitat utilisation has previously been studied in Hong Kong by Young (1994) who showed that whilst this species fed on drained ponds and *gei wai*, intertidal mudflats are typically more important as feeding habitat. However, management of the IEA during winter 2001-2002 showed that Great Egret was strongly attracted to stocked and partially drained-down ponds, exhibiting a similar pattern of use to Grey Heron (including using cleared bunds as roosting and loafing sites).

6.16.10 It was also noted that whilst shortly after stocking (when large numbers of fish were available) Great Egrets fed in open water areas, small numbers persisted in feeding in emergent vegetation around ponds once the larger attraction had ceased. It is considered that these remaining birds were seeking fish sheltering in the vegetation.

Little Egret Egretta garzetta

6.16.11 Little Egrets are found in Hong Kong throughout the year. Habitat utilisation has been studied in Hong Kong by Young (1994) and Cornish (1996). These studies showed that Little Egrets in Hong Kong feed primarily in fishpond and intertidal mudflat areas. Little Egrets feed opportunistically on fish remaining when ponds are drained and are often the most abundant Ardeid species in such feeding concentrations. Breeding birds typically forage within 3 km of egretries (Young 1994), which may be situated either in bamboos or a variety of tree species.

6.16.12 Though Little Egrets were attracted to stocked and partially drained ponds in the IEA during the winter 2001-2002 management exercises, numbers of this species were for the most part smaller than those recorded at nearby commercial fishponds and at Mai Po NR (BV 2002b). In view of the known propensity of this species to use drained-down ponds, this finding was somewhat surprising.

6.16.13 However, surveys of food availability in the stocked IEA ponds showed that, other than the stocked fish, few other food items were available. This contrasted with Mai Po NR *gei wai* where, though the density of potential prey items was lower, the diversity was much higher, including much larger numbers of small prey (BV 2002b). Since stocked fish were almost all 7 – 13 cm in length (BV 2002b) and the preferred prey size for Little Egret is 3.8 cm (Cramp and Simmons 1977) it seems likely that a lack of numbers and/or diversity of small prey was the reason for the failure to attract larger numbers of Little Egrets to the IEA.

6.16.14 Management for Little Egret should, therefore, focus on the provision of a diversity of small prey items, together with manipulation of water levels (i.e. provision of water of less than c. 50 cm depth) to make this prey available. Since this species has an important breeding population in the Deep Bay area, management for this species will include the provision of suitable feeding conditions in both the non-breeding and the breeding seasons.

Chinese Pond Heron Ardeola bacchus

6.16.15 Chinese Pond Herons are found in Hong Kong throughout the year. Habitat utilisation has been studied in Hong Kong by Young (1994) who showed that birds breeding at the Mai Po Village egretry fed mainly around fishponds. Individuals typically forage solitarily along the edges of open water areas or areas within sparse or short vegetation. They utilise open areas such as intertidal mudflats or drained- down ponds less than larger Ardeid species in Hong Kong. Chinese Pond Herons breed colonially, either on their own or with other Ardeid species. Nests are often placed in bamboos *Bambusa* spp. Breeding adults largely forage within 3 km of their colonies (Young and Cha 1995).

6.16.16 Unlike the other target species of ardeids (and Black-faced Spoonbills), Chinese Pond Herons are not attracted in large numbers to drained-down ponds, neither do the make extensive use of *gei wai* (BV 2002b). Rather, this species is a solitary feeder which typically finds much of its prey in shallow water either in or on the edge of areas of emergent or pondside vegetation. Chinese Pond Herons eat small fish, but also feed extensively on invertebrates and amphibians. Within the IEA therefore, provision for this species must focus on creating suitable shallow water conditions with emergent vegetation where a range of small prey species is available.

6.16.17 Since numbers of Chinese Pond Herons in Hong Kong are similar throughout the year, management for this species will provide suitable feeding conditions in the breeding as well as the non-breeding season.

