Environment Management Plan

February 2014

Sri Lanka: Green Power Development and Energy Efficiency Improvement Investment Program

Prepared by Ceylon Electricity Board, Ministry of Power and Energy, Democratic Socialist Republic of Sri Lanka for the Asian Development Bank.

ABBREVIATIONS AND ACRONYMS

AD	Assistant Director
ADB	Asian Development Bank
AGM	Additional General Manager
AP	Affected Persons
asl	Above Sea Level
AT	Advance Tracing
BOD	Biochemical Oxygen Demand
CC	Construction Contractor
CEA	Central Environmental Authority
CEB	Ceylon Electricity Board
CR	Critically Endangered
DC	Design Consultant
DD	Deputy Director
DG	Director General
DGM	Deputy General Manager
DO	Dissolved Oxygen
DPP	Disaster Preparedness Plan
DWC	Department of Wildlife Conservation
EA	Executing Agency
EIA	Environmental Impact Assessment
EN	Endangered
EMO	Environmental Management Office
EMP	Environmental Management Plan
EMoP	Environmental Monitoring Plan
EO	Environmental Officers
EPC	Environmental Pollution Control
EPL	Environmental Protection License
ESA	Environmentally Sensitive Area
F&EM	Forestry and Environmental Management
FD	Forest Department
FS	Feasibility Study
FSL	Full Supply Level
GoSL	Government of Sri Lanka
GPS	Global Positioning System
GRC	Grievance Redress Committee
GRM	Grievance Redress Mechanism
GS&MB	Geological Survey and Mines Bureau
HPP	Hydropower Project
IA	Implementing Agency
ID	Irrigation Dept
IEE	Initial Environmental Examination
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
LA	Local Authority
LC	Least Concern
MASL	Mahaweli Authority of Sri Lanka
MC	Municipal Council

MHPP	Moragolla Hydropower Project
MOL	Minimum Operating Level
MoPE	Ministry of Power and Energy
NEA	National Environment Act
NIRP	National Involuntary Resettlement Policy
NGO	Non-Governmental Organization
NRMC	National Resources Management Centre
NT	Near Threatened
NTU	Nephelometric Turbidity Units
NWS&DB	National Water Supply and Drainage Board
NZG	National Zoological Gardens
OHSP	Occupational Health & Safety Plan
PAA	Project Approving Agency
PD	Project Director
PMO	Project Management Office
PP	Project Proponent
PSC	Project Steering Committee
RC	Reinforced Concrete
RDA	Road Development Authority
RoW	Right of Way
RP	Resettlement Plan
SC	Supervision Consultant
SEO	Senior Environmental Officers
SPS	Safeguard Policy Statement
TEC	Technical Evaluation Committee
ToR	Terms of Reference
TSS	Total Suspended Solids
UC	Urban Council
UDA	Urban Development Authority
VD	Valuation Department
VR	Valuation Reports
VU	Vulnerable
WMP	Watershed Management Plan

WEIGHTS AND MEASURES

GWh	gigawatt hour
ha	hectare
Hz	hertz
km	kilometre
km^2	square kilometres
kV	kilovolt (1,000 volts)
kW	kilowatt
kWh	kilowatt hour
m	metre
m^2	square metre
m^3	cubic metre
$m^3/km^2/y$	cubic metres per square kilometre per year
m^3/s	cubic metre per second
mm/s	millimetres per second
masl	metre above sea level
MCM	million cubic metre
MW	megawatt
MVA	megavolt ampere
rpm	revolutions per minute

PREFACE

This document is the second of five volumes, which together describe the environmental studies conducted in relation to the Moragolla Hydropower Project (HPP) in Sri Lanka. These studies were conducted between 2009 and 2014 on behalf of the Project Proponent, The Ceylon Electricity Board (CEB). The studies comprise: a) a Local Environmental Impact Assessment (EIA) prepared according to the Sri Lankan National Environment Act (NEA) (1980, amended 1988), which was approved by the Mahaweli Authority of Sri Lanka (MASL) in August 2013; b) Final Reports of 15 Additional Studies conducted in 2013 to provide data to update the Local EIA and allow a re-evaluation of project impacts and mitigation; c) an Environmental Addendum and Environmental Management Plan (EMP) prepared to upgrade the Local EIA to comply with the ADB Safeguard Policy Statement (SPS) (2009); and d) a Resettlement Plan prepared according to Sri Lankan law and the ADB SPS.

The report of these studies comprises five volumes, which are arranged as follows:

Volume 1: Environmental Addendum (2014);
Volume 2: Environmental Management Plan (2014) - **this document**;
Volume 3: Resettlement Plan (2014) (Standalone document, to be disclosed in March 2014);
Volume 4: Additional Environmental Studies (2013);
Volume 5: Local Environmental Impact Assessment (2012).

Volumes 1-2 represent the final assessment of the environmental impacts of the Moragolla HPP, prepared in compliance with national law and ADB policy. These documents incorporate all relevant results and data from the earlier Local EIA and the Additional Environmental Studies; and Volumes 4 and 5 are provided only to allow access to all data relating to the updated environmental impact assessment if needed.

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I. INTRODUCTION

A. Background

1. The Moragolla HPP is one of several hydropower projects identified[1] for development by the Government of Sri Lanka (GoSL) to reduce the role of fossil-fuelled power generation, which has outstripped hydropower over the past 30 years as most of the readily exploitable locations have become utilised. Returning hydropower to greater prominence would promote sustainable development and reduce greenhouse gas emissions in accordance with the National Climate Change Policy[2], and limit the country's exposure to fluctuating international fuel prices.

2. Moragolla is one of the most attractive of the currently-proposed projects because of its favourable location (in a steep-sided valley, with stable geology and reliable rainfall); economic and financial acceptability; and the anticipated relatively limited environmental impacts. The Executing Agency (EA) is the Ministry of Power and Energy (MoPE) and the Implementing Agency (IA) is Ceylon Electricity Board (CEB), the government's primary electricity generation, transmission and distribution agency. GoSL has requested assistance from The Asian Development Bank (ADB) in funding project construction.

3. The concept of a hydropower station at Moragolla was first proposed in 1962[3]; and it was one of 27 potential sites identified in a Master Planning Study in 1987[4] and one of four sites incorporated by CEB into their Long-Term Generation Expansion Plan 2009-2022. Subsequent technical studies comprised a review of costs in 2006[5], a Feasibility Study (FS) in 2009[6], and a study to review the FS and prepare detailed designs and bidding documents in 2012-13[7].

4. The Feasibility Study included an Environmental Impact Assessment (Local EIA), completed in 2012[8], which was approved by the Mahaweli Authority of Sri Lanka (MASL) in August 2013. The FS Review Study included a component to review the Local EIA and upgrade it as necessary to comply with the requirements of the ADB *Safeguard Policy Statement* (2009). This report (Volumes 1,2, 4) presents the results of the upgrading, and Volume 5 is the original Local EIA. This document (Volume 2) is the Environmental Management Plan (EMP).

[1] Government of Sri Lanka (2010): *Mahinda Chintana -Vision for the Future; the Development Policy Framework*. Department of National Planning, Ministry of Finance and Planning http://www.treasury.gov.lk/publications/mahindaChintanaVision-2010full-eng.pdf

[2] Government of Sri Lanka (2012): *The National Climate Change Policy of Sri Lanka*. Ministry of Environment: http://www.climatechange.lk/Documents/Climate_Change_Policy/Climate_Change_Policy_English.pdf

[3] Hunting Survey Corporation (1962): *A report on a survey of the resources of the Mahaweli Ganga Basin, Ceylon.* Prepared in co-operation with the Surveyor General of Ceylon. Government Press, Colombo.

[4] GTZ (1987): *Master Plan for the Electricity Supply of Sri Lanka - Volume A-1*. Deutsche Gesellschaft für Technische Zusammenarbeit, Germany.

[5] JICA (2006): *Master Plan Study on the Development of Power Generation and Transmission System in Sri Lanka.* Japan International Cooperation Agency, Tokyo.

[6] CECB/ Al-Habshi (2009): *Moragolla Hydropower Project: Feasibility Study, Final Report (Vols 1-6)*. Central Engineering Consultancy Bureau (Colombo) and Al Habshi Consultants Office (Kuwait).

[7] Nippon Koei (2013): *Moragolla Hydro Power Project, Review of Feasibility Study and Preparation of Detailed Designs and Bidding Documents; Final Report*. Nippon Koei Co Ltd, Tokyo.

[8] CECB/Al-Habshi (2012): *Moragolla Hydropower Project, Feasibility Study, Final Report: Environmental Impact Assessment*. Central Engineering Consultancy Bureau (Colombo) and Al-Habshi Consultants Office (Kuwait).

B. Approach

5. An initial Gap Analysis (see Volume 1) found that the Local EIA report largely conforms to ADB requirements and adequately assesses most project impacts and mitigation. There were some deficiencies, including the lack of an EMP and Grievance Redress Mechanism (not required by Sri Lankan EIA law), and insufficient information on stakeholder consultation and the project implementing institutions. There was also a need to collect additional baseline data to re-assess impacts and plan additional mitigation in certain key fields, including aquatic and terrestrial ecology, water quality, river users, etc. These and other issues were addressed by 15 additional studies and surveys conducted in March - November 2013 and the final reports are provided in Volume 4.

6. The results of the additional studies, and those from the original Local EIA, were used in preparing an Environmental Addendum (Volume 1). This provides a revised assessment of impacts and mitigation in the natural environment (physical and biological factors), and issues in the human environment that are not related to socio-economics (air quality, noise and vibration, landscape, reservoir and dam safety, etc). Volume 2 (this document) is the Environmental Management Plan, which describes how the mitigation proposed in the Environmental Addendum will be implemented.

C. Aims of the EMP

7. An Environmental Management Plan (EMP) provides the framework through which the adverse impacts of a project are avoided, reduced, mitigated or compensated for (in that order of priority) and positive impacts are assured and enhanced to the extent feasible. An EMP normally contains the following key components:

a) A brief description of the project and the construction and operation processes;
b) A summary of the potential impacts of the project (during each phase) and the mitigation and enhancement proposed in the EIA to address negative impacts;
c) An Environmental Management Plan describing the action to be taken to provide each mitigation and enhancement measure, and the agency responsible for each activity;
d) An Environmental Monitoring Plan describing monitoring to be conducted to ensure all mitigation is provided as specified and that it protects the environment as intended;
e) A description of the organisations and institutions involved in implementing the project and their roles and present capacity, with proposals for strengthening if needed;
f) Estimates of the capital/recurrent costs for implementing the EMP and funding sources.

8. The EMP sets out clearly the likely negative impacts of a project and the associated mitigation and monitoring and specifies who is responsible for taking each action. Responsibility is then made legally binding by specifying the actions in the main project contracts, in particular those of the contractors appointed to to construct the various parts of the scheme. If government agencies take on responsibility for implementing any mitigation (eg tree planting) or monitoring, their environmental obligations are included in official signed agreements. Contractors are required to produce their own EMPs, describing how they will address each issue that is their responsibility. These expand on the information in the project EMP, providing details of proposed approaches, equipment, manpower, etc. Thus the project EMP is the cornerstone of environmental management throughout project implementation, and is the definitive guide to all potential impacts, and the required mitigation and monitoring.

II. STATUTORY REQUIREMENTS

A. Environmental Legislative Framework

9. There are a number of legislative and regulatory instruments in Sri Lanka that address environmental management in both general and specific terms. Those that are of particular relevance to the proposed Moragolla HPP are as follows;

- National Environment Act (NEA) No 47 of 1980 as amended by act No 56 of 1988 and act No 53 of 2000;
- EIA regulations gazetted under NEA (Government Gazette Extraordinary No.772/72 dated 24 June 1993 and in several subsequent amendments);
- Environmental Protection License (EPL) regulations gazetted under NEA (Government Gazette Extraordinary No. 1533/16 dated 25 January 2008);
- Environmental Standards stipulated under NEA:
- Wastewater Discharge Standards- Gazette Notification No. 1534/18 dated 01/02/2008;
- National Environmental (Noise Control) Regulations 1996- Gazette Notification no. 924/12 dated 23.05.1996;
- Interim standards on Air Blast Over Pressure and Ground Vibration (2008);
- The Land Acquisition Act No 9, 1950 and subsequent amendments;
- Sri Lanka Electricity Act, No. 20 of 2009;
- Mines and Minerals Act No. 33 of 1992;
- Mahaweli Authority of Sri Lanka Act No. 23 of 1979;
- Soil Conservation Act No. 25 of 1951 and No. 29 of 1953 and amended by Act No. 24 of 1996;
- Irrigation Ordinance No. 32 of 1946, Act No.1 of 1951 and No. 48 of 1968, Law No. 37 of 1973;
- Fauna and Flora Protection Ordinance as amended by Act No. 49 of 1993 and subsequent amendments;
- The Antiquities Ordinance, No.9 of 1940 (now Act) and the subsequent amendments, particularly the Antiquities (Amendment) Act No. 24 of 1998 is the primary Act;
- National Involuntary Resettlement Policy (NIRP) 2001;
- The Urban Development Authority Act No. 41 of 1978;
- Local Authorities acts: The Municipal Council (MC) Act No. 19 of 1987 & Urban Council (UC) Act No. 18 of 1987;
- The Irrigation Ordinance (Chapter 453)

10. The constitution of the Democratic Socialist Republic of Sri Lanka under chapter VI: Directive Principles of State Policy and Fundamental Duties in section 27-14 and in section 28-f proclaim “The state shall protect, preserve and improve the environment for the benefit of the community”, “The duty and obligation of every person in Sri Lanka is to protect nature and conserve its riches” thus showing the commitment by the state to environmental protection and the obligations of the citizens.

11. The National Environmental Act No. 47 of 1980 (NEA) is the basic national charter for protection and management of the environment. It has been amended twice, in 1988 (No 56) and 2000 (No 53) to make improvements and to respond to the needs of the time.

12. There are two main regulatory provisions in the NEA through which impacts on the environment from the process of development are assessed, mitigated and managed:

a) The Environmental Impact Assessment (EIA) procedure for major development projects (regulations published in Government Gazette Extraordinary No.772/72 of 24 June 1993 and in several subsequent amendments).
b) The Environmental Protection License (EPL) procedure for the control of pollution (regulations published in Government Gazette Extraordinary No. 1533/16 of 25 January 2008).

B. Environmental Impact Assessment

13. The provision relating to EIA is contained in Part IV C of the NEA. The procedure for the approval of projects provides for the submission of two types of reports: an Initial Environmental Examination (IEE) or an Environmental Impact Assessment (EIA) report. These are required in respect of "prescribed projects" included in a Schedule in an Order published in the Gazette Extraordinary No. 772/22 of 1993. Prescribed projects in Power Generation include "construction of hydroelectric power stations exceeding 50 MW" and "installation of overhead transmission lines of length exceeding 10 km and voltage above 50 kV", neither of which apply to the Moragolla scheme. However the regulations also state that "any project or undertaking irrespective of its magnitude, if located partly or wholly within an Environmentally Sensitive Area (ESA), will become a prescribed project requiring approval under the EIA regulations". ESAs include locations that are "60 metres from a bank of a public stream having a width of 25 metres or more at any point of its course"; hence the requirement for EIA for the Moragolla scheme.

14. The EIA process is implemented through designated Project Approving Agencies (PAAs), which are line ministries and agencies that are directly connected with a prescribed project. They are responsible for administration of the EIA process under the NEA. Determination of the appropriate PAA is based on the following unranked criteria:

- The PAA having jurisdiction over the largest area; or
- Having jurisdiction over diverse or unique ecosystems; or
- Within whose jurisdiction the environmental impacts (resource depletion) are likely to be the greatest; or
- The PAA having statutory authority to licence or otherwise approve the prescribed project.

15. A given organization cannot act both as the PAA and the project proponent (PP). In such cases the CEA will designate an appropriate PAA. Similarly when there are more than one potential PAA, the CEA decides between them. As the Moragolla Hydropower Project (MHPP) is located in an area under the jurisdiction of Mahaweli Authority of Sri Lanka the MASL was designated by CEA as the PAA for this project.

16. The requirement for submission of an IEE or EIA report is decided by the PAA. After submission of an EIA report there is mandatory period of 30 days during which the public can inspect the document and submit comments. A public hearing may also be held (at the discretion of the PAA) to provide the opportunity for any member of the public to voice their concerns. In the event of a hearing, the PAA will decide whether to approve the project only after the hearing and resolution of the major issues.

C. Environmental Protection License

17. The Environmental Protection License (EPL) is a regulatory/legal tool under the provisions of the NEA that was introduced to: (i) prevent or minimize the release of discharges and emissions from industrial activities in compliance with national discharge and emission standards; (ii) provide guidance on pollution control for polluting processes; and (iii) encourage the use of pollution abatement technology such as cleaner production, waste minimization etc.

18. Industries are classified as A, B or C according to lists provided in Government Gazette Extraordinary No 1533/16 of 25 January 2008. List A comprises 80 high polluting industries; List B comprises 33 medium polluting industries; and List C includes 25 low polluting industrial activities. EPLs for List A and B are issued by the relevant Provincial/ District offices of the CEA. The proponent is required to pay an inspection fee and the issue of the EPL is decided on the basis of the inspection report. For List C industries the EPL is issued by local authorities (Municipal Councils, Urban Councils or *Pradeshiya Sabha*), who appoint a Technical Evaluation Committee (TEC) to make the final decision on the issue of EPL based on the field assessment report. An EPL for a List A industry is valid for one year while List B and C EPLs are valid for three years. For EPL renewal the PP submits an application three months before expiry.

19. There are several activities associated with construction of the MHPP that come under the provisions of this regulation, and the Contractor is responsible for obtaining the EPL in each case. Prescribed activities include: bulk petroleum liquid or liquefied petroleum gas storage or filling facilities; asphalt processing plants; concrete batching plants; mechanized mining activities; granite crushing (metal crushing) plants; incinerators; wastewater treatment plants; solid waste dumping yards; and toxic or hazardous waste treatment or disposal facilities. A more comprehensive description of EIA/IEE and EPL process and procedure is provided in Volume 4 Report 7.

D. Responsible Agencies

20. The Central Environmental Authority (CEA) is the Government's main environmental regulator and has a mandate to implement the provisions of the NEA and to protect and safeguard the country's environment. It operates 9 Provincial Offices and 9 District Offices.

21. There are several other national agencies with responsibilities for environmental management and protection that are relevant to the activities of MHPP. These include: Forest Dept; Dept of Wildlife Conservation; Dept of Archeology; Disaster Management Centre; and Geological Survey and Mines Bureau. These all have regional offices and staff to monitor the environmental safeguards in their fields of operation. The project will also impinge upon the responsibilities of certain other agencies, including: Urban Development Authority (UDA); Water Supply and Drainage Board (NWS&DB); Road Development Authority (RDA); Dept of Agriculture; Dept of Agrarian Services; and Irrigation Dept (ID).

22. The Local Authorities (LA) have other relevant responsibilities in addition to the issuing of EPLs. The Municipal Councils and Urban Councils were established under Acts in 1987 to provide greater opportunities for people to participate effectively in decision-making for administrative and development activities at a local level. These bodies have responsibilities in relation to public health, drainage, latrines, unhealthy buildings, conservancy and scavenging, nuisance etc.

E. Environmental Permits and Approvals

23. The key environmental permits and approvals in relation to the MHPP construction process are shown in Table 1.

Table 1: Environmental permits and approvals required by the Moragolla project

Permit/Clearance/ Approval Required	Approval Authority	Description/Salient Features	Required for the Project?	Remarks
Environmental Approval is required under Part IVC of the National Environment Act No 47 1980 and its amendments after carrying out an EIA or IEE (as determined by the Project Approving Authority PAA)	CEA or other appropriate PAA (Mahaweli Authority of Sri Lanka MASL was appointed by CEA as the PAA for MHPP)	The requirement for environmental assessment is established by the NEA and the procedures are defined in the EIA Regulations (1993). The regulations specify activities for which environmental assessment is mandatory	Yes: MHPP falls within the Projects and Undertakings for which approval under the EIA regulations are required	A Local EIA for the project was conducted in 2009-12 and approved by MASL in August 2013 subject to19 general and 50 specific conditions
Environmental Approval under Section 23EE of NEA for alteration of an approved prescribed project	PAA (MASL) with concurrence of CEA	If any alterations are made to a prescribed project for which approval has been granted, under part IVC of NEA, the PP shall inform the PAA of such alterations and where necessary obtain fresh approval	Possibly: decided by the PAA	CEB should inform MASL of the alternations made to the MHPP during the design stage and any subsequent changes
Environmental Protection License (EPL) from CEA or LA under the NEA No 471980 and its amendments; Gazette Notification No 1533/16, 25 January 2008	CEA or LA	Applicable for industries/ activities with potential to discharge effluents, deposit wastes, emit smoke/gases/ fumes/vapor or excessive noise/vibration. Prescribes the industries/activities required to obtain an EPL	Yes: Applicable to certain activities of MHPP - fuel storage, asphalt plant, quarry, concrete plant, crusher plant, spoil disposal, waste water treatment plant	Construction Contractor shall obtain EPL from CEA or LA as appropriate
Clearance under the Fauna and Flora Protection Ordinance Act No. 49 of 1993 and its amendments	Department of Wildlife Conservation (DWLC)	Five categories of protected areas: (i) strict nature reserves; (ii) national parks; (iii) nature reserves; (iv) jungle corridors; and (v) intermediate zones including sanctuaries. EIA/ IEE is required for any development activity within one mile from the boundary of any national reserve. Written approval shall be obtained from the Director General (DG), DWLC	Yes: The project is not located near any national reserve. However, some of the mitigation measures proposed (such as catch-and-haul operation for fish) require approval from the DG of DWLC	CEB shall obtain approval from DG of DWLC for any proposed mitigation or other activities that could affect endangered or other protected species
Permit under the Mines and Mineral Act No. 33 of 1992	Geological Survey and Mines Bureau (GS&MB)	Mining and exploitation for minerals, including sand and aggregate must be licensed by GS&MB. A permit is required for quarrying of construction materials, either directly or through contractors. If contractors procure such	Yes: Construction contractors are required to obtain a permit from the GS&MB and/or to procure materials from licensed sources/traders	

Permit/Clearance/ Approval Required	Approval Authority	Description/Salient Features	Required for the Project?	Remarks
		material on the open market they have to ensure that sources/traders have valid licenses		
Approval under Gazette No 1152/14 of 4 October 2000, to be read with Section 43(b) of the Antiquities (Amendment) Act No. 24 of 1998. These are called procedural orders No. 01 Projects of 2000	Permit from the Department of Archaeology	Written permission from the Department of Archaeology must be obtained before commencing excavations for: generation and transmission of electricity; resettlement of families; reclamation of lands and wetlands; clearing of all lands exceeding 2 hectares in extent so that such lands and wetlands will be inundated with water etc.	Yes: Archaeology Dept approval was granted with three conditions: i) Services of an officer of the Dept for Supervision shall be obtained during construction; ii) Director General of Dept of Archaeology shall be immediately informed of chance finds of archaeological property; iii) An authorized officer of Dept of Archaeology shall be allowed to inspect the site(s) at any time.	The Construction Contractor shall inform the Supervision Consultant and the Director General of Dept of Archaeology of any chance find of archaeological material
Approval for Felling of Jack, Bread Fruit and female *Palmyra* trees under the Felling of Trees Control Act No 1 of 2000	Felling 1-3 trees: Divisional Secretary; Felling 3-15 trees: District Secretary; Felling >15 trees: Secretary of the Ministry of Agriculture	Permits should be obtained for felling of Jack, Bread Fruit and female *Palmyra* trees because the yield (nuts) of those trees are used as daily food for human beings	Yes	The Construction Contractor shall obtain approval from the relevant authority
Relocation of Weliganga section of Atabage road which will be inundated by the reservoir	Road Development Authority (RDA)		Written approval from RDA is required for alteration of any National or Provincial road	Approval has already been obtained by CEB
Rehabilitation of Dunhinda Ela Irrigation Canal	Irrigation Department (ID)	ID has controlling powers over medium and major irrigation schemes	Yes: CEB propose to improve the intake of Dunhinda Irrigation Canal to ensure it will continue to receive river water when the MHPP is operating	Approval has already been obtained by CEB
Construction of houses and other infrastructure facilities; widening, rehabilitation or construction of minor roads for construction sites	Local Authority	Permission from the LA is required for any physical construction activity within the LA area	Yes:	CEB should submit the application along with drawings of the facilities etc to be constructed

III. DESCRIPTION OF THE PROJECT

A. Project Location and Design

24. The MHPP will be located in the upper reaches of the Mahaweli Ganga in the Central Highlands of Sri Lanka, approximately 22 km south of Kandy City and 130 km north-east of Colombo (Fig 1). The dam site is at 7° 06' north latitude and 80° 34' east longitude, in a hill area with an altitude of 470 to 650 m above sea level (asl). The Mahaweli Ganga is the largest river system in Sri Lanka, with 24 major tributaries; it drains into the Bay of Bengal at Trincomalee on the east coast. There are 9 other hydropower and mini-hydro dams in the Mahaweli catchment, two upstream of Moragolla, of which Kotmale Dam, 6 km away on Kotmale Oya is the closest. Commissioned in 1985, the Kotmale powerhouse and tunnel are beneath the hillside opposite the Moragolla site, and the tailrace discharges to the Mahaweli opposite the proposed Moragolla tailrace (Figs 1 and 2).The Moragolla catchment is 809 km^2, including the Kotmale Oya basin.

25. The Moragolla project involves construction of a 37 m high concrete gravity dam, with a 5-gate spillway, to create a 38.5 ha, 1.98 MCM reservoir with a Full Supply Level (FSL) at 548 masl. Water will be diverted through a 2.7 km, 4.7 m diameter underground tunnel, surge shaft and penstock on the left bank of the river, to an above-ground powerhouse and tailrace opposite the confluence with Atabage Oya (Fig 2). Moragolla is a run-of-river scheme, with an installed capacity of 30.2 MW (2 x 15.1 MW); and it will operate as a "peaking" station, generating power mainly during the daily peak demand period. The dam includes a discharge pipe to provide a constant downstream "Environmental Flow" of 1.5 m^3/s. The location of the main project components is shown in Fig 2 and each element is described briefly below.

26. **Concrete Gravity Dam:** Height 37 m; length 236 m at the crest level of 550 masl; constructed of mass concrete, with an inspection gallery near the base on the upstream side. The dam location was moved 100 m downstream during the FS Review Study to a site where solid rock is exposed on the right bank, reducing the excavation and associated intrusion into the Ulapane Industrial Estate (Fig 2).

27. **Intake:** just upstream of the dam on the left bank (Fig 3), with an entrance sill at 535 masl, 1 m above the spillway crest. A small flushway is provided to remove sediment periodically if it accumulates in front of the intake (predicted to take 50 years to reach this level).

28. **Micro-hydro plant**: immediately downstream of the dam on the right bank alongside the spillway, generating 360 kW from the E-flow. Will comprise a 15 x 10 m building housing a horizontal shaft turbine and generator, with a bypass pipe to release E-flow during maintenance.

29. **Concrete Spillway:** With 5 radial gates, 13 m wide and 15 m high on the overflow crest at 534 masl. Designed with capacity to pass: a) 10,000 year flood (6,700 m^3/s) at FSL 548 masl, with all gates fully open; b) 10,000 year flood at 550 masl, with one gate non-operational and closed; and c) 1,000 year flood (4,100 m^3/s) at FSL with one gate closed. One spillway will have a flap gate, to release surplus water and floating debris from the reservoir.

30. **Headrace Tunnel:** 4.7 m internal diameter, 2,727 m long from intake to surge tank; concrete lining with steel-bar reinforcing. Excavated beneath the hillside on the left bank (Fig 2); located where ground elevation is above 600 m to ensure sufficient rock to maintain ground stability and avoid significant groundwater incursion from above.

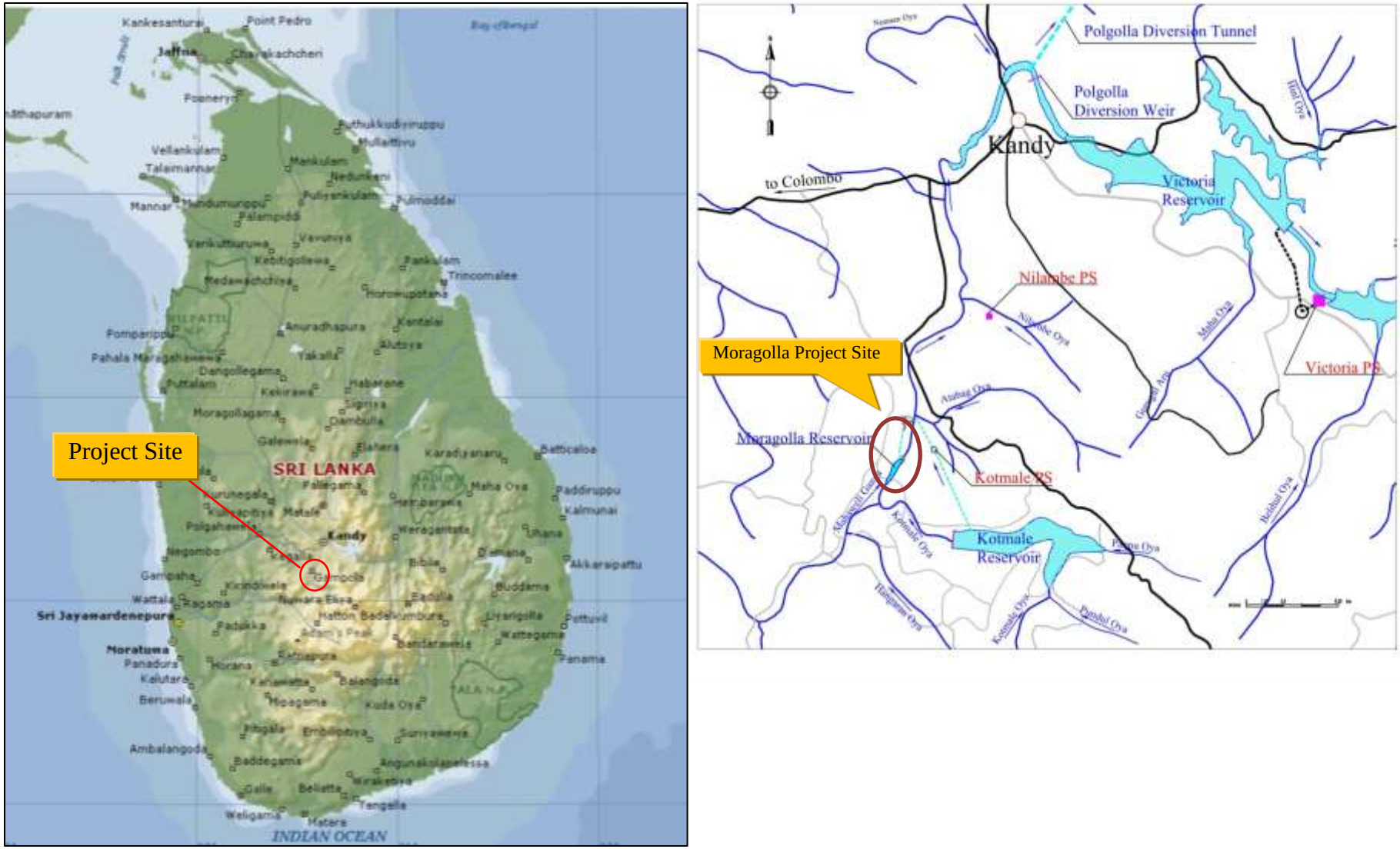

Figure 1: Location of the proposed Moragolla Hydropower Project, and other existing dams and HP stations in the vicinity

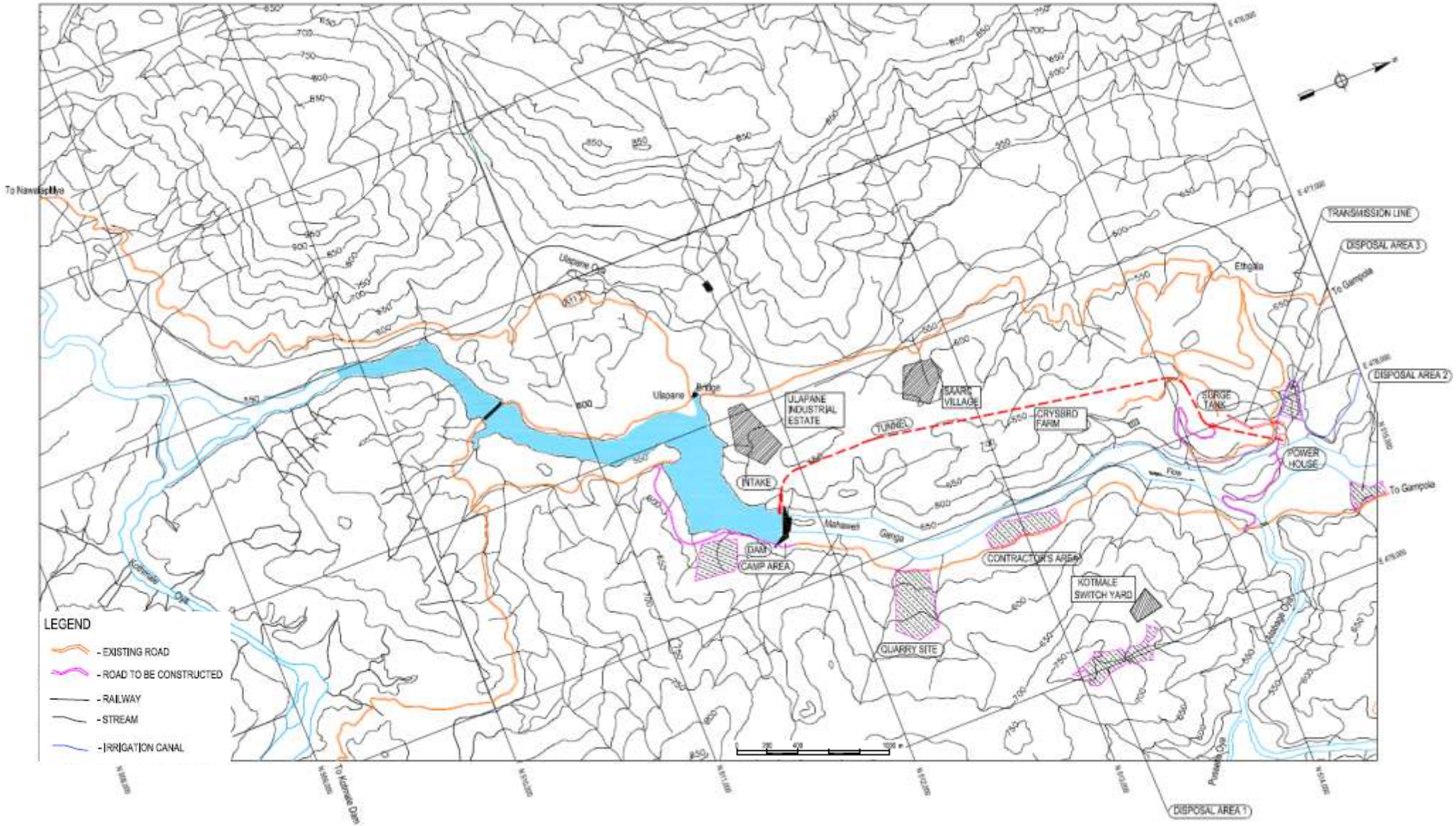

Figure 2: Location of the project components and other construction and disposal areas

31. **Surge Tank:** Concrete; restricted orifice type with 12.5 m inner diameter to absorb excess pressure caused by power flow fluctuations and in case of turbine trips.

32. **Penstock:** Changed from a surface structure to underground during the design stage to reduce excavation and slope protection. Now in a 318 m 3.8 m diameter tunnel.

33. **Power House:** Above-ground, 44 x 24 m and 39 m high, with a floor at 486.5 masl and turbine centre at 469.4 masl. With 3,000 m^2 switchyard, with a platform at 486.5 masl, formed by cutting and filling.

34. **Tailrace Outfall:** Concrete open channel, 28 m long, opposite Atabage Oya confluence.

35. **Access Roads:** Around 3 km of road will be built: a) for access to the power house and surge tank from Atabage-Mawathura Road on right bank; b) to replace 0.5 km of the same road inundated by the reservoir; and c) in the accommodation camp and resettlement area. There will also be a causeway across the river and upgrading the road from Ethgala to the power house.

36. **Reservoir:** FSL 548 masl, Minimum Operating Level (MOL) 542 masl; capacity 4.66 MCM at FSL, surface area 38.47 ha, extending around 3 km upstream from the dam. The steep valley means that the reservoir is quite narrow, about double the present wet season river area.

37. **Transmission Line**: 500 m long, with two transmission towers; to connect Moragolla switchyard to the nearest existing TL (running NW from Kotmale switchyard to Polpitiya HPP).

B. The Construction Process

38. Construction of the MHPP will take 4.5 years (mid-2015 to end-2019), preceded by a 1.5 year pre-construction period of financial arrangements and tendering (Fig 3). Figure 4 shows the location and footprint (to scale) of all sites that will be involved in construction, and Table 2 shows the size of the areas and the main work activities at each. This shows that there are three main construction areas (dam/intake; surge tank/penstock; and powerhouse/tailrace); plus 13 other “ancillary sites”, where activities associated with and arising from the main construction will be conducted (quarrying; spoil disposal; access roads; resettlement site; etc).

39. Table 2 shows the main construction works that will occur at each site, which indicates that there are eleven basic activities. Some of these commonly occur at most construction sites (eg land clearance, excavation, creation of structures), although they vary considerably in scale and complexity. Others are quite specialised and tend to be associated mainly with larger projects (eg tunnelling and blasting). The likely approach to the main activities is outlined below.

40. **Site clearance:** Site clearance normally involves cutting or uprooting trees, shrubs and other vegetation, demolition of buildings, and disposal of debris. Trees are cut by hand using chain saws, or may be pushed over and uprooted by bulldozer; and shrubs and other ground vegetation are scraped by the blade of a bulldozer, or chopped at ground level by hand. The debris is loaded onto dump trucks and taken for disposal; and trees may also be prepared for sale or donation to the community by removal of branches and cutting into smaller lengths.

