PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY

DASU HYDROPOWER PROJECT

ENVIRONMENTAL MANAGEMENT ACTION PLAN

Volume 8: ENVIRONMENTAL MANAGEMENT PLAN

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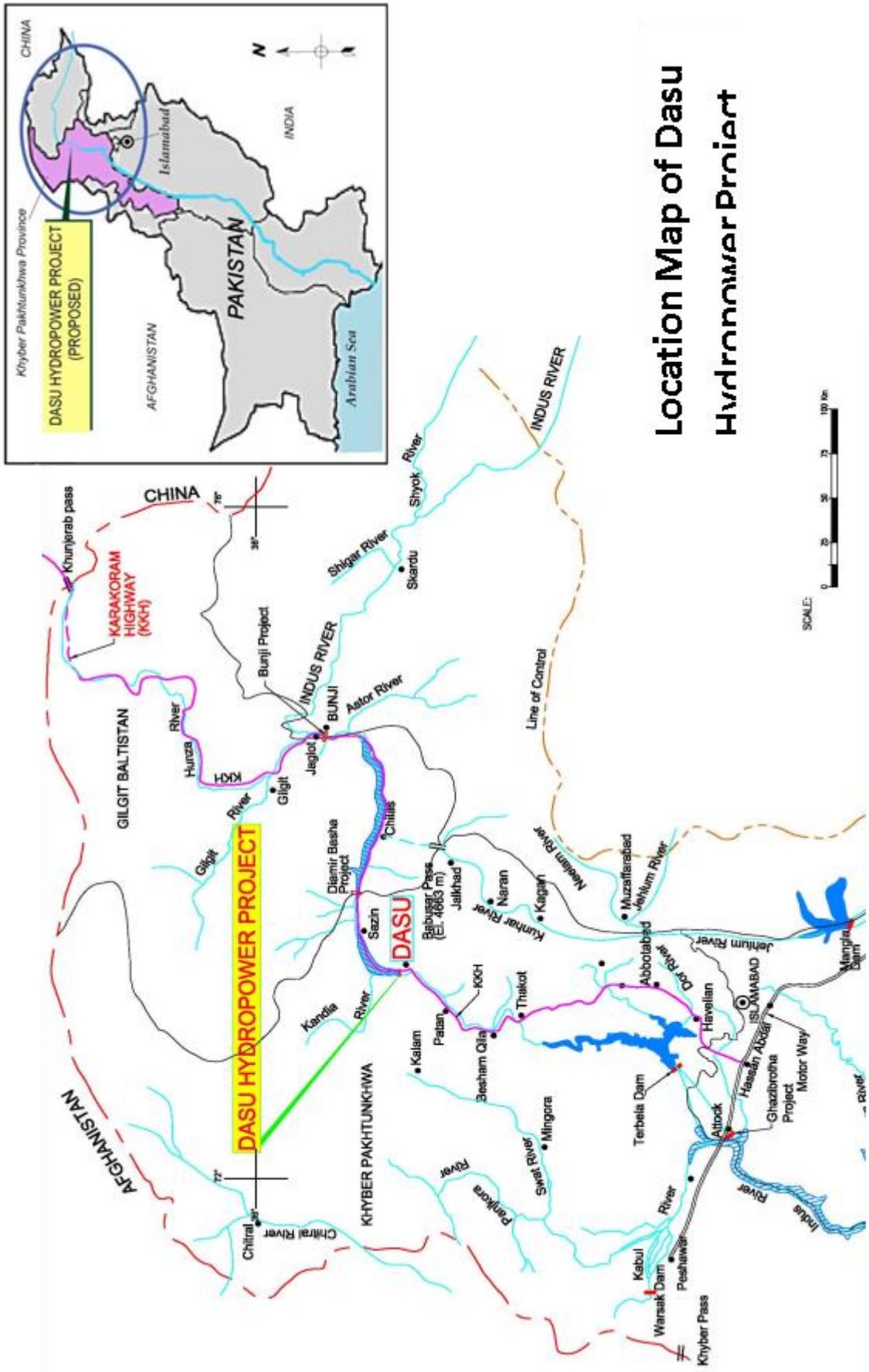
Location Map of Dasu Hydropower Project
DASU HYDROPOWER PROJECT (PROPOSED)
PAKISTAN
AFGHANISTAN
INDIA
CHINA
Islamabad
Arabian Sea
Khyber Pakhtunkhwa Province
DASU HYDROPOWER PROJECT
DASU
KARAKORAM HIGHWAY (KKH)
INDUS RIVER
BUNJI
Bunji Project
Diamir Basha Project
Khunjerab pass
GILGIT BALTISTAN
KHYBER PAKHTUNKHWA
Line of Control
Shigar River
Shyok River
Skardu
Astor River
Hunza River
Gilgit River
Gilgit
Jaglot
Chilas
Sazin
Babusar Pass (El. 4694 m)
Jalkhad
Naran
Kaghan
Kunhar River
Neelam River
Muzaffarabad
Jehlum River
Kandia River
Kalam
Patan
Besham Qila
Thakot
Mingora
Swat River
Peshawar
Kabul River
Chitral
Chitral River
Warsak Dam
Khyber Pass
Tarbela Dam
Attock
Havelian
Abbotabad
ISLAMABAD
Hasan Abdal
Ghazi Brotha Project
Motor Way
Mangla Dam
Indus River
SCALE:

ENVIRONMENTAL MANAGEMENT ACTION PLAN

Vol 1: Executive Summary

Vol 2: Environmental Impact Assessment

Vol 3: Terrestrial Ecology

Vol 4: Aquatic Ecology

Vol 5: Physical Cultural Resources

Vol 6: Environmental Baseline Quality

Vol 7: Cumulative and Induced Impact Assessment

Vol 8: Environmental Management Plan

ABBREVIATIONS

CEAP	Construction Environmental Action Plan
CSC	Construction Supervision Consultant
DCO	District Coordination Officer
DHP	Dasu hydropower project
ECP	Environmental Code of Practices
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
EU-CSC	Environmental Unit – CSC
EU-DHP	Environmental Unit – DHP
FSL	Full Supply Level
GB	Gilgit-Baltistan
GHG	Green House Gas
GRC	Grievance Redress Committee
GT Road	Grand Trunk Road
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome
KKH	Karakoram Highway
KP	Khyber Pakhtunkhwa
MIS	Management Information System
MSDS	Material Safety Data Sheets
MW	Megawatt
NEQS	National Environmental Quality Standards
OEAP	Operation Environmental Action Plan
OHS	Occupational Health and Safety
PD	Project Director
PMU	Project Management Unit
PPE	Personal Protection Equipment
RCC	Roller Compacted Concrete
SA	Social Accountability
STI	Sexually Transmitted Infections
WEC	WAPDA Environmental Cell
WHO	World Health Organization

Volume 8
ENVIRONMENTAL MANAGEMENT PLAN

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1. INTRODUCTION

1.1 PURPOSE OF THE REPORT

This volume presents the Environmental Management Plan (EMP) developed for the Dasu Hydropower Project (the Project or DHP). This document will form the primary mechanism for management of the Project's environmental performance. The EMP is a stand-alone document which outlines mitigation measures, accountability, monitoring and institutional arrangements for the environmental management of the Project. The EMP also provides information on environmental decisions which need to be made during both construction and operational phases of the Project. It provides the basis for evaluating the efficiency of mitigation and enhancement measures and suggests further actions that need to be taken to achieve the desired Project outcomes.

This document is a duplication of EMP provided in Section 9 of Vol.2 EIA and with some description of the Project and an additional note on World Bank Group Environmental Health and Safety Guidelines. This document is prepared for wider circulation of all stakeholders involved in the implementation of the Project. This document will act as a handbook or easy reference guide (without going through voluminous EIA report) for the PMU, Consultants and Contractors.

1.2 PROJECT INFORMATION

1.2.1 Project location

The dam site of the Dasu Hydropower Project (DHP) is located about 7 km north of Dasu town, the administrative headquarters of District Kohistan at geographic location N 35^{o} 19' 6.61", E 73^{o} 11' 41.33" on Indus River in Khyber Pakhtunkhwa (KP) province of Pakistan. The dam site is located about 74 km downstream of proposed Diamer Basha Dam site. Location of the Project site in Pakistan is shown in Figure 1.1. The dam site is located about 350 km north of Islamabad and can be reached by road in about 10 hours through Grand Trunk (GT) road up to Hassan Abdal and then through Karakoram Highway (KKH). The nearest railway station to the dam site is at about 240 km at Havelian that connects Karachi sea port about 1,600 km away.