Black-faced Spoonbill Platalea minor

6.16.18 Black-faced Spoonbills have been subject of a number of studies in Hong Kong (notably Anon. (1999), Melville *et al.* (1999) and Anon (2001)). In addition, when it was discovered during baseline fieldwork that Black-faced Spoonbills were utilising drained ponds at Lok Ma Chau during winter 2000-01, their use of this area was subject to additional specific survey efforts (BV 2002a).

6.16.19 Black-faced Spoonbills are tactile feeders. Feeding takes place in turbid water bodies with a flat or gradually sloping fine sediment bottom with water depths from 5 – 23 cm. (Yu and Swennen 2001). In Hong Kong these requirements are met in the intertidal mudflats in Deep Bay, as well as in fishponds and *gei wai*. The relative importance of intertidal areas and fish ponds and *gei wai* is influenced by tidal regime and pond management, with the latter habitats being particularly important during adverse weather and when ponds are drained for harvesting (Anon 2001, Yu and Swennen 2001). Black-faced Spoonbills largely feed on small prey items, especially shrimps *Palaemonetus* spp. and Mosquito Fish *Gambusia affinis*, but larger prey items such as tilapia *Oreochromis mossambicus* are also eaten, especially when these are readily available in partially drained ponds (Leader 1998, Yu and Swennen 2001).

6.16.20 Management of ponds at Lok Ma Chau during winter 2001-2002 demonstrated that Black-faced Spoonbills could readily be attracted to ponds in the IEA. Stocking alone attracted birds; attraction increased when ponds were partially drained or maintained at a low level which permitted birds to wade over most of the pond. In addition, birds regularly took advantage of bunds which were largely cleared of vegetation as daytime roosting and loafing sites. Indeed, this species was attracted so successfully that during early February 2002 most, if not all, of the Deep Bay population was using the Lok Ma Chau fishponds.

Management of the IEA for other ECA target species

6.16.21 The large waterbirds for which numerical targets must be met during the construction period are not the only fauna for which the Spur Line project must make compensatory habitat provision. However, numerical targets are not appropriate for these species during the construction stage as they largely require habitats which are not the primary focus of the IEA and will not, in any case, be as susceptible to disturbance impacts from construction. However, for some of these species provision can be made in the IEA without compromising its primary objectives. Accordingly, requirements for these species, and how these requirements may be met in the IEA are detailed below.

Eurasian Otter Lutra lutra

6.16.22 Eurasian Otter is restricted to the Deep Bay area in Hong Kong where it is rare (Reels 1996). This species is considered to be "Regionally Threatened" by Fellowes *et al.* (2002). Following its discovery in the Lok Ma Chau area during baseline fieldwork for the EIA during winter 2000-01 (BV 2002a), it was surveyed in the Lok Ma Chau area during winter 2001-2002 (BV 2002c). This survey indicated that it was probable that the Lok Ma Chau area supported a population of three otters. However, in the absence of data concerning the home ranges of this species in southern China it was not clear if these individuals were moving over a larger area (for example to Mai Po NR).

6.16.23 Eurasian Otter feeds largely on fish and amphibians. As is shown in BV (2002c) in Hong Kong it is known to make use of fishponds, *gei wai* and river channels. The former are probably largely used for feeding, whilst the latter appear to provide important movement corridors. This species will benefit from the appropriate management of river channel fringes by providing cover, prevention of burning of vegetation (the traditional way in which rank grassland along river channels is cleared by fish farmers), together with the provision of appropriate natural and artificial sites for holt formation. Otters will also be able to take advantage of the habitat provision (including food available) in marsh areas.

6.16.24 Within the IEA, management of the river channel will be undertaken with a view to the requirements of this species. Tree and shrub vegetation will be retained on the banks and large expanses of rank grassland will be cleared (by cutting).