41. **Earthworks:** Earthwork involves the moving or removal of topsoil, subsoil and/or unconsolidated rock. It is often done to achieve levels or slopes specified in the design, and it can involve excavating to a lower level or filling with material to raise the surface. In this project, earthworks are required at most construction sites, most notably at the dam/intake and

Package No.	Activities	Unit	Quantity
Preconstruction Activities			
Financial Arrangement and Selection of Consultant		lot	1
PQ, Tender, Evaluation and Contracts Award, Lot 1		lot	1
PQ, Tender, Evaluation and Contracts Award, Lot 2, 3. 4, 5		lot	1
Lot 1	Preparatory Works (ICB)		
Construction power supply (33 kV line), repair & relocation of irrigation canal and implementation of catchment management plan, fundation of existing bridge improvement		-	LS
Construction of camp for Employer and Engineer and resettlement area		-	LS
Construction of access roads		-	LS
Lot 2	Civil Works (ICB)		
	Mobilization	-	LS
	Temporary facilities & construction roads	-	LS
River Diversion	River diversion works	-	LS
Dam and Spillway	Excavation, common & rock, dam	m3	237,000
	Foundation treatment	lot	1
	Mass & structural concrete, dam & spillway	m3	108,800
Intake	Excavation, common & rock, Intake	m3	13,500
	Concrete	m3	2,500
H. tunnel	Adit No.1, 2 & 3	m	450
	Excavation, tunnel	m3	77,000
	Concrete, invert & tunnel lining	m3	21,000
	Grouting (backfill & consolidation)	lot	1
	Plug concrete	lot	1
	Water fillling	lot	1
Surge tank	Excavation, commmon	m3	26,000
	Shaft excavation	m3	9,500
	Concrete	m3	2,800
	Grouting (consolidation)	Lot	1
Penstock	Excavation, tunnel	m3	8,300
	Concrete	m3	3,500
P.house	Exca. common & rock , P. house, S. yard & tailrace	m3	47,000
	Concrete	m3	10,400
	Roofing & other architectutral & finishing	lot	1
Switchyard	Excavation, Fill and concete	lot	1
Tailrace	Excavation and concete	lot	1
Lot 3	Hydro-Mechanical Works (ICB)		
Hydr-mechanical	Design, manufacturing & transportation	lot	1
	Install, spillway gates, stoplogs and gantry crane	lot	1
	Install. power intake gates and trashrack	lot	1
	Surge tank gate	lot	1
	Steel liner installation & concreting	lot	1
	Draft tube gates	lot	1
	Test and commissioning	-	LS
Lot 4	Electro-Mechanical Works (ICB)		
Electro-mechanical	Design, manufacturing & transportation	lot	1
	Installation of overhead travelling crane	lot	1
	Installation of draft tube	lot	1
	Unit 1 insatallation of E&M equipment	lot	1
	Unit 2 insatallation of E&M equipment	lot	1
	Switchgear installation	lot	1
	Test and commissioning	-	LS
	Transmission line	-	LS

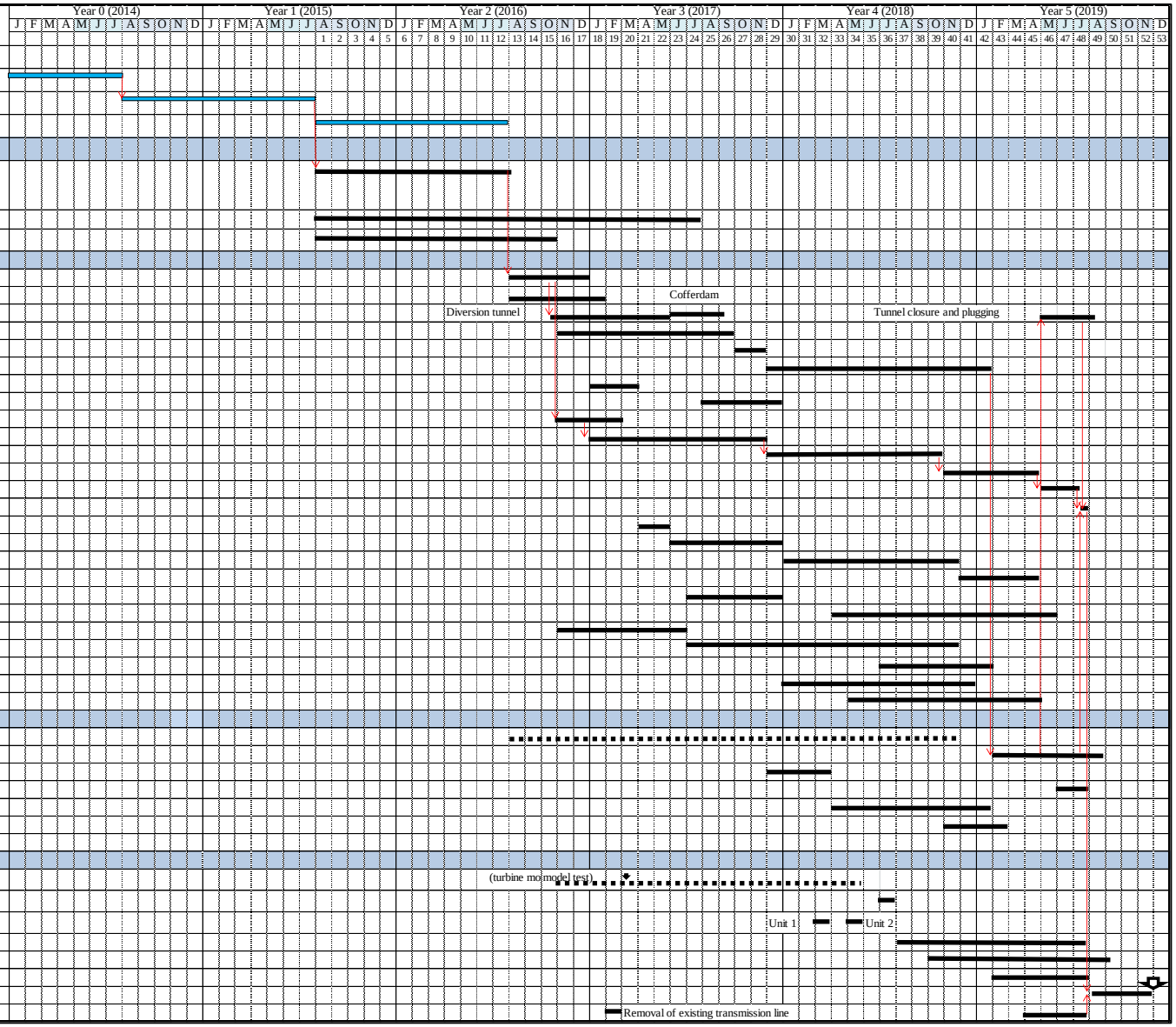

Figure 3: Proposed construction programme

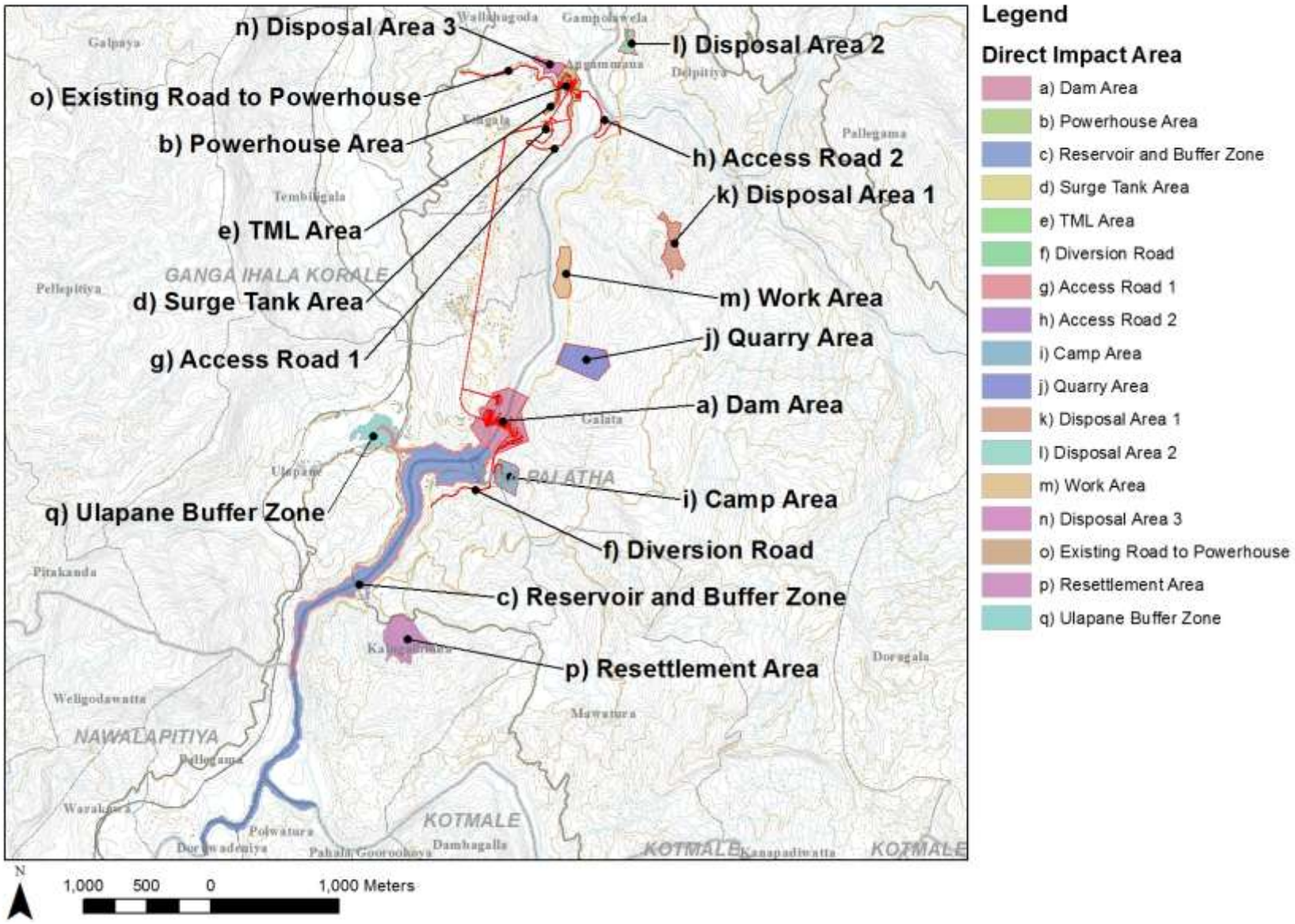

Figure 4: Locations of construction sites and related activities

Table 2: The categories of construction sites and the main activities involved at each

Location (letters are those used in Fig 4)	Area (ha)	Site clearance	Earth works	Blasting	Excavation - General	Excavation - Tunnelling	Crusher; Concrete Plant	Spoil Disposal	Soil covering; planting	Concrete Structures	House Building	Road Construction
a) Dam and Intake	15.27	✓	✓	✓	✓	✓				✓		
d) Surge Tank and Penstock	0.49	✓		✓		✓				✓		
b) Powerhouse and Tailrace	3.45	✓	✓	✓	✓	✓				✓		
m) Contractors' Work Area	4.00	✓	✓				✓					
k) Disposal Area 1	4.58	✓	✓					✓	✓			
l) Disposal Area 2	1.51	✓	✓					✓	✓			
n) Disposal Area 3	1.89	✓	✓					✓	✓			
j) Quarry	7.81	✓	✓	✓	✓							
i) Personnel Camp	3.85	✓	✓		✓						✓	✓
p) Resettlement Site	9.16	✓	✓		✓						✓	✓
f) Diversion Road	0.70	✓	✓									✓
g) Access Road 1	0.65	✓	✓									✓
h) Access Road 2	0.45	✓	✓									✓
o) Road to Powerhouse	0.50											✓
e) Transmission Line	0.92	✓			✓					✓		
c) Reservoir and Buffer	51.75	✓							✓			
q) Ulapane Buffer Area	5.96											

powerhouse/tailrace, but also at sites where excess excavated material will be deposited. Most of this work will be done by bulldozers and backhoes, in conjunction with dump trucks to move the material.

42. **Blasting:** Blasting will be used: to excavate rock from the hillsides and valley floor at the dam site; to penetrate bedrock along the route of the headrace tunnel; and at the quarry. In most cases, blast holes are drilled into the rock by pneumatic hammer drill, after which the explosive charge is installed, connected to detonators and fired. Charges can be used singly or in multiple arrays, often along a fault line. After blasting the collapsed rubble and other debris is loaded into dump trucks and taken for disposal or crushing (see below).

43. **General excavation:** This is small-scale earth removal and moving, to create trenches for utility pipelines/drains, footings/foundations for buildings, etc. It is normally done by single backhoe excavators, again working with dump trucks to transport the material. In this project small-scale excavation will be done at most sites, in particular where buildings or other structures are constructed, and to create concrete foundations for the two transmission towers.

44. **Tunnelling:** The 2.7 km headrace tunnel and the surge chamber and penstock will be created by tunnel excavation, assisted by rock blasting. Three side tunnels or adits will be dug as entry-chambers, one about 200 m downstream of the dam, one at the surge tank and one at the penstock (Fig 4). The adits and the main tunnel will be excavated mainly by drilling and blasting, and the excavated material will again be removed by dump trucks. Metal rock-supports will be installed to strengthen the roof where necessary and the tunnel will be created from reinforced concrete (RC), with a circular cross section.

45. **Crusher and Concrete Plant:** A mechanical crusher will be used to break rocks into smaller sizes for use in construction (stone protection, base fill, aggregate, etc). Rock is tipped into a hopper and after crushing the particles are separated by mesh screens and carried to stockpiles by band conveyors. A concrete plant will be used to produce the large quantities needed for the dam and other structures. This will comprise metal bins for sand, aggregate, potash, cement, etc, a large mixing chamber, plus piped water and various electronic controls. Both plants will be in the contractors' work area, alongside the river on the right bank (Fig 4).

46. **Spoil disposal:** Around 300,000 m^3 of unusable soil, rock and other excavated material will be produced during the construction process, 80% from the dam site and 20% from the powerhouse, including 50,000 m^3 from tunnelling. This will be transported by dump truck to the three disposal sites (Fig 4), chosen because of: stable geology; suitable profile to accept the disposal volumes; proximity to the spoil sources; unlikely to flood; owned by the government; and not located close to major inhabitation. Deposited material will be repositioned by bulldozer.

47. **Soil covering and planting:** When disposal areas are full they will be covered with topsoil (retained from excavation), and planted with native trees, shrubs, grasses, etc to restore a natural appearance and stabilise the ground, preventing rain erosion. A 100 m buffer zone will also be planted around the reservoir perimeter above FSL to compensate for trees felled at construction sites and the reservoir. There will also be smaller-scale planting and landscaping at the resettlement area, personnel camp, etc. Planting schemes will be devised and implemented by specialists employed by CEB, who will maintain all vegetation until it is established.

48. **Concrete structures:** A variety of concrete structures will be built (dam, tunnel, surge tank, penstock, powerhouse, tailrace outfall) mostly from reinforced concrete (RC). Steel reinforcing rods and bars are attached by hand to create an interior skeleton for walls, columns, etc, and metal and timber/plywood formwork is bolted around the outside to create a mould into which pre-mixed concrete is poured. Once the concrete has set, the formwork is removed; and the process is repeated to gradually create the structure. Other components (spillway gates and operating apparatus, turbines, generators, electrical switchgear, etc) will be brought in ready-made or as individual elements for assembly on site (eg transmission towers). These will be delivered on trucks, offloaded and positioned by crane, and connected up in situ.

49. **Dam:** A 300 m diversion tunnel will be dug through the left bank at the dam site, by drilling and blasting as described above. Two cofferdams will be created in the riverbed from cemented sand and gravel, to divert the river through the tunnel to allow dam construction in the dry, and two further cofferdams will be built on the downstream side. The dam will be built from mass concrete, whereby concrete is poured into portions of the dam structure delimited by formwork, but without the use of metal reinforcing. Grouting is then applied to maintain watertight conditions.

50. **House building:** Around 50 houses will be built: a) in the area where CEB will re-house the 17 families whose present accommodation is in the reservoir inundation area; and b) at the accommodation camp for site staff near the dam (Fig 4). Footings and trenches for utility pipes and other services will be excavated by backhoe; and concrete and stone will be poured in to create foundations. Bricks, mortar and plaster are applied by hand to create the walls; wooden joists and roofing materials are added; plus all fixtures and fittings (plumbing, electricity, etc).

51. **Road construction:** Land clearance and earthworks will be done in the Right of Way (RoW) as above, and embankments built if necessary. Once the ground profile is achieved, pavement material (gravel/aggregate) is added in layers, each compacted by heavy roller. Finally a layer of asphalt (bitumen) mixed with aggregate is poured on to form the top surface.

52. **Vehicles, machinery and workforce:** Current estimates suggest that construction could involve up to 10 bulldozers, 12 backhoe excavators, 10 power shovels, 50 dump trucks, 5 concrete pumps, 10 mixer trucks, 5 truck cranes, 2 crawler cranes and 1 tower crane. In general, earth-moving plant will be involved in the early stages and concreting equipment in the middle and later stages. The workforce is estimated at around 650 persons: 150 skilled and 300 unskilled workers, 100 operators/drivers, and 100 foremen/supervisors.

C. Operation of the Completed Scheme

53. CEB will take over responsibility for operating the completed Moragolla HPP once the various commissioning checks have been satisfactorily completed at the end of the construction period. Operation will be done by a relatively small workforce, because of the high degree of monitoring and control offered by modern automated systems. Control rooms are run by a small number of trained technicians, supervised by one or two senior managers, led by a head of operations or site manager, who will be a highly experienced CEB senior expert. There will also be a small maintenance team, to conduct routine maintenance of the various scheme components, and any repairs that may be necessary.

54. Like the nearby Kotmale HPP, the Moragolla scheme will be run as a peaking station, so power will be generated during the peak demand period of 5 - 9 pm each day, and at other times depending on water availability. Figure 5 shows the expected average daily operation throughout the year. This shows that in the monsoon (June to November) there should be sufficient water to allow power generation for 15 - 18 hours per day. However in the dry season (January to April) power will only be generated for 4 - 7 hours a day, and in February and March, during the 4-hour peak demand period only.

55. Whenever power is generated, water will pass through the headrace tunnel and powerhouse and be returned to the river through the tailrace outfall 2.7 km downstream. The guaranteed E-flow of 1.5 m^3/s will be discharged from the dam at all times, and water will also overflow the spillway crest when there is an excess (mainly during the monsoon). Figure 6 shows the calculated monthly release of water from the dam, which shows that in the dry season, discharge will mainly be limited to the E-flow, and in the wet season, dam flow will average at between 4 and 9 m^3/s. Because of the run-of-river design, reservoir water level will not fluctuate greatly, between about 1-2 m per day, and monthly average levels will remain between 547.15 and 547.55 masl throughout the year.

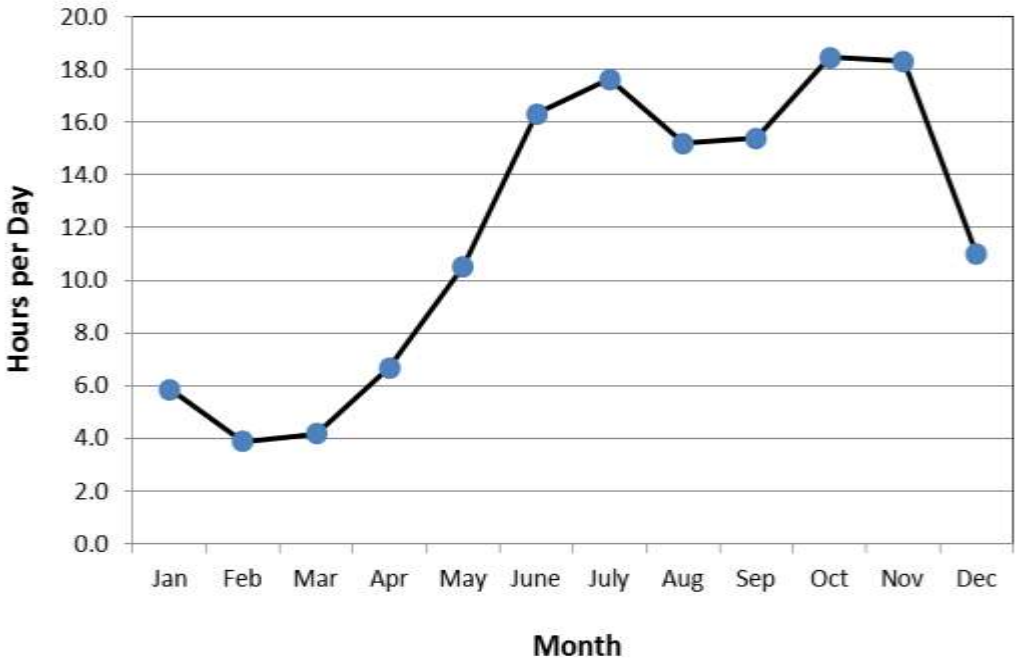

Figure 5: Estimated average operating hours per day for the Moragolla HPP

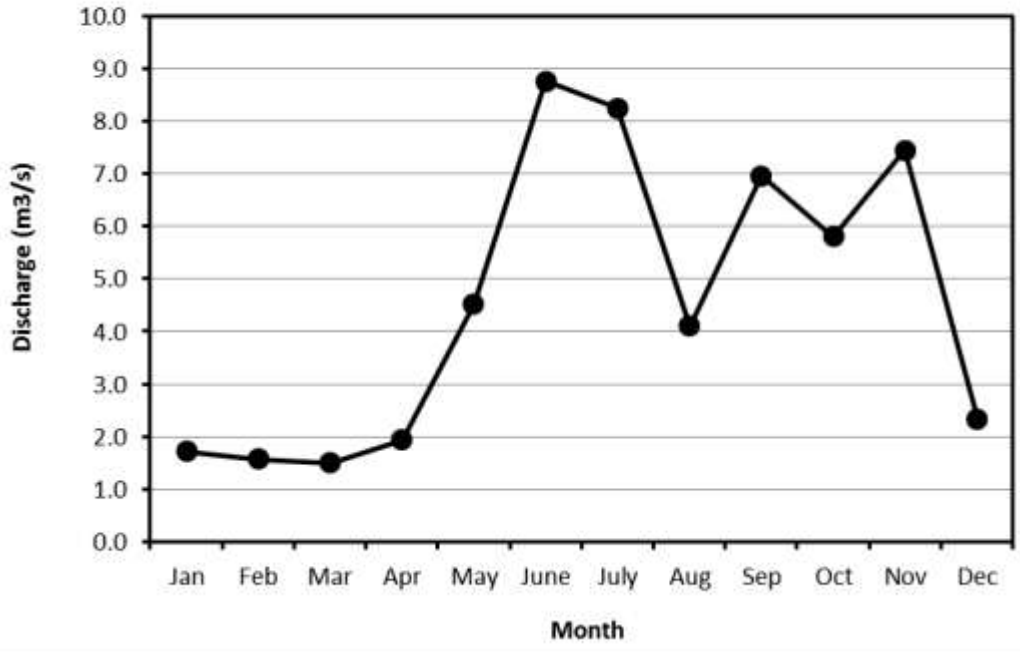

Figure 6: Predicted monthly water release from Moragolla dam (including E-flow)

IV. ENVIRONMENTAL IMPACTS AND PROPOSED MITIGATION

57. Tables 3 and 4 summarise the potential environmental impacts of the project during pre-construction and construction stages and when the completed project is operating, and the mitigation proposed to address each impact. This is taken from the discussion of impacts and mitigation presented in Chapter VI of the Environmental Addendum (Volume 1) and includes all impacts and mitigation proposed in the Addendum and by the previous Local EIA study (Volume 5). Tables 3 and 4 also show the location of each impact, its potential significance and duration (again from the discussion in Volume 1) and identify the agency that will be responsible for implementing each mitigation measure.

A. Pre-construction and Construction Phases

58. From the description in Section III above, it is clear that this is a major project, which will affect multiple locations and a large overall area (>100 ha) over a long construction period, of at least 4½ years. The basic physical statistics of the construction process give an accurate immediate impression of the scale of the work and the main potential sources of impact. Construction will involve:

- Clearance of vegetation from 54.73 ha of land and partial clearance from a further 51.75 ha (removal of trees and shrubs from the reservoir);
- Further earthworks at the majority of locations, some involving deep excavation, tunnelling, drilling and blasting, continuing for a year or more at the major sites;
- Excavation of 400,000 m^3 of bulk soil and rock; and transporting 300,000 m^3 of waste spoil to disposal sites up to 4 km away (Figs 2 and 4);
- Quarrying 100,000 m^3 of stone and transporting it 1 km to the crusher or dam site;
- Reducing 45,000 m^3 of stone to aggregate in a mechanical crusher and storing the material for use on site or in concrete production;
- Bringing to site around 100,000 m^3 of sand and other constituents of concrete;
- Mixing 150,000 m^3 of concrete and transporting for use mainly at the dam/powerhouse;
- Around 55,000 journeys by dump trucks and concrete mixers, of an average of 2 km;
- 100, mostly large, specialised construction vehicles, plus 20-30 smaller utility vehicles, operating on site for most of the four-year main construction period.

59. Clearly land clearance, earthworks and the transportation of materials will be the major sources of impact in the pre-construction and construction periods, and this is reflected in Table 3. This shows that the main risks are as follows:

- Exposed soil could wash into the river during rain, increasing turbidity and affecting aquatic plants and animals, and people who use the river for washing and bathing;
- Silt may also wash from loose material carried to construction sites or stored on site, or from waste spoil transported for disposal;
- Uncovered soil and unpaved site roads could then be a source of dust in dry weather, which could affect workers and local residents and reduce the productivity of crops;
- Water quality could be further reduced by spills of fuel, oil and other toxic material stored and used on site, and by sewage pollution if adequate sanitary facilities are not provided
- Air quality will be reduced locally by exhaust emissions from construction vehicles and machinery, and this will contribute to global emissions of greenhouse gases;

Table 3: Potential impacts of the project in pre-construction and construction stages and proposed mitigation (key at end)

Sector	Potential Impacts	Loc	Sig	Dur	Proposed Mitigation	Rsp
1. Hydrology and Environmental Flow	Diverting the river via cofferdams to build the causeway and tailrace outfall could cause localised flooding outside the main river channel	D T	S	T	Construct the causeway and tailrace outfall in the dry season, when river flow will be near the seasonal minimum	CC
	The project would not maintain the guaranteed E-flow if there is no downstream flow during reservoir first filling, estimated to take 19hrs	D	HS	T	Partially close the diversion conduit gate during first filling to allow 1.5 m^3/s downstream; or find another way to maintain E-flow at this time	CEB
					Monitor downstream flow at this time to ensure it is at least 1.5 m^3/s	CEB
2. Water Quality	Exposed soil may wash into the river during rain, increasing turbidity; this could impede animal respiration and plant photosynthesis and make the water less suitable for human uses, eg washing & bathing	AS	S	T	Plan topography and drainage so all rainwater runs into adequately-sized ponds and sediment is allowed to settle before release to river	CC
					Re-design topography & drainage whenever site topography changes	CC
					Build duplicate settlement ponds to allow regular disposal of sediment	CC
					Monitor silt in discharge water to ensure levels are below set values	CC
	Erosion risks are increased at the main construction sites where there is deep excavation and steep slopes, which may remain uncovered	MC	S	T	Design slope gradients to assure stability and incorporate erosion protection in final slopes (stone facing, gabions, grass) when possible	DC
					Apply covering materials or vegetation to slopes as soon as possible	CC
					Incorporate drainage culverts into slope designs when needed	DC
					Regularly monitor cut slopes to detect erosion; remediate promptly	CC
	Silt may wash from loose material transported to site or for disposal	TR	S	T	Cover all loose material with tarpaulins if transported in rainy season	CC
					If wet material is transported, allow to dry & de-liquefy before loading	CC
	Silt may wash from stored/stockpiled loose material during rainfall	MS	S	T	Cover stockpiled loose material with tarpaulins or in a building	CC
					Ensure drainage from stockpile areas is collected/de-silted as above	CC
	Spoil disposal sites are at particular risk of erosion by rainfall as dumped material is uncovered until the site is closed and vegetated	SD	S	T	Plan the disposal operation to reduce erosion risk, specifying slope gradients, compaction method/frequency, site drainage measures, etc	DC
					Incorporate check-bunds, etc into designs to promote slope stability	DC
					Specify final land profiles and vegetation cover to maintain stability	DC
					Ensure drainage from disposal areas is collected/de-silted as above	CC
					Regularly monitor spoil disposal to ensure all safeguards are followed	SC
	Potential toxins may enter the river from accidental spills of fuel and oil stored on site, and during refuelling	AS	S	T	Store fuel, oil and other polluting liquids in secure, managed areas with concrete floors and bunds; allow refuelling only in these areas	CC
					Ensure drainage from liquid storage areas is passed into oil separator	CC

Sector	Potential Impacts	Loc	Sig	Dur	Proposed Mitigation	Rsp
	Toxins may enter the river from vehicle maintenance workshops if the usage and disposal of oil and other materials is not controlled	AS	S	T	Maintain vehicles and equipment in designated workshops with floors of concrete and surface drains fitted with oil separators	CC
					Collect waste oil in secure containers; deposit safely at a licensed site	CC
	Accommodation camps could be a source of sewage pollution if they are not provided with adequate sanitary facilities	AC	S	T	Provide adequate toilets and bathrooms at all accommodation sites	CC
					Ensure toilets/bathrooms are cleaned daily and materials replenished	CC
					Ensure sewage is treated to national standards on or off site	CC
	Work sites could also be a source of sewage pollution if there is not adequate provision of sanitary facilities	AS	S	T	Provide adequate toilets/washrooms for the number of people on site	CC
					Ensure toilets/bathrooms are cleaned daily and materials replenished	CC
					Ensure sewage is treated to national standards on or off site	CC
3. Ground water	Groundwater may be polluted by spills of fuel/oils; may affect health	AS	S	T	Implement measures proposed above to prevent fuel/oil spillage	CC
	Domestic water in wells could be reduced if water drains into the headrace tunnel area	TU	NS	T	Plan/execute blasting carefully to avoid fissuring rock outside tunnel	CC
					The groundwater study concluded this was not a major risk. Monitor water levels in wells near tunnel; provide water via tanker if needed	CEB
4. Geology, Topography	Areas around reservoirs can be subject to land slips and slides from water destabilising lower slopes and wave action at water surface	R	NS	P	Geological/topographic study concluded that landslides were unlikely	DC
					Monitor reservoir slopes during impoundment to detect small land slips that could trigger larger landslides	CEB
5. Air Quality	In dry conditions dust can be blown from exposed soil and site roads; this could reduce productivity of crops & vegetation, cause respiratory problems for workers and the public, and increase turbidity in the river	AS	S	T	Implement the above measures to limit soil erosion by rain as many will also reduce dust when dry (protect & vegetate cut surfaces; cover stored and transported loose material; design disposal operation; etc)	DC CC
					Plan land clearance to remove vegetation in stages, when necessary	CC
					Plan site planting to revegetate completed sites as soon as feasible	DC
					Spray site roads & large areas of bare soil thrice daily in dry weather	CC
					Periodically lightly spray soil at quarry & disposal sites if feasible	CC
					Provide workers with dust masks and training in their usage	CC
					Provide wheel washes at all site exits; ensure usage by all vehicles	CC
					Monitor dust through construction at Ulapane Estate; and at houses on Gampola Road, and near dam, powerhouse, quarry, disposal sites	CC
	Vehicle exhausts emit air pollutants which pollute the air locally and alongside transportation routes, which may affect human health. Emissions also increase greenhouse gases and global warming	AS	S	T	Do not use any vehicles on site that are older than 10 years	CC
					Service/maintain vehicles & machinery to manufacturers' specification	CC
					Repair or remove any vehicles showing excessive visible exhaust	CC

Sector	Potential Impacts	Loc	Sig	Dur	Proposed Mitigation	Rsp
					Fit all site vehicles & machinery with appropriate equipment to reduce exhaust emissions, including catalytic converters where applicable	CC
6. Noise and Vibration	Noise & vibration is produced by most construction activity & vehicles. Exposure can cause stress and alter the behaviour of both people and wildlife, and reduce their quality of life.	AS	S	T	Implement above measures to reduce air emissions by using newer vehicles & servicing regularly as these will also control noise/vibration	CC
					Repair or remove any vehicles emitting excessive noise or vibration	CC
					Fit all site vehicles & machinery with appropriate equipment to reduce noise, including appropriate exhaust silencers	CC
	Locations with housing nearby (dam, powerhouse, tailrace, disposal site 3) are especially sensitive, so noise barriers may be needed here	D PH T SD3	S	T	Monitor noise in inhabited areas near the sensitive sites; install noise barriers if noise is excessive and if required by residents	CC
					Stop night-time working at affected sites if residents complain	CC
	Vibration could cause structural damage to houses close to work sites		HS	P	Survey condition of all structures in the sensitive areas (crack survey) before & during construction. Remediate or compensate if damaged	CEB
	Workers' hearing may be impaired by exposure to loud and repeated noise; and safety may also be compromised if warning sounds are not heard clearly	AS	HS	T	Prepare Occupational Health & Safety Plan (OHSP) with measures to protect workers & others who come in contact with construction work	CC
					Ensure OHSP is implemented fully at all sites & other work areas	CC
					Include in OHSP at least the following:	
					- Provision and use of appropriate ear protectors when needed	CC
					- Limiting noise exposure to requirements of Sri Lankan law or international standards (whichever provides greater protection)	CC
					- Training in dangers of exposure to repeated/excessive noise and vibration and means of avoidance and reduction	CC
7. Aquatic Ecology	Land clearing and construction work could cause sediments to enter the river increasing turbidity temporarily and occluding aquatic habitat	AS	S	T	Implement the measures specified above to reduce soil erosion and runoff into the river	CC DC
	Turbidity risk is greater at the dam and causeway as cofferdams will be built in the river in the dry season (less dilution and dispersion)	D C	S	T		
	Fuel and lubricants can enter the river from poor work practices and could kill fish and other animals	AS	S	T	Implement the measures specified above to reduce spillage of fuel, oil and other toxins, and treat drainage from storage/refuelling areas	CC
	Fish can be killed by pressure waves from blasting and this is a particular risk at sites close to the river or if blasting on the river bed	D T	S	T	Examine the feasibility of chemical fracturing or hydraulic breakers and adopt a suitable alternative to blasting at the tailrace site	CC
	Site workers may catch fish illegally, including the endangered *Labeo fisheri* and may use damaging indiscriminate methods like explosives	AS	HS	T	Provide training to all workers on the importance of the rare fish and the sanction they risk (dismissal) if they fish for any species	CC
					Regularly monitor fishing activity and dismiss any person caught fishing by any method	CC

Sector	Potential Impacts	Loc	Sig	Dur	Proposed Mitigation	Rsp
	Fish fauna includes 8 nationally threatened species, of which one *Labeo fisheri* is of high conservation priority. Special measures are needed to protect this priority species from any adverse impacts	AS	HS	P	Survey fish in pools above and below dam site in pre-construction phase to determine presence and distribution of *L fisheri* and others	CEB
					If *L fisheri* is present form technical committee (CEB, DWC, FD, NZG, IUCN) to oversee & evaluate catch-and-haul (translocation) program	CEB
					Begin catch-and-haul before construction starts: capture *L fisheri* and other large fish; catalogue; move upstream or to nearby Kelani River	CEB
					In dry season, survey river bed between dam site and tailrace outfall; determine how to cut channels to connect larger pools during low flow	CEB
					After catch-and-haul is finished use hydraulic drills to cut channels in river bed; verify water connections during lowest flow conditions	CEB CC
8. Terrestrial Ecology	Site clearance will remove 55 ha of vegetation, including 3-4% of right bank secondary forest and 15-20% of riparian forest in project area. Animals in cleared areas will be disturbed and forced to relocate	AS	NS	P	Resurvey all project areas including reservoir, to confirm tree species and numbers. Capture vulnerable animals; move to safe distant areas	CEB
					CEB will reforest a 100 m wide strip (70 ha) around the reservoir to compensate for > 900 trees felled at construction sites and reservoir	CEB
	Construction workers may attempt to capture wildlife for consumption. This could include rare or ecologically valuable species (deer, hare)	AS	S	P	Provide training to all workers on the importance of wildlife and the sanction they risk (dismissal) if they capture or harm any species	CC
					Regularly monitor project areas and their environs and dismiss any project employee caught setting traps or harming wildlife	CC
	No trees to be felled are endangered. Terrestrial fauna includes 41 endemic or endangered species, including 5 of high priority. These are not at risk from the project but their habitat will be enhanced	AS	NS	P	Plan forestation of reservoir buffer to reduce soil erosion and provide suitable habitat for the endemic/endangered wildlife & other species	FD FC
					Examine legal means for land acquisition, lease, stewardship, etc and planting in reservoir buffer; arrange planting with Forest Dept (FD)	CEB
					Survey reforestation area; demarcate with posts to prevent farming	CEB
					Assess soil type and quality, slopes, etc; select species combinations, planting sites, densities to reduce siltation and provide faunal habitat	FD or FC
					Prepare detailed planting plan (locations, species, numbers, program)	
					Establish nursery for 80,000 species at suitable site near reservoir, in consultation with FD and with FD approval	FD or FC
					Plant seedlings; maintain for 3 yrs (weeding, watering, fire protection)	
					Regularly monitor planted areas (seedling survival; pests, diseases, invasive species; unauthorised activities). Take remedial action	FD FC
9. Physical Cultural	An expert investigation concluded that excavation is unlikely to reveal archaeological material because this is an area of low potential	AS	NS	P	Adopt a precautionary approach: establish a chance finds procedure defining action to be taken if archaeological material is discovered	CC

Sector	Potential Impacts	Loc	Sig	Dur	Proposed Mitigation	Rsp
Resources					Train excavator operators and site supervisors in recognition of archaeological material and action to be taken if necessary	CC
	Roadside shrines and other locally-important cultural structures or places could be damaged by traffic and resulting vibration; and people visiting them could be injured.	AS	S	T	Contact local communities in the project area to determine location of any sites of cultural importance (shrines, meeting places, etc)	CEB
					Conduct expert assessment of the risk to each site and mitigation	CEB
					Discuss mitigation with affected community; implement when agreed (may include speed limits, compensation, relocation of sites, etc)	CEB CC

KEY to Table 3 (above):

Location (Loc): AS = All Sites; D = Dam; T = Tailrace; MC = Main Construction sites; TR = Transportation Routes; MS = Material Stockpiles; SD = Spoil Disposal; AC = Accommodation Camps; TU = Tunnel; R = Reservoir; PH = Powerhouse; C = Causeway

Significance (Sig): HS = Highly Significant; S = Significant; NS = Not Significant

Duration (Dur): T = Temporary; P = Permanent

Responsibility (Rsp): CC = Construction Contractor; CEB = Ceylon Electricity Board; DC = Design Consultant; SC = Supervision Consultant FD = Forest Department; FC = Forestry Consultant

KEY to Table 4 (below):

Location (Loc): Ri = River; Re = Reservoir; PH = Powerhouse; T = Tunnel; N = Nawalapitiya;

Significance (Sig): HS = Highly Significant; S = Significant; NS = Not Significant

Duration (Dur): T = Temporary; P = Permanent

Responsibility (Rsp): C = Contractor; CEB = Ceylon Electricity Board; FD = Forest Department; FC = Forestry Consultant

Table 4: Potential impacts of the project in operation stage and proposed mitigation (key above)

Sector	Potential Impacts	Loc	Sig	Dur	Proposed Mitigation	Rsp
1. Hydrology and Environmental Flow	Reservoir will provide a new relatively stable water body. River flow will be reduced between dam & tailrace (E-flow is 41% of the natural minimum; plus dam overspill in monsoon). Downstream, E-flow and flow via Moragolla & Kotmale tailraces - similar to existing depth/cycle	Ri	NS	P	The E-flow is designed to provide sufficient water for existing human uses; and impacts on water quality and aquatic ecology are mitigated and compensated for by other actions (see below). So no increase in E-flow is needed	
	If Moragolla and Kotmale operate on the same peaking cycle, flow in the dry season will be E-flow only for 18-20 hrs a day. This will reduce water flow and depth downstream of the tailraces	Ri	HS	P	Examine and implement if feasible a strategy to operate Moragolla & Kotmale HPP out of phase in dry season to avoid both tailraces being dry for 20 hours a day, increasing the affected area downstream	CEB
2. Water Quality	Reduced reservoir circulation in dry season could de-oxygenate water at lower levels, especially if vegetation is decomposing on the bed	Re	S	T	Remove (uproot) all trees and shrubs from reservoir before first filling	C
					Promote improved land management to reduce pollutant inputs in the Moragolla watershed (see Watershed Management Plan below)	CEB
					Plant sediment-retaining trees and other vegetation in the reservoir buffer (see Afforestation Plan - Table 3 above)	FD FC
					Build check dams and sediment traps at the edge of the reservoir; remove and dispose of retained silt regularly (see Watershed Plan)	CEB
					Regularly monitor water quality throughout the reservoir; implement additional mitigation (eg artificial aeration) if found to be necessary	CEB
	Sediment will collect in the reservoir over 50 years. If silt was pumped downstream this would increase turbidity and affect flora and fauna	Re	HS	T	If sediment is pumped downstream, conduct the operation gradually throughout the monsoon season to achieve maximum dilution	CEB
	Reduced river flow will provide less dilution for the Crysbro effluent (which exceeds legal standards) and other pollutants from on land	Ri	S	T	CEB will extend Crysbro outfall to discharge downstream of the tailrace. The upstream pipes are broken and should also be repaired	CEB
					Discuss with CEA & Crysbro their responsibility to treat their effluent to meet national discharge standards before entry to the river	CEB
					Operate Moragolla and Kotmale HPPs out of phase in the dry season to supplement E-flow and increase dilution for a longer time each day	CEB
3. Aquatic Ecology	Reduced flow and water depth between the dam and tailrace will probably cause larger fish to avoid this area in the dry season	Ri	NS	P	Supplement the catch-and-haul operation for *L fisheri* with measures aimed at conservation of moderate priority (nationally threatened) fish	CEB
	Upstream spawning migrations do not seem to be critical in this area but the dam will separate upstream and downstream populations, which may reduce genetic diversity and long-term population survival	Ri Re	S	P	Protect/enhance habitat for moderate priority species in Nawalapitiya, upstream of project site (Fig 4), to offset negative impacts of MHPP	CEB
					Include in habitat protection program: replanting riparian vegetation; reduction of farmed areas; planting to conserve soil & reduce erosion	CEB
					Coordinate the offset habitat protection with reservoir afforestation and Watershed Management Plan to integrate planning & execution	CEB

Sector	Potential Impacts	Loc	Sig	Dur	Proposed Mitigation	Rsp
	Fish could be affected by reduced oxygen in reservoir water if vegetation is allowed to decompose on the bed	Re	S	T	As above: Uproot all trees and shrubs from reservoir before first filling and remove the debris from the site for on-land disposal elsewhere	C
	In the reservoir area, fish able to adapt to deeper water may increase, and those that prefer fast-moving water will probably move upstream	Re	NS	P	Prohibit introduction of exotic species to Moragolla reservoir to avoid competition with native species and reductions in their populations	CEB
					Consult Fisheries Dept to decide whether to prohibit reservoir fishing	CEB
					Monitor fishing in project area; inform Fish Dept if *L fisheri* is caught	CEB
	Fish could be entrained into the headrace intake and killed by contact with the turbines in the powerhouse	Re	S	P	Install a suitable means of excluding fish from the intake (eg screens, small mesh net across reservoir, electronic fish barrier)	CEB
4. Terrestrial Ecology	No impact on terrestrial ecology is expected during MHPP operation. There will be some habitat enhancement as temporary project sites revegetate; and major enhancement as the reservoir buffer matures. Mitigation at this time will focus on protecting the reservoir watershed	UW			Prepare a Watershed Management Plan to improve vegetative cover, stable soil conditions and faunal habitat in the reservoir watershed	CEB
					Include in WMP (as relevant): engineered structures (bunds, check dams); planting (ground-cover crops, grass strips); Reforestation; home garden improvement; creation of wetlands; awareness raising	CEB
					Survey Nawalapitiya to identify suitable areas for implementing WMP techniques; plan specific activities in each area	CEB
					Plan and establish a system to disseminate information on improved land management and fair system to disburse grants for participation	CEB
5. River Users	Needs of Crysbro & Dunhinda will be met by the E-flow. Downstream of tailrace, flow will be reduced in dry season in first 8 km as there are only 3 tributaries. People bathing & sand mining here will experience increased water levels when Moragolla and Kotmale plants operate	Ri	S	P	CEB plans to implement information programs in mass media to raise awareness of changes in water level and when they will occur	CEB
					CEB plans to set up sirens to warn people when combined discharge from Moragolla and Kotmale tailraces exceeds 110 m^3/s	CEB
					Set up sirens to Kaudupitiya Ela (11.2 km downstream of Moragolla dam) to cover whole area in which water level changes are expected	CEB
					Modify operation of sirens to provide warning each time flow from the Moragolla and Kotmale tailraces is about to resume (each day)	CEB
6. Dam Failure	A failure of the dam is extremely unlikely as no concrete gravity dams have failed since 1930's. If there was a failure, water levels would rise by 20 m over a wide area downstream, causing large scale damage & destruction of houses, buildings, farmland, etc and death of people	Ri	HS	P	Prepare Disaster Preparedness Plan (DPP) with instructions of activities & responsibilities to minimise loss of life & property damage	CEB
					Set up emergency warning system to rapidly inform people of likely dam failure and emergency actions to save lives and communities	CEB
					Regularly train those responsible for DPP implementation	CEB

- Construction vehicles, machinery and activities produce noise and vibration, which can cause stress and impair the quality of life for local people, workers and wildlife;
- Vibration can cause structural damage to houses and other buildings near work sites and transport routes, including roadside shrines and other culturally-important places.