1.2.2 Salient Features

DHP will be comprised of a 242 m high concrete gravity dam and 73 km long reservoir behind the dam with an average width of 365m. The project will have an underground powerhouse housing 12 turbines, each of which will produce 360 MW power, and a final maximum capacity to produce 4320 MW. The salient features of the Project are given in Table 1.1. The Project also involves relocation of about 46 km of KKH that will be submerged in DHP reservoir.

Table 1.1: Salient Features of DHP

Item	Detail
General	
- Location	Near Dasu town, Kohistan District, KP
- Installed Capacity	4,320 MW
- Total Energy	18,440 GWh/annum (pre-Basha) 21,485 GWh/annum (post-Basha)
- Catchment area at dam site	158,800 km^2
- Average discharge at dam site	2,102 m^3/s
- Safety Check Flood (SCF)	51,957 m^3/s
- Basic Design Flood (BDF)	24,932 m^3/s
Water Level	
- Flood Water Level under SCF	EL. 959.46 m

Item	Detail
- Flood Water Level under BDF	EL. 951.28 m
- Full Supply Level (FSL)	EL. 950.00 m
- Minimum Operating Level (MOL)	EL. 900.00 m
Reservoir	
- Gross Storage Capacity (El.950m)	1.41x 10^9 m^3
- Operational Storage Capacity	0.82x 10^9 m^3
-Reservoir Area Full Supply El 950m	23.85 Km^2
-Reservoir Area: BD Level El 951.28m	24.46 Km^2
-Reservoir Area : MOL El 900m	11.53 Km^2
Main Dam	
- Type	Arch-Gravity Dam in Roller Compacted Concrete (RCC)
- Maximum Height above foundation	242m
- Crest Length at EL. 957m	570m
Spillway	
- Maximum Discharge Capacity under SCF	45,097 m^3/sec
Low Level Outlet	
- Discharge Capacity under SCF	2,756 m^3/s by 2 LLO at reservoir El.959.46m 12,157 m^3/s by 9-LLO at El. 955.67 m
Flushing Tunnels	
- Discharge Capacity under SCF	1,060 m^3/s per tunnel
Power Generation	
- Generating Units and Unit Capacity	12 Francis turbines - 360 MW, 167 rpm
- Powerhouse Location	Underground, left bank
- Design Head	Approximately 179.51 m
- Rated Discharge (12 units) and Voltage	2,670 m^3/s, 16.5 kV
Tailrace Tunnel	
- Number, shape and average length	4 no, D-shaped, 2,200m in average
- Size and lining	10mW x12.5mH concrete lined
- Discharge per Tunnel	650 m^3/s
Tail Water Level	
- Flood Water Level under SCF	EL. 778.39 m
- Tail water level under 12-unit operation	EL. 762.83 m
- Tail water level under 3-unit operation	EL. 759.24 m
Power Transmission	
- Transmission Voltage	500 kV (AC)
- Powerhouse Substation &	Gas Insulated Substation (GIS) , Underground
- Transmission Substation	Air Insulated System, Surface
- Length and Location of Transmission Line	250 km, Dasu to Pathar Garh Design of transmission line and its EIA is not covered by the present study
KKH Realignment	
KKH Realignment (to compensate loss of 52 km of existing KKH)	62 km
Major Ancillary Works	
Access road on right bank from Komilla to damsite	12.96 km
Right bank road from Damsite to Kandia; and Track from Kandia to Utter Gha	22.85 km 17.84 k
Bridge on Indus on the upstream of Kandia river	350 m

Item	Detail
confludence	
132 kv transmission line from Dubair to Dasu	45 km
Resettlement Sites Development	30 nos.
WAPDA's colony with necessary infrastructure (water, sanitation, roads, power distribution etc.)	31.5 ha