Common Teal Anas crecca

6.16.25 The following is based on non-systematic observation in Hong Kong including observations at Lok Ma Chau during winter 2000-01 (BV 2002a). Common Teal are winter visitors to Hong Kong and are present between September and April. Though there are occasional records from other wetland sites; the majority of Common Teal are found in the Deep Bay area. Within Deep Bay favoured habitats are intertidal creeks amongst mangroves, *gei wai* and well-vegetated ponds, especially those with abundant growth of the facultative wetland grass *Paspalum distichum*. A common denominator in these preferences is the presence of mud or shallow water feeding areas in proximity to cover. More open wetland habitats such as active fishponds, intertidal mudflats and Deep Bay itself are less favoured by Common Teal than most other duck species in Hong Kong – it is probably not co-incidence that this species is a frequent prey item for raptors including Greater Spotted and Imperial Eagles.

6.16.26 Diet of Common Teal has not been studied in Hong Kong; however elsewhere in its range it is considered to be omnivorous, filtering invertebrates and seeds from water or soft mud whilst either walking or swimming. Seeds are often particularly important in winter (Cramp and Simmons 1977).

6.16.27 In the IEA Common Teal will benefit from shallow pond areas with emergent vegetation, managed to meet the requirements of Chinese Pond Heron. Further habitat will be provided for this species in the marshland areas which are to be created in the ECA.

Greater Spotted Eagle Aquila clanga

6.16.28 Habitat utilisation in the Deep Bay area was studied during winter 2000-01 (BV 2002a). Greater Spotted Eagles are a winter visitor to Hong Kong and are present from late October to early April. Their distribution in Hong Kong is restricted to the Deep Bay area, with the notable exception that they roost at night in hills to the south; with most birds apparently roosting in the Castle Peak area during winter 2000-01 (Carey *et al.* 2001, BV 2002a). As with Imperial Eagle, observations during winter 2000-01 showed that the most important area for this species was Mai Po, with secondary foci at Tsim Bei Tsui and Nam Sang Wai. Together these areas accounted for 86% of records (BV 2002a). In contrast to the distribution of Imperial Eagles, during this study there were no records from Lok Ma Chau; indeed there were very few records from east of Mai Po. This species is scarcer in Hong Kong than Imperial Eagle (Carey *et al.* 2001); the frequency of sightings during winter 2000-01 was approximately half that of Imperial Eagle (BV 2001).

6.16.29 The pattern of occurrence was related to the presence of abundant waterbirds on ponds (especially wild ducks). Despite the presence of large numbers of waterbirds (including ducks) the intertidal zone is not utilised. Trees are required for daytime loafing or hunting perches and the study in winter 2000-01 suggested that, in comparison with Imperial Eagle, this species is less likely to occur in extensive open active fish pond areas

6.16.30 Greater Spotted Eagles do not, technically, meet the criterion of regular occurrence in the Lok Ma Chau area required for inclusion on the list of Key Target Species for the ECA as this species was not recorded regularly there during winter 2000-01 (BV 2002a). However this species is included as a Key Target Species for the ECA because it is Globally Threatened (BirdLife International 2000) and has habitat requirements which can be accommodated without compromising any other mitigation objectives (in fact the mitigation proposals are identical to those required for Imperial Eagle).

6.16.31 Greater Spotted Eagles will be attracted to concentrations of waterbirds, especially ducks, which will provide a source of food. They are likely to avoid areas adjacent to the LMC Station as well as the eastern part of the mitigation area where human activities associated with the presence of the Spur Line and the Boundary Crossing point will deter use.

6.16.32 The management of the IEA for large waterbirds is likely to provide some attraction for Greater Spotted Eagle. However, this potential attraction for eagles has to be set against the fact that, since eagles are predators on waterbirds, the attraction of eagles to the IEA will not benefit the primary IEA target species.

6.16.33 Accordingly, whilst in the longer term, the attraction of eagles to the ECA is an important element of ecological mitigation measures, during the construction period active measures to attract eagles are not proposed.