60. The potential significance of these impacts is moderated considerably by the nature of the project location, which is quite sparsely inhabited, and where most of the natural habitat has been removed in the past to provide land for agriculture, significant proportions of which have since been abandoned. This is therefore not a very sensitive location, so few of the negative impacts are expected to be highly significant. However it will still be necessary to mitigate these and other environmental impacts carefully, to avoid damaging the few sensitive features that are present, and to minimise disturbance of people who live near the project sites or alongside transportation routes. Table 3 shows that the mitigation measures include the following:

- Planning the topography of all sites to ensure that surface water drains into constructed ponds where sediment is allowed to settle before discharge to the river;
- Covering loose material with tarpaulins when carried by truck or stored on site, or stockpiling loose material in buildings to protect it from rain and wind;
- Spraying site roads and large areas of uncovered soil with water to reduce dust;
- Planning land clearance to remove vegetation in stages, only when it is necessary;
- Storing fuel, oil and other toxic liquids in areas with concrete floors and bunds, and ensuring that drainage is treated in oil separators before discharge to the river;
- Prohibiting the use of older vehicles and machinery and ensuring those operating on site are regularly serviced and fitted with equipment to reduce noise and air emissions;
- Conducting condition surveys of buildings before construction and compensating owners for any vibration damage, and protecting cultural sites as agreed with the community.

61. These and many of the other mitigation measures require action in relation to the way the construction process is conducted, so responsibility is mainly allocated to the Construction Contractors (shown as CC in Table 3). Some of the mitigation needs to be incorporated into the project design, so this is the responsibility of the design consultant (DC) and some of the action is the responsibility of the project proponent (CEB). Further information on the implementation of these and the other mitigation measures is provided in the Environmental Management Plan presented in Chapter V below.

62. Table 3 shows that there are two other potential sources of impact in the pre-construction and construction stages, which are highly sensitive, mainly because they involve risks to rare species that inhabit the project area, despite its degraded nature and the ongoing damage and disturbance from the activities of man. The additional studies and surveys conducted in 2013 (Volume 4) showed the presence of certain endemic, rare and endangered fish and wildlife, and an analysis by the World Conservation Union (IUCN[9]) showed that six of these are priority species in conservation terms. These are: the fish *Labeo fisheri* (green or mountain labeo); the butterflies *Cepora nadina* (lesser gull) and *Eurema andersoni* (one-spot grass yellow); and the mammals *Prionailurus viverrinus* (fishing cat), *Prionailurus rubiginosus* (rusty spotted cat) and *Moschiola kathygre* (Sri Lanka pygmy mouse-deer).

[9] Expert Reports on Fish and Terrestrial Biodiversity - Volume 4

63. Table 3 shows that *L fisheri* is at risk from the reductions in water quality mentioned above, and also from pressure waves caused by blasting, and from poaching by site workers. These impacts will be mitigated by actions to address these specific issues, including: reducing the incidence of water pollution as outlined above; utilising non-explosive methods of rock-breaking on the river bed; and educating workers on the environmental value of rare species and prohibiting all fishing on site. Table 3 shows that two further activities will be conducted, aimed specifically at conserving *L fisheri* and other large-sized fish species to ensure the long-term survival of their populations. This will involve:

- A catch-and-haul program to capture *L fisheri* and other large species and relocate them upstream or to the nearby Kelani River, where they will be undisturbed by the MHPP;
- Cutting channels in the river bed below the Moragolla dam site to improve connectivity between pools in the area during low flow conditions when the project is operating.

64. The other highly sensitive issue relates to terrestrial ecology and involves action to conserve the five priority species. Table 3 shows that none of these is considered likely to be affected by the project, but action will nevertheless be taken to enhance their populations by increasing the area of suitable habitat available. In the Local EIA study CEB proposed to revegetate a 70 ha, 100 m wide buffer zone around the reservoir perimeter to compensate for the >900 trees that will be felled at the project sites, and to trap sediment to reduce inputs to the reservoir. Table 3 shows that the planting programme will be modified to also provide habitat for the five priority terrestrial species (and others). The revised afforestation programme will be implemented by or in conjunction with the Forest Department, and full details of the activities involved are also provided in Chapter V below.

B. Operation Phase

65. Table 4 shows that there are fewer environmental concerns once the MHPP is functioning, because an operating hydropower station produces no major emissions, and hydropower is widely considered to be one of the less environmentally damaging forms of power generation. There are however some sources of potential negative impacts, and Table 4 shows that these mainly relate to: a) the reductions in downstream flow in the river, and the effects that will have on aquatic ecology, water quality and people who use the river; and b) the effect of the dam in creating a new and different aquatic environment upstream, and isolating the upstream and downstream fish communities. The principal risks are as follows:

- Retention of water in the reservoir in the dry season and the reduced circulation could de-oxygenate water at lower levels especially if vegetation is decomposing on the bed;
- Reduced downstream flow will provide less dilution of pollutants, especially in the dry season, including the Crysbro discharge, which does not meet legal standards;
- The dam will separate upstream and downstream fish populations, which may reduce genetic diversity and long-term survival of the populations;
- Creation of the reservoir will alter fish populations as those able to adapt to deeper water will increase and those that prefer fast-flowing water may move upstream;
- People bathing and sand-mining downstream of the tailrace will experience increases in water level when the Moragolla and Kotmale stations re-start operations each day.

66. Various actions are proposed in order to avoid or mitigate these impacts, including:

- Removal (by uprooting) of all trees and shrubs from the bed of the reservoir before first filling and disposing of the material at a licensed on-land disposal site;
- Extending the Crysbro outfall to discharge downstream of the MHPP tailrace and reminding the factory owners of their obligation to treat their effluent before discharge;
- Prohibiting introduction of exotic fish species into Moragolla reservoir to allow native species to achieve a natural balance without deleterious competition from alien species;
- Establishing sirens to warn river users of water level increases when Moragolla and Kotmale re-start daily operations and if the combined discharge exceeds 100 m^3/s.
- Preparing a Disaster Preparedness Plan with details of activities and responsibilities to protect life and property in the (unlikely) event of a dam failure; with an emergency warning system in the potential flooded area;
- Operating Moragolla and Kotmale HPPs out-of-phase in the dry season to extend the daily period in which the Moragolla E-flow is augmented, to avoid flow reductions farther downstream and related impacts on ecology, water quality and river users.

67. As in the construction period there are two somewhat more complex mitigation measures, focused on the conservation of the six priority species (and others), by improving habitat conditions (terrestrial and aquatic) and thus long-term population densities in the wider project catchment. These are both linked to the conservation activities begun in the construction period, and comprise: a) an offset habitat protection programme for *L fisheri* and medium priority fish species; and b) a Watershed Management Plan to improve land management and reduce pollutant inputs into the reservoir.

68. The offset habitat protection programme aims to improve the habitat for larger fish species at Nawalapitiya upstream of the MHPP reservoir, by means of a range of measures. These include: improving land-use and land management practices; reducing vegetation clearance and land degradation; increased planting of riparian vegetation; etc. The Watershed Management Plan will implement similar measures in the wider Moragolla catchment, to reduce pollutant inputs and improve water quality and therefore fish habitat, in the reservoir and in the river upstream and downstream. This will include a range of additional measures, funded by grants, including checkdams and bunds, planting to conserve soil, reforestation of degraded areas, improved home-garden planting, creation of wetlands, etc. Planting schemes will be linked to those of the reservoir afforestation programme to also provide further suitable habitats for the priority terrestrial species. Further details of these and the other mitigation measures are provided in Chapter V below.

V. ENVIRONMENTAL MANAGEMENT PLAN

A. EMP Rationale

69. The potential environmental impacts of the project in the pre-construction, construction and operational phases, and the mitigation proposed in the Environmental Addendum, were summarised in Chapter IV above. In addition to the general and specific aspects of the impacts and mitigation as discussed in the text of that chapter, the summary in Tables 4 and 5 reveals certain other features, which have influenced the approach to preparation of the Environmental Management Plan (EMP) for the project, which is presented in the chapter below. These features are as follows:

- In common with many infrastructure projects, most of the pre-construction and construction phase impacts on individual elements of the physical environment (air and water quality, noise, etc) will be mitigated by adopting specific approaches to the construction work (eg collecting drainage; spraying site roads); mitigation of these impacts is therefore mainly the responsibility of the Contractors;
- Certain other issues (regarding terrestrial and aquatic ecology), have arisen because of the presence of rare species in the project area, and mitigation of these impacts will involve more complex and inter-linked activities in both construction and operation phases. This will be organised by the Project Proponent CEB and conducted mainly by specialist consultants, contractors or the appropriate Government department;
- There are other issues in the operation phase (mainly relating to downstream river flow and the safety of downstream communities and river users), which will also be addressed by CEB, in their role as the operator of the completed MHPP.

70. The purpose of the Environmental Management Plan (EMP) is to set out clearly the required mitigation measures and allocate responsibility for each, and to provide additional information to assist in planning and implementing the various activities. The information should be provided in a form in which it is useful to and can easily be accessed by the responsible parties. The above analysis shows that the impacts and mitigation for this project fall into four distinct categories, based on the phase in which the mitigation will be provided and the parties who will take the necessary action. For this reason the EMP for this project is subdivided into the equivalent four parts. These are as follows:

a) Construction Phase EMP;
b) Operation Phase EMP;
c) Special Issues EMP: Aquatic Ecology;
d) Special Issues EMP: Terrestrial Ecology.

71. These are provided in Sections C-F below. Each section begins with a brief summary of the potential impacts and proposed mitigation related to the specific issue or project phase, so that the EMP can be used by the responsible parties without extensive reference to the remainder of this volume and the Environmental Addendum if necessary. Further information on implementation of the mitigation measures is then provided, covering (where relevant): implementation arrangements; performance indicators and monitoring requirements; scheduling; budgets; and Terms of Reference (ToR) for consultants.

B. EMP Implementation

72. Each mitigation measure will be provided by the party or parties shown as responsible in Tables 3 and 4 above, and at the beginning of each section of the four parts of the project EMP provided below. In the construction phase most mitigation is the responsibility of the Contractors appointed by CEB to build the various elements of the scheme; and in the operation phase most of the mitigation is the responsibility of CEB, who will be both the owner and the operator of the completed scheme. In both phases some of the mitigation also requires action by the other party, and some of the mitigation needs to be incorporated into the project design, which is the responsibility of the Design Consultant. The two "special issues" EMPs (Aquatic Ecology and Terrestrial Ecology) involve actions to be taken in the design, pre-construction, construction and operation phases, and responsibility is allocated to the various parties as appropriate.

73. To ensure successful implementation of the EMP in its entirety, each of the main parties must be provided with a copy of the first two volumes of this Environmental Study (Volume 1: Environmental Addendum; and Volume 2: EMP) so that they have access to full information on the mitigation that is their responsibility, how it should be implemented, and the rationale behind the development of each measure (provided in the Addendum). Prospective contractors also need to be provided with a copy of the construction-phase EMP (Chapter V of Volume 2) during the tender process for the construction contracts, so that they can incorporate the work involved in providing each mitigation measure into their physical and financial planning. The Supervision Consultant will be responsible for ensuring that all parties provide the mitigation that is their responsibility throughout the construction period, so tenderers for the Supervision contract should also be provided with Volume 2 or this chapter.

74. The construction contracts will require the appointed Contractors to provide all mitigation assigned to them in the EMP in the manner described in this document, so they will be legally required to implement each measure and subject to penalties if they do not comply. Similarly the supervision contracts will require the Supervision Consultant to observe and monitor the work of the contractors to ensure all parties provide the mitigation in the specified manner, and again penalties can be enforced if the supervision falls short of expectations. These legal safeguards, and the detailed information provided in this document, should ensure that the mitigation is provided as intended.

75. The construction contracts will also require each of the main contractors to produce and implement their own EMPs, describing how they will provide each mitigation measure for which they are responsible. These documents should not simply duplicate the project EMP, but should set out the action the contractor proposes to take to provide each mitigation measure. This should include information on the activities involved, the resources (equipment, manpower, etc), and the intended programme for each activity. A typical format for a Contractor's EMP is provided in Appendix 1, which contractors may follow if they wish.

76. Each of the main parties (main contractors, supervision consultant and client) should have properly qualified and experienced senior staff in the role of Environmental Manager (or equivalent), supported by both mid-range and junior professional staff. CEB will establish an Environmental Management Office within the PMO (see Chapter VII), containing environmental specialists, and it is expected that the main civil works contractor will also have an environmental unit or team arrangement. The main contractors will be required to submit written reports to CEB and the Supervision Consultant every month describing process on implementing each mitigation measure, and to report by email and verbally at least each week.

C. Construction Phase EMP

77. This is a large construction project, involving some major physical changes in an area of over 100 ha (including the reservoir), during a construction period of 4½ years. Although the project site is sparsely inhabited and supports little unaltered natural habitat, there are still some sensitive locations and features, so environmental impacts need to be carefully controlled and reduced by a range of mitigation measures throughout the construction period and beyond. Given the scale of the physical activity, it is not surprising that most of the individual elements of the physical environment are at risk of harm during the construction period. The main risks are as follows:

- Water quality: exposed soil could wash into the river during rain, increasing turbidity and affecting aquatic plants and animals, and people who use the river for washing/bathing;
- Water quality: silt may also wash from loose material carried to construction sites or stored on site, or from waste spoil when transported for disposal;
- Water quality: may be further reduced by spills of fuel, oil and other toxic material stored and used on site, and by sewage pollution if adequate sanitary facilities are not provided
- Air quality: uncovered soil and unpaved site roads could liberate dust in dry weather, which could affect workers and local residents and reduce the productivity of crops;
- Air quality: will be reduced locally by exhaust emissions from construction vehicles and machinery, and this will contribute to global emissions of greenhouse gases;
- Noise: construction vehicles, machinery and activities produce noise and vibration which can cause stress and impair the quality of life for local people, workers and wildlife;
- Vibration can cause structural damage to houses and other buildings near work sites and transport routes, including roadside shrines and other culturally-important places.

78. The mitigation required to avoid these and other potential impacts of the construction process, or reduce them to the level of no significance is described below. The issues are dealt with according to the individual environmental feature at risk (water quality, air quality, etc), which mirrors the account in the Environmental Addendum (Volume 1) and in the summary in Chapter VI above, which will allow the more detailed explanations in those sections to be readily accessed if necessary. Further information on the implementation arrangements, performance indicators and monitoring requirements, scheduling, budgets, and Terms of Reference (ToR) for consultants are provided below where appropriate.

79. For some of the measures the last two factors are not relevant because: a) these mitigation measures relate mainly to working practices, and most activities will already be part of the normal site procedures of experienced national and international contractors, so they will require no additional budget and no input from consultants; and/or b) even where mitigation requires a change to a working practice it will not require special budget provision as it will not involve costs beyond those that are already included by the contractors in their budgets for the work item. Nevertheless, budgets are provided for all environmental monitoring activities (including monitoring to be done by the contractors), so that the cost of the Environmental Monitoring Plan can be compiled (see Chapter IX), and to enable any of the more complex and specialised monitoring activities to be outsourced if necessary.

1. Hydrology and Environmental Flow

80. **Impacts and Mitigation:** Although the construction process requires substantial work in the river bed and diversion of the river through a tunnel to allow dam construction in the dry, this is not expected to impede downstream flow. The diversion works have been designed to pass a flood of 320 m^3/s without interruption and coffer dams will withstand the expected minimal overtopping without structural damage. There is some concern at the downstream sites where the causeway and tailrace outfall will be built on the river bed and cofferdams alone will be used to deflect water away from the worksites, as this might cause localised flooding outside the main river channel in the monsoon. Table 5 shows that this can be avoided quite simply, by conducting this work during low flow conditions in the dry season, so this should be incorporated into construction planning.

81. Table 5 also shows that the presently proposed method of reservoir first-filling, where the diversion conduit gate is closed completely, will allow no downstream flow during the estimated 19-hour filling period, until water reaches the level of the E-flow intake. CEB will therefore be in contravention of their undertaking to MASL, to provide a downstream flow of 1.5 m^3/s at all times; so some means of allowing the necessary E-flow at this time needs to be found. Partial closure of the diversion gate would be a solution, but if this is impracticable, another solution should be devised.

Table 5: Potential construction phase impacts on hydrology and the mitigation required

Potential Impact	L	Required Mitigation	By
Diverting the river via cofferdams to build causeway and tailrace outfall could cause flooding outside the main river channel	D T	Construct the causeway and tailrace outfall in the dry season, when river flow will be near the seasonal minimum	CC
The project would not maintain constant E-flow if there is no downstream flow during reservoir filling, estimated to take 19hrs	D	Partially close diversion conduit gate during first filling to allow 1.5 m^3/s downstream; or find another way to allow E-flow at this time	CEB DC
		Monitor downstream flow at this time to ensure it is 1.5 m^3/s	CEB
KEY:			
Location (L):	D = Dam; T = Tailrace; AC = Accommodation Camps		
Responsibility (By):	CC = Construction Contractor; CEB = Ceylon Electricity Board; DC = Design Consultant		

82. **Implementation arrangements:** Construction Contractors are legally bound by their contracts to implement all mitigation that is allocated to them in this EMP, so the Main Civil Works Contractor should incorporate into their work planning the proposed dry-season construction of the causeway and tailrace outfall as indicated above. The revision of the reservoir first-filling procedure to allow the downstream E-flow needs to be investigated by the Design Consultant during their present study, so CEB should ensure that this is done.

83. **Performance indicators and monitoring requirements:** If the mitigation at the causeway and tailrace outfall sites is successful there should be no egress of river water outside the main river channel at these locations, during the period in which the cofferdams are in place. This will be monitored by the Supervision Consultant during their routine observations of the ongoing work at these sites. If a revised reservoir filling procedure is devised and implemented there will be a downstream flow of at least 1.5 m^3/s before, during and after the filling period and this will be shown by the river flow monitoring (conducted or commissioned by CEB) specified in Table 5 above. This is explained in detail in the Environmental Monitoring Plan in Chapter VI.

84. **Scheduling:** The proposed scheduling of construction of the causeway and tailrace outfall will be planned during the pre-construction period when the Contractors plan their work in detail; and the work will then be implemented during one or more of the subsequent dry-season periods. The causeway will be required throughout the construction phase so this will almost certainly be built during the first available dry season; and the tailrace outfall will be built later, probably during powerhouse construction.

85. Devising an alternative means of filling the reservoir to allow downstream E-flow needs to be done immediately, so that the solution can be reflected in this document and the Environmental Addendum. CEB should therefore discuss this with the Design Consultant as soon as possible. The reservoir will then be filled via the alternative method in early 2020, as shown in the scheduling bar-chart in Figure 7 below.

Figure 7: Programme for mitigating construction-phase impacts on hydrology

Activities	2014		2015		2016		2017		2018		2019		2020			
		Pre-cons			Construction								Operation			
Prevent local flooding near causeway and tailrace outfall sites																
Provide E-flow during reservoir first filling																

86. **Budget:** Planning/implementing the dry-season scheduling of the causeway and tailrace outfall construction will be done by the Contractor within the overall construction planning and implementation process and will not require additional budget. Devising an alternative means of filling the reservoir will also not require additional budget, as it will be done by the Design Consultant within their existing contract. Monitoring downstream flow during the reservoir first filling will be very small in scale, as it requires the simple operation of a fixed-location flow meter in the current of water discharging from the dam over a 32-hour period before, during and after the filling operation. CEB will probably employ a monitoring contractor; and the work will require two people on-site to conduct the monitoring, plus one senior expert to analyse the data and prepare a short report.

Table 6: Budget for mitigation of construction-phase impacts on hydrology

Work Item	Quantity	Unit	Rate (SLR)	Cost (SLR)
Monitoring flow during reservoir first-filling				
Senior Monitoring Specialist	$\frac{3+1}{22}$	Person-month	300,000	54,000
Field Assistants (2)	$\frac{2 \times 3}{22}$	Person-month	150,000	40,500
Fixed position flow meter	1	LS	300,000	300,000
Transport	1	300 km	40	12,000
Per diem	3 x 2	day	6,000	36,000
Assumptions:			**Total:**	**442,500**
Monitoring for 36 hours, so 3 days including travel; Senior specialist 1 extra day to analyse data and prepare report				

87. **Consultant Terms of Reference:**

a) Field Technicians:

- Monitor the speed of flow in the current of water flowing downstream from the Moragolla HPP dam, during the period when the reservoir is filled for the first time, and for 6 hours before and 6 hours after the filling operation;
- Use for the monitoring a properly calibrated automatic flow meter that will measure in the range of 1 - 100 m^3/s, with a recording frequency of one reading every 5 minutes;
- Monitor flow of water immediately at the discharge from the dam conduit into the river.

b) Senior Monitoring Specialist:

- Plan and supervise the field exercise to monitor downstream flow from the dam;
- Analyse the data recorded and write a report (containing all data); calculate and illustrate average rates of flow per hour, and highlight any instances when the flow was less than 1.5 m^3/s.

2. Water Quality

88. **Impacts and Mitigation:** Water quality is one of the main concerns regarding potential impacts during the construction period, because of the size of the areas involved, the fact that most sites will be cleared of vegetation leaving bare soil exposed, and the sensitivity of the river, which contains rare species and is used by local people for washing and bathing. Table 7 below shows that the main risks are that during rainfall silt may wash into the river from site roads, exposed soil, stored materials, transported spoil, or the quarry or disposal sites; and that spilled fuel, oil or other toxic materials used or stored on site may also wash into the river. Most of the construction sites are located near the river, and the topography of the area carries surface drainage into the waterway. A high degree of vigilance will therefore be required to reduce these impacts, in an intensive and coordinated effort at all construction sites.

89. Table 7 shows that the principal mitigation measures are: collecting all site drainage in ponds and allowing sediment to settle out before discharge to the river; reducing erosion from excavated areas and cut surfaces as much as possible; protecting loose material from rainfall when stored or transported; managing spoil disposal to minimise erosion; storing and using fuel, oil and other toxic materials responsibly; and providing adequate sanitary facilities in accommodation camps and at all sites.

90. **Implementation Arrangements:** Most measures are the responsibility of Construction Contractors (CC) and will be implemented by the Preparatory Works Contractor and the Main Civil Works Contractor and any sub-contractors employed by them. Tender Documents require all contractors to implement fully the mitigation measures for which they are assigned responsibility in the EMP (this document), and to prepare their own EMP explaining action they will take to comply. They will therefore be legally bound to implement these measures. Some measures are the responsibility of the Design Consultant (DC), so senior staff should confirm to CEB that each measure is included in the designs. If any measures have not been included, CEB should make arrangements to ensure the necessary action is taken.

Table 7: Potential construction phase impacts on water quality and mitigation required

Potential Impact	L	Required Mitigation	By
Exposed soil may wash into the river during rain, increasing turbidity; this could impede animal respiration and plant photosynthesis and make the water less suitable for human uses, eg washing & bathing	AS	Plan topography/drainage so rainwater runs into adequately-sized ponds and sediment is allowed to settle before release to river	CC
		Re-design topography & drainage when site topography changes	CC
		Build duplicate ponds to allow regular sediment disposal	CC
		Monitor silt in discharge water - ensure levels are below set value	CC
Erosion risks are increased at the main construction sites where there is deep excavation and steep slopes, which may remain uncovered	MC	Design slope gradients to assure stability; incorporate erosion protection in final slopes (stone facing, grass) when possible	DC
		Apply covering material/vegetation to slopes as soon as possible	CC
		Incorporate drainage culverts into slope designs when needed	DC
		Regularly monitor cut slopes to detect erosion; remediate rapidly	CC
Silt may wash from loose material transported to site or for disposal	TR	Cover loose material with tarpaulins if transported in rainy season	CC
		If wet material is transported, allow to dry & de-liquefy first	CC
Silt may wash from stored/stockpiled loose material during rainfall	MS	Cover stockpiled loose material with tarpaulins or in a building	CC
		Ensure drainage from stockpile areas is collected/de-silted	CC
Spoil disposal sites are at particular risk of erosion by rainfall as dumped material is uncovered until the site is closed and vegetated	SD	Plan disposal operation to limit erosion; specify slope gradients, compaction method/frequency, site drainage measures, etc	DC
		Incorporate check-bunds, etc into designs to ensure slope stability	DC
		Specify final land profiles and vegetation cover to ensure stability	DC
		Ensure drainage from disposal areas is collected/de-silted	CC
		Monitor spoil disposal to ensure all safeguards are followed	SC
Potential toxins may enter the river from accidental spills of fuel and oil stored on site, and during refuelling	AS	Store fuel, oil and other polluting liquids in secure, managed areas with concrete floors & bunds; allow refuelling only in these areas	CC
		Ensure drainage from liquid storage areas treated by oil separator	CC
Toxins may enter the river from vehicle maintenance workshops if use & disposal of oil and other materials is not controlled	AS	Maintain vehicles and equipment in designated workshops with floors of concrete and surface drains fitted with oil separators	CC
		Collect waste oil in secure containers; deposit at a licensed site	CC
Accommodation camps could be a source of sewage pollution if they are not provided with adequate sanitary facilities	AC	Provide adequate toilets/bathrooms at all accommodation sites	CC
		Toilets/bathrooms to be cleaned daily and materials replenished	CC
		Ensure sewage is treated to national standards on or off site	CC
Work sites could also be a source of sewage pollution if there is not adequate provision of sanitary facilities	AS	Provide adequate toilets/washrooms for number of people on site	CC
		Toilets/bathrooms to be cleaned daily and materials replenished	CC
		Ensure sewage is treated to national standards on or off site	CC

KEY:

Location (L): AS = All Sites; MC = Main Construction sites; TR = Transportation Routes; SD = Spoil Disposal; D = Dam; T = Tailrace; AC = Accommodation Camps

Responsibility (By): CC = Construction Contractor; DC = Design Consultant; SC = Supervision Consultant

91. **Performance Indicators and Monitoring Requirements:** If this mitigation is successful, the regular water quality monitoring specified in Table 7 (conducted by the Main Civil Contractor throughout the construction period) will confirm that:

- The levels of suspended sediment recorded in drainage water discharged to the river did not exceed specified levels (see Chapter VI); and
- There were no increases in sediment content in the river, above the average dry season and wet season values recorded in the surveys in 2013.

Scheduling: Measures relating to the design have already been implemented, and any that are outstanding will be addressed in early 2014 as shown in Figure 8. Measures regarding the stability of slopes relate mainly to the earthworks, which will be conducted in the first two years of construction (2016-17). The remaining measures apply to most of the construction sites and ancillary areas, and should be implemented throughout the period in which each site remains active, so these are shown in the schedule as being provided constantly during this time. Provision of adequate sanitary facilities in site accommodation, and treatment of sewage to national standards needs to continue throughout both construction and operation stages.

Figure 8: Programme for mitigating construction-phase impacts on water quality

Activities	2014	2015			2016		2017		2018		2019		2020		2021	
		Pre-cons			Construction								Operation			
Plan/revise site topography, collect drainage; reduce silt in ponds																
Monitor silt in the river and in water discharged from site																
Design slope gradients, drainage, covering material to reduce erosion																
Apply final covering as soon as possible; monitor slopes for erosion																
Cover loose material with tarpaulins when transported																
Cover stockpiles with tarpaulins; or store in buildings																
Plan disposal operation to minimise erosion - specify profiles, bunds,																
Monitor spoil disposal																
Store fuel, oil in areas with concrete floors, bunds; treat drainage																
Maintain vehicles in areas with concrete floors; treat drainage																
Provide adequate toilets/bathrooms in accommodation; clean daily																
Treat effluent to national standards																
Provide adequate toilets/ and washrooms on site; clean daily																
Treat effluent to national standards																

92. **Budget:** There is unlikely to be any additional design work needed to comply with these measures; and the activities to avoid water pollution at construction sites are all examples of good site management, which should already be part of the standard approach of experienced contractors, so again no additional budget should be needed. Similarly, monitoring the spoil disposal operation by observation, checking slopes and any engineered stability or drainage measures would be the sort of work that the Supervision Consultant would expect to conduct.

93. One item that does need to be budgeted additionally is the monitoring of the silt content of water discharged to the river from the sedimentation ponds used to collect drainage water at each site. This is required because of the sensitivity of this site and the presence of important fish and downstream river users, and may therefore not have been anticipated by contractors. It is also quite labour-intensive as water quality will need to be monitored daily for the first few months of construction, after which it can be reduced to a weekly exercise if specified sediment levels have not been exceeded. The work will be conducted by junior-level professional staff of the Contractor, supervised by the Contractor's Environmental Manager.

Table 8: Budget for mitigation of construction-phase impacts on water quality

Work Item	Quantity	Unit	Rate (SLR)	Cost (SLR)
Monitoring silt content of discharged water				
Environmental Manager	$\frac{(0.5x168)+80}{22}$	Person-month	300,000	2,235,000
Other Professional Staff (2)	$\frac{2 \times 246 \times 0.5}{22}$	Person-month	150,000	1,677,000
Water quality meter with GPS recorder	1	LS	1,500,000	1,500,000
Assumptions:			**Total:**	**5,412,000**
Monitoring by water quality meter at all points of discharge from sedimentation ponds and in main river channel Assumed 10 monitoring points, 0.5 day per survey. Monitoring daily for 3 months; then weekly for 3 years Conducted by Contractor's personnel so no allowance needed for per diem and transport Environmental Manager will write weekly report, reviewing data, highlighting if any set values are exceeded (½ day)				

94. **Consultant Terms of Reference:** These activities (including sediment monitoring) will be conducted by the contractor's regular staff and no consultancy inputs will be needed.

3. Groundwater

95. **Impacts and Mitigation:** Initial concerns that groundwater may drain into the headrace tunnel during construction, depleting surface aquifers and domestic wells on the left bank, were allayed by the additional study conducted in 2013. This found that the aquifers are small and confined and the tunnel route is located deep within intact bedrock, so seepage is unlikely. The study recommended however that: a) blasting should be carefully planned and controlled to avoid fissuring outside the tunnel vicinity, which could create drainage routes; and b) groundwater levels should be monitored around the tunnel route so that alternative water can be supplied by tanker if water levels were to fall. These are the main mitigation measures required to protect groundwater (Table 9), and survey contractors should refer to the report of the 2013 study (Volume IV) for geo-references of all of the wells in the area and baseline data on the level of water in each well in March and May 2013.

96. There is also a risk that groundwater could be contaminated by spills of oil and other toxins if these were stored or used irresponsibly on site, so this is another reason to implement the pollution control measures specified in Section V.C.2 to protect surface water quality.

97. **Implementation Arrangements:** As noted above, Contractors are required by their contracts to implement all mitigation assigned to them in this report, and the Supervision Consultant is contractually required to observe and monitor the construction process, so these two legal safeguards should ensure that the mitigation is adequately provided. As blasting is

Table 9: Potential construction phase impacts on groundwater and mitigation required

Potential Impact	L	Required Mitigation	By
Groundwater may be polluted by spills of fuel/oils; may affect health	AS	Implement measures proposed above to prevent fuel/oil spillage	CC
Domestic water in wells could be reduced if water drains into the headrace tunnel area	TU	Plan blasting carefully to avoid fissuring rock outside tunnel	CC
		Groundwater study concluded this was not a major risk. Monitor water levels in wells near tunnel; provide tanker water if needed	CEB
KEY:			
Location (L): AS = All Sites; TU = Tunnel			
Responsibility (By): CC = Construction Contractor; CEB = Ceylon Electricity Board			

98. also a source of potential environmental impacts on aquatic ecology (risk of fish death from pressure waves) and the human environment (structural damage to buildings) (see below), it is further recommended that CEB and the Supervision Consultant should examine proposed blasting regimes very carefully and monitor results on the ground and adjust the approach if necessary to confine damage to the target areas to the extent possible. The monitoring of wells will be done by a suitably experienced domestic contractor, commissioned by CEB.

99. **Performance Indicators and Monitoring Requirements:** If this mitigation is successful the monitoring of water levels in the wells in the vicinity of the tunnel route will show no significant change from the baseline levels established during the 2013 survey.

100. **Scheduling:** Blasting will be employed in the earthworks (conducted during the first two years of construction) and tunnelling (scheduled for mid-2016 to mid-2019). The groundwater monitoring will be conducted throughout the tunnelling period, although the frequency will be reduced if no changes in water level are observed.

Figure 9: Programme for mitigating construction-phase impacts on groundwater

Activities	2014		2015		2016		2017		2018		2019		2020		2021	
		Pre-cons			Construction								Operation			
Plan/implement blasting carefully to avoid fissuring rock outside tunnel																
Monitor water levels in wells; provide alternative water if needed																

101. **Budget:** Careful monitoring and amending of the blasting regime if necessary is work that the Supervision Consultant would expect to do, so associated costs will be included in their budgets for their supervision activities. The monitoring of well levels will be the responsibility of CEB as the project proponent, because it requires contact with the general public. CEB will probably employ a monitoring contractor, so additional budget provision will be needed. Experience from the 2013 survey suggests that water levels in 20 wells can be monitored in two days and this should be done every two weeks for the first three months and then once every 3 months for two years if no changes have occurred. The cost of this work is shown in Table 10.

102. **Consultant Terms of Reference:** ToR for the water level survey are as follows:

a) Senior Groundwater Specialist:

- Plan and conduct surveys of the level of water in 20 wells in the vicinity of the headrace tunnel, monitoring the same 20 wells each time;
- Conduct one survey before construction begins (baseline); then conduct further surveys once every 2 weeks for three months; then every 3 months for next two years;
- After each survey prepare a report describing water levels and drawing comparisons with previous data; draw conclusions regarding whether tunnel construction is causing any significant changes in water level in the wells

b) Field Assistants:

- Work under direction of the Senior Specialist, providing assistance as necessary.

Table 10: Budget for mitigation of construction-phase impacts on groundwater

Work Item	Quantity	Unit	Rate (SLR)	Cost (SLR)
Water levels in wells along tunnel route				
Senior Groundwater Specialist	$\frac{15 \times 4}{22}$	Person-month	300,000	819,000
Field Assistant (2)	$\frac{2 \times 15 \times 3}{22}$	Person-month	150,000	613,500
Water level dip meter	1	LS	200,000	200,000
Transport	15	300 km	40	180,000
Per Diem	15 x 3 x 3	day	6,000	810,000
Assumptions			**Total:**	**2,622,500**
3 days per survey including travel; 20 wells each time; monitored every 2 weeks for 3 months, then every 3 months for 2 years. Senior specialist will also spend 1 day writing a report after each survey				

4. Geology and Topography

103. **Impacts and Mitigation:** Expert geological and topographic studies of slope stability in the proposed reservoir area in 2009 and 2013 found no evidence of previous large-scale landslides and concluded that there was no significant risk of landslides during reservoir filling or as a result of the expected relatively small-scale fluctuations in reservoir water level during MHPP operation. The only precaution recommended by the 2013 study was to monitor reservoir slopes during impoundment to detect any small landslips (that cannot be predicted in advance) that may trigger larger landslides. The purpose of the monitoring is to enable appropriate mitigation to be devised and implemented in the unlikely event that landslips were to occur and remedial action was found to be necessary.

Table 11: Potential construction phase impacts on geology/topography and mitigation required

Potential Impact	L	Required Mitigation	By
Areas around reservoirs can be subject to land slips & slides from water destabilising slopes and wave action at water surface	R	Geological/topographic study found that landslides are unlikely	DC
		Monitor reservoir slopes during impoundment to detect small land slips that could trigger larger landslides	CEB
KEY: Location (L): R = Reservoir Responsibility (By): DC = Design Consultant; CEB = Ceylon Electricity Board			

104. **Implementation Arrangements:** CEB is responsible for monitoring the stability of land around the reservoir during impoundment, but the work will most likely be done by engineering geologists from the Supervision Consultant, who will observe sites on both sides of the river.

105. **Performance Indicators and Monitoring Requirements:** The expert study on reservoir slope stability (Volume 4) does not recommend any physical site investigations, so this survey will consist of observations only. If the conclusions of the expert studies are correct, the initial filling of the reservoir will be completed without any landslips or larger landslides.

106. **Scheduling:** Reservoir first-filling is scheduled for April 2020 and is expected to take 19 hours. This work will be conducted throughout that period, and over the subsequent month.

Figure 10: Programme for mitigating construction-phase impacts on geology/topography

Activities	2014	2015	2016	2017	2018	2019	2020	2021
		Pre-cons	Construction				Operation	
Monitor reservoir slopes during impoundment								

107. **Budget:** No additional budget provision is needed as this work will be covered by the budget for the services of the Supervision Consultant.

108. **Consultant Terms of Reference:** ToR for this monitoring are as follows:

- Observe the stability and behaviour of the reservoir slopes during the filling operation;
- If landslips occur, prepare an expert report describing any remedial action needed.

5. Air Quality

109. **Impacts and Mitigation:** Like water quality, air quality is another key area in which there are significant risks from these construction activities. Some of the potential sources are essentially the same as those for water quality impacts, as uncovered soil and site roads that may release silt during rainfall, could also liberate dust during dry and windy weather. Other air quality risks relate to the large numbers of vehicles used on site and in the transportation of materials, which will liberate exhaust gases. The river is again a sensitive site, as the project should not increase turbidity loads by allowing atmospheric dust to enter the river. Other sensitivity relates to site workers and staff, who should be protected from exposure to excessive dust; and local people who live or work in the vicinity of construction sites (eg Ulapane Industrial Estate near the dam, and small residential areas near the powerhouse and tailrace) or alongside the transportation routes. Vehicular emissions also have global implications by contributing to the loads of greenhouse gases, and the project will need to minimise these as much as possible to avoid negating any of the significant gains from the use of hydropower over fossil-fuelled forms of generation.

110. Table 12 shows that a range of activities are required to reduce the production of dust, including: implementing the measures aimed at reducing silt runoff as many will also limit dust; avoiding blanket clearance of site vegetation and re-vegetating areas as soon as feasible; spraying site roads, uncovered soil and spoil disposal areas in dry weather; providing workers with efficient dust masks; and regularly monitoring dust on site and in residential areas nearby. Measures to reduce emissions from vehicles and machinery include: prohibiting the use of older

vehicles; regular servicing of vehicles and machinery; repairing or replacing any with excessive emissions; and ensuring the use of emissions-reducing fittings on all vehicle exhausts.

111. **Implementation Arrangements:** Most of these measures are the responsibility of the Contractors; and the Supervision Consultant (on behalf of CEB) will ensure that site practices comply with these and the other mitigation requirements. The few activities assigned to the Design Consultant should already have been implemented; and if not, CEB will require the work to be conducted in January 2014 under the present contract.