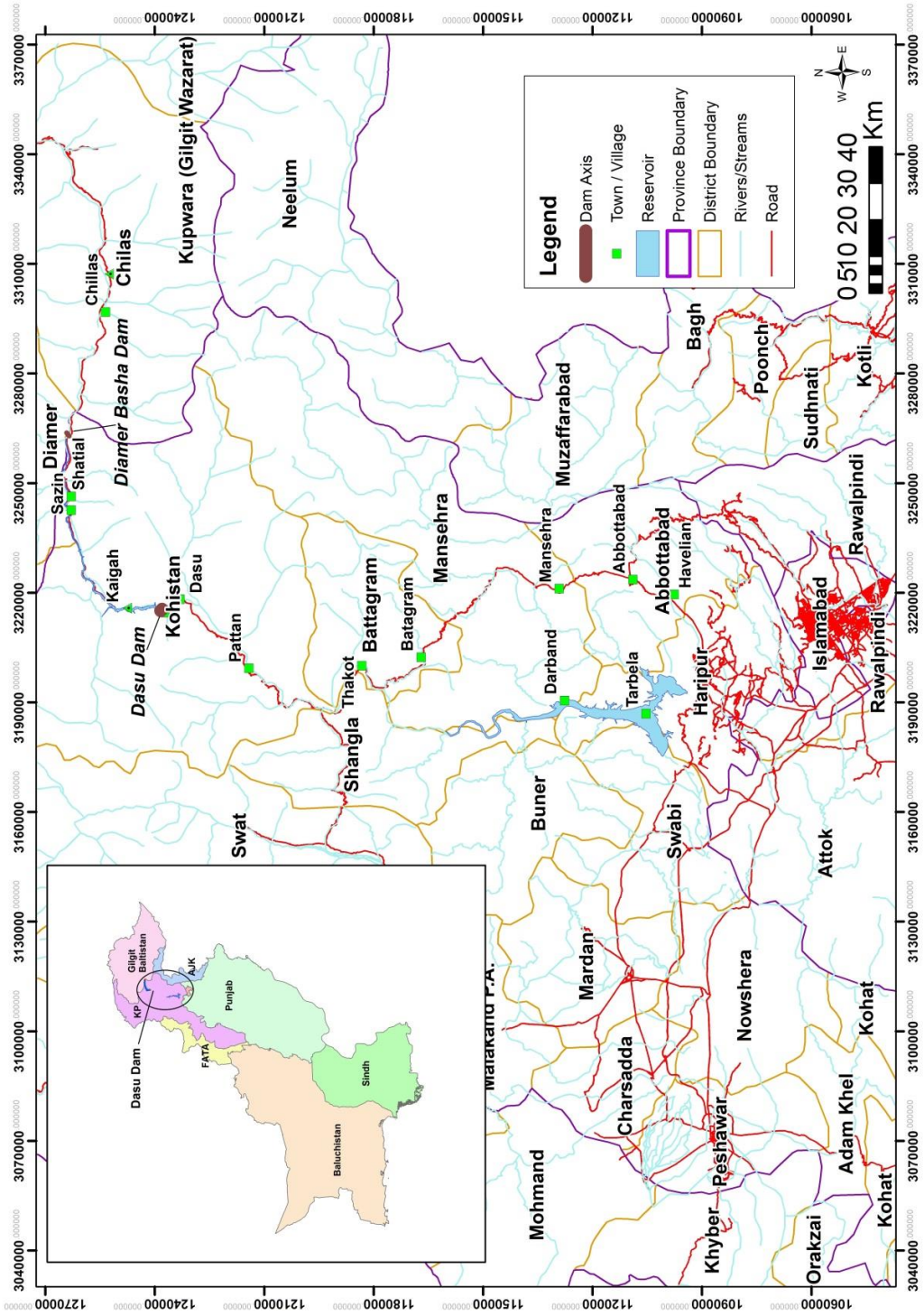


Figure 1.1: Location of DHP

1.2.3 Description of Project Components

Details of various civil, mechanical and electro mechanical works (Project Components) of the Project are given in Table 1.2. A brief description of each of these components is explained in the following sections. A layout map of the Project facilities is shown in Figure 1.2.