Imperial Eagle Aquila heliaca

6.16.34 Habitat utilisation in the Deep Bay area was studied during winter 2000-01 (BV 2002a). Imperial Eagles are a winter visitor to Hong Kong and are present from late October to early April. Their distribution in Hong Kong is restricted to the Deep Bay area, with the notable exception that they roost at night in hills to the south; with most birds apparently roosting in the Castle Peak area during winter 2000-01 (Carey *et al.* 2001, BV 2002a). Observations during winter 2000-01 showed that the most important area for Imperial Eagles is Mai Po Nature Reserve, with Ma Tso Lung being the second most important area. Together, these two areas accounted for 66% of sightings during the study. Tsim Bei Tsui, Nam Sang Wai and Lok Ma Chau were sites of similar secondary importance, with Lok Ma Chau accounting for 8% of sightings.

6.16.35 The pattern of occurrence was related to the presence of abundant waterbirds on ponds (especially wild ducks), with a secondary factor being an avoidance of developed and disturbed areas. Despite the presence of large numbers of waterbirds (including ducks) the intertidal zone is not utilised. Trees are required for daytime loafing or hunting perches, but ponds surrounded by continuous large trees (as at parts of Nam Sang Wai) are avoided.

6.16.36 Imperial Eagles will benefit from the reduction in human disturbance arising from the management of the mitigation area. They will also be attracted to concentrations of waterbirds, especially ducks, which will provide a source of food. However, Imperial Eagles are likely to avoid areas adjacent to the LMC Station as well as the eastern part of the mitigation area where human activities associated with the presence of the Spur Line and the Boundary Crossing point will deter use.

6.16.37 As with Greater Spotted Eagle, the management of the IEA for large waterbirds is likely to provide some attraction for Imperial Eagle, as these will provide it with a potential source of food. However, this potential attraction for eagles has to be set against the fact that the attraction of eagles to the IEA will not benefit the primary target species.

6.16.38 Accordingly, whilst in the longer term, the attraction of eagles to the ECA is an important element of the ecological mitigation measures, during the construction period active measures to attract eagles are not proposed.

Black-winged Stilt Himantopus himantopus

6.16.39 The following is based on non-systematic observation in Hong Kong including observations at Lok Ma Chau during winter 2000-01 (BV 2002a). In Hong Kong, Black-winged Stilts are restricted to fresh or brackish water habitats, favouring large disused fishponds in the Deep Bay area and bloodworm ponds in Long Valley. Black-winged Stilts are recorded in Hong Kong throughout the year, but have not been known to breed; the small numbers present in summer presumably being non-breeding individuals or early returning migrants (Carey *et al.* 2001). Distribution on the Deep Bay area is somewhat erratic with flocks opportunistically utilising ponds which are of a suitable depth for feeding (c. 5 – 15 cm water depth) as this species rarely forages whilst swimming (Cramp and Simmons 1983). There is also some evidence that birds may move several kilometres between feeding and roosting areas in Hong Kong, with birds which roost in the Deep Bay area during the day flying to Long Valley to feed at night (BV 2002a).

6.16.40 Black-winged Stilts feed predominantly on aquatic invertebrates, especially insects. Food is taken by wading in open water and invertebrates are taken from on and below the water surface and from aquatic vegetation (Cramp and Simmons 1983). Black-winged Stilts will benefit from shallow open water areas overlying soft mud with aquatic vegetation sparse or absent.

6.16.41 Black-winged Stilts will benefit from the shallow ponds and partially drained ponds, especially in spring and autumn when peak numbers occur in Hong Kong (Carey *et al.* 2001). The requirements of this species thus show a synergy with those of Chinese Pond Heron and are complementary to the focus for larger waterbird species (where the focus of management action will be in midwinter).

Common Snipe Gallinago gallinago

6.16.42 Common Snipe requires marsh vegetation with muddy margins and, in Hong Kong, is much more abundant in freshwater than brackish water areas. Edges of fishponds are used by Common Snipe, but these are not a major habitat for this species (Carey *et al.* 2001).

6.16.43 Common Snipe will benefit to a limited extent from shallow ponds with emergent vegetation provided primarily to meet the needs of Chinese Pond Heron. However, the primary provision for this species will be in the marsh areas to be formed in the ECA.