Table 12: Potential construction phase impacts on air quality and mitigation required

Potential Impact	L	Required Mitigation	By
When dry, dust can be blown from exposed soil and site roads; this could reduce productivity of crops & vegetation, cause respiratory problems for workers and the public, and increase turbidity in the river	AS	Implement measures to limit soil erosion by rain as many will also reduce dust when dry (protect/vegetate cut surfaces; cover stored and transported loose material; design disposal operation; etc)	DC CC
		Plan & implement land clearance to remove vegetation in stages	CC
		Plan/conduct site planting to re-vegetate sites as soon as feasible	DC
		Spray site roads & large areas of bare soil thrice daily when dry	CC
		Periodically lightly spray soil at quarry & disposal sites if feasible	CC
		Provide workers with dust masks and training in their usage	CC
		Provide wheel washes at site exits; ensure usage by all vehicles	CC
		Monitor dust at Ulapane Estate; houses on Atabage-Mawathura Road; and near dam, powerhouse, quarry, disposal site 3	CC
Vehicle exhausts emit air pollutants. These pollute the air locally and alongside transportation routes, which may affect human health. Emissions also increase greenhouse gases and global warming	AS	Do not use any vehicles on site that are older than 10 years	CC
		Service/maintain vehicles/machines to manufacturer specification	CC
		Repair or remove any vehicles showing excessive visible exhaust	CC
		Fit all site vehicles & machinery with equipment to reduce exhaust emissions, including catalytic converters where applicable	CC
KEY:			
Location (L): AS = All Sites			
Responsibility (By): DC = Design Consultant; CC = Construction Contractors			

112. **Performance Indicators and Monitoring Requirements:** If the mitigation measures listed in Table 12 are conducted diligently throughout the construction period, dust will be adequately controlled, and the dust monitoring will show no significant or repeated exceeding of the specified levels either within the residential areas or on the construction sites themselves.

113. **Scheduling:** The risk of dust production is related primarily to the earthworks and other excavation (scheduled for 2016-17), and also to the spoil transportation and disposal operation, which will continue throughout the tunnelling period, from mid-2016 to mid-2019. There will be some initial planning of these activities in the design stage (by the design consultant) and in the pre-construction period (by the contractor). Heavy vehicles will operate on site throughout the whole construction period, so air quality risks from vehicular emissions will be a constant factor throughout almost the whole operation. The programme for this mitigation is shown in Fig 11.

114. **Budget:** Most of these measures just reflect good site practice, and should therefore already be the norm for experienced contractors, so no additional budget should be needed. The few activities assigned to the Design Consultant should already have been implemented;

and if not, CEB will require the work to be conducted in January 2014, within the present contract, so again no additional budget is needed. Dust monitoring is a specialised activity, so it might be beyond the capability of the Contractor; a budget for this activity is therefore provided below to allow the option of outsourcing this work if necessary.

Figure 11: Programme for mitigating construction-phase impacts on air quality

Activities	2014	2015	2016	2017	2018	2019	2020	2021
		Pre-cons	Construction				Operation	
Plan and implement land clearance to remove vegetation in stages								
Plan and implement planting to re-vegetate sites as soon as feasible								
Spray site roads and large areas of bare soil thrice daily in dry weather								
Periodically lightly spray spoil disposal areas if feasible								
Provide workers with dust masks and training in their usage								
Provide wheel washes at site exits and ensure usage by all vehicles								
Monitor dust at edge of all sites and in residential areas nearby								
Do not use any vehicles or machines >10 years of age								
Service/maintain all vehicles to manufacturers' specifications								
Repair or remove any vehicles showing excessive visible exhaust								
Fit all site vehicles with equipment to reduce air emissions								

Table 13: Budget for mitigation of construction-phase impacts on air quality

Work Item	Quantity	Unit	Rate (SLR)	Cost (SLR)
Dust Monitoring				
Senior Specialist	$\frac{45 \times 5}{22}$	Person-month	300,000	3,069,000
Field Assistants (2)	$\frac{2 \times 45 \times 4}{22}$	Person-month	150,000	2,454,000
Dust meters or gravimetric samplers (2)	2	Nos	3,000,000	6,000,000
Transport	45	300 km	40	540,000
Per Diem	45 x 4 x 3	Day	6000	3,240,000
Assumptions:			**Total:**	**15,303,000**
Monitoring dust at the edge of five construction sites and in nearby residential areas Dust to be monitored simultaneously at one site and the nearby residential area, for 3 hours per site 2 monitoring periods per working day; 4 days per monitoring exercise including travel. Conducted once a week for 2 months, then once a month for 3 years Senior Expert will write a report after each survey, reviewing data, highlighting any exceeding of set values (1 day)				

115. **Consultant Terms of Reference:**

c) Senior Air Quality Specialist:

- Plan and conduct surveys of ambient dust at the 5 sensitive sites (dam and Ulapane Estate; Transportation route and houses on Atabage-Mawathura Road; powerhouse, quarry, disposal site 3);
- Conduct surveys before construction begins (baseline); and then during construction, once a week at each site for 2 months; then once a month for the next 3 years;
- In each survey use 2 identical fixed meters or dust collectors to record dust simultaneously at a site and the nearby residential area, over a period of 3 hours;
- Prepare an expert report at the end of each month or survey, explaining the results and highlighting any exceedence or other concerns, with suggested remedial action.

d) Field Assistants:

- Work under direction of the Senior Specialist, providing assistance as necessary.

6. Noise and Vibration

116. **Impacts and Mitigation:** Noise and vibration is another field in which there are significant risks from these construction activities, both on and off site. Noise and vibration is produced by most construction activity: by the vehicles and equipment; and by their interaction with the physical environment when conducting the construction work; and in this project there will be major physical works within a relatively large area over a substantial period (4.5 years including site preparation). The risks relate mainly to: the disturbance of local residents and wildlife by noise and vibration from construction works and the transportation operation; the potential for structural damage to houses and other buildings; and the risk to the hearing of workers from exposure to repeated loud noise.

117. Table 14 shows that mitigation to reduce noise and vibration includes: expanding the controls on vehicles specified above, to incorporate measures targeted at noise and vibration; monitoring noise on site and in residential areas nearby; surveying the structural condition of houses and other buildings near major sites and transportation routes and providing remediation or compensation if damage occurs; and preparing and implementing an Occupational Health and Safety Plan (OHSP) at all sites, with measures to reduce exposure to noise and other workplace risks (see also section V.C.8 below).

118. **Implementation Arrangements:** Most of these measures are the responsibility of the Contractors, who will be required by their contracts to comply. The condition survey is assigned to CEB as it requires sensitive contact with the general public. In view of this it would be advisable for CEB to conduct this work themselves, although costs are estimated below so that it can be assigned to a suitably experienced survey company if necessary.

119. **Performance Indicators and Monitoring Requirements:** These mitigation measures will have been successful if:

a) The noise monitoring in sensitive areas (Table 14) shows no significant or repeated measurements above the prescribed values (see Chapter VI) *per se*; or
b) There was no significant or repeated exceedence after installation of noise barriers at any sites at which there was excessive noise initially; and
c) There was no significant vibration or structural damage to buildings as a result of the construction activities; or

d) Any structural damage was remediated or compensated by CEB to the satisfaction of the owners.

Table 14: Potential construction phase impacts on noise/vibration and mitigation required

Potential Impact	L	Required Mitigation	By
Noise & vibration is produced by most construction activity & vehicles. Exposure can cause stress and alter the behaviour of both people and wildlife, and reduce their quality of life.	AS	Implement measures to reduce air emissions by using newer vehicles & regular servicing- these will also control noise/vibration	CC
		Repair or remove any vehicles emitting excessive noise/vibration	CC
		Fit all site vehicles & machinery with appropriate equipment to reduce noise, including appropriate exhaust silencers	CC
Sensitive sites are those with houses nearby (dam, powerhouse, disposal site 3, tailrace); noise barriers may be needed	D PH T SD3	Monitor noise & vibration in inhabited areas near sensitive sites; install noise barriers if noise is high and if required by residents	CC
		Stop night-time working at affected sites if residents complain	CC
Vibration could cause structural damage to houses close to work sites		Survey condition of structures in sensitive areas (crack survey) before & during construction. Remediate/compensate if damaged	CEB
Workers' hearing may be impaired by exposure to loud and repeated noise; and safety may also be compromised if warning sounds are not heard clearly	AS	Prepare OHSP with measures to protect workers & others who come in contact with construction work	CC
		Ensure OHSP is implemented fully at all sites & other work areas	CC
		Include in OHSP at least the following:	
		- Provision and use of appropriate ear protectors when needed	CC
		- Limiting noise exposure to requirements of Sri Lankan law or international standards (whichever provides greater protection)	CC
		- Training in dangers of exposure to repeated/excessive noise and vibration and means of avoidance and reduction	CC

KEY:

Location (L): AS = All Sites; D = Dam; PH = Powerhouse; T = Tailrace; SD3 = Spoil Disposal Site 3

Responsibility (By): CC = Construction Contractor; CEB = Ceylon Electricity Board

120. **Scheduling:** Noise and vibration are a risk whenever there is any activity on site, so most of the related mitigation measures should commence during the pre-construction site clearing activity and continue throughout the whole construction period. The vibration and condition survey of buildings should be conducted before there is any activity on site (baseline) and then be conducted annually. Smaller-scale surveys of individual buildings should also be conducted at any time there are complaints from residents.

121. **Budgets:** Most of these measures are elements of good construction site practice, so (as with many of the other environmental safeguards discussed above) CEB is entitled to expect that experienced contractors will already comply automatically with all requirements, and that additional budget provision will not be necessary. CEB may conduct the vibration and structural condition survey themselves or they may engage a specialised consultant to do so, so a budget for this is outlined below. A budget is also provided for the noise survey as this is specialised work, which may also need to be outsourced.

Figure 12: Programme for mitigating construction-phase impacts on noise/vibration

Activities	2014	2015	2016	2017	2018	2019	2020	2021
		Pre-cons	Construction				Operation	
Repair or remove any vehicles emitting excessive noise/vibration								
Fit all site vehicles with equipment (eg silencers) to reduce noise								
Monitor noise in inhabited areas; erect noise barriers if necessary								
Stop night working at any sites at which there are complaints								
Survey condition of structures; remediate/compensate for damage								
Prepare OHSP to protect workers against all site risks; implement								
Provide regular OHSP training								

Table 15: Budget for mitigation of construction-phase impacts on noise/vibration

Work Item	Quantity	Unit	Rate (SLR)	Cost (SLR)
1. Structure Condition Survey:				
Senior Building Surveyor or Architect	3	Person-months	300,000	900,000
Field Assistants (2)	2 x 3	Person-months	150,000	900,000
Per Diem	3 x 6 x 14	day	6,000	1,512,000
Transport	6	300 km	40	72,000
			Total:	**3,384,000**
2. Noise and Vibration Survey:				
Senior Noise and Vibration Specialist	$\frac{6 \times 20}{22}$	Person-months	300,000	1,635,000
Field Assistants (2)	$\frac{2 \times 5 \times 20}{22}$	Person-months	150,000	1,363,500
Per Diem	3 x 5 x 20	day	6,000	1,800,000
Transport	20	300 km	40	240,000
Noise Meter	2	LS	250,000	500,000
Vibration Meter	2	LS	1,500,000	3,000,000
Assumptions			**Total:**	**8,538,500**
Structure survey:	2 weeks per survey, including travel and report preparation; 6 surveys			
Noise and vibration survey:	4 h per site; duplicate meters; 4 locations per day. 16 locations = 5 days per survey with travel. Senior Expert 1 extra day for report. Weekly for 2 months; then every 3 months for 3 years			

122. **Consultant Terms of Reference:**

123. Structure Condition Survey:

a) Senior Building Surveyor/Architect:

- Consult Aerial Photographs and Land Use Map in the Environmental Addendum;
- Identify buildings at risk from vibration near construction sites and transport route;
- Visit all buildings and conduct a baseline survey the in pre-construction period:
- Take measurements and photographs of all cracks and other structural weaknesses and mark each with a unique reference number; record any other relevant observations;
- Prior to each subsequent survey, specify ten buildings at which the vibration consultant will conduct vibration surveys; these can be the same or different buildings each time;
- Review data from vibration surveys and incorporate into this study as appropriate;
- Repeat the survey every six months during the construction period;
- Produce an expert report after each survey, discussing the condition of all buildings and highlighting any damage that may have been caused by the MHPP construction.

b) Field Assistants:

- Work under direction of the Senior Building Surveyor, providing assistance with measurements, observations and other matters as necessary.

124. Noise and Vibration Survey:

a) Senior Noise and Vibration Specialist:

- Plan and conduct surveys of ambient noise and vibration at the 5 sensitive construction sites (dam, powerhouse, disposal site 3, tailrace and contractors area/transport route) - and at one other location specified by CEB;
- Locate noise and vibration meters at the edge of the construction site and in the nearest inhabited area;
- Monitor noise and vibration at ten other buildings specified by the structural surveyor;
- Use two identical meters for both noise and vibration measurements. At each site record for 4 hours in the working day and cover 4 locations per day;
- Conduct surveys before construction begins (baseline); and then once a week at each site for 2 months; then once every 3 months for 3 years if noise and vibration levels are not exceeded significantly or repeatedly and there are no complaints from residents;
- Prepare an expert report at the end of each survey, explaining the noise and vibration results; highlight any exceedence or other concerns, with suggested remedial action.

b) Field Assistants:

- Work under direction of the Senior Noise Specialist, providing assistance as necessary.

7. Physical Cultural Resources

125. **Impacts and Mitigation:** An expert assessment in 2009 concluded that there is little risk of the construction work causing archaeological damage because: a) the four known sites in the area are all more than 2 km away and will therefore not be affected by vibration from blasting or other sources of impact; and b) there was no archaeological scatter in the area so it is unlikely that excavation will uncover new material. The project will however adopt a precautionary approach by establishing a 'chance finds' procedure, which prescribes appropriate action in the event that a discovery is made. The procedure is provided in Appendix 2, and must be applied by the Contractor whenever any archaeological material is suspected. Excavator operators and

site supervisors will also be given training by archaeologists in the requirements of the chance finds procedure, and recognition of archaeological material in the field.

126. There are some locations of local cultural importance in the project area that could be damaged by traffic or vibration, including a Buddhist shrine beside the entrance to the Contractors' area (Photo 1). A precautionary approach will also be adopted to these places, and CEB will consult the local community to determine the location and nature of all such sites, to assess the potential risks from the project, and to agree suitable protection if necessary. This could involve such measures as enforcing speed limits in the vicinity, moving structures to safer locations if feasible, and/or paying compensation if any damage is sustained.

Photo 1: Buddhist shrine on Atabage-Mawathura Road at the entrance to the proposed Contractors' Area

127. **Implementation Arrangements**: As noted variously above, the Contractors will be legally bound by the construction contracts to implement these and all other mitigation measures allocated to them in this document to the satisfaction of the Supervision Consultant and the client; and this should mean that the chance finds procedure and any measures required to protect the locally-important sites will be adhered to. The other mitigation measures shown in Table 16 are the responsibility of CEB as they require contact and discussion with the local community and commissioning of training by experts from the government Department of Archaeology.

Table 16: Potential construction phase impacts on physical cultural resources and mitigation required

Potential Impact	L	Required Mitigation	By
An expert investigation concluded that excavation is unlikely to reveal archaeological material because this is an area of low potential	AS	Use precautionary approach: establish a chance finds procedure with action to be taken if archaeological material is discovered	CC
		Train excavator operators and site supervisors in recognition of archaeological material and action to be taken if necessary	CEB
Roadside shrines and other locally-important cultural structures or places could be damaged by traffic and vibration; and people visiting them could be injured.	AS	Contact local communities to determine location of any sites of cultural importance (shrines, meeting places, etc)	CEB
		Discuss mitigation with affected community; implement when agreed (eg speed limits, compensation, relocation of sites, etc)	CEB CC
KEY:			
Location (L): AS = All Sites; D = Dam; PH = Powerhouse; T = Tailrace; SD3 = Spoil Disposal Site 3			
Responsibility (By): CC = Construction Contractor; CEB = Ceylon Electricity Board			

128. **Performance Indicators and Monitoring Requirements:** There is no monitoring associated with this component of the EMP, because the risk of impacts is quite low. If the chance finds procedure is successfully applied, then at the end of the construction period it will be concluded that either:

a) No archaeological material was found at any site during the course of the works; or
b) All archaeological material found was recognised, protected and subject to an expert assessment, and was removed to an archaeological laboratory or museum for further study and preservation if appropriate.

129. The measures to protect the locally-important cultural sites will have been successful if at the end of the construction period it is concluded that:

a) No damage as a result of the project was sustained at any site; and
b) No person visiting any cultural site was injured or inconvenienced in any way as a result of construction traffic or activity.

130. **Scheduling:** The chance finds procedure will need to be in operation at any time there is ground disturbance, so it should be applied throughout the construction period, and also in the pre-construction stage when there will be some ground clearance. Training in the chance finds procedure and recognition of archaeological material should be provided at the beginning of the pre-construction and construction periods (before any work starts in each case), and then repeated approximately annually to any new staff and workers. CEB should conduct their discussions with the local community regarding locally-important sites in the pre-construction period, so that any relocation or other protection measures can be completed before construction begins.

131. **Budgets:** The archaeological training will need to be conducted by suitable qualified and experienced experts, so a budget for this work is outlined below.

Figure 13: Programme for mitigating construction-phase impacts on physical cultural resources

Activities	2014		2015		2016		2017		2018		2019		2020		2021	
		Pre-cons			Construction								Operation			
Establish and operate chance-finds procedure																
Training to identify archaeological material & chance-finds procedure																
Consult local community on sites of local cultural importance																
Assess risk to each site and propose protection																
Implement protection with community agreement/participation																

Table 17: Budget for mitigation of construction-phase impacts on physical cultural resources

Work Item	Quantity	Unit	Rate (SLR)	Cost (SLR)
Senior Archaeologist	$\frac{7 + (3 \times 5)}{22}$	Person-month	300,000	300,000
Per Diem	3 x 5	day	6000	90,000
Transport	5	300 km	40	60,000
Assumptions:			**Total:**	**450,000**
7 days of training preparation; 3 days per training session (including travel and observation of work); 5 sessions				

132. **Consultant Terms of Reference:**

c) Senior Archaeologist:

- Prepare a training course for excavator operators and site supervision staff to promote the protection of any archaeological material discovered during MHPP construction;
- Cover at least: the importance of archaeological discoveries and the risks from construction work; the likelihood of finding material at the MHPP site; the specific requirements of the MHPP chance-finds procedure; and how to recognise and protect chance archaeological finds;
- The course should take a maximum of one day, if needed and should include presentation sessions and examination of discovered material;
- Deliver the training course five times at approximately annual intervals as arranged by CEB;
- During each visit to site, observe construction practices and advise CEB on any additional precautions to avoid archaeological damage, if appropriate.

8. Occupational Health and Safety

133. **Impacts and Mitigation:** In construction projects the client and the contractor both have a responsibility to provide a safe working environment for people engaged in the construction process, and any visitors to site, and any persons who may come into contact with the construction activity outside the designated sites (along transportation routes for example). The Occupational Health and Safety Plan (OHSP) is the principal mechanism of complying with this responsibility, and the main contractors will be required to produce their own OHSPs (which are carefully reviewed and amended if necessary by the Supervision Consultant on behalf of the client) and to apply them thoroughly at all sites and offsite locations, at all times. Sub-contractors may also be required to produce their own OHSP, or at least to be aware of and comply fully with the requirements of the main contractor's plan when engaged in this project.

134. All OHSPs prepared within this project must incorporate at least the following:

- A thorough assessment of all risks associated with each element of the construction work for which the contractor is responsible, including physical, chemical, biological and radiological hazards;
- Appropriate steps to prevent accidents, injury and disease arising from or associated with each work activity, by means of the following as appropriate:
  a. Identifying and minimising the causes of potential hazards;
  b. Providing preventative and protective measures, including modification, substitution or elimination of hazardous conditions or substances;
  c. Providing appropriate equipment to minimize risks and requiring/enforcing its use;
  d. Training workers and providing them with appropriate incentives to use and comply with H&S procedures and protective equipment;
  e. Documenting and reporting occasional accidents, diseases and incidents; and
  f. Establishing emergency prevention, preparedness and response arrangements.
- Preventative and protective measures must be consistent with international good practice, as reflected in internationally recognised standards[10].

135. Specific OHS requirements identified in the Environmental Addendum and already mentioned above are as follows, which must be fully incorporated into the Contractor's OHSP, along with the full range of further measures to comply with all other risks in compliance with the above requirements:

- Provide adequate toilets and bathrooms at all accommodation sites and ensure they are cleaned and consumable materials are replenished each day;
- Provide adequate toilets and washrooms at all work sites according to the numbers of persons present and ensure they are cleaned and consumable materials are replenished each day;
- Provide all workers and staff with face masks designed to eliminate dust inhalation and replenish filters according to manufacturers' specifications;
- Provide all workers and staff with appropriate ear protection and instruction in its usage;
- Limit exposure to noise according to the requirements of Sri Lankan Law (see Appendix 3) or international standards[10], whichever provides the greater protection;

[10] World Bank (2007): *Environmental, Health and Safety General Guidelines.* Washington DC

- Train all workers and staff in the dangers of exposure to repeated and excessive noise and dust and means of avoidance and reduction.

136. **Implementation Arrangements**: All main Contractors will be required by their contracts to produce an OHSP in compliance with the above requirements and to apply its provisions rigorously throughout all work activity. Contractors will also be required to ensure that any sub-contractors and other third parties they may employ also comply with the OHSP in all activity conducted in relation to this project. Draft OHSPs will be reviewed by senior staff of the Supervision Consultant, who will also observe and examine compliance during their construction supervision activities.

137. **Performance Indicators and Monitoring Requirements:** The specific items listed above include a requirement for the contractor to keep records of all accidents, diseases and incidents that occur in relation to construction activities and the mitigation provided by these measures will be deemed successful if these records show no deaths, no major accidents or incidents, and only minor injuries, diseases or incidents, that were appropriately dealt with, restoring the affected persons to full health and resumed employment within an appropriate time.

138. **Scheduling:** Construction contracts will require the main contractors to submit their draft OHSPs for review and approval or amendment by the Supervision Consultant and Client, before any construction work begins, and to then apply the measures of the OHSP rigorously throughout the entire period of their engagement.

139. **Budgets:** Preparation and implementation of an OHSP is required by all major contracts, so contractors will make the necessary budget provision in preparing their tenders.

140. **Consultant Terms of Reference:** OHSPs are prepared by senior specialists within the Contractor's organisation, so there will be no usage of external consultants.

D. Operation Phase EMP

141. Compared with the construction phase, there will be far fewer environmental risks when the MHPP is operating, primarily because hydropower does not use finite sources of energy or produce significant environmental emissions. There are still some potential sources of negative impact however, which will need to be mitigated to the extent possible, and responsibility for this lies mainly with CEB, who will take on the role of operating agency. Environmental risks mainly relate to the changes in flow regime in the river and include the following:

- Hydrology: if Moragolla and Kotmale stations are operated on the same peaking cycle, water flow and depth may be reduced downstream of the tailrace in the dry season;
- Water Quality: retention of water in the reservoir in the dry season and reduced circulation may de-oxygenate water, especially if vegetation is decomposing on the bed;
- Biodiversity: The dam will separate upstream and downstream fish populations, which may reduce genetic diversity and long-term survival of the populations;
- Ecology: creation of the reservoir will alter fish populations as those able to adapt to deep water will increase and those that prefer fast-flowing water may move upstream;
- Safety: people bathing and sand-mining downstream of the tailrace will experience raised water levels when Moragolla and Kotmale stations re-start operations each day.

142. Mitigation of the impacts on fish biodiversity and ecology is discussed in the Special Issues EMP for Aquatic Ecology in Section V.E below. Mitigation of the other impacts of the operational phase is described in this section below. Issues are summarised in Table 4 above and relate to hydrology, water quality, river users and dam safety. Mitigation is dealt with according to these individual environmental parameters so that further information can be sourced readily from the Environmental Addendum if necessary, by referring to the relevant topic. Each topic is dealt with in the same way as in the other EMPs in this document, providing information on: impacts and mitigation; implementation arrangements; performance indicators and monitoring requirements; scheduling; budgets; and ToR for consultants where appropriate.

1. Hydrology and Environmental Flow

143. **Impacts and Mitigation:** When the MHPP is operating the reservoir will provide a large, new and relatively stable water body upstream, but river flow will be reduced downstream. Around 50 m^3/s of water is diverted through the headrace tunnel when power is generated, and returned to the river through the tailrace outfall 2.7 km downstream. There will therefore be major changes in flow between the dam and tailrace. In the dry season there will be very little overflow from the dam, so river flow will comprise the E-flow of 1.5 m^3/s (which is 41% of the average minimum natural flow), plus an input from a small local stream (Gal Kotuwa Ela, Fig 2). In the monsoon, E-flow will be augmented by overspill from the reservoir and increased inflow from Gal Kotuwa Ela, so flow will be higher, but still less than normal.

144. Downstream of the tailrace outfall, river flow will be similar to normal in the monsoon as water will be discharged from the Moragolla and Kotmale tailraces during the 15-19 hour power generation period each day and there will be flood season inputs from Atabage Oya and other tributaries. In the dry season the tailraces will only release water during the 4-6 hour generation cycle, so for 18-20 hours each day river flow will comprise Moragolla E-flow (as there is no E-flow from Kotmale), plus dry season inputs from tributaries. Figure 14 shows that there are only three tributaries in the first 8 km below the tailrace so flow will is likely to be reduced in this area.

145. These flow reductions provide less habitat for fish and other aquatic animals and plants and less dilution for pollution inputs (including the Crysbro outfall), and may increase the risk to people bathing and mining sand in the river from increases in depth when the tailraces resume operation. These impacts would be exacerbated if the Moragolla and Kotmale stations were operated on the same peaking cycle, which is the present proposal. Conversely the impacts would be moderated if it was possible to operate the stations out-of-phase in the dry season, thus extending the daily period in which E-flow is augmented by additional tailrace water. The Environmental Addendum recommended that CEB should investigate the feasibility of operating the stations in this way as a means of limiting the downstream extent of hydrological and other changes.

146. **Implementation Arrangements:** No special arrangements are needed in order to implement this work as it will be conducted by discussion at senior level within CEB, organised by the MHP Project Manager. Any technical work involved will also be done by CEB, who will report on the outcome to ADB.

147. **Performance Indicators and Monitoring Requirements:** If the two stations are operated out-of-phase in the dry season, it is expected that the major changes in river flow and water depth would be limited to the 2.7 km between the Moragolla dam and the tailrace outfall and would not extend downstream. This could be determined by establishing automatic depth

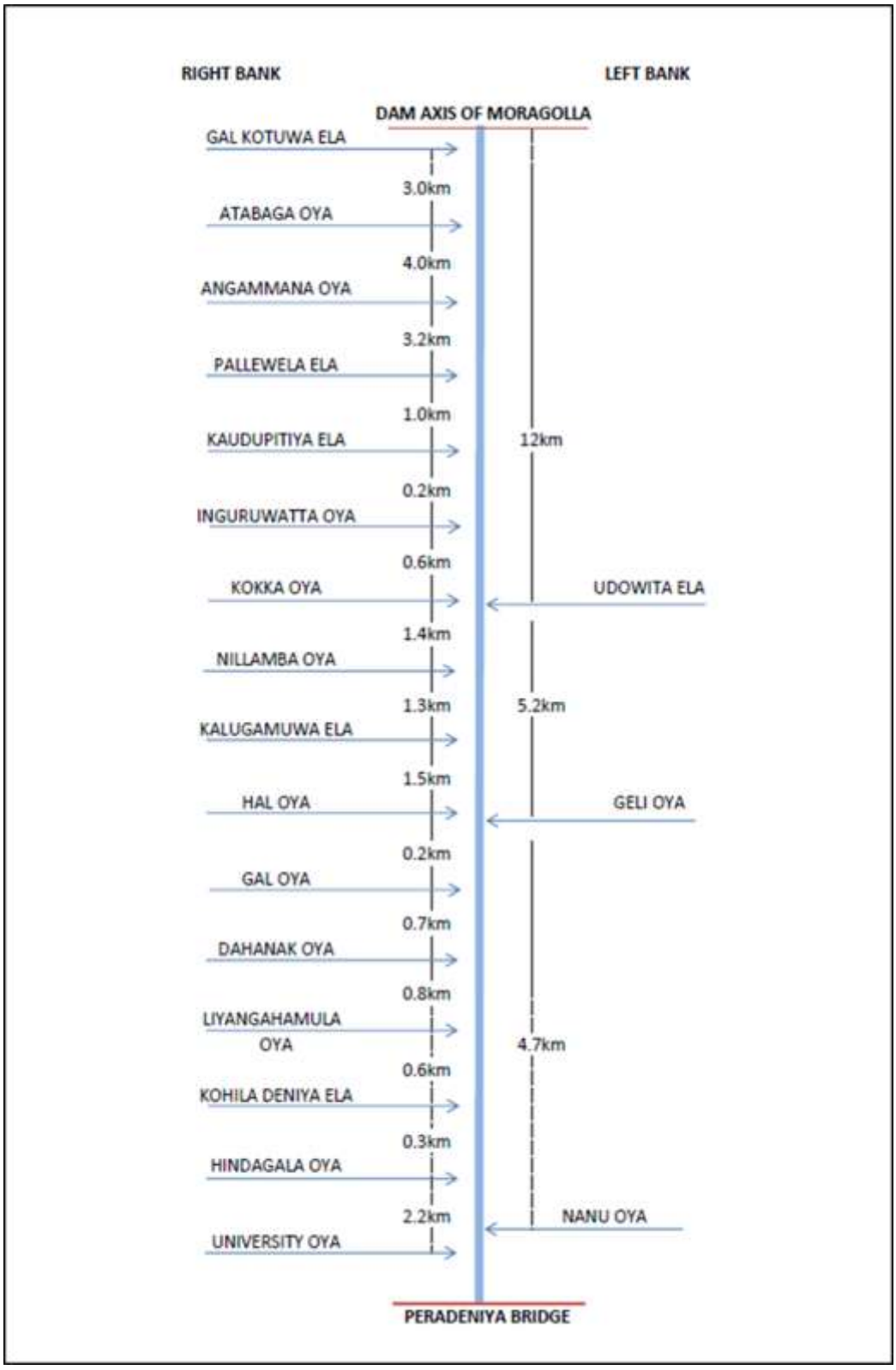

Figure 14: Confluences of the Mahaweli Ganga from Moragolla Dam site to Peradeniya Bridge

and flow monitoring stations at regular intervals. However this would be a major undertaking (and data analysis task) that would not enhance the mitigation, as this is the only way that flow can realistically be increased whilst still meeting the power generation requirements from the two stations. It is proposed instead that CEB should assess whether operation of the two stations out of phase reduces the effect of flow changes downstream much more simply, by interviewing river users three months after the start of operations, to determine whether they have noticed any changes in flow and depth.

148. **Scheduling:** The assessment of the feasibility of operating the two stations out of phase in the dry season should be done as soon as possible (in late 2013 or early 2014), so that ADB can be informed of the outcome, as this is the only mitigation measure proposed in the Environmental Addendum to address long-term downstream hydrological impacts. The informant survey of river users should be conducted once, in the first dry season after the MHPP begins full operation.

149. **Budgets:** The operational assessment and the survey of river users will both be done by CEB staff in the course of their normal duties so no budget provision is needed.

150. **Consultant Terms of Reference:** There is also no need for input from consultants. CEB is the national authority on operation of hydropower stations in Sri Lanka so they will need no external assistance in determining whether the two stations can be operated out-of-phase; and they conducted the downstream river users survey for the Additional Studies in October 2013, so they also have experience of this kind of work.

2. Water Quality

151. **Impacts and Mitigation:** There are some concerns regarding the quality of water in the reservoir and flowing downstream once the MHPP is operating, and these are mainly related to the reduced downstream flow discussed above, and the reduced turnover of water in the reservoir in the dry season, when there will be only limited replenishment by rain-driven inflow from upstream. Table 18 shows that the risks are that: a) water in the reservoir could become de-oxygenated in the dry season, especially if the present vegetation is left in place to decompose, which could affect fish and other organisms living in the water; b) the reduced downstream flow will provide less dilution for the Crysbro effluent (which currently exceeds the national discharge standards), which again could cause ecological impacts; and c) there could be major increases in turbidity if at some stage in the future the sediment that accumulates in the reservoir over the long-term, is pumped downstream.

152. Mitigating these impacts will require a range of measures shown in Table 18. These include; implementing Watershed Management and Afforestation Plans (discussed in Section V.F below) to reduce inputs of silt and other pollutants; removing trees and shrubs from the reservoir before impounding; extending the Crysbro outfall to discharge downstream of the Moragolla tailrace and coordinating Crysbro releases to occur when the Moragolla tailrace is also in operation; and operating the Moragolla and Kotmale tailraces out-of-phase in the dry season (as discussed above) to dilute the Crysbro effluent over a longer period each day.

153. **Implementation Arrangements:** Uprooting trees and shrubs in the reservoir area should be done at the very end of the construction period, to avoid disturbed and exposed soil being present over a long period, which could liberate dust or silt-laden runoff. This is already included in the tender documents for the main civil works contract and should be implemented

Table 18: Potential operation phase impacts on water quality and mitigation required

Potential Impact	L	Required Mitigation	By
Reduced reservoir circulation in dry season could de-oxygenate water at lower levels, especially if vegetation is decomposing on the bed	Re	Remove (uproot) all trees/shrubs from reservoir before first filling	C
		Promote improved land management to reduce pollutant inputs in Moragolla watershed (see Watershed Management Plan below)	CEB
		Plant sediment-retaining trees and other vegetation in the reservoir buffer (see Afforestation Plan below)	FD FC
		Build check dams and sediment traps at the reservoir edge; dispose of retained silt regularly (see Watershed Plan)	CEB
		Regularly monitor water quality in the reservoir; set up additional mitigation (eg artificial aeration) if found to be necessary	CEB
Sediment will collect in the reservoir over 50 years. If silt is pumped downstream it will increase turbidity and affect flora/fauna	Re	If sediment is pumped downstream, do this gradually throughout the monsoon season to achieve maximum dilution	CEB
Reduced river flow will provide less dilution for the Crysbro effluent (which exceeds legal standards) and other pollutants	Ri	CEB will extend Crysbro outfall to downstream of the tailrace. The upstream pipes are broken and should also be repaired	CEB
		Discuss with CEA & Crysbro their responsibility to treat effluent. Discuss discharging effluent when Moragolla tailrace is operating	CEB
		Operate Moragolla and Kotmale HPPs out of phase in dry season to supplement E-flow and dilute pollutants for a longer time	CEB
KEY:			
Location (L):	Re = Reservoir; Ri = River		
Responsibility (By):	C = Contractor; CEB = Ceylon Electricity Board; FD = Forest Dept; FC = Forestry Contractor		

as one of their final activities. The design consultant is currently preparing designs for a refurbished and extended Crysbro outfall, and this will be built as part of the tailrace construction works. The remaining mitigation measures are ultimately the responsibility of CEB as the scheme operator, and they will appoint contractors and consultants to conduct some of the work, including: preparation and implementation of the Watershed Management Plan and Afforestation Plan (see Section V.F); and monitoring water quality in the reservoir. The programme is shown in Fig 15.

154. **Performance Indicators and Monitoring Requirements:** If the mitigation to sustain water quality in the reservoir is successful, the monitoring shown in Table 18 will confirm the presence of well aerated good quality water throughout the reservoir in all seasons. To demonstrate the effective dilution and dispersion of the Crysbro effluent, the monitoring will be extended to include 3 stations in the vicinity of that outfall.

155. **Scheduling:** Vegetation in the reservoir should be removed at the end of the construction period to avoid leaving bare soil exposed as explained above. Water quality in the reservoir should be monitored at intervals throughout the operation period as discussed below. The repair and extension of the Crysbro outfall will be carried out during construction of the tailrace outfall, which is scheduled for 2018 according to the construction programme (Fig 3). At that time CEB will discuss with Crysbro the need for them to apply adequate treatment to their effluent before discharge, and will also discuss the concept of coordinating the irregular releases from the Crysbro outfall with the daily operation of the Moragolla tailrace to maximise the dilution (and dispersion) potential.

Figure 15: Programme for mitigating operation-phase impacts on water quality

Activities	2014	2015	2016	2017	2018	2019	2020	2021
		Pre-cons	Construction				Operation	
Uproot & remove trees & shrubs from reservoir before first filling								
Monitor water quality in reservoir and downstream								
Extend Crysbro outfall and repair upstream pipes								
Discuss with Crysbro effluent treatment & coordinating discharge								
Investigate feasibility of operating Moragolla & Kotmale out of phase								

156. **Budgets:** CEB will employ an environmental monitoring contractor to monitor water quality in the reservoir and downstream; so a budgets for this activity is given below.

Table 19: Budget for mitigation of operation-phase impacts on water quality

Work Item	Quantity	Unit	Rate (SLR)	Cost (SLR)
Monitor water quality in reservoir and river				
Senior Water Quality Specialist	$\frac{3 \times (6+8)}{22}$	Person-months	300,000	573,000
Field Assistant (2)	$\frac{2 \times 2 \times 14}{22}$	Person-months	150,000	382,500
Boat and Operator	14	Day hire	5,000	70,000
Water Quality Meter; GPS Reader	Purchased in Construction Phase			
Laboratory Analysis (BOD_5, NH_3, NO_3, P, Coliforms)	14 x 30	Per sample	5,000	2,100,000
Transport	14	300 km	40	168,000
Per diem	3 x 2 x 14	day	6,000	504,000
Assumptions:			**Total:**	**3,797,500**
Water quality:	Monthly for 6 months; then 6 monthly for 4 years; 9 stations in reservoir - surface, mid depth, bed; 3 stations downstream (one depth). Parameters: Temperature, pH, Turbidity, TSS, DO, BOD_5, Ammonia, Nitrate, Phosphorus, Faecal Coliform, Total Coliform. 2 days per survey including travel; Senior 1 extra day for report			

157. **Consultant Terms of Reference:**

158. Water Quality Survey:

a) Senior Water Quality Specialist:

- Plan and conduct surveys of water quality at 9 stations in the MHPP reservoir and 3 stations in the river downstream;
- Surveys should be conducted at one-month intervals for the first six months and then at six-monthly intervals for the next four years;
- Stations in the reservoir should be arranged in a grid pattern comprising three rows of three stations: near the dam; towards the centre of the reservoir; and near the upstream

end of the reservoir; in each row of three, the stations should be arranged towards the left and right banks and in the centre of the reservoir;
- In the river downstream one station should sample the water discharged from the new Crysbro outfall, and the two other stations should be at 100 m intervals downstream;
- At each reservoir station, parameters should be recorded at three depthts: 0.5 m below the surface; 0.5 m above the bed; and at mid-depth;
- At downstream stations, parameters should be recorded once, 0.5 m below the surface;
- Each station shall be geo-referenced and stations shall be positioned at the same locations for each survey;
- At each depth the following shall be recorded: Water temperature, pH, Turbidity, TSS, DO, BOD_5, Ammonia, Nitrate, Phosphorus, Faecal Coliform, Total Coliform;
- After each survey prepare a report presenting and discussing the results, comparing with previous data, explaining the reasons for any key features, and drawing conclusions regarding water quality in the reservoir and in the river downstream.

b) Field Assistants:
- Work in the field under the direction of the Senior Water Quality Specialist, taking meter readings and water samples, and providing other assistance as necessary.

3. River Users

159. **Impacts and Mitigation:** Surveys for the Local EIA and Environmental Addendum showed that the only human uses between the proposed sites of the dam and tailrace outfall are the Crysbro factory and the Dunhinda Irrigation Canal, which both have intakes to extract permitted amounts of water (220,000 litres/day and 0.28 m^3/s respectively). The E-flow has been designed to provide sufficient water for these operations, so the changes in downstream flow should have no impacts on human uses in this area. There are other uses downstream of the tailrace outfall, comprising sand-mining and washing/bathing in the river by the local community. The hydrological analysis discussed in Section V.C.1 suggests that there may be flow changes in the upper 8 km of this stretch in the dry season, when the Moragolla and Kotmale outfalls will only discharge for 4-6 hours each day. Farther downstream there are 14 tributaries in a length of 10 km (Fig 14), so inputs from these should provide a relatively normal regime.

160. People using the river in the first 8 km downstream of the tailrace outfall may therefore be subject to changes in flow and water depth over a relatively short timescale when the Moragolla and Kotmale HPPs resume operations each day, especially if both stations are operated on the same daily cycle; so this could increase the risk inherent in these activities. CEB already has plans to address these risks, by: a) raising awareness of the likely changes in water level through information programmes in the mass media; and b) installing sirens in this area to warn people when the combined discharge from the Moragolla and Kotmale tailraces will exceed 110 m^3/s. Two additional measures were proposed in the Environmental Addendum to further increase safety. These were to:

- Extend the system of warning sirens to Kaudupitiya Ela 11.2 km downstream (Fig 14), to cover the whole area in which changes in flow rate and water level are anticipated;
- Modify the operation of the sirens to provide a warning each time that flow from the tailraces is about to resume (on a daily basis) after a period of no flow.

161. **Implementation Arrangements:** CEB is already proposing to set up warning sirens in the area downstream of the Moragolla Dam before the scheme begins to operate, so extending this system down to Kaudupitiya Ela will be done very simply, by including the work in the same contract. Modifying the operational parameters to provide a warning when the tailraces resume daily operations will be done in the same way.