Table 1.2: Main Civil, Mechanical and Electromechanical Works in DHP

No	Work	Quantity/Details
1	**River Diversion Works**	
1.1	Diversion Tunnel on Left Bank	
	- No. and Shape	2, D-shape shape
	- Size and Lining	17 m W x20m H, shotcrete lined
	- Length	1,261 m ~1,101m
1.2	Coffer Dams	
	- Length and Height of Upstream integrated Coffer Dam	Length 88m, height 95 m
	- Length and Height of Downstream Coffer Dam	Length 40m, height 19 m
2	**Main Dam and Associated Facilities**	
2.1	Dam	
	- Maximum Height above foundation	242m
	- Crest Length at El 957m	570m
2.2	Spillway	
	- Number of Bays	8
	- Type and Size of Gates	Radial, 16.5 m wide x 22.4m high
	- Plunge Pool	162.26 m from dam toe
2.3	Low Level Outlet	
	- Number and Size	9 no. (Circular, 6.4 m diameter, 180.23m length)
	- Type and Size of Gates	
	Service gates:	fixed wheel,8.4mWx8.4mH
	Guard gates:	fixed wheel, 5.1 m W x 6.4m H
	Regulating gates:	Radial, 5.1m W x 6.4mH
2.4	Flushing Tunnels on Right Bank	
	-No and size	2 No 9.5 m dia (L= 820 m & 680 m)
	Type & Size of Gates	Stoplogs: 4.75mW x 9.5mH
		Guard/Regulating gates: Roller, 4.0mW x 9.5mH
3	**Power Intake**	
	- Number and Shape	4 no, D=12m, Flatbed type
	- Removal Trash rack	4 sets,
	- Intake service gates	4 no,9.5 m W x 12.5m H
	- Intake maintenance gates	2,9.5m W x 12.5m H
4	**Tunnels (Water Ways)**	
4.1	Power Tunnel	
	- Number and Shape	4 no, circular
	- Size and Lining	D=12.5~5.5m dia, concrete lined
	- Average Length	450m
4.2	Tailrace Tunnel	
	- Number and shape	4 no, D-shaped
	- Size and lining	10mW x12.5mH concrete lined
	- Average Length	2,152m in average
	- Surge Chamber	4 no, D=37m, H=56m
	- Surge Chamber Stoplogs	4, 6.2m W x 7.8m H gantry crane
	- Tailrace Outlet Gates	8 no, 9.0m W x 8 m high
5	**Power Generation**	
5.1	Generating Units	12 no, Francis turbines (360 MW), 166.7 rpm

No	Work	Quantity/Details
5.2	Powerhouse	
	- Powerhouse Cavern L × W × H	424m × 31m × 62m
	- Transformer Cavern L × W × H	424m × 22m × 33.5m

Locations of temporary facilities such as construction yards, construction camps, etc. are given in Figure 1.3 and Figure 1.4.

1.2.4 Implementation schedule

The DHP requires huge and committed investment. A staged development is the practical way to achieve earlier power generation with the minimum investment cost (committed finance from the World Bank) and to deal with uncertainties in future investment. It was agreed with WAPDA and World Bank that a two staged approach will be followed for DHP with each stage divided into two phases as shown in Table 1.3. The stage 2 development is assumed to be implemented after Basha project construction, which has some implications on the sediment load to DHP and thereby operations of DHP. During each phase additional power generating capacity of 1,080 MW (three turbines of 360 MW) will be installed. During Phase-1 (5 years, 2015-2020) the major hydraulic structures and related infrastructure will be constructed and one power tunnel including generating facilities for 1,080 MW of installed capacity. Another tunnel would be constructed during Phase-2, together with power generating facilities for another 1080 MW. Both phases of Stage 1 will be implemented simultaneously (2015 -2022). The Second Stage will include the construction of a third power tunnel and generating facilities for an additional 1,080 MW. Phase-3 and 4 would preferably be carried out after the development of Diamer-Basha dam.