Richard's Pipit Anthus richardi

6.16.44 The race *A. r. richardi* of Richard's Pipit is a common passage migrant and winter visitor in Hong Kong, whilst the race *A. r. sinensis* is an upland breeding form (Carey *et al.* 2001). *A. r. richardi* occurs in flocks in the Deep Bay area in winter, favouring fish pond bunds or other areas which are bare or covered with sparse or short grass. It does not use areas of rank grassland or full ponds except around the fringes. However, it does make use of drained-down ponds once these are largely dry.

6.16.45 The cleared internal bunds within the IEA will provide suitable feeding areas for this species, as will the drier areas around partially drained ponds.

Common Stonechat Saxicola torquata

6.16.46 Common Stonechats are common passage migrants and winter visitors in Hong Kong. They are most abundant in areas of open cultivation and shrubland (Carey *et al.* 2001) but also occur in significant numbers along fishpond bunds and the fringes of reedbeds in the Deep Bay area.

6.16.47 Primary mitigation provision for this species will be in fringe areas of the ECA, notably the interface between the freshwater marsh and the reedbed and the drier raised shrub and tree-planted area around the station itself. No explicit provision for this species is proposed in the IEA; however it will continue to utilise the areas around the drainage channel and the more vegetated bunds on the fringes of the IEA site.

Zitting Cisticola Cisticola juncidis

6.16.48 Zitting Cisticola is a common winter visitor and passage migrant in Hong Kong and a rare breeding species. It favours areas of grass, especially in lowland wetland areas such as active and disused fishponds (Carey *et al.* 2001).

6.16.49 Primary mitigation provision for this species will be in fringe areas of the ECA, notably the interface between the freshwater marsh and the reedbed, together with some bunds where patches of long grass will be retained. No explicit provision for this species is proposed in the IEA; however it will continue to utilise the areas around the drainage channel and the more vegetated bunds on the fringes of the IEA site.

Red-billed Starling Sturnus sericeus

6.16.50 Red-billed Starling is a winter visitor to Hong Kong, occurring in large flocks in the northwest New Territories. The wintering population in Hong Kong is considered probably to be of international importance for this species (Carey *et al.* 2001). Red-billed Starlings are omnivores and feed around fishponds, wet agricultural areas (especially where these are contaminated by effluent from pig farms), edges of reedbeds and both natural and artificial drainage channels. They readily take advantage of spilled food provided for fish or ducks. Much food is obtained on the ground but they also frequently feed in trees where they consume insects and fruit (though their gape size is too small to permit them to take most fruits of *Melia azedarach*, the most frequent fruiting tree around fishponds).

6.16.51 In the ECA and IEA this species will benefit from sparely vegetated fringes to ponds and marsh areas, especially where these are close to tree and shrub areas adjacent to the drainage channels and the station perimeter. In the ECA it will also benefit from the proposed tree and shrub planting which will provide fruit and invertebrate food and shelter.

6.16.52 Red-billed Starling makes use of the trees along the river channel in the IEA and this area will be managed so that it remains suitable for this species by the retention of fruiting tree species and the clearance of some of the rank grass. This will permit Red-billed Starling to gain access to the muddy fringes of the river channel and its invertebrate food.

Burmese Python Python molurus

6.16.53 The occurrence of Burmese Python in the Lok Ma Chau area was noted or inferred by ERM (1999) but it was not recorded in the baseline survey (BV 2002a) or subsequently. However, as noted in the EIA Report, because reptiles are often cryptic and difficult to survey, it is included within the list of target species for the ECA on a precautionary basis. Further, large pythons have large home ranges (one tracked on Lantau over only 24 days moved in an area of 12 ha (Karsen *et al.* 1998), so the probability of an encounter during a survey is correspondingly low.