162. **Performance Indicators and Monitoring Requirements:** If the mitigation to maintain safety for downstream users is successful there will be no deaths or injuries due to changes in water flow or depth as a result of operation of the MHPP. There will be no need to monitor any such occurrences, as the MHPP personnel will be members of the local community and will learn of any such incidents without surveys.

163. **Scheduling:** This mitigation essentially requires relatively straightforward modifications to CEB's existing plans, so the work will be done according to the presently proposed schedule, presumably towards the end of the construction period in 2019.

164. **Budgets:** These measures will require some additional budget, but the amount cannot be estimated precisely as the nature of the work proposed by CEB and the budget is not known at this stage. CEB should therefore recalculate the budget when incorporating the additional work.

165. **Consultant Terms of Reference:** The following simple additions should be made to the ToR prepared by CEB for the work as originally proposed:

- The system of warning sirens shall cover the riverbank areas between the Moragolla Dam and the confluence with Kaudupitiya Ela approximately 11.2 km downstream;
- Operation of the sirens should include provision of a warning 15 minutes before the time at which flow from the Moragolla and/or Kotmale tailraces is about to resume (on a daily basis) after a period of no flow.

4. Dam Safety

166. **Impacts and Mitigation:** Independent analyses for the Feasibility Study in 2009 and the FS Review in 2013 (see Volume IV) both came to the strong conclusion that there is no possibility that the dam might fail. The FS Review study explained that 2,500 concrete gravity dams have been built worldwide since the 1930's and none has failed. Nevertheless CEB wishes to ensure that rigorous safeguards are in place to reduce and avoid to the extent possible the widespread damage and destruction of property, assets, livelihoods and natural resources that may occur downstream in the unlikely event that the dam were to break, and the associated loss of life. The table below shows that the mitigation proposed to provide these safeguards is to establish a Disaster Preparedness Plan (DPP) and an early warning system, and to regularly train the key persons responsible for implementing the DPP.

Table 20: Potential operation phase impacts on dam safety and mitigation required

Potential Impact	L	Required Mitigation	By
It is very unlikely that a concrete dam will fail as this has not occurred since 1930s. If there was a failure, water levels would rise by 20 m over a wide area, causing large	Ri	Prepare a Disaster Preparedness Plan (DPP) with activities and responsibilities to minimise loss of life and property damage	CEB
		Set up emergency warning system to inform people of likely dam failure and emergency actions to save lives and communities	CEB

scale damage, destruction and death		Regularly train those responsible for DPP implementation	CEB

167. The DPP should address the training, resources, responsibilities, communications, procedures and other aspects required to respond effectively to the emergencies associated with a potential dam failure. It should include a plan to provide appropriate information to the potentially-affected communities about emergency preparedness and response activities, resources and responsibilities, in a manner that is appropriate to the risk that will not raise unnecessary alarm.

168. The DPP should include but not be limited to the following elements:

Dam Break Analysis and Inundation Mapping	• Risk of dam breach, including seismic analysis; • Accurate and current inundation mapping for the dam breach event (incorporating analyses from the design stage if suitable); • Land use in inundation areas, inhabitation, significant development and high-risk areas (schools, hospitals, dense inhabitation, etc);
Emergency Action Plan	• All actions in the event of a dam breach, covering pre-disaster, emergency, and post-disaster stages, with activity schedules and responsibilities; • Actions include: preventative; notifications; warning procedures; inter-agency coordination; evacuation plans, with prioritisation and shelter plans;
Preventative Action	• Dam inspections; spillway opening regimes; regimes at downstream dams; • Emergency equipment and personnel (sources and sourcing);
Notification:	• Notification procedures: key responsible personnel; emergency agencies; national authorities; communication methods; contact details
Warning System	• Downstream warning system: sirens; mass media (TV, radio); • Levels: early warning; emergency situation; evacuation; post-evacuation
Evacuation Plans	• Prioritization rationale and prioritized evacuation areas; • Notification procedures; evacuation process; safe routes; transport; traffic control; safe areas and shelters; evacuation team and responsibilities;
Emergency Action Committee	• Membership: CEB Chief Engineers Moragolla & Kotmale; Superintendents of Police; Kandy Disaster Management Coordinating Unit; Depts of Health, Transport, Railways; Army; Red Cross; Divisional Secretaries; NGOs; etc; • Roles and responsibilities; training; communication; periodic review and updating of DPP; definition and declaration of levels of emergency.

169. **Implementation Arrangements:** CEB should engage qualified and experienced experts, who are not involved in project design and construction, to review the designs, proposed construction process and operational procedures, re-evaluate the risks and prepare a DPP plan and procedures as outlined above.

170. **Performance Indicators and Monitoring Requirements:** The most likely performance indicator in the case of dam safety is that the dam remains fully intact throughout its life, and there is no incidence of any failure, leakage or any other incident involving malfunction of the dam. If the dam were to fail, the success of the DPP and its implementation would unfortunately be measured in the number of deaths, and the loss of property and other assets. Potential losses will be estimated as part of the DPP investigation and planning stage, and it would be a reasonable expectation that successful implementation of the DPP in the event of a complete

dam failure would be for loss of life to be limited to 10 % of the inhabitants of the flooded area. Compiling a register of deaths would be one of the responsibilities of the Emergency Action Committee, in coordination with the emergency services.

171. **Scheduling:** Initial reservoir impoundment is the first time of risk in relation to the performance of the dam, so the DPP needs to be in place well before then, with the key institutions and infrastructure (Emergency Action Committee, warning system, communications, etc) set up, trained/tested and functioning. The study to prepare the DPP should therefore be conducted two years before, to allow the requisite period of awareness-raising, organisation and training of the key participants in the year before first-filling (Figure 16).

Figure 16: Programme for mitigating operation-phase impacts on dam safety

Activities	2014		2015		2016		2017		2018		2019		2020		2021	
		Pre-cons			Construction								Operation			
Dam break analysis, inundation mapping, review of risks & impacts																
Emergency planning																
Preparation of DPP																
Awareness raising - community																
Establishing institutions, training																
Practice Disaster Management Exercise																
Feedback, finalisation of DPP																

172. **Budgets:** This study and follow-up actions will be conducted by external consultants with no prior relationship to the MHPP, who will be appointed by CEB. A budget for the work is given below.

Table 21: Budget for mitigation of construction-phase impacts on dam safety

Work Item	Quantity	Unit	Rate (SLR)	Cost (SLR)
Senior Disaster Management Specialist	10	Person-month	300,000	3,000,000
Flood-risk modeller	2	Person-month	150,000	300,000
Supporting staff	10	Person-month	150,000	1,500,000
Per Diem	10 x 22	day	6,000	1,320,000
Transport	10	300km	40	120,000
Assumptions:			**Total:**	**6,240,000**
Senior specialist and support staff: 50% in field, 50% home office; Flood modeller: 100% home office. Fieldwork conducted in two-week visits, including travel, one vehicle				

173. **Consultant Terms of Reference:**

a) Senior Disaster Management Specialist:

- Obtain from CEB and review all available material on the MHPP (Feasibility Study reports, FS Review reports, Detailed Designs, reports and drawings); and the project location and its characteristics (Environmental Addendum and EMP), etc.
- Obtain and review data from other studies, government departments, satellite imagery, etc, as appropriate;
- Plan and manage dam break analysis, flood-risk modelling and inundation mapping; quantify risks and prioritise areas using internationally accepted norms;
- Plan all emergency procedures and prepare a draft Disaster Preparedness Plan;
- Plan, organise and conduct a programme of awareness raising amongst institutions and the general public in the flood risk area (in discussion with CEB), which is appropriate to the level of risk, and prepares people and institutions, without raising undue alarm;
- Assist CEB in setting up an Emergency Action Committee and other necessary organisations; and prepare and conduct training for all members in their roles, responsibilities and activities in DPP implementation
- Assist CEB in planning, organising and conducting a practice Disaster Management Exercise, and recording the outcomes, effectiveness and any necessary revisions;
- Revise the draft DPP as necessary to incorporate experience and feedback from the practice exercise and prepare and submit the final version.

b) Supporting Staff:

- Work under direction of the Senior Specialist, providing assistance in: obtaining, analysing and reviewing data; conducting field observations; preparing material for the DPP; preparing training materials; liaising with community organisations and other parties; etc, as directed.

c) Flood-risk modeller:

- Create and run a topographically accurate mathematical model of the area downstream of the proposed Moragolla Dam and conduct an analysis of the flood risk following total dam failure with the reservoir in maximum flood. Include on the model accurate depictions of land use, inhabitation, population and other key features to enable a comprehensive analysis of flood risk areas, categories of risk and prioritisation;
- Assist the Senior Specialist in interpreting the model and applying its output in providing material for the DPP as necessary.

E. Special Issues EMP: Aquatic Ecology

1. Pre-Construction and Construction Phase

174. The main concern during project construction is the risk of poaching of fish by construction workers, and the loss of habitat and actual mortality of *Labeo fisheri* (especially from blasting in the area of the tailrace, where *Labeo fisheri* has been seen). These are addressed below.

a. Preventing Poaching

175. **Mitigation Measures:** To reduce the incidence of poaching, all construction workers will be told about the risk to fish in the Mahaweli Ganga (their ongoing vulnerability) and notified of sanctions (including job loss), if they are caught fishing (for any species). Their activities will be monitored and sanctions strictly applied, if any workers are caught fishing (by any method). This communication will be undertaken as half-day dissemination sessions for all project workers. Signs will also be posted at various points along the river in the project area to reinforce the message.

176. **Implementation Arrangements:** The Project Management Office (PMO) will be responsible for engaging an individual (from an NGO or university) to undertake the dissemination sessions for each project contractor, to ensure that all workers understand the reasons for these actions and the consequences if they engage in fish poaching.

177. **Performance Indicators and Monitoring Requirements:** If mitigation is successful, no fish are caught by any project workers over the duration of project construction and there are no adverse impacts on the local fish populations. Worker activities near the river will be monitored, as much as possible, by the oversight staff from the PMO.

178. **Scheduling:** Worker dissemination will be undertaken as project contractors establish themselves on site (during the pre-construction and construction phases). Monitoring will then be undertaken throughout the project construction period (spot checks at worksites adjacent to the river).

Activities	**2014**		**2015**		**2016**		**2017**		**2018**		**2019**		**2020**		**2021**	
		Pre-constn			**Construction**								**Operation**			
Worker dissemination sessions.																
Monitoring (spot checks) of worksites adjacent to the river.																

179. **Budget:**

Work Item	Quantity	Unit	Rate (LKR)	Cost (LKR)
Half-day dissemination sessions.	8	½ day	12,500	100,000
Related travel time (Colombo to site).	8	day	25,000	200,000

Transportation cost.	8	trip	13,000	104,000
Spot checks (local person).	54	spot check	8,000	432,000
Signs.	12	sign	4,000	48,000
Total				**884,000**

180. **Consultant Terms of Reference:** Two individuals are required to address the risk of poaching of fish. Their terms of reference are noted below:

a) Facilitation/Extension Specialist (Fish): National Consultant (12 days effort over pre-construction, early construction phase):

- To provide, to project workers, an overview of the importance and vulnerability of mountain labeo, and other fish, in the Mahaweli Ganga;
- To review the current Sri Lanka fisheries regulations; and,
- To outline the possible sanctions for being caught fishing in the Mahaweli Ganga and joining tributaries.

b) River Monitor: National Consultant (local person; approximately 27 days over four years of construction):

- To undertake unannounced surveillance of both banks of the Mahaweli Ganga, at least once a week in the first few months (less frequently later in the construction phase), at times when workers are most likely to be fishing (early morning/end of day);
- To record all community observations of construction workers fishing (as passed on by the community); and,
- To alert the Project Management Office to any fish poaching incidents (for their follow-up).

b. Minimizing Loss of Fish Due to Blasting

181. **Mitigation Measures:** With regard to blasting at the tailrace site (the project location nearest to the occurrence of *Labeo fisheri* in this stretch of the river), alternatives to the use of explosives can be considered, including the use of dexpan (drilling and chemical fracturing of rock) and hydraulic breakers (mechanical fracturing of rock). The intention is to avoid any pressure waves in the water, which could kill fish. The contractors can be instructed to examine the feasibility of either or both techniques, in order to avoid any disturbance to fish at the tailrace area.

182. **Implementation Arrangements:** The Project Management Office will make the case for not using explosives at the tailrace area in all contract documents, and will allow contractors to come up with the best mix of options to undertake rock clearing at the tailrace site to ensure no fish mortality.

183. **Performance Indicators and Monitoring Requirements:** Assuming no explosives are used at the site, PMO monitoring of the work site and adjacent river will indicate no fish mortalities for the duration of construction work at the tailrace site.

184. **Scheduling:** Work at the tailrace site may be expected in the second year of the construction phase.

Activities	2014		2015		2016		2017		2018		2019		2020		2021	
		Pre-constn			Construction								Operation			
Non-explosive rock removal at the tailrace site.																

185. **Budget:** There are no specific costs associated with this action. Non-explosive rock removal is expected to be part of the project construction budget.

186. **Consultant Terms of Reference:** No consultants are required for this mitigation measure.

c. Confirmation of Fish Distributions (Fish Survey)

187. **Mitigation Measures:** It is recommended that a fish survey of all the pools above and below the dam site (down to the confluence of the Mahaweli Ganga and the Atabage Oya) be undertaken in the pre-construction phase, in order to determine the presence and distribution of larger fish (such as *Labeo fisheri*) in the river section that is most likely to be affected by the project. This survey should be undertaken with an inflatable raft and a Garmin-type fish finder, which can establish the depth of the riverbed, the presence of fish (numbers and depth), and specific locations (GPS coordinates). If this survey indicates the presence of larger fish (possibly including *Labeo fisheri*), then a pre-emptive catch-and-haul program should be implemented, before substantial project construction starts (this would involve a small mesh net being used to fish the deeper pools). Any fish caught in this manner would be identified, catalogued, and then safely moved to selected locations further upstream, or to an adjacent watershed (see discussion of the proposed translocation below, which is budgeted separately). Some specimens of each species caught would be left in the river (but placed further downstream, away from project construction sites), in order not to deplete the local fish population. The survey should be completed just before the monsoon, as fish that move in the river may be underway, but before discharge is too high to make boat work in the river unmanageable. The fish survey would provide a detailed verification of fish in the project zone of influence to inform the translocation program. In this manner, vulnerable fish near project construction sites can be saved, and their distribution in the river system maintained.

188. **Implementation Arrangements:** This measure can be implemented as a consultancy under the management of the PMO.

189. **Performance Indicators and Monitoring Requirements:** A successful fish survey will define the distribution of the larger fish in the Mahaweli Ganga section near the project, including an assessment of the location and importance of the deeper pools, which have been referred to as preferred habitat for *Labeo fisheri*. The survey is a “monitoring” exercise, and should be repeated as part of the routine environmental monitoring after the project has been in operation for a year.

190. **Scheduling and Pacing:** The fish survey needs to be undertaken in the early pre-construction phase, before there is disturbance of the river (and in the pre-monsoon period; April-May).

Activities	2014		2015		2016		2017		2018		2019		2020		2021	
		Pre-constn			Construction								Operation			
Logistics preparation for survey (equipment procurement; maps, boat).																
Fish survey.																
Linkage to fish translocation program.																

191. **Budget:**

Work Item	Quantity	Unit	Rate (LKR)	Cost (LKR)
Equipment (inflatable raft; motor, Garmin fish finder, GPS, maps, nets, camera, etc.)	1	package	900,000	900,000
Transportation (Colombo-return and project site)	1	LS	75,000	75,000
Per diems x 2	20	day	12,800	256,000
Boat handler	25	day	12,500	312,500
Fish specialist	30	day	25,000	750,000
Total				**2,293,500**

192. **Consultant Terms of Reference:** Two individuals are required to implement the fish survey. Their terms of reference are noted below:

a) Boat Handler: National (25 days effort over pre-construction phase):
- To procure equipment required for the fish survey; and,
- To manage all the equipment in the field.

b) Fish Specialist: National Consultant (30 days effort over the pre-construction phase):
- To plan the fish survey and assist with procurement of the required equipment;
- To implement the fish survey and document all observations, including location of fish in the pools (depth and GPS readings), and subsequent identification of fish specimens from each pool where fish are observed with the fish finder; and,
- To coordinate with the specialists involved in the fish translocation program.

d. Catch-and-Haul (Fish Translocation)

193. **Mitigation Measures:** A catch-and-haul (translocation) program is proposed for fish which occur in the Mahaweli Ganga at the dam site, the reservoir location, and downstream to the tailrace. These will have been confirmed in their distribution and species identification in the

pre-monsoon (see the fish survey details above). The goal is to rescue and translocate less mobile and cryptic fish species encountered in the river at the project location. This would be undertaken in the pre-construction and early construction phase of the project, as a pre-emptive measure. All translocation activities would be carried out in accordance with the Guidelines for Reintroductions and Other Conservation Translocations (IUCN/SSC, 2013); IUCN has previous experience in moving fish from one location to another.

194. While various fish species which have conservation status in Sri Lanka would be targeted with this program, the main concern is *Labeo fisheri* (mountain or green labeo), which is the only critical fish species present in the Moragolla project area. *Labeo fisheri* is restricted to the middle part of the Mahaweli River, including the Amban Ganga and Kalu Ganga sub-catchments of the Mahaweli basin; there is also the one observation of *Labeo fisheri* above the Kothmale dam. Given the existing pressures on this fish (restricted movements, loss of habitat, turbidity, historical over-fishing), translocation of this species to another river basin (the Kelani River basin is proposed) is recommended. However, this trans-river basin translocation should only be carried out after thorough assessments of the existing population of *Labeo fisheri* in the project area (the fish survey proposed above), and the habitat conditions and species composition at the destination site (Kelani River; see Figure 17). Other fish encountered during the catch-and-haul program would also be included in the program, as noted in Table 22. Fish locations will have been confirmed during the fish survey; these areas will then be subjected to a fish catch program, with only half of the fish caught in each pool being translocated (leaving a resident population, in case the translocated fish do not survive).

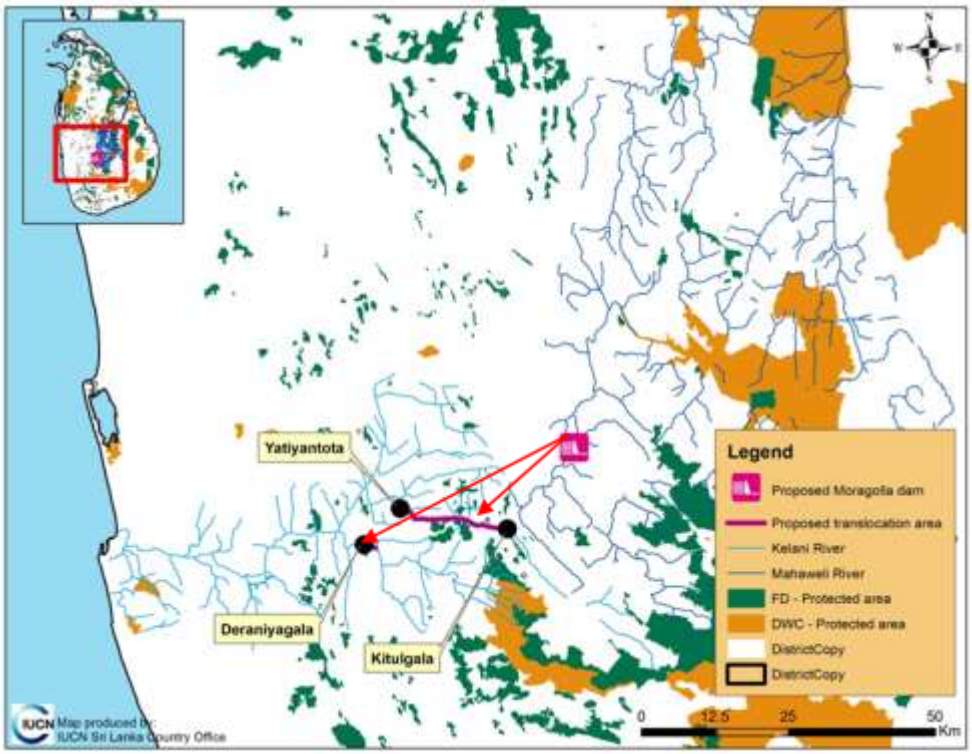

Figure 17: Proposed sites for translocation of *Labeo fisheri*.

Table 22: Proposed fish catch-and-haul program (translocation).

Species Name	Common Name	Proposed Area for Collection	Proposed Translocation Destination Site
Labeo fisheri	Mountain (green)labeo	Inundation area (if there) and downstream areas to the tailrace.	Suitable from Kitulgala to Yatiyanthota in the Kelani River or Sitawake River.
Belontia signata	Combtail	Inundation area.	AtabageOya and UlaponeOya.
Schistura notostigma	Banded mountain loach	Inundation area.	AtabageOya and UlaponeOya.
Species of the Family Bagridae		Inundation area.	AtabageOya and UlaponeOya.
Tor khudree	Mahseer	Downstream areas to the tailrace.	AtabageOya or the upper catchment of Mahaweli up to Nawalapitiya.
Channa ara	Giant snakehead	Downstream areas to the tailrace.	The upper catchment of the Mahaweliup to Nawalapitiya.
Channa orientalis	Smooth-breasted snakehead	Inundation area and downstream areas to the tailrace.	AtabageOya and UlaponeOya.
Wallago attu	Shark catfish	Downstream areas to the tailrace.	The upper catchment of the Mahaweli up to Nawalapitiya.
Ompoc bimaculatus	Butter catfish	Downstream areas to the tailrace.	The upper catchment of the Mahaweli up to Nawalapitiya.

195. Depending on the success of the fish translocation program, some consideration might also be given to a national recovery program for *Labeo fisheri* (although not expected to be funded by this project). The recovery program would include an assessment of the data from the fish survey, from the fish translocation program, and a review of all historical data for *Labeo fisheri*, including unpublished data. The recovery program would have to include consideration of captive breeding of *Labeo fisheri* (to determine the feasibility of developing a breeding program in the future), and a better understanding of the previous impacts of dam projects and over-fishing.

196. **Implementation Arrangements:** A technical committee, including representatives from the Ceylon Electricity Board (CEB), the Department of Wildlife Conservation (DWC), the Forest Department (FD), the National Zoological Gardens (NZG), IUCN and other experts, would be established in order to oversee and evaluate the implementation of the proposed catch-and-haul program. The PMO would have overall control of the mitigation measure and would hire fish specialists (national consultants) to undertake and document the work.

197. **Performance Indicators and Monitoring Requirements:** Targeted fish species are encountered at the project location, captured, and successfully moved to specified locations; subsequent monitoring indicates the ongoing survival of existing and/or new fish populations (if the introduced species was not there before) in the new locations.

198. **Scheduling and Pacing:** The fish translocation program needs to be undertaken before there is any substantial project construction activity.

Activities	2014		2015		2016		2017		2018		2019		2020		2021	
		Pre-constn			Construction								Operation			
Review of fish survey data.																
Survey and selection of translocation sites.																
Undertake catch-and-haul.																
Public awareness-raising at target sites to support fish conservation.																
Subsequent monitoring of fish distribution and survival (in Mahaweli Ganga and at new locations).																

199. Budget:

Work Item	Quantity	Unit	Rate (LKR)	Cost (LKR)
Equipment (most from fish survey) and materials.	1	package	250,000	250,000
Transportation costs for all activities.	1	LS	500,000	500,000
Per diems x 2	85	day	12,800	1,088,000
Fish specialist: survey of translocation sites.	15	day	25,000	375,000
Field assistant: survey of translocation sites.	15	day	12,500	187,500
Fish specialist: catch-and-haul.	20	day	25,000	500,000
Field assistant: catch-and-haul.	20	day	12,500	250,000
Fish specialist: public awareness.	10	day	25,000	250,000
Field assistant: public awareness.	10	day	12,500	125,000
Fish specialist: monitoring.	40	day	25,000	1,000,000
Field assistant: monitoring.	40	day	12,500	500,000
Total				**5,025,500**

200. **Consultant Terms of Reference:** Two individuals are required to implement the fish translocation program. Their terms of reference are noted below:

a) Fish Specialist: National Consultant (85 days effort over the pre-construction, construction, and operation phases):

- To plan the survey of potential translocation sites (in coordination with the fish survey team);
- To oversee the translocation site survey;
- To implement the catch-and-haul program;
- To carry out public awareness programs at translocation sites to help enhance survival of translocated fish;
- To undertake monitoring to determine the effectiveness of the fish translocation program and the status of fish populations in the project area of the Mahaweli Ganga; and,
- To document all observations, including conditions of translocation sites, the collection and transfer process, the kinds of fish that have been moved, population success, etc.;

b) Field Assistant: National (85 days effort over pre-construction phase, construction, and operation phases):

- To manage the equipment required for the program;
- To assist with field planning and logistics; and,
- To help with all other aspects of the program as required.

e. Fish Pool Connection Analysis

201. **Mitigation Measures:** After the proposed fish survey, sometime during the lean season when river discharge is at a minimum, it is proposed to undertake a "pool connection" analysis from the dam site to the tailrace, the purpose of which will be to identify how to maintain a connection between all of the larger deeper pools in the section of the river that will receive only the minimum environmental flow (1.5 m^3/s). Once the survey is completed, and the most practical channel connections between the individual pools are identified, and fish have been surveyed and moved, connector channels can be created with hydraulic drills (either deepening existing channels or making new ones, fairly unobtrusively). This might actually be undertaken in the first year of project operation, when the required channel connections between pools can be properly verified under the lowest flow conditions. The overall intention is to establish connections between pools that will maintain some water exchange during lean season minimum environmental flow, allowing fish to move between the dam and tailrace at all times, and helping to maintain appropriate water quality.

202. **Implementation Arrangements:** This measure can be managed as a consultancy by the PMO.

203. **Performance Indicators and Monitoring Requirements:** All of the larger pools in the Mahaweli Ganga between the dam and the tailrace are connected, and water exchange is continuously maintained. This can be verified with visual observations, floats, and dye tests.

204. **Scheduling and Pacing:** To be undertaken in the first year of construction.

Activities	2014		2015		2016		2017		2018		2019		2020		2021	
		Pre-constn			Construction								Operation			
Hydrological survey between the dam and the tailrace under low flow conditions, using floats and dyes; mapping of the optimal channel connections.																
Drilling/chipping of selected channel connections.																
Verification of pool connections (same techniques as above).																

205. **Budget:**

Work Item	Quantity	Unit	Rate (LKR)	Cost (LKR)
Hydrological survey materials.	1	LS	125,000	125,000
Transportation costs for all activities.	1	LS	150,000	150,000
Per diems x 2	14	day	12,800	179,200
Hydrologist: survey. and assisting in the supervision of drilling work	25	day	25,000	625,000
Field assistant: survey.	10	day	12,500	125,000
Drilling/chipping of selected channel connections (estimated for a construction contractor).	1	LS	2,000,000	2,000,000
Hydrologist: verification of pool connections (same techniques as above).	4	day	25,000	100,000
Field assistant: verification of pool connections (same techniques as above).	4	day	12,500	50,000
Total				**3,354,200**

206. **Consultant Terms of Reference:** Two individuals are required to undertake the fish pool connection analysis. Their terms of reference are noted below:

a) Hydrologist: National Consultant (29 days effort over the late construction and early operation phases):

- To plan and undertake the survey of flow conditions and connectivity of pools in the Mahaweli Ganga between the dam site and the tailrace;
- To mark sites for channel creation or enhancement and assist in supervising the drilling; and,
- To verify and document the connectivity of fish pools after channels have been created.

b) Field Assistant: National (14 days effort over late construction phase and early operation phases):

- To manage the equipment required for the program;
- To assist with field planning and logistics; and,
- To help with all other aspects of the survey, as required.

2. Operation Phase

207. The main concern in the operation phase is maintaining present fish populations above and below the dam site in a viable state (effectively continuing to breed within the newly confined sections, above and below the dam). Various possible mitigation measures were examined (one of the additional studies undertaken by IUCN). The most appropriate and practical mitigation measures during the operation phase are described below.

a. Offset Fish Habitat Protection

208. **Mitigation Measures:** The Mahaweli River upper catchment (upstream from the Moragolla reservoir) is identified as a key area for aquatic habitat protection, to enhance the conservation of moderate priority fish in the project area, as well as to maintain vegetation and reduce soil loss, to prevent negative impacts on aquatic habitats. Given that the upper catchment of the Kothmale Oya, up to the Kothmale dam, remains relatively dry (except at spillage time), only the Mahaweli Ganga itself up to Nawalapitiya will continue to provide suitable habitats for species such as *Wallago attu* (Shark catfish), *Channa ara* (Giant snakehead), *Tor khudree* (Mahseer), and possibly *Labeo fisheri* (although it has not been reliably recorded in the Mahaweli Ganga above the confluence area with the Atabage Oya). Until now, the removal of river bank vegetation up to Nawalapitiya and the depletion of the upper catchment due to encroachment have been observed; the offset habitat protection program is proposed to arrest those practices and improve the water quality and shoreline conditions (providing more shading) along the river section above the reservoir. This program would be associated with most of the initiatives in the terrestrial ecology mitigation program (e.g., planting 70 hectares of vegetation around the reservoir perimeter, and planting 60 hectares of vegetation in the upper watershed, as well as enhancing soil management in those areas with new technical measures) and some of the initiatives with the aquatic ecology mitigation program (e.g., translocation of some fish species to river sections above the dam; see Table 22 above). They are, therefore, all described and budgeted elsewhere. However, Table 23 is provided here to summarize the main actions as they relate to protection or enhancement of fish habitat.

Table 23: Proposed offset habitat protection program.

Action	Output/ Outcome for Fish Habitat
Identification of critical areas for fish in order to facilitate natural movement and relocation; this action is linked with the fish translocation plan described previously.	Map of the critical and suitable areas in the Mahaweli Ganga system for natural upstream relocation and facilitation of natural upstream movement of fish.
Identification of the most depleted areas in the upper catchment and preparation of suitable habitat improvement plans that include sediment erosion controls (watershed management).	Map of the upper catchment up to Nawalapitiya prepared, along with proposed watershed management plans (sediment erosion controls).
Implementing an afforestation program around the reservoir. This action is linked with terrestrial habitat enhancement for wildlife.	Reservoir buffer zone (100-meter wide) planted; reducing sediment inputs to the reservoir and providing shade along reservoir edges.
Community awareness program; this action can be linked with other awareness programs related to fish conservation and the afforestation and watershed management plan.	Communities are educated about the importance of upper watershed management for the conservation of the native fish of the area.

209. **Implementation Arrangements:** Discussed under other mitigation measures.

210. **Performance Indicators and Monitoring Requirements:** Reduction of sediment inputs to the upper Mahaweli Ganga watershed, and increased shade from riparian vegetation should all help improve fish habitat in the reservoir and upper reaches of the Mahaweli Ganga.

211. **Scheduling and Pacing:** Discussed under other mitigation measures.

212. **Budget:** Discussed under other mitigation measures.

213. **Consultant Terms of Reference:** Discussed under other mitigation measures.

b. Prohibition of the Introduction of Competitive Exotic Species to the Moragolla Reservoir

214. **Mitigation Measures:** Reservoirs tend to be attractive to the fisheries industry. However, given that there are no natural lakes in Sri Lanka, large reservoir conditions are not suitable for the majority of native fish species. As a result, many exotic species have been introduced to the reservoirs of Sri Lanka, with variable results. Some of these exotic species are similar to native species, and as such, compete with the indigenous species for resources. For instance, the introduced species *Labeo rohu* is considered a direct competitor of the threatened native species *Labeo lankae*, and various tilapia species have become dominant in some reservoirs[11]. Therefore, a ban on the introduction of competitive fish species, such as *Labeo rohu*, to the Moragolla reservoir is recommended. The larger question of whether or not fishing should be allowed in the Moragolla reservoir at all needs further consideration, as sometime the intensive fishing efforts for exotic species result in over-fishing of native species. In any case, fishing for *Labeo fisheri* should continue to be banned, and riverine fishing carefully monitored for this species specifically.

[11] Amarasinghe and de Silva (1999). Cited in FAO on-line document: Capture Fisheries of Tilapias.

215. **Implementation Arrangements:** This action should be under the responsibility of the Fisheries Department, as they would be the agency handling fish introductions if they were to occur. There are no specific additional measures, apart from signage and routine monitoring of the reservoir area.

216. **Performance Indicators and Monitoring Requirements:** Populations of exotic fish species do not dominate the reservoir area. The fish monitoring proposed elsewhere (as part of the monitoring follow-up for the fish translocation program; see previous details above) will help determine this.

217. **Scheduling and Pacing:** This should be a continuous situation during operation of the reservoir.

218. **Budget:** No specific budget required.

219. **Consultant Terms of Reference:** No requirement for consultant inputs.

F. Special Issues EMP: Terrestrial Ecology

1. Pre-Construction/Construction Phase

220. Clearing of vegetation is required in the pre-construction and early construction phases, in order to allow access to work sites. This is the main project activity that will have an impact on terrestrial ecology, as it will force animals to move away from the area, and natural habitat will be destroyed (until vegetative re-growth occurs after construction. Prior to clearing, all sites will be re-surveyed and tree identifications and counts confirmed (for payment of compensation). At this point, mitigation measures will need to be implemented.

a. Animal Rescue Program

221. **Mitigation Measures:** Land clearing (mobilization of construction equipment) may result in encounters with wildlife and birds. Vulnerable animals will be captured and moved to adjacent habitat, if possible, or at least allowed to move away from the land clearing work sites. A contractor can be engaged to undertake this service as needed. All wildlife encounters will be logged, to build up the faunal database for the project area (voucher specimens may be collected, as needed, if plant and animal numbers allow this; unique specimens will be photographed and moved carefully).

222. **Implementation Arrangements:** The PMO will be responsible for managing a standing contract with a local contractor who can undertake the wildlife identifications, removals, and releases as and when animals are encountered by the workforce. Removal and handling activities must be done according to national and international guidelines, with supervision by IUCN and/or CEA as appropriate.

223. **Performance Indicators and Monitoring Requirements:** Mortality or disturbance of larger birds, amphibians, reptiles, and mammals at project work sites is minimized. The faunal database for the project area is built up, including correct identification, records of seasonality, and known distribution of animals.

224. **Scheduling and Pacing:**

Activities	2014		2015		2016		2017		2018		2019		2020		2021	
		Pre-constn			Construction								Operation			
Animal rescue program.																

225. **Budget:**

Work Item	Quantity	Unit	Rate (LKR)	Cost (LKR)
"On-call" staff for trapping/tranquilizing wildlife and moving them, and related expenses.	Provision for 20 per yr x 1.5 yrs	animal rescue	32,000	960,000
Total				**960,000**

226. **Consultant Terms of Reference:** A local team of experienced and registered wildlife experts is required to be "on-call" for animal rescue when required, according to the terms of reference below:

- Provision for up to 30 animal captures (amphibians, reptiles, birds, mammals) over 1.5 years of land clearing (pre-construction and early construction phase; total of 960,000 LKR);
- To operate as "on-call" staff for trapping/tranquilizing wildlife (as they are encountered by construction crews) and moving them safely to appropriate adjacent undisturbed sites; and,
- Photographic and narrative documentation of all wildlife encounters, noting developing spatial and temporal trends.

b. Afforestation/Habitat Enhancement

227. **Mitigation Measures:** The main mitigation measure for this phase of the project is initiation of the afforestation plan, which is intended to enhance habitat for wildlife (to compensate for those habitats which will be lost to land clearing and inundation). The main planting area will be a 100-meter buffer strip all around the reservoir, an area of about 70 hectares (twice the area that will be inundated, which will more than compensate for the flooded area and other permanent project "footprints"). This area will be surveyed and marked with posts early in the construction phase, and the various steps required to undertake the planting of trees will be started as early as possible (before the reservoir is filled, and preferably early in the construction stage), so that riparian forest habitat development can start as early as possible. The combination of selected vegetation types will reflect the needs of targeted faunal species, for habitat enhancement. There is provision for an additional 60 hectares of planting in other areas in the upper watershed, which will be addressed in the upper watershed management plan described below. The concept and required steps are described below.

228. According to the ADB Safeguard Policy Statement (2009), a critical habitat includes areas with high biodiversity value, including habitats required for the survival of Critically Endangered (CR) or Endangered (EN) species, areas of special significance for endemic or

restricted-range species, sites that are critical for the survival of migratory species, areas that support globally significant concentrations or numbers of individuals of congregatory species, areas with unique assemblages of species, that are associated with key evolutionary processes or provide key ecosystem services, and areas with biodiversity of significant social, economic, or cultural importance to local communities. Critical habitats include those areas either legally protected or officially proposed for protection, such as areas that meet the criteria of the World Conservation Union classification, the Ramsar List of Wetlands of International Importance, and the United Nations Educational, Scientific, and Cultural Organization's Natural World Heritage Sites. In the case of the Moragolla project, it has been determined that there are no project areas that can be classified as "critical habitat"[12]. On the other hand, the concept of habitat enhancement to strive towards protection of critically endangered or endangered species that may frequent the area has been assumed as a mitigation measure for this project.

229. A process was undertaken by IUCN to rank the 41 faunal species recorded in the project area that are either endemic, near threatened, vulnerable, endangered, or critically endangered (in the Sri Lanka classification), so that habitat enhancement measures can address those species that would gain the most protection potential from the effort. The key parameter that can be used to ascertain the importance of a given habitat or area for the long term survival of a critical species, is the proportion of the population of that critical species that occupies a specific habitat. However, information on the overall population sizes of the 41 critical species is not available or reliable, so, in the absence of population data, alternative proxies were used to make such an assessment which allowed ranking of species in the project area which would have the maximum protection benefit from an afforestation program. This process is described below.

230. The ranking of individual species (as candidates for targeted habitat enhancement) was based on an accumulated score reflecting various species factors, as follows (higher scores reflect greater conservation needs):

Species status: This indicates the overall status of the species, as follows:

(i) Indigenous (1 point);
(ii) Endemic (3 points); and,
(iii) Possible new species (3 points).

Distribution: A species that shows a wider distribution within a country across several bio-climatic zones is less likely to be affected by a single project or catastrophic event that might result in large-scale mortality of members of that species, compared to those with more limited distribution. Distribution was scored as follows:

(i) Island wide (0 points);
(ii) Mahaweli basin and Dry Zone (1 point);
(iii) Mahaweli basin and Wet Zone (2 points);
(iv) Mahaweli basin only (3 points); and,
(v) Restricted to the project area (4 points).

[12] See details in the Environmental Addendum and the IUCN Additional Study (2013).

Habitat impact: Some species can be affected negatively, while others may benefit, through the habitat changes that can take place as the result of a project. Habitat impact was scored as follows:

(i) Positive impact (-2 points);
(ii) No impact (0 points); and,
(iii) Negative impact (+ 2 points).

For all the terrestrial faunal species encountered in the project area, the project is considered to have a net negative impact, mostly because the project will result in the conversion of terrestrial habitats into waterbodies (net loss of terrestrial habitat). However, this presents an opportunity to support fauna which have an association with water.

Conservation status: This indicates the long term survival potential of the species, and has been determined based on overall population trends, as well as threats that are operating on the species at a national scale. Conservation status was scored as follows:

(i) Not evaluated (2 points, as this indicates species that have been described after 2012);
(ii) Least Concern (LC) (0 points);
(iii) Near Threatened (NT) (1 point);
(iv) Data Deficient (DD) (2 points, as Data Deficient species may be extremely rare species);
(v) Vulnerable (VU) (3 points);
(vi) Endangered (EN) (4 points); and,
(vii) Critically Endangered (CR) (5 points).

231. Based on this ranking scheme, the maximum possible score is 14, reflecting species that have significant conservation needs and which could gain maximum benefit from habitat enhancement. The cut-off point was taken to be eight points. A species that obtained a score above the cut-off point was considered to be a suitable candidate for habitat enhancement in the project area, with a moderate to significant impact on survival of the species. Figure 18 shows the ranking for the 41 faunal species considered in this analysis (see the IUCN report in the appendices for the detailed scores). Photo 2 shows the top five ranked species that can be targeted for the habitat enhancement program and Table 24 shows the conservation classifications and habitat needs of these species.

232. The proposed new forested buffer zone around the reservoir will provide habitat for these selected faunal species (and many others) as well as protection for the immediate catchment of the reservoir, to reduce soil erosion and potential siltation of the reservoir (some of the slopes near the inundation area approach 50^{o} and are therefore quite vulnerable to erosion).The most suitable tree and shrub species for these purposes will be planted in this area as soon as possible after the project construction starts. Figure 19 shows the proposed buffer zone around the reservoir, which will replace mostly old tea plantations, home gardens, and scrub vegetation.

Figure 18: Ranking of endemic and/or threatened faunal species in the project area for habitat enhancement targets.

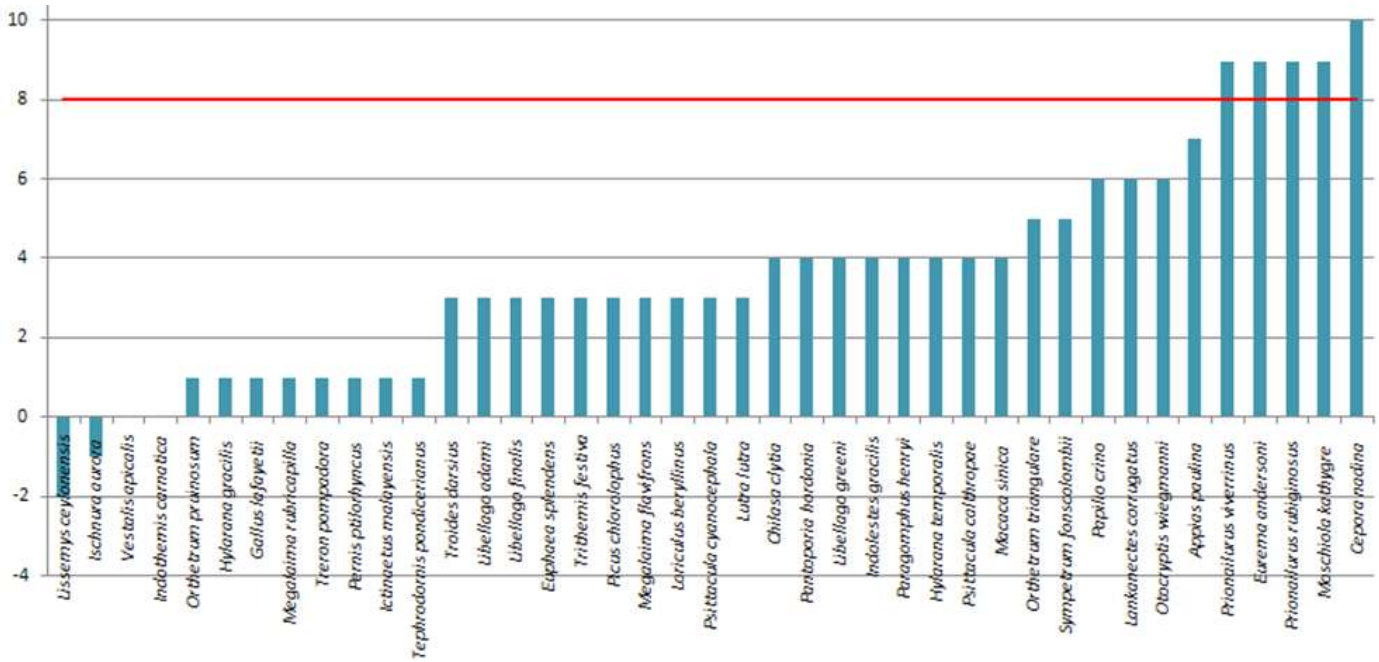

Photo 2: The top five ranked faunal species in the project area targeted for habitat enhancement (left-to-right; top-to-bottom: lesser gull butterfly; one-spot grass yellow butterfly; fishing cat; rusty-spotted cat; Sri Lanka pygmy mouse-deer).

Table 24: Conservation status and habitat risks of the five selected species.

Family	Species	Status	Conservation Status		Habitat Risks *
			National	Global	
Pieridae	*Cepora nadina* Lesser gull	Indigenous	CR		Reduction of feeding and nectar plants.
	Eurema andersoni One-spot grass yellow	Endemic	VU		Reduction of feeding and nectar plants.
Felidae	*Prionailurus rubiginosus* Rusty-spotted cat	Indigenous	EN	VU	Reduction of hiding places and hunting grounds.
	Prionailurus viverrinus Fishing cat	Indigenous	EN	EN	Reduction of hiding places and hunting grounds.
Tragulidae	*Moschiola kathygre* Sri Lanka pygmy mouse-deer	Endemic	VU	LC	Reduction of hiding places and feeding grounds.

* Based on the IUCN analysis undertaken for the project in 2013.

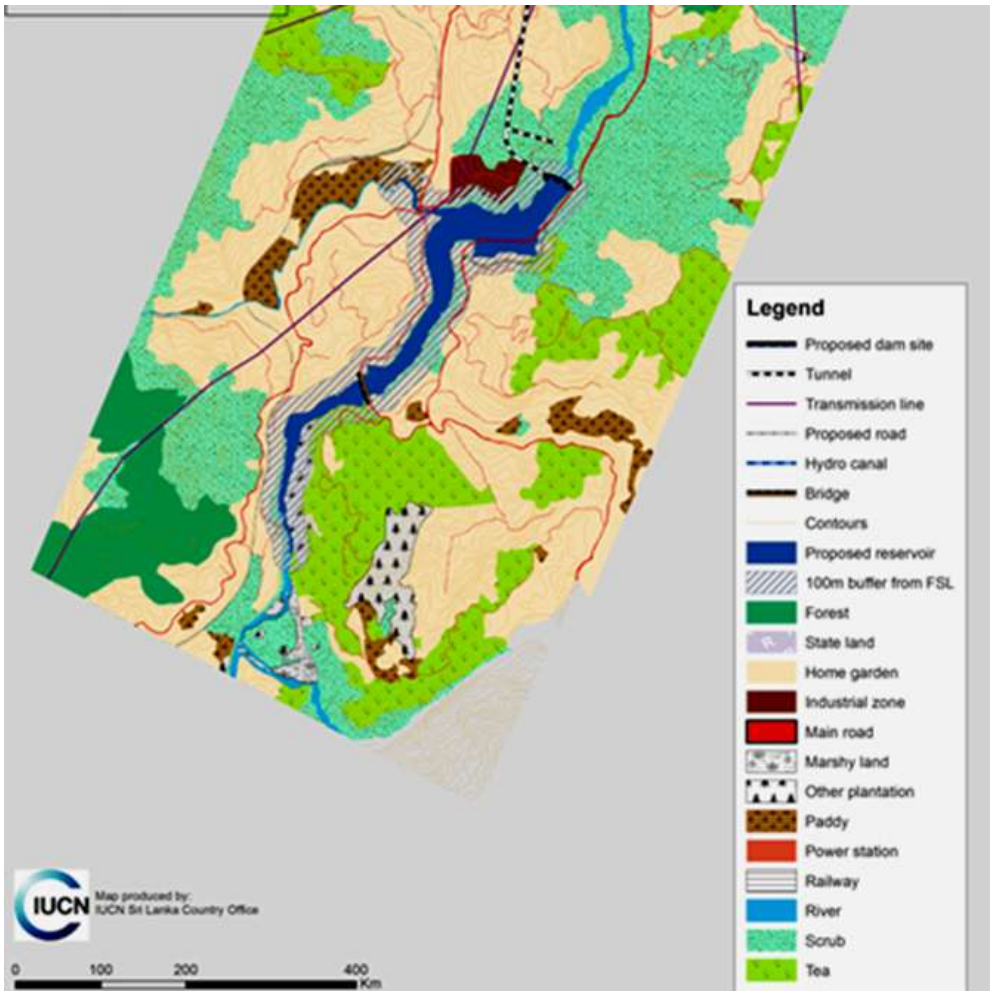

Figure 19: Proposed buffer zone around the reservoir, for faunal habitat enhancement.

233. Planting trees and shrubs in dense patches will help to create the habitats necessary for the three mammal species and two butterfly species that have been identified, as well as others occurring in the project area. Table 25 shows the range of vegetation that can suit the habitat enhancement purposes; and Photo 3 shows the intended effect of habitat enhancement (what the reservoir buffer forest should look like in 5-10 years). A mixed-species planting approach (polyculture) is recommended in order to create suitable habitat conditions.

Table 25: Proposed species for the reservoir buffer area (habitat enhancement).

Plant Species	Common Name	Beneficiary Faunal Species
Trema orientalis	Gedumba	Insect eating birds.
Macaranga peltata	Kenda	Fruit eating birds.
Macaranga indica	Kenda	Fruit eating birds.
Mallotus tetracoccus	Bu Kenda	Fruit eating birds.
Ficus sp.	Nuga	Fruit eating birds, *Moschiola kathygre* (Sri Lanka pygmy mouse-deer)and *Macaca sinica* (Toque monkey).
Ficus racemosa	Attikka	Insect eating birds and mammals (e.g. *Macaca sinica* and *Moschiola kathygre*), and butterflies for which this species is a host plant.
Acacia sp.		Insect eating birds and species for which it is a host plant.
Albizia lebbeck	Kabal mara	*Pantoporia hordonia* (Common lasker) (as a host plant).
Madhuca neriifolia	Gam Mi	Fruit eating birds and mammals (e.g. *Macaca sinica* and *Moschiola kathygre*).
Symplocosco chinchinensis	Bombu	Butterflies for which it is a feeding plant.
Artocarpus nobilis	Wal del	Fruit eating birds and mammals (e.g. *Macaca sinica*).
Chloroxylon swietenia	Satinwood	*Papilio crino* (Banded peacock) (as a host plant).
Plant species belonging to Family Lauracea (camphor, laurel, and cinnamon)	Wal enasal	*Papilio clytia* (Mime) (as a host plant); *Prionailurus rubiginosus* (Rusty-spotted cat), *Prionailurus viverrinus* (Fishing cat) and *Moschiola kathygre* (Sri Lanka pygmy mouse-deer) as a hiding place.
Erythrina subumbrans	Erabadu	Shade loving flora and fauna.
Delonix regia	Mara	Insect eating birds and species for which it is a host plant.
Mangifera indica	Amba	Fruit eating birds and mammals (e.g. *Macaca sinica*).
Artocarpus heterophyllus	Kos	Fruit eating birds and mammals (e.g. *Macaca sinica* and *Moschiola kathygre*).
Capparis sp.	Wellangiriya	Butterflies (as a host plant) and *Prionailurus rubiginosus* (Rusty-spotted cat), *Prionailurus viverrinus* (Fishing cat) and *Moschiola kathygre* (Sri Lanka pygmy mouse-deer) as a hiding place.
Spathodea campanulata	African tulip tree	Small mammals, birds and butterflies that feed on these plants.
Ochlandra sp.	Bata	Larval feeding plant for butterflies; *Prionailurus rubiginosus* (Rusty-spotted cat), *Prionailurus viverrinus* (Fishing cat) and *Moschiola kathygre* (Sri Lanka pygmy mouse-deer) as a hiding place.
Cassia sp.	Thora	Grass yellow butterfly larvae, as a feeding plant.

Photo 3: Expected habitat vegetative diversity in the reservoir buffer area (examples from the Kothmale reservoir and the Moragolla project area)**.**

234. Since the afforestation program for the reservoir buffer will involve state lands (reservations with degraded forests), private home gardens, cultivated lands, tea lands and RDA lands (road reservations), new legislation will be required to facilitate the planting of trees and shrubs and then to regulate land use activities in the buffer area. There are several options which will be explored in the pre-construction phase of the project, including declaring the buffer zone as an "Environmental Protection Area" under the National Environment Act (under the jurisdiction of the Central Environmental Authority, or reaching a local agreement between landowners and the Mahaweli Authority of Sri Lanka to encourage local people to be custodians of the reservoir buffer area. Actual planting of trees will probably fall within the responsibilities of the Forest Department, with the activity funded by CEB. There will have to be extensive dissemination of the reservoir buffer concept, so that trees, shrubs, and animals are left undisturbed (backed up with regular compliance monitoring). As well, there will have to be vigilance to ensure that invasive alien species do not proliferate in the reservoir buffer area (or other project sites); these species include *Lantana camara* (Gandapana), *Eupatorium odoratum*, *Mimosa pigra* (Yodha Nidi kumba), *Alstonia macrophylla* (Hawari Nuga), *Ludwigia peruviana*, and *Clusia rosea* (Gal Goraka).

235. The proper development of the reservoir buffer forest will require several tasks in the correct sequence. The intention is to develop the reservoir buffer forest as quickly as possible. It obviously will not be ready to receive any displaced animals from the land clearing phase, so those animals encountered will have to be moved to other suitable adjacent habitats for the time being. The afforestation steps are summarized below:

- Demarcation (with posts) of the reservoir buffer area, to ensure no further development or farming within its area;
- Selection of specific sites and species combinations and planting densities within the reservoir buffer zone (250 to 1,100 trees per hectare, depending what is already there), determining soil type and depth, slope, soil moisture levels; home gardens may be left up to the individual land owners, but other degraded forest areas adjacent to the reservoir should be planted according to the faunal habitat needs mentioned above;
- Development of a detailed planting plan, including the specific locations, number of plants of each selected species, and expected planting time;

- Establishment of the nursery (based on the requirements identified above, to handle up to 80,000 seedlings); this will require collaboration with the Forest Department and selection of an appropriate site (near the reservoir area, with adequate water supply); the nursery will probably have to be in operation for at least 8-10 months before planting can begin;
- Planting of seedlings, then ongoing maintenance (including fire protection) and weeding for at least three years; and,
- Regular monitoring of the reservoir buffer forest, including: seedling survival counts; regular surveillance of pests and diseases; careful monitoring of invasive species; monitoring of changes in the floral and faunal composition of the area; monitoring of significant soil erosion in the afforestation sites; and, monitoring of encroachments or unauthorized activities in the afforestation area.

236. **Implementation Arrangements:** This long-term measure will be under the overall management of the CEB Project Management Office, but under the direct supervision of the Forest Department. Actual implementation will involve a forest technical consultant. As noted previously, the engagement of local landowners in the tree planting initiatives and ongoing custodial care for the reservoir buffer forest will need to be carefully considered and well-established, before actual planting occurs.

237. **Performance Indicators and Monitoring Requirements:** Assuming successful marking, clearing, and planting of the 70 hectares of the reservoir buffer area during the early construction phase, a well-established cluster of saplings, developing into small trees after 5 years, with obvious infiltration of this developing forest by a wide variety of animals, including especially the five target species. Regular monitoring of the reservoir buffer forest is built into the mitigation measure (described previously).There are no abandoned lands and degraded areas within the reservoir buffer area which are prone to soil erosion. Alien and invasive plant species are not present in the forest areas in the catchment; native tree species are growing at a healthy rate as there is no competition from invasive plants.

238. **Scheduling and Pacing:** Details on the implementation of the afforestation/habitat enhancement program, including descriptions of activities and the required timeframe, are shown below, followed by the schedule. The total program will span five years, including planning, implementation, post-planting maintenance and management, and monitoring of progress and impacts.

Activity	Description	Timeframe*
Final selection of afforestation/reforestation sites.	Afforestation sites should be more precisely identified by the organization responsible for carrying out this work.	Year 1 (February)
Survey and demarcation of planting sites.	The periphery of the selected afforestation sites and various blocks within those sites should be surveyed and demarcated.	Year 1 (April)
Final site-specific selection of tree species.	Final selection of tree species and matching with suitable sites.	Year 1 (June)
Preparation of detailed afforestation plan.	Preparation of a detailed planting plan, including the species names and numbers to be planted in each block.	Year 1 (July)
Preparation of detailed planting maps.	Detailed planting maps, including tree species that should be planted in each block.	Year 1 (August)
Establishment and maintenance of nurseries.	Establishment of a semi-permanent nursery for the afforestation program.	Year 2 (January)

Activity	Description	Timeframe*
Land preparation for planting.	Preparation of the planting sites, including digging holes.	Year 2 (September)
Supply of planting material.	All tree species recommended for use in the afforestation programme should be supplied from nurseries.	Year 2 (October)
Afforestation planting.	Planting should be carried out by an experienced agency or organization.	Year 2 (October to December)
Post-planting maintenance and management.	Post-planting maintenance and management activities are essential.	Years 3, 4 and 5 (March to October)
Weeding	Weeding is one of the most important operations to be carried out during the first three years after planting.	Years 3 and 4 (March to August)
Fire protection.	Maintenance of fire lines in the afforestation sites (if needed).	Year 3, 4 & 5 (July to August)
Application of fertilizer.	Chemical fertilizer may be applied as a top dressing, if required.	Years 2 and 3 (October)
Cutting of climbers and creepers.	Creeper/climber cutting should be a regular operation in infested stands, as necessary.	Years 3, 4 and 5 (May to June)
Pest and disease control.	If incidence of pests or diseases is noticed, appropriate action should be taken.	When the need arises.
Vacancy planting.	Filling up of vacancies should be undertaken in the year following initial planting.	Year 3 (October - November)
Monitoring.	Regular monitoring activities are an essential component of the afforestation programme.	On a regular basis after the second year.

* From the IUCN additional study in 2013 (see appendices).

Activities	2014		2015		2016		2017		2018		2019		2020		2021	
		Pre-constn			Construction								Operation			
Final selection of afforestation sites.																
Survey and demarcation of planting sites.																
Final site-specific selection of species.																
Preparation of detailed afforestation plan.																
Preparation of detailed planting maps.																
Establishment and maintenance of nurseries.																
Land preparation for planting.																
Supply of planting material.																
Afforestation planting.																

Activities	2014		2015		2016		2017		2018		2019		2020		2021	
		Pre-constn			Construction								Operation			
Post-planting maintenance and management.																
Weeding.																
Fire protection.																
Application of fertilizer.																
Cutting of climbers and creepers.																
Pest and diseases control.																
Vacancy planting.																
Monitoring.																

239. **Budget:** The assumptions used to develop the budget for this mitigation measure are summarized below (for 130 hectares; 70 of which is around the reservoir – this mitigation measure; and 60 hectares of which is for planting as part of the upper watershed management plan; see below), as the afforestation methodology is the same in both cases:

- the area for enrichment planting (addition of trees to an existing vegetated area; so a lower density of planting) is approximately 40 ha in extent;
- the area for afforestation/ reforestation (bare-land planting; which requires a higher density of tree planting) is approximately 30 ha in extent; and,
- the area for home garden improvement (lower density of tree planting) is approximately 60 ha in extent (approximately 40 ha are in the proposed reservoir buffer area).

240. Based on these assumptions and the required density of planting for each component, the numbers of plants required are as follows:

Purpose	Number of Plants
Enrichment planting program.	10, 000
Afforestation/reforestation program (bare-land planting).	33, 300
Home garden improvement.	15, 000
Additional plants to compensate for damage and other issues (approx10%).	6,700
Plants required for vacancy filling during the year following initial planting (approx20%).	13,000

Purpose	Number of Plants
Total number of plants required for the entire program.	78, 000

241. Survey and demarcation will be done only in enrichment planting and afforestation or reforestation (bare-land planting) areas (40 ha + 30 ha = 70 ha). The home garden improvement program will be done on private lands, with no survey and demarcation activities. The transport of plants to planting sites is based on the number of plants, as follows:

- enrichment planting:250 trees per ha[13];
- afforestation (i.e., bare land):1,110 plants per ha; and,
- 50 seedlings per hectare for home gardens.

Work Item	Quantity	Units and Rates (LKR)	Cost (LKR)[14]
Selection of afforestation/reforestation sites.	130 ha	lump sum	60, 000
Survey and demarcation of planting sites.	70 ha	14, 000 per ha	980, 000
Preparation of afforestation plan.	-	lump sum	50, 000
Preparation of detailed planting maps.	-	lump sum	100, 000
Establishment of nurseries and production of plants.	78, 000 plants	20 per plant	1, 560, 000
Transport of plants to planting sites, including loading and unloading.	85 ha	6,000 per ha	510, 000
Holing and planting.	78, 000 plants	32 per plant	2, 496, 000
Weeding.	70 (for three years)	41,400 per ha(calculated at two weeding events per year)	8, 694, 000
Fire protection.	70	22,500 per ha(for three years)	1, 575, 000
Application of fertilizer.	70	18, 000 per ha(two times)	1,260, 000
Cutting of climbers and creepers.	70	10,000 per ha(two times)	700, 000
Pest control (including at the nursery stage).	For three years	Lump sum	800, 000

[13] Guidelines from the IUCN additional study (2013).
[14] IUCN (2013). Additional Study on Afforestation.

Vacancy planting.		20 % of planting cost	485, 000
Monitoring.	130 ha	10,000 per ha	1, 300, 000
Total estimated cost of activities.			20, 570, 000
Contingencies (10%).			2, 057, 000
Total.			22, 627, 000
Administrative and supervision cost (13%).			2, 941, 500
Grand Total			**25, 568,500**

242. **Consultant Terms of Reference:** A Forest Management Specialist (national) will be responsible for undertaking the following tasks related to administration and supervision:

- Preparing the afforestation plan, including specific instructions regarding selection of sites, raising seedlings, planting, maintenance, and subsequent vegetation management (including planting locations, methods, schedule, and monitoring plan);
- Designing and providing technical oversight for all activities at the nurseries;
- Providing technical oversight for the planting and maintenance of seedlings, ensuring the transplanting of the selected tree species; and,
- Designing and implementing public awareness addressing forest management.

2. Operation Phase

243. The main concern during the operation phase of the Moragolla project is maintaining vegetative cover and stable soil conditions in the upper watershed, to maintain habitat for fauna (as much as possible) and to reduce the sediment inputs to the Moragolla reservoir. Therefore, a Watershed Management Program is proposed, which will include various technical approaches for private land (home gardens and tea land) and state land in the upper watershed (up to Nawalapatiya). This program will include provision of technical assistance and funding. Details are summarized below.

244. Table 26 shows the range of watershed management techniques that have been proposed for the Moragolla upper watershed area, along with their intended objectives and their association with various land uses in the area.

Table 26: Summary of proposed watershed management techniques for the Moragolla upper watershed.

Technique	Description	Purpose	Applicable Land Uses
Lock and spill drains	Specific type of drains along contours that capture runoff in small stilling ponds.	Slowing down runoff, temporary storage of runoff water, promotion of infiltration and thereby groundwater recharge, and trapping of silt.	Tea cultivation areas.
Bunds and stone	Embankments along	Slowing down of runoff, trapping of	Cultivated lands

Technique	Description	Purpose	Applicable Land Uses
walls	contours that intercept runoff and sediments, and lead runoff to exit the land.	sediments, and disposal of runoff water from the fields.	and home gardens.
Small check dams along tributaries	Small scale embankments across creeks to create ponds.	Slowing down of storm water, prevention of flash flooding, trapping of silt, and temporary holding of water allowing groundwater recharge through the banks.	Creeks and streams.
Ground-cover crops	Crops that provide either continuous ground cover or a multi-layer canopy to intercept rainfall.	Reduction of soil detachment and transport (soil erosion), reduction of runoff velocity, possible provision of additional income depending on the type of cover crop used.	Tea cultivation areas and home gardens.
Mulching	Covering the ground with organic matter (grass, leaf litter).	Reduction of soil detachment and transport (soil erosion), reduction of runoff velocity, provision of natural fertilizers to crops and thereby increasing yields and income, and increasing of the water holding capacity of the soil.	Tea cultivation areas.
Grass strips	Establishing vegetative barriers along the contour lines at a relatively low cost, with little labour and maintenance.	Slowing down runoff, intercepting and settling sediments, provision of a good quality and quantity of runoff to streams and reservoirs.	Tea cultivation areas, stream reservations, home gardens and abandoned lands.
Reforestation	Replanting blocks of lands with suitable tree species, particularly those that are consistent with the natural vegetation of the area.	Provision of canopy cover to intercept rainfall, provision of litter layer on the ground further reducing the runoff velocity and allowing infiltration, improvement of soil texture, support of cover crops, interception of dew and thereby provision of additional precipitation, and creation of micro- and macro-habitats.	Stream banks, degraded forest areas and other reservations owned by the state.
Home garden improvement	To establish a suitable vegetative cover (see details in the EMP) in private home gardens to provide effective protection against soil erosion.	Minimization of soil erosion.	Home gardens.
Establishment of wetlands	To establish and maintain areas which are inundated seasonally and feature aquatic and semi-aquatic vegetation.	Trapping of silt, allowing groundwater recharge, purification of water by removal of certain pollutants and creation of habitats.	Suitable places within the stream reservation.
Awareness raising	To carry out public awareness programmes in order to raise the awareness of local communities regarding the importance of protecting the watershed.	Encouragement of the local community - particularly the private land owners - to adopt environmentally friendly land use options.	Tea cultivation areas, cultivated lands, and home gardens.

245. A detailed survey will be undertaken in the area between Nawalapatiya and the reservoir, to identify candidate sites for implementation of the watershed management techniques. A mechanism to disseminate the various technical approaches for watershed management and a fair system to disburse grants for their installation and maintenance will be established, so that these techniques can be applied throughout the target area. Photo 4 shows an example of a checkdam and the expected effect of such watershed management techniques. Note that reforestation and home garden improvements (for about 60 hectares) in the table above are part of the habitat enhancement program described previously, and have been budgeted accordingly.

Photo 4: Example of a checkdam near the project area.

246. The attributes of each of the proposed watershed management techniques are described below:

a) *Lock and spill drains:* Lock and spill drains are constructed along the contour lines and across slopes for the purpose of intercepting surface runoff and sediment load. The lock and spill drains slow down the speed of runoff water, and thereby reduce soil erosion. The advantages of lock and spill drains include protection of cultivated lands from hillside runoff, control of gully erosion, and reducing the erosive power of runoff.
b) *Bunds and stone walls:* These artificial embankments are constructed and graded to intercept rainfall and sediments, and lead runoff away from the cultivated land. Stone walls are usually constructed along contours in fields or at road sides, and provide an irregular form of terracing.
c) *Small check dams along tributaries:* Small check dams can be constructed in order to prevent gully erosion. Check dams are barriers erected across seasonal waterways, such as gullies, to decelerate the flow of water, allowing soil particles to deposit. The excess water will spill over the barrier once the check dam is filled. They can be constructed as concrete, masonry, earthen or loose stone check dams. For small gullies, check dams can be constructed using branch wood. The recent trend is to construct check dams using Gabion cages filled with stones collected locally. It is necessary to observe the erosion in progress in major gullies and to construct at least a loose stone check dam as a preventive measure. Advantages of these structures include control of

gully erosion, reducing the erosive power of runoff, and increasing retention time to facilitate groundwater recharge.

d) *Cover crops:* Cover crops are grown to protect the soil from erosion and to improve soil through green manuring. These are usually short rotation crops (less than two years), planted in fields or under trees, during fallow periods. Some of the advantages of cover crop planting include improvement of soil fertility, reduction of soil erosion and water loss, suppression of weeds, reduction of the need for fertilizers and herbicides, and an increase of soil organic matter.

e) *Mulching:* Mulching is a soil and water conservation practice in which a covering of cut grass, crop residues or other organic material is spread over the ground, between rows of crops or around the trunks of trees. This practice helps to retain soil moisture, prevents weed growth and enhances the structure of the soil. Advantages of mulching include interception of rain, reducing the direct impact of raindrops on bare soil, reducing surface runoff and soil loss, suppression of weeds and reduction of the labour cost of weeding, increased soil organic matter and increased moisture holding capacity of the soil.

f) *Grass strips:* Planting grass along contour lines creates barriers to minimize soil erosion and runoff. It includes a process of natural terracing on slopes, as soil collects behind the grass barrier, even in the first year. Grass can be planted along the bottom and sides of ditches to stabilize them, and to prevent erosion of the upper slope. Grasses can also be planted on the ridges of bench terraces to prevent erosion and maintain the stability of the benches. Advantages of grass cover include control of soil erosion and runoff (i.e., the root systems of vetivera grass act as a natural barrier to bind soils), and provision of fodder.

g) *Reforestation:* Forest cover with a good canopy and well developed litter on the forest floor can reduce or prevent soil erosion. Vegetation is the primary factor that changes the rate of soil erosion most radically within a given site. Forest vegetation, along with other factors such as the nature of the canopy, understorey vegetation, ground vegetation and ground cover by leaf litter, provides the best possible protection against soil erosion. Apart from reducing soil erosion, forest cover can reduce nutrient losses from the soil, and can build up the nutrient status and fertility of the soil. Forest vegetation also increases soil organic matter, as well as the moisture holding capacity of the soil.

h) *Home garden improvement:* Home gardens constitute a traditional system of perennial cropping for a wide range of valuable crops providing commodities such as food, fruits, timber, medicines and spices, and are considered important sites for the in situ conservation of crop germplasm. Kandyan home gardens are essentially a luxuriant system of mixed cropping with a variety of economically valuable tree crops and form an essential component of the land use. These home gardens are like forests in many respects. They provide shelter to birds and other wildlife, and conserve soil and water almost as well as the natural forest. They also provide a range of products including timber, fuelwood and non-wood forest products. However, some of the home gardens in the Moragolla catchment are managed poorly in terms of soil conservation. Therefore, a home garden improvement program is an essential component of the watershed management programme.

i) *Establishment of wetlands:* Wetlands affect the landscape by virtue of their capability to retain water and decrease its velocity, controlling erosion. They also provide valuable habitats for wildlife and enhance water quality. Hydrological functions of wetlands include flood buffering, water storage, groundwater discharge and recharge, surface flow

augmentation, and removal of pollutants, such as nutrients and heavy metals. Therefore, in addition to biodiversity conservation, the establishment of wetlands in the Moragolla watershed will also facilitate these hydrological functions.

j) *Awareness raising:* The objective of the public awareness program is to promote public awareness of the importance of conservation and management of soil and water resources in the Moragolla project area, in order to emphasize the need to protect these resources among local communities. Such a public awareness program will enhance and facilitate the other soil and water conservation and management activities implemented in the Moragolla reservoir area.

247. The required sequence of activities to implement the upper watershed management program is summarized below:

(i) Detailed field survey to identify specific locations to establish proposed soil conservation structures and measures appropriately;
(ii) Engineering design of mechanical structures required, including lock and spill drains, bunds and stone walls, and small check dams;
(iii) A brief feasibility study on the establishment of wetlands;
(iv) Preparation of a detailed program on awareness raising, including identification of different target groups;
(v) Provision of inputs to the afforestation programme for implementation of home garden improvement activities;
(vi) Preparation of an implementation plan;
(vii) Establishment of lock and spill drains, bunds and stone walls and small check dams, as necessary;
(viii) Establishment of cover crops, mulching and grass strips, as well as implementation of home garden improvement programs;
(ix) Establishment of wetlands, as necessary;
(x) Implementation of the awareness program; and,
(xi) Routine monitoring.

248. Implementation Arrangements: The most feasible option for implementing the proposed upper watershed management program is to have it implemented through professional organizations in Sri Lanka with adequate experience in planning and implementation of such activities. The following government institutions might be considered (with the CEB paying an administration and supervision fee for their engagement).

a) *Forest Department (FD):* The FD has a vast amount of experience in the implementation of afforestation and biodiversity conservation programs in Sri Lanka. While the headquarters of this agency is located in Battaramulla, it has a well distributed district office network throughout the country. It also has many experienced professional staff in the field of forestry. The Moragolla project area comes under the authority of Divisional Forest Officer of the Kandy District. The field-level authority for the Moragolla project area is the Range Forest Officer located at Nawalapitiya. The Beat Forest Officer of the Gampola Beat operates under the Divisional Forest Officer. In addition, a number of Field Assistants are also stationed in the project area. Considering this field-based structure and the experience of the FD in watershed management work, the involvement of the FD could be considered.

b) *Natural Resources Management Center (NRMC):* The Natural Resources Management Center of the Department of Agriculture is a professional organization with much experience in handling watershed management related activities. It has experienced professional staff in the field of soil conservation and watershed management. The NRMC is located in Peradeniya, and can be considered for involvement in the proposed upper watershed management program.

249. **Performance Indicators and Monitoring Requirements:** A successful watershed management program would significantly reduce soil loss, erosion, and sediment inputs to the Mahaweli Ganga and the Moragolla reservoir. Vegetative cover in the upper watershed (to Nawalapitiya) would increase, and the incidence of animals in the upper watershed would also increase. Effectiveness of the soil conservation measures, vegetative cover, and faunal incidence will be monitored, in addition to the routine water quality monitoring (described elsewhere). Local people in the Moragolla project area would be fully aware of the importance of adopting soil conservation measures and better landuse options to help protect the Moragolla reservoir and would be amending their practices accordingly.

250. It is proposed that program implementation be monitored by a monitoring committee comprising the CEB PMO, implementing partners, and community organizations in the area. This program monitoring committee would meet once each quarter to monitor the progress of implementation (including field observations; to be undertaken by staff of the agency engaged for the initiative). If there are any issues adversely affecting the progress of the program, immediate action would then be taken to resolve such issues. Monitoring should continue, at intervals, into the operation phase of the project.

251. **Scheduling and Pacing:** The proposed upper watershed management program would be implemented during the first two years of construction, well before filling of the reservoir. The schedule of activities is shown below.

Activities	**2014**		**2015**		**2016**		**2017**		**2018**		**2019**		**2020**		**2021**	
		Pre-constn			**Construction**								**Operation**			
Detailed field survey to identify specific locations for the implementation of proposed soil conservation measures.																
Design of mechanical structures required, including lock and spill drains, bunds and stone walls, and small check dams.																
A brief feasibility study on establishment of wetlands.																
Preparation of a detailed awareness program on awareness.																
Provision of inputs to the																

Activities	2014		2015		2016		2017		2018		2019		2020		2021	
		Pre-constn			Construction								Operation			
afforestation program for the implementation of the home garden improvement component.																
Preparation of an implementation plan.																
Establishment of lock and spill drains, bunds and stone walls and small check dams.																
Establishment of cover crops, mulching and grass strips, and implementation of home garden improvement programs.																
Establishment of wetlands.																
Implementation of awareness program.																
Monitoring.																

252. **Budget:** The following assumptions and estimates were used to calculate the program costs, as follows[15]:

- Lock and spill drains: approximately 30 m of lock and spill drains to be constructed for each hectare of tea lands (in 63 ha of tea in the immediate catchment);
- Earthen dams: approximately 20 m of earthen dams for each hectare of land in the 31-60% slope category (83 ha of tea in the immediate catchment);
- Stone walls: approximately 14 m of stone walls for each hectare of land in the 31-60% slope category (83 ha) of tea in the immediate catchment;
- Small check dams: 10 cubic meters for each hectare (24 ha) of immediate catchment occupied by water bodies;
- Mulching and cover crops: 8% of the total extent (about 100 ha) of tea and 5% of the total extent (about 230 ha) of home-gardens/degraded tea lands in the immediate catchment, up to a distance of 100 m from the FSL around the reservoir periphery;
- Grass strips: in 20% of the total periphery of the reservoir up to 100 m from the FSL in the immediate catchment; and,
- Wetlands: roughly 5% of the total land area of the immediate catchment is occupied by water bodies.

[15] See IUCN (2013). Additional Studies. Afforestation and Watershed Management Plan, for detailed assumptions and units used to develop the budget for this initiative.

Work Item	Quantity	Units and Rates (LKR)	Cost (LKR)
Detailed field survey to identify specific locations to establish proposed soil conservation measures.		lump sum	300,000
Design of proposed mechanical measures.		lump sum	400,000
Brief feasibility study on the establishment of wetlands.		lump sum	150,000
Preparation of a detailed awareness program.		lump sum	400,000
Provision of inputs for the implementation of the home garden improvement component.		lump sum	300,000
Preparation of implementation plan.		lump sum	400,000
Construction of lock and spill drains.	2,000 m	LKR 225 per meter	450,000
Construction of earthen bunds.	1,700 m	LKR 225 per meter	382,500
Construction of stone walls.	1,200 m	LKR 360 per meter	432,000
Construction of small check dams.	24 m^3	LKR 1,200per m^3	28,800
Cover crops and mulching.	20 ha	LKR 15,000 per ha	300,000
Grass strips.	1,400 m	LKR 450 per meter (2 m width)	630,000
Establishment of wetlands.	1 ha	LKR 15,000 per ha	15,000
Implementation of the awareness program.	1 year		375, 000
Monitoring.		lump sum	450,000
Total estimated cost of activities			5,013,300
Contingencies (10%)			501,330
Total including contingencies			5,514,630
Administrative and supervision			716,902

Work Item	Quantity	Units and Rates (LKR)	Cost (LKR)
Cost (13%)			
Grand Total			**6,231,532**

253. **Consultant Terms of Reference:** A team of Watershed Management Specialists (nationals, from the selected agency, to be funded through the fee for administration and supervision) will be responsible for undertaking the following tasks related to administration and supervision of the upper watershed management program:

- Undertaking the field survey to identify suitable locations for the specific watershed management techniques;
- Undertaking the design of the proposed technical measures;
- Undertaking a feasibility study of the practicality of developing wetlands;
- Developing the overall upper watershed management implementation plan;
- Designing and implementing the public awareness program;
- Facilitating home garden improvements;
- Providing oversight to installation/ construction of the technical measures; and,
- Overseeing the monitoring process.

VI. ENVIRONMENTAL MONITORING PLAN

A. Role of the EMoP

254. The Environmental Management Plan (EMP) and the Environmental Monitoring Plan (EMoP) are the two main practical tools employed during project implementation to provide the environmental protection measures derived in the earlier Local Environmental Impact Assessment (EIA) (and in this case also the Environmental Addendum). The EMP and EMoP build on and expand the mitigation outlined in those documents, and provide the mechanism through which the measures are physically delivered and their performance is checked to ensure they provide the necessary protection.

255. As seen in Chapter V above, the EMP describes each mitigation measure in detail and the manner in which it should be provided, and allocates responsibility for all related actions. It also provides important supporting information, including implementation guidance, a programme, an estimated budget, ToR for any consultancy inputs needed, etc. The EMP provides the framework within which the mitigation is delivered. The Environmental Monitoring Plan then provides the mechanism to ensure that:

- All of the actions required to provide the mitigation are taken as set out in the EMP;
- The actions mitigate the impacts and protect the environment as intended; and
- The residual impacts of the project are recorded, so that if there are unexpected impacts, these can be reduced by applying additional mitigation.

256. The EMP and EMoP therefore have different roles, but they operate in tandem to ensure that the mitigation is delivered and that it provides adequate protection, and that if for any reason the protection is insufficient, additional action is planned and provided. Both documents cover all phases of the project (pre-construction, construction, operation and de-commissioning where relevant).

B. Environmental Supervision

257. The first of the three functions listed above is provided via environmental supervision, which is the process through which the activities to provide the mitigation are independently monitored, to ensure they are conducted as specified in the EMP. Environmental supervision is mainly conducted during the construction stage (which is the phase in which the major environmental risks normally occur), and is performed as part of the Construction Supervision contract.

258. Construction supervision involves a variety of activities conducted by the Supervision Consultant on behalf of the client, to ensure that contractors build the infrastructure as designed and that the client therefore obtains a functionally and financially viable project. Supervision is conducted by experienced site engineers and supporting staff, and involves site observations and inspections, document review, sampling and testing of materials (concrete, infill mixes, etc) and many other activities, conducted throughout the entire construction period.

259. Environmental supervision is the environmental equivalent and involves site observation, document review, interviews with site managers and other personnel, monitoring and testing of

environmental parameters, and other activities, to ensure that the mitigation measures are provided by the contractors and others as specified in the EMP. Environmental supervision is conducted within the framework of the EMP and EMoP but the supervision activities are not normally specified in these documents as they are planned in detail and managed by the Supervison Consultant's Environmental Manager (or equivalent). The Environmental Manager refers extensively to the EMP in planning and conducting the environmental supervision, as the EMP prescribes how the mitigation should be provided and how it is expected to perform. He/she also refers extensively to the results of the environmental monitoring set out in the EMoP, because this is the principal means of determining whether the mitigation is functioning adequately

C. Environmental Monitoring Plan

260. The individual environmental monitoring measures are identified in the Local EIA/Addendum and in the EMP and relate primarily to those activities in which there are measurable environmental emissions (eg air quality, water quality, noise, etc). These activities are drawn together in the EMoP, which describes in detail the purpose of each monitoring activity and the methodology to be employed (including the approach, parameters to be measured, survey locations, frequency, and other information). It also recommends thresholds that will signal the need for corrective actions.

261. Tables 27, 28 and 29 show the EMoP for this project. This is divided into three parts, equivalent to the different parts of the EMP. Part 1 (Table 27) is the EMoP for the construction phase. This shows that some quite extensive monitoring is required in relation to the three main fields in which there is the most risk of impacts from the construction work (water quality, air quality and noise and vibration) This involves monitoring at and around all of the main construction sites and several of the ancillary sites (quarry, disposal sites and main transportation route), and before construction begins (baseline) and regularly throughout the construction period. This monitoring is assigned to the contractor to raise awareness of the environmental risks and impacts associated with the construction work and the way they need to be mitigated.

262. The remainder of this EMoP involves: small-scale monitoring to confirm the requisite E-flow is provided during reservoir impoundment; regular monitoring of water levels in domestic wells during tunnel construction; and checking the structural condition of buildings that may be at risk of structural damage throughout the construction period. These activities are assigned to CEB because they involve contact with the public regarding some quite sensitive issues, and because provision of a continuous E-flow is one of the main conditions of the Environmental Approval for the project, granted by MASL. CEB will probably appoint specialised consultants and contractors to conduct this work, but it is important that the responsibility for the monitoring and any resulting remedial action remains with CEB as the Project Proponent.