6.16.54 Burmese Python is widely distributed in Hong Kong, but is considered to prefer shrubland, woodland and the edges of mangroves. (Karsen *et al.* 1998). Mangroves are not a habitat which is present or proposed to be present in the ECA; however it will be able to utilise the marsh area together with the interface between this and the woodland and shrubland around the station and the river channels. Explicit provision for this species is not proposed in the IEA, however, this species (if present) will continue to be able to use the corridor formed by the river channel.

Chinese Soft-shelled Turtle Pelodiscus sinensis

6.16.55 The regionally uncommon Chinese Soft-shelled Turtle was not recorded in the Lok Ma Chau area during the baseline survey but was found in the IEA in November 2001 (BV 2002a). This species is rare and localised in Hong Kong with a natural population restricted to fishponds around Deep Bay (Karsen *et al.* 1998). Chinese Soft-shelled Turtle spends much time buried in the mud but also wanders on land and will bask on mudbanks or floating logs. Eggs are buried in the mud banks of a pond.

6.16.56 The Chinese Soft-shelled Turtle will benefit from the management of the fishponds in the IEA as these will provide suitable conditions corresponding to those which it favours in commercial fishponds but with a reduced risk of being accidentally killed during fish harvesting or pond management activities. In addition, it will benefit from the greater security and lower risk of disturbance to nesting sites.

Chinese Bullfrog Rana rugulosa

6.16.57 This large frog species is thought to be in marked decline locally and drastic decline regionally, and has therefore been rated as of Potential Regional Concern by Fellowes *et al.* (2002). It is commonly sold in food markets in Hong Kong and in southern China. It is a species closely associated with areas of wet agriculture, and breeds in ponds and marshes. The species is present but not common at Lok Ma Chau.

6.16.58 Chinese Bullfrogs feed on insects and small frogs and rodents (Karsen *et al.*, 1998). They will benefit from provision of permanent and, particularly, seasonal marsh habitat (from which predatory fish are absent), with good development of emergent and/or edge vegetation and variable, but generally shallow, depth. Presence of prey items such as odonate larvae and other frog species will also encourage establishment of this species.

6.16.59 As a marsh species, habitat provision for Chinese Bullfrog will be in the freshwater marsh area of the ECA rather than the brackish fishpond habitat of the IEA.

Habitat requirements of Target Species

6.16.60 A summary of the habitat requirements of the target species for the IEA detailed in this section is provided in Table 6.3. All habitats listed will be provided in the IEA, however the area of emergent/marsh vegetation will be relatively limited and lacking in species and structural diversity.

Table 6.3

Summary of Habitat Requirements of Target Species of Conservation Importance
Primary target species for the IEA are shown in bold.

Key: habitat important for F = Foraging; R = Roosting/loafing; B = Breeding. Habitats of secondary importance are shown in lower case.

Species	Deep water	Shallow water	Muddy vegeta-tion free margins	Trees on bunds/ channels	Emerg-ent / marsh vegetation	Bare or sparsely vegetat-ed bunds
Amphibians		F,B	F,B		F,B	
Reptiles		F	F	f	F	F,B
Eurasian Otter	F	F	F	B	F	
Great Cormorant	F	f		R		R
Grey Heron		F		R	f	R

Species	Deep water	Shallow water	Muddy vegeta-tion free margins	Trees on bunds/ channels	Emerg-ent / marsh vegetation	Bare or sparsely vegetat-ed bunds
Great Egret		F		R	F	R
Little Egret		F	f	R	F	r
Chinese Pond Heron		f	f	R	F, r	
Black-faced Spoonbill		F	F			R
Common Teal	F	F, r	f		F, R	
Greater Spotted Eagle		F		R	F	F
Imperial Eagle		F		R	F	F
Black-winged Stilt		F	F		f	
Common Snipe			F		F,R	
Richard's Pipit			F			F
Pallas's Grass. Warbler					F,R	
Zitting Cisticola					F,R	f
Common Stonechat				f	F,R	F
Red-billed Starling			F	F, R	f	F

Habitat Condition Targets

6.16.61 The principal management activities to be conducted in the IEA are the enhancement of fishponds. Currently, when the primary target species for the IEA use fishponds in the Deep Bay area, they feed on the abundant small non-commercial fish and invertebrates (termed 'trash fish') that thrive as a by-product of the highly productive commercial fish-farming systems. These include *Gambusia affinis* (Mosquito Fish), *Macrobrachium nipponense* (a prawn) and *Oreochromis mossambicus* (a species of tilapia).