263. Table 28 shows the EMoP for the operation stage of the project. There are not expected to be major environmental impacts during this stage, so there is no need for extensive environmental monitoring. Monitoring in relation to the hydrological changes downstream of the tailrace only requires simple checks, because if CEB mitigates these impacts by operating the Moragolla and Kotmale stations out-of-phase in the dry season it is very unlikely that there will be noticeable the changes in flow when one station begins to operate. Water quality monitoring

Table 27: Environmental Monitoring Plan for the Moragolla Hydropower Project: Construction Phase

Impact	Mitigation	Monitoring	Parameters	Method	Rsp	Frequency	Location
1. Hydrology: Proposed mode of reservoir filling will not allow E-flow in the 19h filling period so CEB would not fulfil their obligation to provide E-flow at all times	Devise an alternative filling method that provides the guaranteed E-flow	Record downstream flow throughout the revised filling operation to confirm a flow of at least 1.5 m^3/s at all times	Monitor: Rate of downstream water flow (m^3/s) Threshold: No flow below 1.5 m^3/s	Fixed position automatic reading river flow meter; range 1-100 m^3/s	CEB	One survey. One reading every 5 minutes during reservoir filling and 6 hours before and after	In flow of water from the dam
2. Water Quality: Silt may wash from bare soil at construction sites during rainfall, increasing turbidity in the river and affecting aquatic ecology and people who use the river for washing/bathing	Cover finished cut surfaces; cover loose material when transported of stored; collect all drainage from construction sites in ponds and allow sediment to settle out before discharge to the river	Measure silt content of water discharged from settlement ponds and in the river immediately upstream	Monitor: Turbidity (NTU) and Total Suspended Solids (TSS) (mg/litre) Threshold: No repeated or gross exceeding of natural baseline levels in river (from 2013 Additional Studies)	Portable water quality meter, with Turbidity and TSS facility	CC	Monitor at each active work site daily for 3 months, then once a week for the next 3 years	All active construction and ancillary sites
3. Groundwater: Levels of domestic water in wells could fall if groundwater drains into headrace tunnel cavity during construction, reducing the water supply available for local people	This is not expected to cause major impacts as tunnel is embedded in intact bedrock. Monitoring is precautionary, to allow mitigation if well levels were to fall	Measure water levels in wells in the vicinity of the tunnel route	Monitor: water level from surface and depth of water in each well (m) Threshold: No significant reduction from water levels before construction and/or in 2013 Additional Studies	Portable water level dip meter	CEB	Baseline survey pre-construction. Then monitor every 2 weeks for 3 months, then every 3 months for 2 years	20 wells in vicinity of tunnel route. Same wells each time
4. Air Quality: Dust may blow from exposed soil in dry weather, reducing productivity of crops and vegetation, and causing respiratory problems for workers and residents	Remove vegetation in stages; re-vegetate completed sites quickly; spray site roads and bare soil in dry weather; spray soil at quarry & disposal sites if feasible	Monitor levels of dust at edge of construction sites and in nearby residential areas	Monitor: Airborne dust ($PM_{2.5}$ and PM_{10} fractions) Threshold: No repeated or gross exceeding of natural baseline levels recorded before construction begins	High-volume dust sampler with glass filters and gravimetric analysis	CC	Baseline survey pre-construction. Then once a week for 2 months; then once a month for 3 years. Monitor for 3 h each time	5 work sites with most risk (dam, quarry, Atabage-Mawathura Rd, powerhouse, disposal site 3) and nearby residential areas
5. Noise and Vibration: Noise/vibration are produced by most construction and this is a major project with a large site and significant transport of materials. Noise can affect quality of life; vibration can cause structural damage	Do not use vehicles older than 10 years; service regularly; fit with silencers; repair or replace any vehicles emitting excessive noise; survey condition of buildings near work sites & remediate or compensate if damaged	Monitor structural condition of at risk buildings & structures near construction sites and alongside transport routes	Monitor: cracks and other structural weakness Threshold: any changes causing structural weakness or risk since baseline pre-construction records	Take measurements and photographic records. Number all defects *in situ*	CEB	Baseline survey pre-construction. Then one survey every 6 months (6 surveys in total)	At-risk buildings and structures from aerial photos; and any locations from which there are complaints
		Monitor noise and vibration at perimeter of construction sites & in nearby residential areas/ and in vulnerable buildings identified by structural survey	Monitor: Ambient noise dB(A) LA_{eq} and LA_{max} Threshold: No repeated or gross exceeding of relevant levels as defined in national standards (see Appendix 3)	Portable noise meter (range 0-120 dB(A)) Portable vibration meter. 4 hour recording period at each site	CC	Baseline survey pre-construction. Then once a week for 2 months; then every 3 months for 3 years	Perimeter of the 5 at-risk sites above & nearby residential areas; plus 10 other buildings

Table 28: Environmental Monitoring Plan for the Moragolla Hydropower Project: Operation Phase

Impact	Mitigation	Monitoring	Parameters	Method	Rsp	Frequency	Location
1. Hydrology: If Moragolla & Kotmale HPPs operate on same cycle, flow may be reduced up to 8 km downstream of the tailraces in dry season. This will offer less suitable habitat for fish and may increase risks to sand miners & river bathers from rapid increases in flow & depth when the two outfalls resume operations each day	Operate the two stations out of phase in the dry season if feasible so the outfalls do not resume daily operation together, so changes in flow and depth will be gradual. This will also extend the daily period in which Moragolla E-flow is augmented by tailrace discharges, thus providing more suitable fish habitat downstream each day	If the two tailrace outfalls are operated out-of-phase, conduct a survey of downstream river users to determine whether any rapid daily increases in flow and water depth are observed	Conduct: Informant interviews to determine: a) whether daily changes in river flow and depth have been observed; and b) the nature and timing of any changes observed	Interview a sample of downstream river users. Asking if they have noticed any daily changes in flow and depth since MHPP began operations. If the answer is yes, ask what changes have been observed and when. Assess whether these correlate with Moragolla and Kotmale discharges	CEB	One survey; in the first dry season after the Kotmale and Moragolla HPPs begin out-of-phase operations	At riverside locations used for washing and bathing in the 8 km downstream of the tailrace outfall. Interview at least 100 persons separately
2. Water Quality: Reservoir water may become deoxygenated at lower levels in the dry season, especially if vegetation is decomposing on the bed. Reduced flow downstream will provide less dilution for Crysbro effluent. These could both cause ecological impacts.	Uproot and remove trees & shrubs before reservoir first filling. Reforest a buffer around the reservoir and implement a Watershed Management Plan to reduce inputs of soil and pollutants. Extend Crysbro outfall to downstream of the Moragolla tailrace. Operate Moragolla & Kotmale out of phase to dilute Crysbro effluent for a longer period each day	Regularly monitor water quality in the reservoir and downstream of the Crysbro outfall	Monitor: Temperature, pH, Turbidity, TSS, DO, BOD_5, Ammonia, Nitrate, Phosphorous, Faecal Coliform, Total Coliform. Compare: with proposed ambient water quality standards (Appendix 3) and baseline data from river before dam & reservoir from 2013 surveys (Volume 4)	Portable water quality meter (temp, pH, TSS, turbidity, DO) Sub-surface sampling bottle to collect water samples for laboratory analysis of BOD_5, Ammonia, Nitrate, Phosphorus, Faecal and Total Coliforms	CEB	Once a month for 6 months; then every 6 months for 4 years	Reservoir: 9 stations (3 x 3 grid). Monitor/ sample: 0.5 m below surface; 0.5 m above bed; mid-depth. Downstream: 3 stations: 1 in effluent; 2 at 100 m intervals downstream; 1 sample at each

Table 29: Environmental Monitoring Plan for the Moragolla Hydropower Project: Special Issues

Impact	Mitigation	Monitoring	Parameters	Method	Rsp	Frequency	Location
6. Aquatic Ecology: The project area supports 8 nationally threatened fish species, including *Labeo fisheri,* which is of high conservation priority. These species may be affected by disturbance, poaching, turbidity, blasting, etc	Special measures to protect the rare fish include catch and haul (translocation) to the nearby Kelani River; and cutting channels in the river bed downstream of the dam to improve connections between pools in dry season	Catch and haul requires a prior survey to determine the presence and distribution of *L fisheri* and other large species; and this should then be repeated during MHPP operation to assess changes in the populations	Monitor: Locations of river bed pools above and below the dam site; fish species present, their distributions and approximate numbers in pools in the river bed; locations of pools and fi	Use an inflatable raft and portable electronic fish finder to determine depth of riverbed, numbers and depth of fish, & locations (GPS coordinates). Use small mesh nets to catch fish samples for species identification; release the captured specimens upstream or downstream	CEB	Two surveys: one pre-construction and one after one year of MHPP operation	In all major pools in the river bed, at the sites of the reservoir and dam, down to Atabage Oya.
		The translocation area in Kelani River should then be surveyed annually for the first four years after translocation to monitor survival and population expansion	Monitor: Fish species present and their distributions. Estimate population densities and record other features, such as breeding status	Use similar netting techniques to capture samples of fish in the translocation area		Five surveys: one baseline before translocation and then annually post-translocation	Kelani River, over around 5 km upstream and downstream
7. Terrestrial Ecology: The project will remove >900 trees, none of which are endangered. Terrestrial fauna includes 41 endemic or endangered species of which 5 are high priority. These are not at risk from the project but their habitat will be enhanced	CEB will reforest a 100 m buffer around the reservoir to reduce soil erosion and planting will incorporate measures to provide habitat for the 5 priority faunal species	The planted area will need to be regularly monitored so that dead seedlings can be replaced and other remedial action (weed removal, disease treatment, etc) planned and implemented as necessary	Monitor: seedling deaths, indications and presence of pests and disease, invasive species, human encroachment, farming and other unauthorised activities	Conduct walkover surveys of features that can be recognised visually (seedling survival, encroachment) and smaller scale investigations of other aspects (pests, disease). Record locations on maps to plan remediation	CEB	Surveys every 3 months for the first year, then every six months for the next four years	Cover the whole planted buffer zone
	When the MHPP is operating the main mitigation will be to protect the reservoir catchment from human impacts by implementing a Watershed Management Plan to improve vegetative cover, stabilise soil and enhance faunal habitat	Once the WMP is underway there will need to be regular monitoring of the key expected improvements in order to record progress and plan refocusing if needed	Monitor: the key parameters in which improvements are needed: soil conservation, vegetation cover and the presence of the key faunal species (reservoir and river water quality will also be monitored as described above)	Monitoring methodologies will be developed in detail during the planning stage for the WMP		Surveys every six months, plus shorter-term records of aspects like faunal sightings when appropriate	The overall WMP area, and in particular those locations targeted for specific activities

is more extensive because de-aerated and polluted water could affect the priority fish species and other aquatic organisms; but this can be reduced over the longer term (say after the first two years) if the data up to that point shows consistently good quality water, with no values that exceed the proposed national ambient water quality standards (provided in Appendix 3).

264. There is also some monitoring related to the mitigation and enhancement proposed for the "special issues" associated with this project (aquatic ecology and terrestrial ecology), and this is shown in Table 29. For aquatic ecology the monitoring is required: firstly to assess the fish populations to be captured and translocated so that the exercise can be planned in detail; and secondly to review the success of the operation over the longer-term. For terrestrial ecology the monitoring is required to record the progress of implementation of the afforestation plan and the Watershed Management Plan, to identify where remedial action may be needed. The mitigation and enhancement measures for the special issues encompass the pre-construction, construction and operation phases, and this is also the case for the associated monitoring. Responsibility for the monitoring is assigned to CEB as the constant party throughout these periods, and because much of the proposed action is intended to enhance the habitats for the priority species, rather than to address negative impacts with specific causes.

D. Reporting Procedures

265. The contractual arrangements and roles assigned to the key parties should ensure that progress on implementing the mitigation and the results of the supervision and environmental monitoring are reported accurately, transparently and with sufficient frequency to allow a proper evaluation on the performance of the measures, so that timely remediation can be applied if necessary.

266. As explained in Section V.B the construction contracts will require each of the main contractors to report in writing to CEB each month on the progress of implementing all mitigation that is their responsibility as shown in the EMP, and on the monitoring assigned to them in the EMoP. These reports will be reviewed by both CEB and the Supervision Consultant, who will specify remedial action if necessary. This may be required for a variety of reasons, for example: if monitoring shows that threshold values are being grossly or repeatedly exceeded; if there are deficiencies in the monitoring procedures or data; if site supervision shows deficiencies in the manner in which mitigation is being provided; etc. Contractors will also be required to report to the Supervision Consultant by email each week, and verbally immediately that any incident occurs that has environmental consequences (followed up by a written account within 24 hours).

267. The Supervision Consultant will also be required by their contract to report to CEB each month on these issues, with a more substantial report each quarter. This system, along with regular site meetings and information provision during the course of informal contacts on site, should keep the CEB Project Management Office fully informed at all times regarding the progress of the various environmental measures and their degree of success in mitigating the impacts or enhancing habitat conditions. CEB will also be fully aware of and involved in any incidents that occur on site, whether or not they have environmental implications.

268. CEB will report periodically to ADB on progress in implementing the EMP, and any compliance issues and corrective actions. The reporting frequency will be established by ADB and will be quarterly or semi-annually. CEB will disclose these reports to the public, on their website and at the CEB site office, and in other locations in the vicinity of the project area.

VII. IMPLEMENTATION ARRANGEMENTS

A. Executing and Implementing Agencies

269. The Ministry of Power and Energy (MoP&E) is the Executing Agency of this project. The Ceylon Electricity Board (CEB), which is one of the four agencies[16] comes under the purview of MoP&E, is the Implementing Agency or the Project Proponent (PP). In order to ensure smooth functioning of the project, a Project Management Office (PMO), headed by a Project Director (PD) will be established by CEB. The PD will report directly to the Additional General Manager (Projects) –AGM (P) of CEB. The overall organization of the project is illustrated in Fig 20.

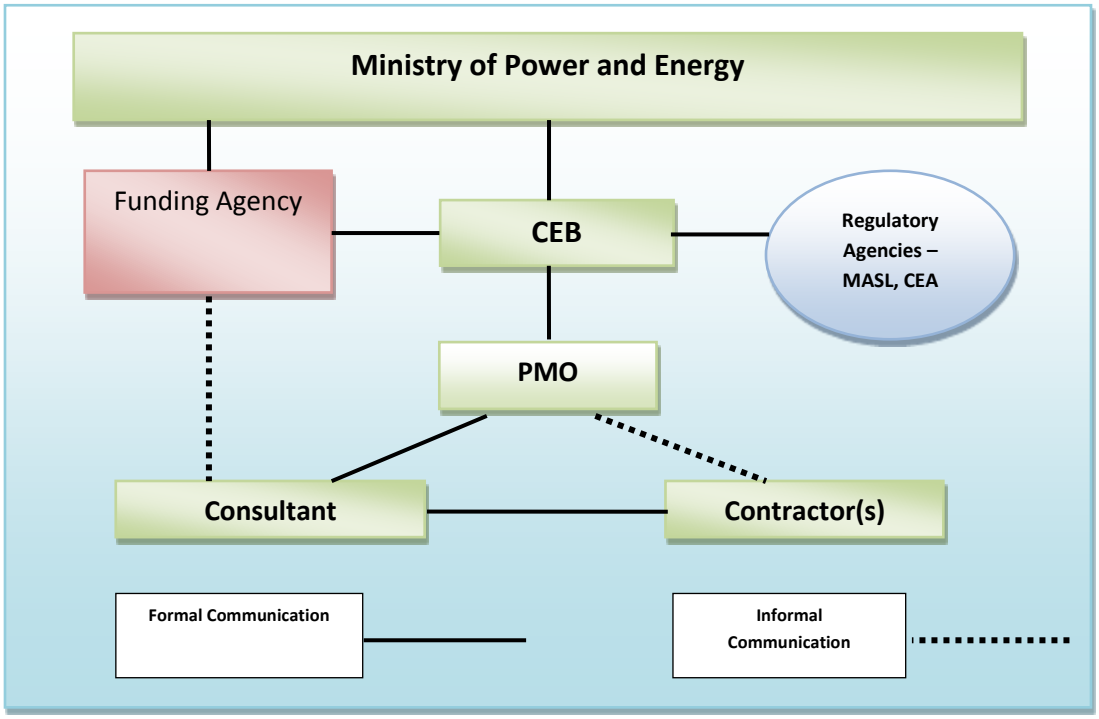

Fig 20: Overall Organisation of the Project

270. A Project Steering Committee (PSC) will be established by MoP&E immediately after the financial arrangements for project implementation are finalised. The proposed composition of the PSC and their statutory responsibilities that may impinge on the project are shown in Table 30.

[16] Other three agencies are: Lanka Electricity Company (Pvt) Limited, LTL Holdings (Pvt) Ltd. and Lanka Coal Company (pvt) Ltd

Table 30: Draft Composition of the Project Steering Committee

1.	Secretary, Ministry of Power & Energy	Chair Person
2.	Representative from the Ministry of Defence and Urban Development	Planning approval for infrastructure development facilities
3.	Representative from the Ministry of Lands and Land Development	Publish the relevant Gazette Notifications pertaining to land acquisition.
4.	Commissioner General of Lands or a representative	Prepare relevant documents for land acquisition
5.	Representative from the Mahaweli Authority of Sri Lanka (MASL)	Designated Project Approving Agency under the National Environmental Act. Responsible for compliance monitoring with conditions of the environmental approval issued by MASL
6.	Representative from the Department of External Resources	Loan disbursement
7.	Representative from the Central Environment Authority	Monitoring the environmental impacts of the project.
8.	Representative from the Survey General's Department	Carry out legal survey for land acquisition
9.	Representative from the National Water Supply and Drainage Board (NWS&DB)	Provide water supply for resettlement sites and other facilities
10.	Survey General (SD)	Legal survey of land and prepare Advance Tracing (AT) and Preliminary Plan (PP)
11.	Valuation Department (VD)	Valuation of the lands and prepare Valuation Reports (VR)
12.	Divisional Secretary, Udapalatha	Responsible for the following activities of the Land acquisition process: - Decide the legal owners of the land to be acquired. -Request the SD to survey the land and prepare AT and PP. -Request the VD to submit the VR. -Pay the compensation in respect of acquired lands and property.
13.	Divisional Secretary, Ganga Ihala Korale	

271. The PSC will act as the apex decision-making body for the project. The PSC will meet once every two months to review the progress of project activities, provide policy guidelines, resolve issues that may impede the progress of project implementation, and advice on remedial action. The PSC will provide a forum for deliberation of important aspects of the project among its members and facilitate inter-agency coordination.

272. The responsibility of implementing the project lies with the Project Proponent, CEB who will appoint Contractor(s) to construct the various elements of the project once the financial arrangements are finalized, and a Consulting Engineer to supervise construction.

273. The PMO will co-ordinate the pre-construction, construction and commissioning of the project. An Environmental Management Office (EMO), which will form part of the PMO, will also be established. This will be staffed with an Environmental Specialist (Physical and Natural),

Environmental Specialist (Social) and supporting staff as shown in Figure 21. International Environmental and Social Specialists supported by qualified local specialists will also be appointed by the Supervision Consultant.

274. The contractor(s) are legally required to implement those elements of the project Environmental Management Plan that are allocated to them in the EMP document; and they will be required to report on this and any other environmental issues to the EMO at monthly intervals or more frequently if necessary. All main contractors will be required to appoint Environmental Officers, who will be the primary point of contact for all environmental issues in relation to construction activities.

275. The internal arrangement of the PMO of CEB is illustrated in Figure 21.

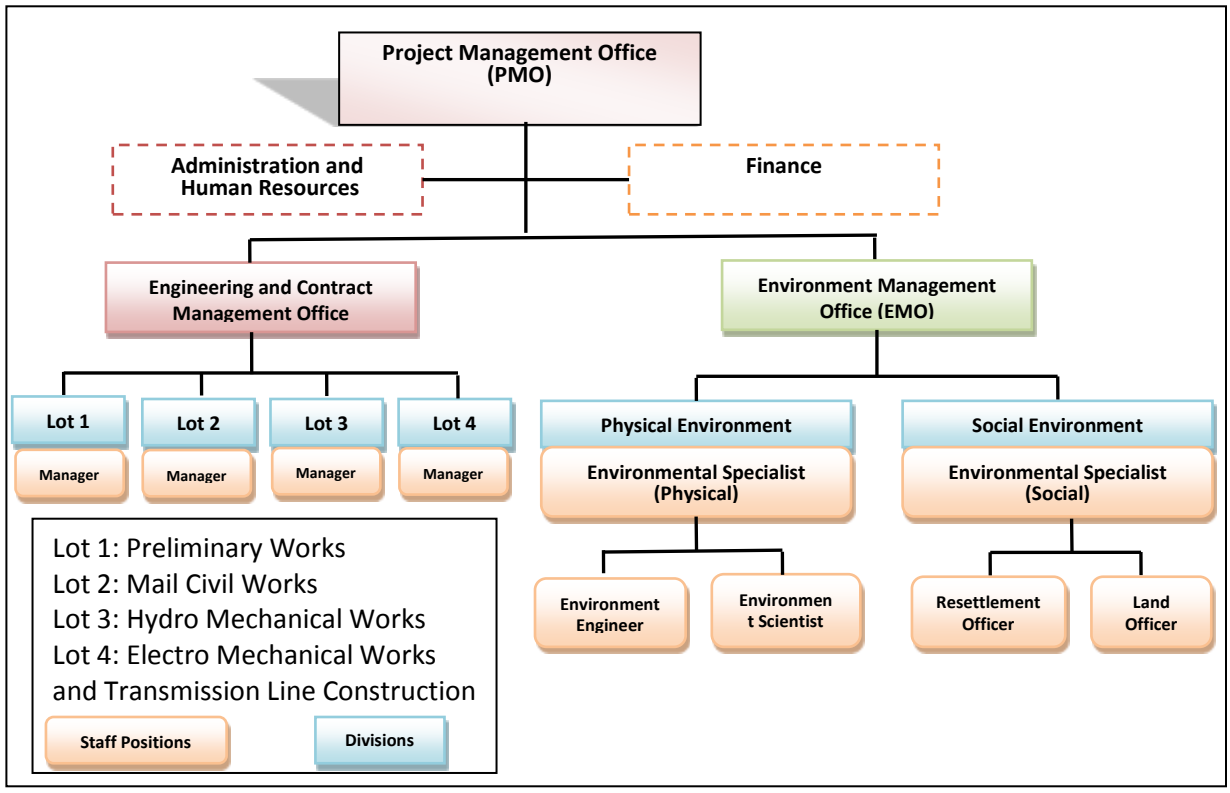

Fig. 21: Proposed structure of the Project Management Office

276. The successful construction and operation of the MHPP will depend on many factors, which include the successful implementation of the various monitoring and mitigation measures set out in the Local EIA report and the EMP. To achieve this it is imperative that all the participants and organisations having a designated role in project execution and implementation act in a responsible manner and implement their duties professionally and diligently, as set out in the EMP. The main participants and their responsibilities are summarised in Table 31.

Table 31: Organisations involved in project implementation and their main responsibilities

Agency	Project related responsibilities
Ministry of Power and Energy (MoP&E)	Executing Agency (EA) - Apex decision making body. Responsible for administration of loan / grant finance on behalf of the Government and Progress monitoring through establishment of a Project Steering Committee (PSC). Resolving issues that impede the progress of project implementation, through inter-agency coordination.
Ceylon Electricity Board (CEB)	Project Implementing Agency or the Project Proponent (PP).
Project Management Office (PMO)	Day-to-day project management and coordination: financial management; project administration; technical oversight (engineering and environmental); review and approval of the work of the Design Consultant. Also responsible for ensuring the project adheres to national law and the policy of the lender, including environmental safeguards.
Design Consultants (DC)	Detailed design of all elements of the project infrastructure; project planning and programme; calculation of project budgets; preparation of tender documents; inclusion of environmental mitigation measures in design, tender documents and budgets as specified in project EMP.
Supervision Consultants (SC)	Supervision of the work of the Contractors to ensure that all infrastructure is built as designed. Environmental Supervision to ensure that all mitigation is provided as specified in the project EMP (by Contractors, Design Consultants and other bodies).
Construction Contractor(S) (CC)	Construction of specific elements of the infrastructure according to designs, drawings and tender documents; provision of mitigation and monitoring impacts of construction activities as specified in the project EMP.
Mahaweli Authority of Sri Lanka (MASL)	Functions as the Project Approving Agency (PAA) under the National Environmental Act. Responsible for administering the EIA process, including scoping, preparing ToR, public disclosure, review of EIA report, decision-making and compliance monitoring which would involve compliance with conditions and the effectiveness of the mitigatory measures.
Central Environmental Authority (CEA)	Oversees the EIA implementation by the PAA, Monitor the quality of the environmental to ascertain the long term effects (if any). Issuing of EPL for prescribed activities.

B. Institutional Assessment and Proposed Strengthening

277. The outcome of the discussions had with the Deputy Director General (Environmental Management and Assessment) and the Director (EIA) of the Central Environmental Authority, Director (Forestry and Environmental Management) of Mahaweli Authority of Sri Lanka, Project Manager of Moragolla Hydropower Project Feasibility Study Review and Environmental Officer of Ceylon Electricity Board were used in this institutional assessment study.

1. Central Environmental Authority

a. EIA Unit

278. The EIA Unit, headed by the Director (EIA), functions under the Environmental Management and Assessment Division of CEA and is responsible for: administration of the EIA process; co-ordination between Project Approving Agencies (PAA's); preparation of manuals and guidelines on EIA; and maintenance of a database on EIA. Currently there are three Deputy Directors (DD), six Assistant Directors (AD), eight Senior Environmental Officers (SEO) and three Environmental Officers (EO) attached to the EIA Unit. All of them are science graduates, with post graduate qualifications in environment management related specialties; and in general the senior positions are occupied by those staff with the most experience

279. Since its introduction in 1994, the CEA has gathered considerable experience and expertise in managing (over 800 EIAs and IEEs) the EIA process in Sri Lanka and has benefited from numerous capacity building and training projects supported by various donor agencies (NAREPP/IRG project funded by the World Bank, ISEA project funded by ADB and Netherlands funded capacity building project ect.,). However, it is understood that, although the CEA has achieved fairly high standards in implementing EIA procedures and also gained quite a lot of experience in monitoring of post-implementation impacts during the last decade (Upper Kothmale Hydropower Project financed by JICA, Southern Transport Development Project financed by ADB/JICA and Outer Circular Highway Project and Colombo-Katunayake Expressway financed by the Government of China), this is still a weak area that needs to be strengthened (according to the D(EIA) of CEA).

b. Environmental Pollution Control (EPC) Unit

280. The EPC Unit of CEA is responsible for management of the Environmental Protection License (EPL) scheme through: development of pollution control guidelines; review and upgrading the existing discharge and emission standards; and introduction of new mechanisms such as the load base license scheme. This division is headed by the Director (EPC), who reports to the Deputy Director General (EPC). Currently there is one Deputy Director (DD), four Assistant Directors (AD), eight Senior Environmental Officers (SEO) and four Environmental Officers (EO) attached to this Unit. As in the EIA unit, all of the professional staff are science graduates, with post graduate qualifications in environment management related specialties. Issuing of EPL is now delegated to the Regional offices of CEA and Local Authorities (see below).

c. Regional Offices of CEA

281. The CEA operates Provincial and District offices that handle most of the compliance and enforcement functions at grass-roots level. These offices often function as the focal points for EIA17and EPL matters in their area of jurisdiction and issue EPL for prescribed activities.

282. The MHPP area comes under the jurisdiction of the Central Provincial office of CEA. This is headed by the Regional Director (Central Province), with two DDs, four ADs, eight SEOs

[17] Administration of IEE process for the projects and undertakings for which CEA functions as PAA are now totally delegated to Provincial offices. This involves all elements of the process, including scoping, issuing of ToR, review of report and decision-making.

and forty EOs. Qualifications and experience for each level are equivalent to those for the CEA as described above.

2. Mahaweli Authority of Sri Lanka

283. As explained above, the CEA designates the MASL as the Project Approving Agency (PAA) for the environmental approval process for proposed prescribed projects that are in the areas of MASL jurisdiction. The Forestry and Environmental Management (F&EM) Division of MASL functions as the "environment cell" to implement the requirements of the NEA. This division is headed by a Director who is qualified to MSc level in the field of Natural Resources Management, with more than 20 years of experience in relevant government departments. He is supported by four Deputy Directors, thirteen Environmental Officers, three Water Quality Officers and several support staff. All staff are qualified science graduates and most of them possess at least a MSc degree in environmental science or a related field, with periods of experience that are generally commensurate with their level of seniority (for example 5 or more years for EO grade).

3. Ceylon Electricity Board

284. In general, responsibility for implementing the Environmental Management Plan (EMP) of MHPP lies with CEB as the project proponent. In practice this will be delegated to the Project Director and staff of the PMO, once it is established. The existing Environment Unit of CEB, which functions under DGM Transmission Design and Environment, will have the responsibility of monitoring the implementation of the EMP and coordinating the monitoring activities with the Project Approving Agency, MASL and CEA.

285. The Environment Unit of CEB is the focal point for most of the environmental activities of CEB. Their main responsibilities include:

- Implementation of the complete environmental approval process for all the transmission projects of CEB, including preparation of EIA/IEE reports and obtaining the Environmental Approval.
- Coordination of the complete environmental approval process for the generation projects of CEB, including Public Consultations/ Public Hearings, and obtaining the Environmental Approval.
- Implementation of the Environmental Assessment Process under the relevant Environmental guidelines of the respective funding agencies for all CEB projects.
- Monitoring the implementation of Environmental Management/Monitoring Plans for the ongoing projects of CEB.

286. Currently the staff of Environment Unit of CEB consists of three officers, namely Environmental Officer (Head of Environment Unit), Civil Engineer and one Electrical Superintendent. This does not provide sufficient staff numbers or technical specialisation to deal with the amount or range of activities for which the unit is responsible and the time targets set for most of the environmental approvals (which currently includes preparation of IEE reports for four (4)[18] transmission line projects funded by ADB for which environmental approval is needed

[18] Anuradhapura-Vaunia-Mannar (220kV, 127km); Polpitiya-Pannipitiya (220kV, 70km); Thulhiriya-Kegalle (132kV, 22km); Mannar-Nedukudu (132kv, 32km)

by the end of 3013, five (5)[19] environmental studies for JICA funded transmission line projects to be completed in early 2014 and two (2)[20] feasibility studies funded by JICA).

287. Considering the large number of activities involved in the Environmental Management and Monitoring Plan of MHPP it would be very difficult for the Environment Unit to handle the coordination / monitoring of the implementation of the EMMP without additional resources. It is recommended therefore the Environment Unit of CEB shall be strengthen after carrying out a detailed assessment of the workload and the staff requirement.

4. Institutional Strengthening

a. CEA, MASL and CEB

288. During research conducted for this institutional study, the current Director (EIA) of CEA expressed the view that most of the Environmental Management Plans received by CEA are not up to the expected quality and hence return them to the project proponents requiring revision. The Director also stated that the staff members of the EIA unit are not properly exposed to the EMP process and therefore do not have the knowledge or experience necessary to guide project proponents and consultants on preparation of good EMPs. To address this deficiency and raise the capacity of others who are in key positions in relation to the review/approval, implementation and supervision of the EMP for the MHPP, it is proposed to have a training workshop on EMP for relevant members of CEA, PP and PAA. The content would be as follows:

Subject : "Environmental Management and Monitoring Plans".

Target Group: Staff members of EIA unit of CEA, F&EM Division of MASL and Environment Unit of CEB who are involved in activities related to MHPP.

No of Participants: 20

Duration: 3 days (Including one day of practical work on EMP preparation)

Principal Resources Person: International Environment Specialist of Design/Supervision Consultant

Venue: Kotmale Holiday Resort

Purpose/Objectives of the training workshop:

- Expose participants to the purposes, principles and methods of EMP;
- Improve the level of appreciation and understanding of EMP implementation;
- Provide participants with the capacity and confidence to support the design and implementation of EMP;
- Enable participants to conduct training programmes for other organisations and thus allow for improved environmental performance within such organisations; and
- Inform the participants about the Moragolla HPP and its likely environmental impacts and mitigation, to assist them in fulfilling their roles in the project.

[19] Veyangoda-Kirindiwela-Padukka (220kV, 41km); Polpitiya –habarana (123kV, 131km); Polpitiya-Kotmale (220kv, 27km); Veyangoda-Thulhiriya (132kV, 26km); Kirindiwela-Koggala (132kV, 12km)

[20] Feasibility study on Energy Diversification Enhancement of Sri Lanka and Peaking Power Generation Options of Sri Lanka

289. According to the Head of the Environment Unit of CEB, the training received by the staff of his Unit, in the work areas they are currently engaged in (especially in the field of Environmental Impact Assessment of generation projects) is rather inadequate, compared to most of the other branches of CEB. For example, the Civil Engineer in the Environment Unit has never participated in a training programme focused on EIA process of projects.

290. Hence, it is proposed that the staff of the Environment Unit be provided with suitable training in order to improve the quality and accuracy of their outputs to the organisation (CEB) and particularly to the project (MHPP) in the area of environment protection and management.

b. PMO, Supervision Consultants and Construction Contractors

291. The PMO will be led by the project director, appointed from the existing CEB senior staff, and he will be supported by a variety of technical and administrative positions as shown in Fig 2 above. Some of the technical staff will be existing CEB employees and others will be consultants, employed on a contract basis, for the duration of the project, or for shorter fixed terms. The requirements of these positions will be decided in advance and specified in the job descriptions and advertisements. It is likely that all senior technical positions will require a higher degree and several years of relevant experience in similar positions. Senior staff in the Environment Management Office will require higher degrees in environmental management or other relevant specialism, plus previous work experience in preparing and implementing Environmental Management Plans, conducting environmental monitoring surveys, and/or other relevant activities.

292. The Terms of Reference for the Supervision Consultants will specify the requirements for all key positions, and this will include a Senior Environmental Specialist, plus two or more Environmental Specialists, who together will be responsible for supervising the work of the contractors to ensure they all provide the mitigation that is assigned to them in the project EMMP. Similarly the major Construction Contractors will each be required to provide a Senior Environmental Manager, who will be responsible for the Contractor's environmental performance, and in particular implementing the EMP requirements. It is likely that the senior environmental specialists of both the Supervision Consultant and the Construction Contractors will also require a higher degree in a relevant subject plus several years of experience of similar work activities, preferably involving hydropower projects.

293. If these requirements are properly adhered to and staff of the required calibre are appointed, then all should have sufficient expertise and previous experience to be able to adequately fulfil their duties on this project without further extensive training or capacity building exercises. It would however still be advisable for CEB to provide a brief induction programme for all those involved in environmental matters in relation to the MHPP to ensure they are all fully informed of the specific requirements of the MHPP and their individual and collective responsibilities.

294. The training and induction course should include but not be limited to:

- Overview of Environmental Legislation in Sri Lanka;
- Relevant environmental Standards and Guidelines (water, air, noise etc.);
- National Involuntary Resettlement Policy (NIRP) principles;
- CEB's environmental policy;
- Requirements of the ADB Safeguard Policy Statement (2009);

- An introduction to the Environmental Management and Monitoring Plans of MHPP;
- Environmental responsibilities of all project staff;
- Site- and project-specific requirements such as the afforestation programme, watershed management plan, habitat creation and biodiversity conservation plan, etc;
- Dissemination of extra information as required during the course of the construction works.

VIII. COMPLAINT HANDLING AND GRIEVANCE REDRESS

A. Rationale

295. Construction activities of hydropower projects, especially where Involuntary Resettlement is involved, might give rise to grievances among Affected Persons (APs), however much the potential sources of conflict have been addressed in Environmental Management Plans and Resettlement Plans and Policies. Grievances may be related to social issues such as eligibility criteria and entitlements, location of resettlement sites, quality of services at those sites, allocation of houses, livelihoods and cultural issues, etc. Grievances may also be related to environmental issues such as dust generated due to clearing and grubbing works, vibration and damages to structures, noise, traffic congestion, decrease in water level and water pollution in private and public wells due to blasting and tunnelling, damage to tea plantations and agricultural lands, etc.

296. Social grievances occur mostly at the time of implementation of the Resettlement Action Plan; and complaints on environmental issues and public nuisances generally occur during the construction period. Both types of grievances are different in nature. However, it is imperative to have a mechanism in place to examine each and find solutions in a transparent manner, to demonstrate to the people that their grievances are examined carefully. A Grievance Redress Mechanism (GRM) is essential for smooth implementation of the project. The main objective of establishing a GRM is to resolve problems in an efficient, timely and cost-effective manner in a cordial environment with the participation of all stakeholders including affected parties.

297. It is preferable to resolve the grievances and disputes at the community level and as and when they occur. Donor agencies are inevitably highly concerned about the grievance redress and dispute resolution mechanisms in the implementation of development projects. The GRM should be able to provide benefits to both the project and affected parties by setting up the following objectives:

- Provide a forum for redressing grievance and disputes at the lowest feasible level;
- To create effective communication between the project and affected parties;
- To build up productive relationships among the stakeholders including affected parties;
- Provide access to allow affected parties to negotiate and influence the decisions and policies of the project which might adversely affect them;
- Mitigate or prevent adverse impacts of the project on the environment and produce appropriate corrective or preventive action;
- To harmonize both project and affected parties' activities.

B. Complaints Management

298. All complaints regarding environmental issues are usually received either orally or in writing by the Project Proponent (PP) or the Construction Contractor (CC). A key part of the GRM is the requirement for the PP /CC to maintain a registry of complaints received at the respective project site offices. A sample complains registry is provided in the EMP (Volume 2).

299. All complainants shall be treated respectfully, politely and with sensitivity. Every possible effort should be made by the PP or the CC to resolve the issues referred to in the complaint within their purview. However, there may be certain problems that are more complex and cannot

be solved through project-level mechanisms. Such grievances will be referred to the Grievance Redress Committee (GRC, see below).

300. The proposed complaint handling and Grievance Redress Mechanism for the Moragolla project is illustrated in Figure 22.

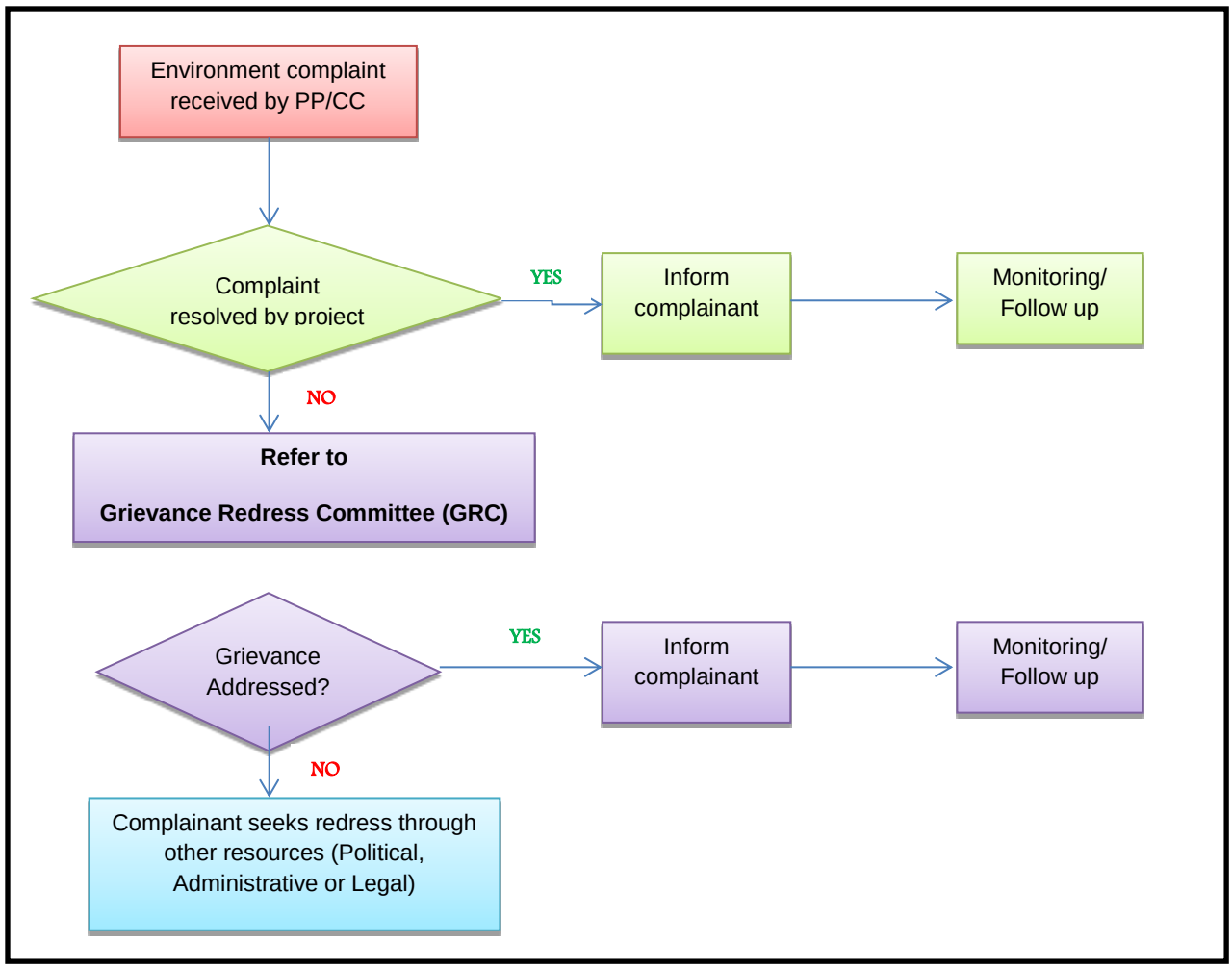

Fig. 22: Complaint handling and Grievance Redress Mechanism (PP= Project Proponent (Ceylon Electricity Board); CC= Construction Contractor)

C. Grievance Redress Committee (GRC)

301. The Moragolla Hydropower Project, in keeping with the ADB and national safeguard policies, will set up a Grievance Redress Committee (GRC), which will function as an independent body to find solutions to grievances and disputes among the affected and concerned parties.