6.16.62 However, when ponds are operated commercially, these food resources are generally only readily available to birds when the ponds are drained down for fish harvesting during the winter. Drain-down for commercial harvesting tends to be concentrated in a short period during the winter, in the few weeks before Chinese New Year. Furthermore, since the purpose of drain-down of commercial ponds is to produce human food for market, the drain-down activity has the following characteristics which do not benefit birds:

- drain-down is conducted as quickly as possible (typical ponds being emptied during a period of 4 – 7 days) in order to make harvesting more efficient and to minimise losses to birds;

- most fish are of a size suitable for human food and hence too large for many of the waterbird species (especially Black-faced Spoonbill and the smaller ardeids);

- most fish are removed from the system (as food for humans) hence only the residue is available to birds;

- once drain-down and harvesting has been accomplished, a pond is either quickly refilled or, if recontouring and clearance of mud is required, allowed to dry out completely. In either case, the period when it provides feeding opportunities to fish-eating birds is minimised.

6.16.63 In addition, the following physical characteristics of commercial fishponds reduce the availability of fish and other food to waterbirds:

- commercial ponds are steep-sided and typically 1.5 – 2.0 m in depth. Of the target bird species only Great Cormorants can catch fish in these conditions;

- emergent or floating vegetation is lacking thus reducing potential niches for invertebrates which would provide additional food especially for Chinese Pond Herons.

6.16.64 Accordingly, the principal fishpond enhancement measures will include the following:

- extending the period during which drained ponds are available by draining ponds sequentially throughout the winter period;

- draining ponds more slowly so that fish and other food is available over a longer period;

- maintaining some ponds with shallow water suitable for Black-faced Spoonbills and ardeids to wade for an extended period;

- maximising the usefulness of fish stocks to birds by stocking in a way that most fish are of a suitable size to be eaten by the target bird species;

- recontouring ponds so that the pond base has a shallow slope, thus providing a larger feeding area when ponds are full as well as a progressive increase in the feeding area when ponds are drained;

- establishment and maintenance of bankside and emergent vegetation on some ponds to provide refuges for fish and appropriate conditions for invertebrates that will themselves provide food for birds;

- repeat stocking of some ponds with trash fish during the winter months to permit the same pond to be drained (or partially drained) more than once per season.

6.16.65 In addition, the ponds' suitability for use by the target bird species will be enhanced by the following bund management activities:

- clearance of vegetation (including trees, shrubs, herbs and rank grass) from internal bunds to reduce the inhibitory effect that enclosure of ponds has on their use by some waterbirds and to provide suitable loafing and roosting areas;

- linking some ponds, both to increase overall pond size (larger ponds are favoured by some of the target species) and to create island areas from former bund sections which will form roost areas free from ground predators and disturbance.

6.16.66 Specific fishpond habitat targets for the IEA area are:

- Enhancement and maintenance of a total of 15.5 ha of fishponds;

- > 20% of the fishpond area (excluding bunds) consists of shallow water (i.e. < 50cm depth);

- vegetation cover >50% of the land area is established on 20-30% of the area of fishpond bunds and islands;

- vegetation cover >10 cm in height is <5% on 70-80% of the area of fishpond bunds and islands;

- 70-80% of the fishpond area (excluding bunds) is maintained under a drain-down regime to maximise fish availability to target species of waterbirds;

- 20-30% of the fishpond area is maintained as shallow ponds (with or without supplementary fish stocking) to suitable long-term feeding conditions for target species of waterbirds;

- emergent and pondside vegetation is maintained over 10-20% of pond areas and 20-30% of pondsides respectively;

- undesirable invasive species and exotic species are < 10% of vegetation cover.

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