302. The appointment of the GRC will be notified to the general public by publication of a notice in national newspapers in three languages ie., Sinhala, Tamil and English. The local

community will also be informed about the grievance handling procedures of the project through Grama Niladharis[21]of the area and displaying notices at important public places within the Divisional Secretariat Divisions of Udapalatha and Ganga Ihala Korale.

D. Institutional Arrangements for GRM

303. The Additional District Secretary of the Kandy District will function as the Chairperson of the GRC. Members to represent the Affected Persons (AP) at the GRC will be appointed from among respected persons[22]in the area on the recommendations of the Divisional Secretaries of Udapalatha and Ganga Ihal Korale. Other members of the GRC shall be the Project Director (PD) of the PMO, a senior representative of the Design and Supervision Consultant and representative(s) of the Contractor(s). An officer nominated by the Project Director of the MHPP will serve as the Secretary to the GRC. An honorarium will be paid to the members of the GRC; the required funds for operation of the GRC will be borne by CEB.

304. A suitable place and other facilities to conduct the meetings of the GRC will be provided by MHPP. However, GRC meetings can also be held at any other suitable location for the convenience of the affected parties (eg. in case of ill health or any other valid reasons).

305. The GRC is expected to meet at least once a month, although more meetings may be held depending on the number of complaints received. The GRC may make field visits where necessary and these will be facilitated by MHPP.

E. Terms of Reference of GRC

306. The GRM will be established by CEB during the pre-construction stage, so that the GRC and grievance redress procedures are in place and functioning before land acquisition, resettlement and project construction activities begin. The following is a draft ToR for the GRC, which CEB will consider and incorporate or amend as necessary:

- The GRC will examine any kind of dispute or grievance arising out of implementation of the Resettlement Plan (RP) and Environmental Management and Monitoring Plans (EMP and EMoP) and resolve such disputes and grievances in a transparent manner.
- GRC will not deal with matters that are pending in a court of law.
- The GRC will not have any jurisdiction over the amount of compensation determined by the Chief Government Valuer.
- The decision of the GRC is deemed final, although a dissatisfied complainant may seek redress through the Sri Lankan legal system if they so wish.
- Only authorized members will be allowed to participate in the GRC meetings (including the relevant Affected Persons and their representatives).
- A decision on a particular dispute/grievance will be made unanimously or on a majority vote basis.

[21]GramaNiladhari (Village leader) is a Sri Lankan public official appointed by the central government to carryout administrative duties in a GramaNiladhari division, which is a subunit of a divisional secretariat. The duties of a GramaNiladhari include the reporting of issuing of permits, gathering statistics, maintaining the voter registry and keeping the peace by settlement of personal disputes. They are responsible for keeping track of any criminal activity in their area and issuing character certificates on behalf of residents when requested.

[22]Such as Senior Citizens; Priest of the Temple, Church or Kovil; Headmaster of school etc.,

- The disputes and grievances will be resolved on the first day of the hearing or within 2 – 4 weeks of the first hearing where the issues may be more complicated and more information is required to arrive at a decision.
- A Hearing of certain disputes or grievances may be postponed and a new date be fixed if more evidence is required to make decisions.
- The decision of the GRC will be intimated to the Project Director and the aggrieved party in writing within a week from the meeting.
- The following general conditions should also apply: Persons who make appeals to the GRC shall attend the meetings of the GRC in person. In a case where the appellant is unable to attend the meeting on the appointed date due to sickness or other unavoidable circumstances, he/she can nominate a close relative or other representative in writing.
- No legal professionals are allowed to represent an appellant.
- Appellants may request an alternative date to attend at a particular meeting of the GRC if they are physically unfit to attend the meeting or due to other unavoidable circumstances.

IX. ENVIRONMENTAL MANAGEMENT COSTS

307. Table 32 shows the estimated costs of implementing the Environmental Management and Environmental Monitoring Plans for this project, described in Chapters V and VI above. All costs are derived from the budgets provided in Chapter V (Sections VC-F), where a full breakdown of each total is given, with details of the assumptions made in arriving at each figure. Table 32 excludes those mitigation measures that require good construction site practice, because this should already be the norm for experienced contractors, and the client should not incur additional costs for adoption of such measures. Table 32 does include three items of monitoring that are the responsibility of the contractor (asterisked), to allow the option of outsourcing these to specialised local environmental contractors, if necessary.

Table 32: Estimated costs of environmental management and monitoring

	Phase	Issue	Item	Cost (SLR)
MITIGATION	Construction	Phys-Cult Res	Archaeology chance-finds procedure	450,000
			Sub-Total	**450,000**
	Operation	Dam Safety	Disaster Management Plan	6,240,000
			Sub-Total	**6,240,000**
MONITORING	Construction	Hydrology	Monitor downstream flow during reservoir filling	442,500
		Water Quality	Monitor silt content of site discharge water*	5,412,000
		Groundwater	Monitor water levels in wells along tunnel route	2,622,500
		Air Quality	Dust monitoring on and off site*	15,303,000
		Noise and Vibration	Structure condition survey	3,384,000
			Noise and vibration surveys on and off site*	8,538,500
			Sub-Total	**35,702,500**
	Operation	Water Quality	Monitor water quality in reservoir & downstream	3,797,500
			Sub-Total	**3,797,500**
MITIGATION & MONITORING	Special Issues	Aquatic Ecology	Preventing Poaching	884,000
			Fish Distribution Survey	2,293,500
			Catch-and-Haul (Fish Translocation)	5,025,500
			Fish Pool Connection Analysis	3,354,200
			Sub-Total	**11,557,200**
		Terrestrial Ecology	Animal Rescue Programme	960,000
			Afforestation/Habitat Enhancement	25,568,500
			Watershed Management Plan	6,231,532
			Sub-Total	**32,760,032**
	TOTALS		**TOTAL (SLR)**	**90,507,232**
			TOTAL (US$)	**691,380**

308. Table 32 shows that the largest cost items are for mitigation, enhancement and monitoring related to the two special issues (aquatic and terrestrial ecology) (SLR 44 million)

and monitoring environmental emissions during the construction stage (SLR 36 million). This is understandable given the size of the project and the nature of the physical processes involved and the fact that the project area contains a variety of rare and endemic species, some of which are of high conservation priority. The remainder of the costs are relatively small: SLR 7 million for mitigating other impacts during construction and operation (those not related to construction site practice) and SLR 4 million for operational phase monitoring (reservoir and downstream water quality).

309. Excluding the cost of the three items of construction stage monitoring that will be conducted or commissioned by the contractor, the remaining environmental mitigation and monitoring costs are estimated at SLR 61,253,732 or US$ 470,000.

APPENDICES

APPENDIX 1: OUTLINE OF A CONTRACTOR'S ENVIRONMENTAL MANAGEMENT PLAN

A. General

1. The Contractor shall prepare an Environmental Management Plan (EMP) setting out in detail how he proposes to manage and minimise the environmental impacts of his activities throughout the construction period.

2. The Contractor's EMP shall be based on the Outline EMP submitted with the Tender and shall have the content shown in Section B below.

3. The Contractor shall submit his EMP for review by the Supervision Consultant within 60 days after the Commencement Date of the Services, and shall amend the EMP to address any comments made by the Supervision Consultant and submit a Final EMP within 14 days of receipt of comments.

4. The Final EMP shall be binding on the Contractor for the duration of the Services

B. Content of EMP

1. Contractor's Environmental Policy

5. The first section of the EMP shall contain a statement of the Contractor's intent with respect to the environment and the management of environmental impacts, which sets the framework for, and guides, all other aspects of the plan.

2. Management Responsibility

6. This section of the EMP shall name the most senior manager in the contracting company or at their project site as having overall responsibility for environmental management, with an explanation of how that responsibility is delegated down to each level of management. It shall also name the Chief Environmental Manager who is responsible for day-to-day environmental management, supervision and monitoring at all work-sites, and has company authority to stop construction works if environmental non-compliance is observed.

7. At each active construction site there must be at least one named person with delegated responsibility for environmental management on each shift. This person will be referred to as the Senior Environment Officer (SEO), and on larger sites he may be assisted by Environment Officers (EO), who will work under his direction conducting routine monitoring, data collection, etc.

8. The EMP must also identify a Community Liaison Officer (CLO) who will deal with community relations and liaise on behalf of the Contractor with people who may be affected by the construction process. The CLO shall integrate all of his activities with those of other specialists responsible for implementing the Resettlement Plan (RP) for the project on behalf of the Employer; and shall operate within the framework of the Entitlement Matrix and Grievance Redress Procedure established by the RP.

3. Management Contacts

9. The office and home telephone or radio contacts shall be listed for all named persons having environmental management responsibility.

4. Mitigation Measures and Environmental Monitoring

10. The description of the approach to environmental mitigation and monitoring is the major part of the Contractor's EMP. In this section the Contractor shall deal in turn with each of the mitigation measures identified as his responsibility in the project Environmental Management Plan (EMP) and the monitoring allocated to him in the Environmental Monitoring Plan (EMoP). The Contractor shall explain in detail how he proposes to provide the mitigation and monitoring as specified in these documents and the Tender/Contract Documents

11. This should not simply repeat the clauses from the Tender/Contract Documents or measures specified in the project EMP or EMoP but shall explain in detail: a) the action or series of actions the Contractor will take to comply with each requirement; b) responsibility for each action; c) the programme for each action; d) how the Contractor proposes to monitor the provision and effects of each action; and e) parameters or performance indicators to be monitored.

5. General Environmental Management

12. In this section the Contractor shall identify and describe the more general actions he proposes to take to manage and mitigate the environmental impacts of his day-to-day operations. These shall be presented and explained in the same way as the specified mitigation measures, as above.

13. Actions shall include, but not be limited to, those specified below (any items that are adequately covered in Section B.4 above need not be repeated).

a. Construction Site Management

14. General environmental management at construction sites shall include at least the following:

- Dedicated concrete-floored areas for vehicle maintenance, from which all drainage passes through an oil/water separator and sediment trap;
- Dedicated concrete-floored areas for vehicle washing, also with drainage via an oil/water separator and sediment trap;
- Storage of all liquid fuel, lubricants and other toxic liquids in concrete-floored and bunded areas, the volume of which is at least equivalent to that of all stored liquids;
- Watering of site roads and other exposed soil during the dry season to suppress dust, with water tankers permanently available for this purpose;
- Collection of drainage at all sites and passage into settlement tanks/sediment traps before discharge;
- Treatment of all sewage and any other liquid discharges to national effluent standards and/or consent conditions before discharge;
- All point-source atmospheric emissions (eg from crushers, batching plants, engines, generators, etc) shall comply with national or international standards;

- All motor-driven generators, compressors, pumps, etc to be properly silenced to suppress noise to national or international standards;
- Site lighting and use of machinery near inhabited areas to be limited to normal daytime working hours;
- Disposal of solid waste by arrangement with local municipalities;
- No use or disposal of nationally or internationally proscribed toxic and hazardous substances;
- Issuance of a Code of Practice to all workers, specifying required behaviour, including:
    - No hunting, fishing, timber collection or lighting of fires;
    - No discarding of litter or other waste;
    - Proper usage of toilets and washrooms;
    - Other behaviour to comply with defined local cultural and religious sensitivities;
    - No unauthorised entry onto private property;
    - Immediate dismissal for any transgression.

b. Labour Accommodation Camp Management

15. Environmental management at worker accommodation camps shall involve the same general environmental protection measures as applied at construction sites (where appropriate), plus the following:

- Provision of suitable living accommodation in separate quarters for men and women;
- Suitable and adequate toilet and bathroom facilities, also separate for men and women;
- Daily cleaning and replenishment of accommodation and toilets/ bathrooms;
- Provision of a free laundry facility;
- Clean and well-equipped kitchen and canteen facilities providing good quality meals for workers;
- Suitable areas set aside for religious worship and recreation.

c. Solid and Toxic Waste Management

16. The Contractor shall prepare and implement a Solid Waste Management Plan (SWMP) for all sites, which includes but is not limited to the following:

- Specified procedures to minimise waste, applying the hierarchy: Avoid → Minimise → Reuse → Recycle → Treat → Dispose;
- Composting of vegetable waste; separation and recovery of any recyclable materials for which a market exists (eg glass, cans, plastic, paper); and disposal of all remaining domestic refuse to a properly managed disposal site (ie a landfill with daily covering of the working face with sand or soil);
- Proper storage and disposal of toxic and hazardous waste in consultation with the competent authority and relevant municipalities; this includes oil filters, empty paint cans, etc;
- Puncture and/or crushing of empty containers of toxic or hazardous materials to prevent them being used for drinking water;
- Appropriate storage and subsequent sale to appropriate recycling companies of such materials as: waste lubricating oil; spent vehicle batteries; used vehicle tyres; and wood, paper, glass, cans, plastic, etc.

- No waste is to be burnt.

d. Management of Land

17. Preparation, use and after-care of land shall include at least the following:

- Conservation of topsoil during vegetation removal, and disposal of cut vegetation by composting to the extent possible, and provision of wood/timber to local communities free of charge where permitted by the client;
- Disposal of any remaining vegetation at managed sites, without burning;
- Removal of topsoil before excavation; and storage for future use, with measures to prevent erosion or dust production from stockpiles;
- Prior recording of the location of all walls, fences and other structures on temporarily acquired land, so that they may be replaced at the end of construction;
- Reinstatement of all temporarily acquired land after use to its pre-construction condition or as otherwise reasonably required by the owner;
- Detailed planning of cut and fill volumes to maximise the re-use of material in the project and minimise the disposal of spoil, with excess spoil being deposited at planned disposal sites only;
- Adoption of a precautionary approach towards the risk of uncovering archaeological material, by: a) operating a "chance finds" procedure; b) training workers and digger operatives to recognise archaeological material; and c) halting work if any finds are suspected.

e. Transport Management

18. The Contractor shall prepare and implement a Transport Management Plan (TMP), which *inter alia*: identifies routes to be used for all significant transportation operations, avoiding settlements and known areas of congestion as much as possible; and incorporates other measures to reduce the environmental impacts of protect-related traffic, such as planning deliveries to avoid peak hours, providing diversions where needed, etc. All measures shall be discussed with and approved by relevant highway authorities.

19. Other measures to reduce the impacts of traffic and transportation shall include:

- Ensuring that all vehicles are in a safe and legal condition with respect to all of their systems and comply with national regulations on emissions and noise;
- Ensuring that all drivers are licensed for the class of vehicle they are driving;
- Training all drivers in safe driving and the use of environmentally-responsible techniques, such as switching off engines whenever vehicles are parked;
- Fitting all vehicles with a fire extinguisher and first aid kit;
- Ensuring that all construction vehicles have upward-facing exhaust pipes and audible indicators for reversing;
- Covering loose material when carried on trucks, to prevent dust and losses;
- Prompt cleaning of public roads if affected by spillage of materials.

f. Community Liaison and Facilities

20. The Contractor shall establish regular contact with communities local to all construction sites for the purposes of exchanging information and developing mutual understanding. Such contacts shall include:

- Consulting all communities in the vicinity of construction sites prior to commencement of any work (via the CLO and other staff as necessary), to inform them of the work proposed, construction programmes, and measures to maintain safety and minimise disruption and disturbance; all such contacts shall be coordinated with the Client's ongoing programme of community liaison;
- Identification via the consultation process of any important community features, which the Contractor shall make arrangements to conserve or remove/relocate with community agreement, at his own expense;
- Protecting features to be retained (cemeteries, buildings, etc) by secure fences, fluorescent tapes, and appropriate signs;
- Clear marking of excavated areas near settlements with posts, fluorescent tapes and warning signs;
- Providing suitable temporary bridges or diversions wherever existing roads, tracks or footpaths are intersected by construction works;
- Providing temporary potable water supplies if access to the existing water supply is interrupted at any time.

g. Occupational Health and Safety

21. The Contractor shall develop and implement an Occupational Health and Safety Plan (OHSP), which provides measures to protect the health and safety of employees at all times when engaged in the construction process and the general public when exposed to construction activities either on- or off-site. This shall include:

- Giving all workers a medical examination (including sight and hearing tests) before being employed and annually thereafter, with records of the examinations kept by the Contractor;
- Providing all employees with verbal and printed information on the health implications of their work and how to avoid problems, with advice on sexually transmitted diseases, including HIV/AIDS;
- Providing regular H&S training to all workers (at least monthly);
- Providing all workers with a set of Personal Protective Equipment (PPE) comprising hard hat, protective boots, leather gloves, ear defenders and dust mask, with additional safety equipment for certain workers (eg harnesses when working at height); and adoption of a zero tolerance policy towards any non-usage of PPE;
- Provision of adequate drinking water and clean and suitably equipped toilet and washroom facilities for the number of workers at each site;
- Installation of posts, tapes and warning signs around all excavations;
- Provision of a comprehensive first aid kit and eyewash bottle at all sites, plus a dedicated vehicle to take any injured persons to the nearest hospital if necessary;
- Storage of all legally-used toxic or hazardous materials in locked, waterproof, ventilated enclosures;
- Storage and use of all explosives strictly in accordance with national regulations and international best practice;

- Storage of all compressed gas bottles chained in the upright position in a locked ventilated enclosure, at a location where there is no risk of accidental damage from heavy vehicles or machinery;
- Application of international standards of occupational health and safety to all workplaces.

6. Emergency Response Plan

22. In this section the Contractor shall provide an Emergency Response Plan (ERP) to be applied on all sites to deal with accidents, emergencies and unexpected incidents with attendant environmental risks. This shall identify Most Probable Accidents and specify in succinct terms the action to be taken in each case, including fire, terrorism and other major risks.

23. The ERP shall include contact details for all local emergency services, hospital/clinic and senior management of the Contractor, Engineer and Client. It shall include an evacuation plan and route for the site and require practice of emergency procedures at appropriate intervals.

7. Training

24. The contractor shall describe the training programme and content he will provide for workers and staff in order to:

- Raise awareness of: the role and importance of environmental matters both globally and locally; the potential negative impacts of construction work in general and the ways in which impacts can be mitigated; and the expected construction impacts and long-term environmental benefits of the MHP project;
- Disseminate the philosophy and approach of the EMP to environmental protection throughout the workforce, and explain the roles of all parties in implementing the mitigation and environmental safeguard measures;
- Inform all employees of the mitigation and environmental protection measures they are required to comply with when conducting their work, and the penalties for non-compliance.

25. Training to raise the awareness and capacity of sub-contractors and their employees shall also be incorporated where necessary.

8. Appendices

26. The EMP shall contain as appendices any other plans that are necessary in order to provide the mitigation measures specified in the project EMP and/or in the Tender/Contract documents. These may include the following, where relevant, with contents as shown:

a. Solid Waste Management Plan

27. Waste minimisation, reuse and recycling; collection/disposal of solid waste from construction sites, labour accommodation camps and other locations; includes inert construction waste, hazardous materials, domestic and office waste, etc; specifies procedures, equipment, collection timetable, arrangements with municipal authorities.

b. Pollution Prevention and Control Plan

28. Measures to avoid and minimise pollution of air, water and land by atmospheric and liquid emissions; and measures to detect, contain and clean-up any pollution that may occur; includes operational procedures, monitoring methods, equipment, etc.

c. Site Rehabilitation Plan

29. Measures to reinstate all temporarily occupied sites after use, including quarries and borrow pits, labour accommodation camps, waste disposal areas, storage areas, etc; includes removal and disposal of waste, reconstruction of former structures, landscaping, tree planting and such other measures as may reasonably be required by the landowners.

d. Site Drainage and Flood Prevention Plan

30. Proposals to collect and treat drainage from construction sites and prevent runoff and pollution of surface and groundwater and flooding of surrounding land, with drawings of existing drainage and proposed modifications.

e. Occupational Health and Safety Plan

31. Measures to maintain the health and safety of workers, staff, visitors and the general public on and around all construction sites; covers management, responsibility, procedures, equipment, information and training.

f. Accommodation Camp Management Plan

32. Proposed approach to: site selection; provision of water, electricity and other basic amenities; accommodation; toilet and washing facilities, sanitation and hygiene; waste disposal; health and safety; and regular maintenance.

g. Transport Management Plan

33. Proposed approach to minimising the environmental impacts of all significant transportation operations, as discussed and agreed with the relevant highway authorities, including routes to avoid settlements and areas of congestion as much as possible, planning deliveries to avoid peak hours, and such other measures as may be necessary.

h. Physical Cultural Resources Plan

34. Procedures to ensure the recognition, recording and appropriate protection of any material of archaeological or cultural/historical importance that may be discovered in the course of the construction activities; may includea desk study to identify archaeological risk, archaeological watching brief, chance finds procedure, etc.

C. EMP Implementation

35. The contractor's EMP shall be implemented within the framework of a company Environmental Management System (EMS), which is certified to ISO 14001-2004, or is scheduled to be so certified within the timescale of this project.

36. Each company sub-contracted by the contractor shall prepare their own daughter Environmental Management Plans, which follow the format specified in Section B above. This applies to all sub-contractors and major suppliers, whether or not they are working on-site. Thus transport contractors, waste management contractors, quarry companies, materials merchants, fuel suppliers, etc shall all prepare their own EMPs describing how they will manage and minimise the environmental impacts of their activities related to this project.

37. The EMP shall be brought to the attention of all employees engaged in construction or supporting activities, and they shall be given training in those aspects of the EMP that relate to their work, and an insight into the potential adverse impacts of their work and how they are to be mitigated.

38. All EMPs shall be submitted to the Supervision Consultant for review and approval at least 60 days before the company is scheduled to begin work on the project.

APPENDIX 2: PROCEDURE FOR "CHANCE FINDS" OF ARCHAEOLOGICAL MATERIAL

A. Introduction

1. The following procedures outline the measures that will be undertaken in the event of an accidental discovery of or an encounter with a Physical Cultural Resource (PCR) during the construction phase of the Moragolla Hydropower Project (MHPP). The Chance Finds Procedure (CFP) described in this document will be finalised by CEB in consultation with the GoSL Department of Archaeology, to ensure compliance with applicable regulations. The CFP will be included in the Contractor's Environmental Management Plans that all main contractors will be required to produce and operate, as specified in the tender and contract documents. The CFP aims to identify and promote the preservation, protection and recording of any PCR that may be discovered or exposed during the earthworks or other activities associated with this project.

B. Orientation of Workers

2. The Department of Archaeology, as arranged by CEB, will conduct orientation or training for all workers employed by Contractors (particularly those who will be involved in earthworks, excavation and tunnelling), regarding how to recognize artefacts that they may encounter or discover in the course of their work activity.

3. The training will include an expert assessment of the potential for discovering archaeological material in the project's area of influence, with a map of potential "hot-spots" for discoveries if appropriate. The map will guide site supervision staff in applying the chance-finds procedure and exercising vigilance in these areas when necessary.

C. Procedures

1. General

4. In the event a PCR is discovered, construction activities in the area will be stopped. The site or area discovered will be marked or demarcated using a Global Positioning System (GPS) unit to determine the exact coordinates and photographs of the PCR *in situ* and the location will be taken. The construction supervision staff will secure the site to prevent damage, loss or pilferage of removable objects. The supervising engineer will be responsible for coordinating with CEB and the relevant Government authorities.

5. If the discovery involves removable items, a security person will be posted until the representative of the relevant Government authority arrives to assess and determine its value. The Government representative will be responsible for determining the appropriate course of action. Further excavation or earth moving works may be conducted at the distance and demarcation area recommended by the representative of the Government authority.

6. If the chance find is expected to have significant cultural value, this may entail consequent changes in the Project layout, particularly if the discovery is the remains of material of cultural or archaeological importance that is not removable.

7. The Contractor will not be entitled to compensation due to work stoppage as a result of the discovery and any associated actions.

2. Tunnelling

8. Appropriate heavy equipment, such as a wheel loader, will be made available to recover the discovered excavated material from the tunnel to allow the on-site geologist/archaeologist or the representative of a relevant Government authority to inspect, recover or conduct sampling. A safe storage area will be provided to protect the discovered object. If the “chance find” is part of a large artefact, deposit or structure, the inspection or recording will include photography and video in an “as-is, where is” manner. The exact location will be recorded using a GPS unit.

3. Resumption of Work

9. The Contractor can resume the construction works within the affected area after clearance is given by the relevant Government authority. All the discovered objects of value will be given to the Government.

D. Report

10. The Contractor(s) will prepare a Chance Find Report within one week, showing the date and time of discovery, specific location, description of the PCR, and the interim protection measures implemented. This report will be submitted to CEB, who will provide it to the relevant Government authority.

APPENDIX 3: SRI LANKAN ENVIRONMENTAL QUALITY STANDARDS

Table A3.1: General standards and criteria for the discharge of industrial effluents into inland surface waters[23]

No.	Parameter	Unit/Type of Limit	Tolerance Limit Values
01	Total suspended solids	mg/l, max	50
02	Particle size of the total suspended solids	µm, less than	850
03	pH at ambient temperature	-	6.0 – 8.5
04	Biochemical oxygen demand (BOD_5 in five days at 20^0 C or BOD_3 in three days at 27^0C)	mg/l, max	30
05	Temperature of discharge	^{0}C, max	Shall not exceed 40^0C in any section of the stream within 15m downstream from the effluent outlet
06	Oils and greases	mg/l, max	10
07	Phenolic compounds (as C_6H_5OH)	mg/l, max	1
08	Chemical oxygen demand (COD)	mg/l, max	250
09	Colour	**Wavelength Range**	**Maximum Spectral Absorption Coefficient**
		436 nm (yellow range)	7 m^{-1}
		525 nm (red range)	5 m^{-1}
		620 nm (blue range)	3 m^{-1}
10	Dissolved phosphates (as P)	mg/l, max	5
11	Total Kjeldahl nitrogen	mg/l, max	150
12	Ammoniacal nitrogen (as N)	mg/l, max	50
13	Cyanide (as CN)	mg/l, max	0.2
14	Total residual chlorine	mg/l, max	1.0
15	Fluorides (as F)	mg/l, max	2.0
16	Sulphide (as S)	mg/l, max	2.0
17	Arsenic (as As)	mg/l, max	0.2
18	Cadmium (as Cd)	mg/l, max	0.1
19	Chromium, total (as Cr)	mg/l, max	0.5
20	Chromium, Hexavalent (as $Cr^{6+)}$	mg/l, max	0.1
21	Copper (as Cu)	mg/l, max	3.0
22	Iron (as Fe)	mg/l, max	3.0
23	Lead (as Pb)	mg/l, max	0.1
24	Mercury (as Hg)	mg/l, max	0.0005
25	Nickel (as Ni)	mg/l, max	3.0
26	Selenium (as Se)	mg/l, max	0.05

[23] Source: Gazette Ordinary of the Democratic Socialist Republic of Sri Lanka No 1534/18 dated February 1st, 2008.

27	Zinc (as Zn)	mg/l, max	2.0
28	Pesticides	mg/l, max	0.005
29	Detergents/surfactants	mg/l, max	5
30	Faecal coliform	MPN/100 ml, max	40
31	Radioactive material: (a) Alpha emitters (b) Beta emitters	 microcurie/ml, max microcurie/ml, max	 10^{-8} 10^{-7}
Note 1: All efforts should be made to remove unpleasant odour as far as possible. Note 2: These values are based on dilution of effluents by at least 8 volumes of clean receiving water. If the dilution is below 8 times, the permissible limits are multiplied by the 1/8 of the actual dilution. Note 3: The above mentioned general standards shall cease to apply with regard to a particular industry when industry specific standards are notified for that industry. Note 4: Pesticides as per World Health Organization (WHO) and Food and Agriculture Organization (FAO) requirements.			

Table A3.2: Drinking water standards

Parameter	Maximum Desirable Level	Maximum Permissible Level
A. Physico - Chemical[24]		
Colour	5 Hazen units	30 Hazen units
Odour	Unobjectionable	Unobjectionable
Taste	Unobjectionable	Unobjectionable
Turbidity	2 Jackson Turbidity units	8 Jackson Turbidity units
pH Range	7.0 - 8.5	6.5 - 9.9
Electrical Conductivity	750 µs/cm	3500 µs/cm
Chloride (as Cl)	200 mg/l	1200 mg/l
Free Residual Chlorine (as Cl_2)	-	0.2 mg/l
Total Alkalinity (as $CaCO_3$)	200 mg/l	400 mg/l
Free Ammonia (as NH_3)	-	0.06 mg/l
Albuminoidal Ammonia		0.15 mg/l
Nitrate (as N)		10 mg/l
Nitrite (as N)		0.01 mg/l
Fluoride (as F)	0.6 mg/l	1 .5 mg/l
Total Phosphorus (as PO_4)		2.0 mg/l
Total Residue	500 mg/l	2000 mg/l
Total Hardness (as $CaCO_3$)	250 mg/l	600 mg/l
Total Iron (as Fe^{-})	0.3 mg/l	1 .0 mg/l
Sulphate (as SO_4^{2-})	200 mg/l	400 mg/l
Anionic Detergents	0.2 mg/l	1 mg/l
Phenolic Compounds (as phenolic OH)	0.001 mg/l	0.002 mg/l

[24] Source: Sri Lanka Standards SLS 614, 1983; Specification for potable water; Part 1 – Physical and Chemical Requirements.

Oil & Grease	-	1.0 mg/l
Calcium (as Ca)	100 mg/l	240 mg/l
Magnesium (as Mg)	Not more than 30 mg/l if there are 250 mg/l of sulphate. If there is less sulphate, magnesium up to 150 mg/l may be allowed.	
Copper (as Cu)	0.05 mg/l	1.5 mg/l
Manganese (as Mn)	0.05 mg/l	0.5 mg/l
Zinc (as Zn)	5.0 mg/l	15 mg/l
Aluminium (as Al)		0.2 mg/l
Chemical Oxygen Demand		10 mg/l
Pesticide residues		As per WHO/FAO[25] requirements
Arsenic (as As)	0.05 mg/l	1 mg/l
Cadmium (as Cd)	0.005 mg/l	1 mg/l
Cyanide (as CN)	0.05 mg/l	1 mg/l
Lead (as Pb)	0.05 mg/l	1 mg/l
Mercury (total as Hg)	0.001 mg/l	1 mg/l
Selenium (as Se)	0.01 mg/l	1 mg/l
Chromium (as Cr)	0.05 mg/l	1 mg/l
B. Bacteriological[26]		
Pipe borne public water supplies	Coliforms organisms / 100ml	(i) Throughout any year, 95% of the samples shall not contain any coliform organisms (ii) None of the samples examined shall contain more than 3 coliform organisms per 100 ml (iii) Coliform organisms shall not be detected in 100 ml of any two consecutive samples
	E.coli / 100 ml	Absent
Individual or small community supplies: wells, bores and springs	Coliform organisms / 100 ml	None of the samples examined shall contain more than 10 coliform organisms per 100 ml
	E.coli / 100 ml	Absent

[25] WHO – World Health Organization; FAO- Food and Agriculture Organization.
[26] Source: Sri Lanka Standards SLS 614, 1983; Specification for potable water; Part 2 – Bacteriological Requirements and Amendment No 1 approved on June 7th, 1988.

Table A3.3: Permissible noise levels in accordance with noise control regulations

Maximum Permissible Noise Levels (as L_{Aeq} T) at Boundaries of the land in which the noise source is located shall not exceed the limits set out below.

Area	L_{Aeq} T, dB (A)	
	Day Time	Night Time
Low Noise (Pradeshiya Sabha area)	55	45
Medium Noise (Municipal Council / Urban Council area)	63*	50
High Noise (EPZZ of BOI & Industrial Estates approved under part IVC of the NEA)	70	60
Silent Zone (100, from the boundary of a courthouse, hospital, public library, school, zoo, sacred areas, and areas set apart for recreation or environmental purposes)	50	45

* Provided that the noise level should not exceed 60 dB (A) inside existing houses, during day time.

The following noise levels will be allowed where the background noise exceed or is marginal to the given levels in the above table.

(a) For low noise areas in which the background Noise level exceeds or is marginal to the given level — Measured Background Noise level + 3 dB (A)

(b) For medium noise areas in which the background Noise level exceeds or is marginal to the given level — Measured Background Noise level + 3 dB (A)

(c) For silent zone in which the background noise level Exceeds or is marginal to the given level — Measured Background Noise level + 3 dB (A)

(d) For high noise areas in which the background noise level exceeds or is marginal to the given level

(i) For day time — Measured Background Noise level + 3 dB (A)

(ii) For night time — Measured Background Noise level + 3 dB (A)

Construction Activities

Maximum permissible noise levels at boundaries of the land in which the source of noise is located in L_{Aeq} T for construction activities.

L_{Aeq} T, dB (A)

Day Time	Night Time
75	50

Note 1:

"**L_{Aeq} T**" means the equivalent continuous, A-weighted sound pressure determined over a time interval T (in dB)

"**Day Time**" from 06.00 hours to 18.00 hours except for the purposes of construction activities where it means 06.00 hours to 21.00 hours.
"**Night Time** "means from 18.00 hours to 06.00 hours except for the purposes of construction activities where it means 21.00 hours to 06.00 hours.

Table A3.4: Noise exposure limits for the work environment

Since there are no National Standards for Noise Exposure limits, the occupational Hygiene Division of the department of Labour use the following Threshold Limit Value for Noise specified in ACGIH27 standards.

Threshold Limit Value for Noise

Duration per day		**Sound Level dB(A)**
Hours	24	80
	16	82
	8	85
	4	88
	2	91
	1	94
Minutes	30	97
	15	100
	7.5	103
	3.75	106
	1.88	109
	0.94	112
Seconds	28.2	115
	14.06	118
	7.03	121
	3.52	124
	1.76	127
	0.88	130
	0.44	133
	0.22	136
	0.11	139

[27] American Conference of Governmental Industrial Hygienists.

Table A3.5: Limits for noise emanating from vehicular horns[28]

	Distance	Sound pressure level L^{29}_{Amax} in dB[30](A)
1	2 m in open space from the front of the vehicle when the vehicle is in a stationary position and the engine is switched on	105
2	7 m in open space from the front of the vehicle when the vehicle is in a stationary position and the engine is switched on	93

Table A3.6: Emission standards for vehicles[31]

A. Petrol Vehicles			
Type of vehicle	Emission standard effective from January 1st, 2014		Remarks
	Carbon Monoxide CO (%v/v)[32]	Hydrocarbon HC (ppm v/v)[33]	
Petrol vehicle other than motor cycles and motor tricycle	3.0	1000	Both idling and 2500 RPM[34]/ No load
Petrol motor cycles and motor tricycle	4.0	6000	
B. Diesel vehicles			
Type of vehicle	Emission standard effective from January 1st, 2014		Remarks
	K factor[35] (m^{-1})		
Diesel vehicle	4.0		Smoke opacity on snap acceleration[36]

[28] Source: National Environmental (Vehicle Horns) Regulation, No 1 of 2011, published in the Government Gazette Extraordinary No 1738/37 dated December 29th, 2011.
[29] L_{Amax} means- the maximum A-weighted sound pressure level as is recorded during a period of measurement.
[30] dB means – decibel.
[31] Source: National Environmental (Air Emission, Fuel and Vehicle Importation Standards) Regulation No 1 of 2003, published in the Government Gazette Extraordinary No 1295/11 dated June 30th, 2003 and subsequent amendments.
[32] %v/v – present by volume.
[33] ppm v/v – parts per million by volume.
[34] RPM – resolutions per minute.
[35] K factor – absorption coefficient.
[36] Snap acceleration – has the same meaning as defined in SAE recommended practice J1167.

Table A3.7: Ambient air quality standards[37]

	Pollutant	Averaging Time*	Maximum Permissible Level		Method of Measurement+
			μgm^{-3}	ppm	
1	Particulate matter aerodynamic diameter is less than 10 μm in size (PM_{10})	Annual	50	-	Hi-Volume Sampling and Gravimetric or Beta Attenuation
		24 hrs	100	-	
2	Particulate matter aerodynamic diameter is less than 2.5 μm in size ($PM_{2.5}$)	Annual	25	-	Hi-Volume Sampling and Gravimetric or Beta Attenuation
		24 hrs	50	-	
3	Nitrogen Dioxide (NO_2)	Annual	100	0.05	Colorimetric using Saltzman Method or equivalent gas phase
		24 hrs	150	0.08	
		1 hr	250	0.13	
4	Sulphur Dioxide (SO_2)	Annual	80	0.03	Pararosaniline Method or equivalent Pulse Fluorescent
		24 hrs	120	0.05	
		1 hr	200	0.08	
5	Ozone (O_3)	1 hr	200	0.10	Chemiluminescence Method or equivalent Ultraviolet Photometric
6	Carbon Monoxide (CO)	8 hrs	10,000	9.00	Non-Dispersive Infrared Spectroscopy
		1 hr	30,000	26.00	
		Any time	58,000	50.00	

* Minimum number of observations required to determine the average over the specified period
3 hour average – 3 consecutive hourly averages
8 hour average – 8 hourly averages
24 hour average – 18 hourly averages
Yearly average – 9 month average with at least 2 monthly averages each quarter
+ By using Chemical or Automatic Analyzer

[37] Source: National Environmental (Ambient Air Quality) Regulations, No 1 of 1994, published in the Government Gazette Extraordinary No 850/4 dated December 1994 and subsequent amendments published in the Government Gazette Extraordinary No 1562/22 dated August 15th, 2008.

Table 8: Proposed air blast over pressure and ground vibration standards for Sri Lanka[38]

A. Building Classification

Before introducing the vibration standards for operation of machinery blasting activities, construction activities and vehicle movement, it is necessary to classify the building structures as the vibration affects in accordance with the nature of the nearby structures. Buildings that have been built-up in Sri Lanka could be categorized into the following categories in accordance with the ISO 4866:1990(E) standards. Please note that the following categorization of buildings has been adopted in introducing the vibration standards for all cases. However, it is noteworthy to mention here that even though the classification of buildings given by the International standards is almost the same categories have been divided into sub categories to suit the Sri Lankan situation.

8.1: Categorization of structures according to the type of buildings (from ISO 4966:1990(E))

Category of the structure of the building	Description
Type 1	Multi story buildings of reinforced concrete or structural steel, with in-filling panels of block work, bricks work or precast units not designed to restrict earthquakes.
Type 2	Two-story domestic houses and buildings constructed of reinforced block work, precast units and with reinforced floor and roof construction, not resigned to resist earthquakes.
Type 3	Single and two-story houses and buildings made of lighter construction, using lightweight material such as bricks, cement blocks etc., not designed to resist earthquakes.
Type 4	Structures that, because of sensitivity to vibration, do not correspond to those listed above 1, 2 and 3 declared as archeologically preserved structures by the Department of Archaeology.

8.2: Interim standards for vibration of the operation of machinery, construction activities, and vehicle movement's traffic

Category of the structure as given in Table 8.1	Type of vibration	Frequency of Vibration (Hz)	Vibration in Peal Particle Velocity (PPV) (mm/sec)
Type 1	Continuous	0-1	5.0
		10-50	7.5
		Over 50	15.0
	Intermittent	0-1	10.0
		10-50	15.0
		Over 50	30.0
Type 2	Continuous	0-1	2.0
		10-50	4.0
		Over 50	8.0

[38] Source: Amended interim "Air Blast Over Pressure Standards" of the Central Environmental Authority; Pollution Control Division; December 04, 2008

	Intermittent	0-1	4.0
		10-50	8.0
		Over 50	16.0
Type 3	Continuous	0-1	1.0
		10-50	2.0
		Over 50	4.0
	Intermittent	0-1	2.0
		10-50	4.0
		Over 50	8.0
Type 4	Continuous	0-1	0.25
		10-50	0.5
		Over 50	1.0
	Intermittent	0-1	0.5
		10-50	1.0
		Over 50	2.0

8.3: Interim Standards on Air Blast Over Pressure and Ground Vibration for Blasting activities

Category of the structure as given in Table 8.1	Type of vibration	Type of blasting	Ground Vibration in Peal Particle Velocity (PPV) (mm/sec)	Air blast over pressure (dB(L))
Type 1	Impulsive	Single bore hole	8.0	105
		Multi bore holes with delay detonators	10.0	115
Type 2	Impulsive	Single bore hole	6.0	105
		Multi bore holes with delay detonators	7.0	115
Type 3	Impulsive	Single bore hole	4.0	115
		Multi bore holes with delay detonators	5.0	120
Type 4	Impulsive	Single bore hole	0.5	95
		Multi bore holes with delay detonators	0.75	100