Table 1.3: Staged Development of DHP

	Stage 1		Stage 2	
	Phase-1	**Phase-2**	**Phase-3**	**Phase-4**
Works	Full dam & Three Turbines	Three Turbines	Three Turbines	Three Turbines
Cumulative Installed Capacity MW	1,080	2,160	3,240	4,320
Generation GWh under each Phase	8056	12,255	15,544 (18,730 post Basha)	18,440 (21,485 post Basha)
Start	2015		To be initiated after the completion of Basha	
Completion	2022 (first unit will start generating form 2020)		4 years after commencement	

Note: Diamer Basha project implementation is expected to be completed in 15 years

The proposed construction schedule is given in Figure 1.5.

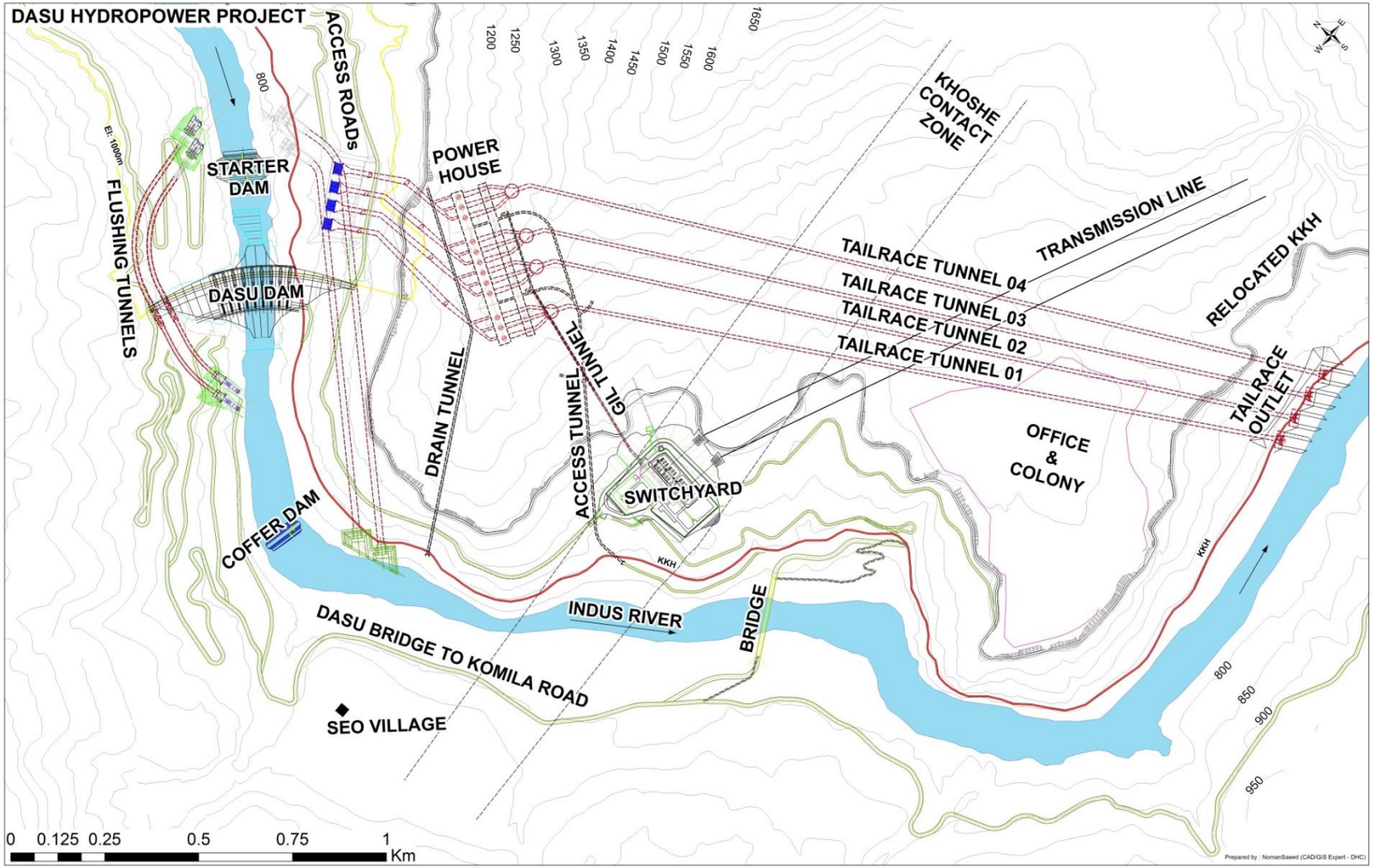
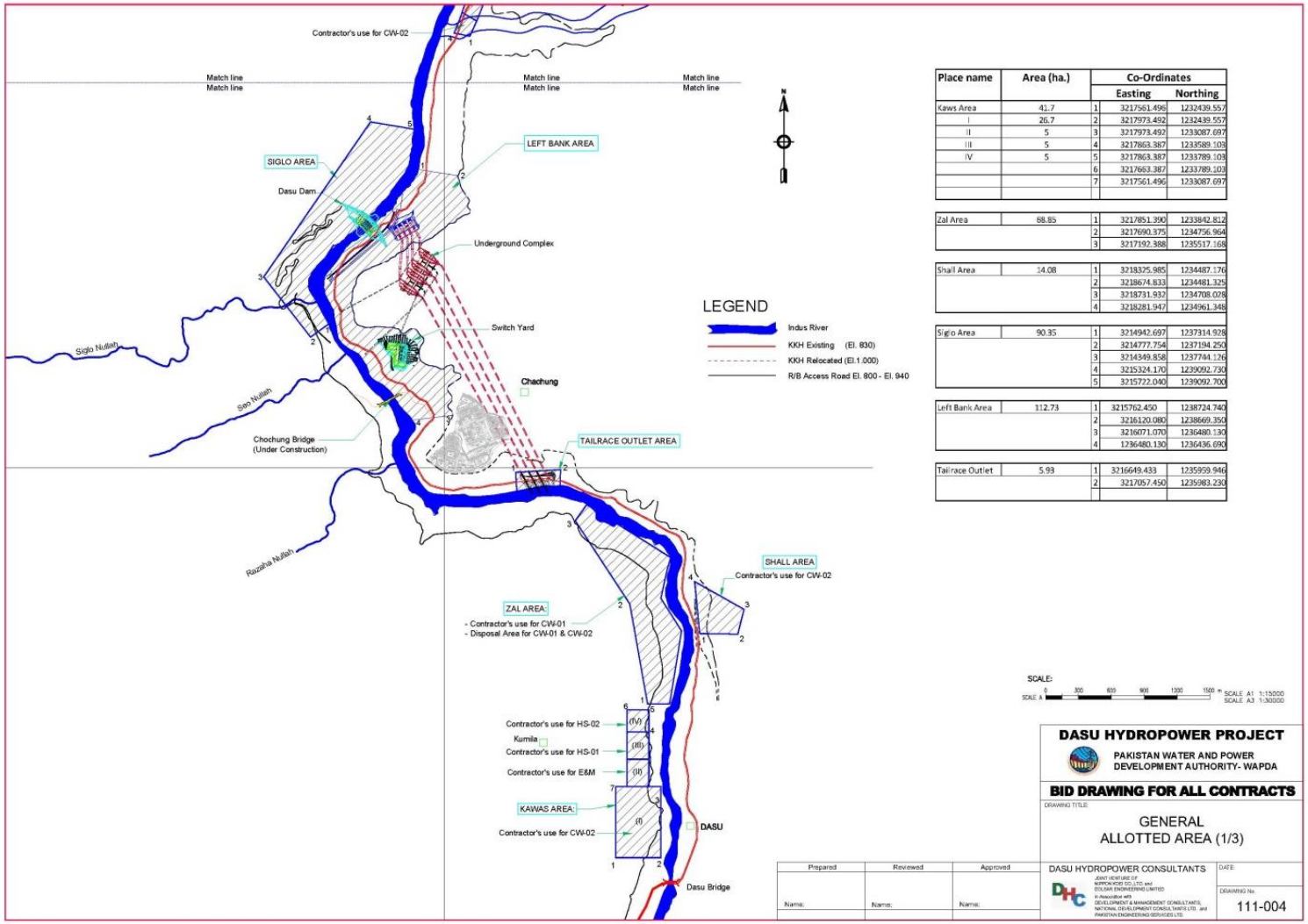
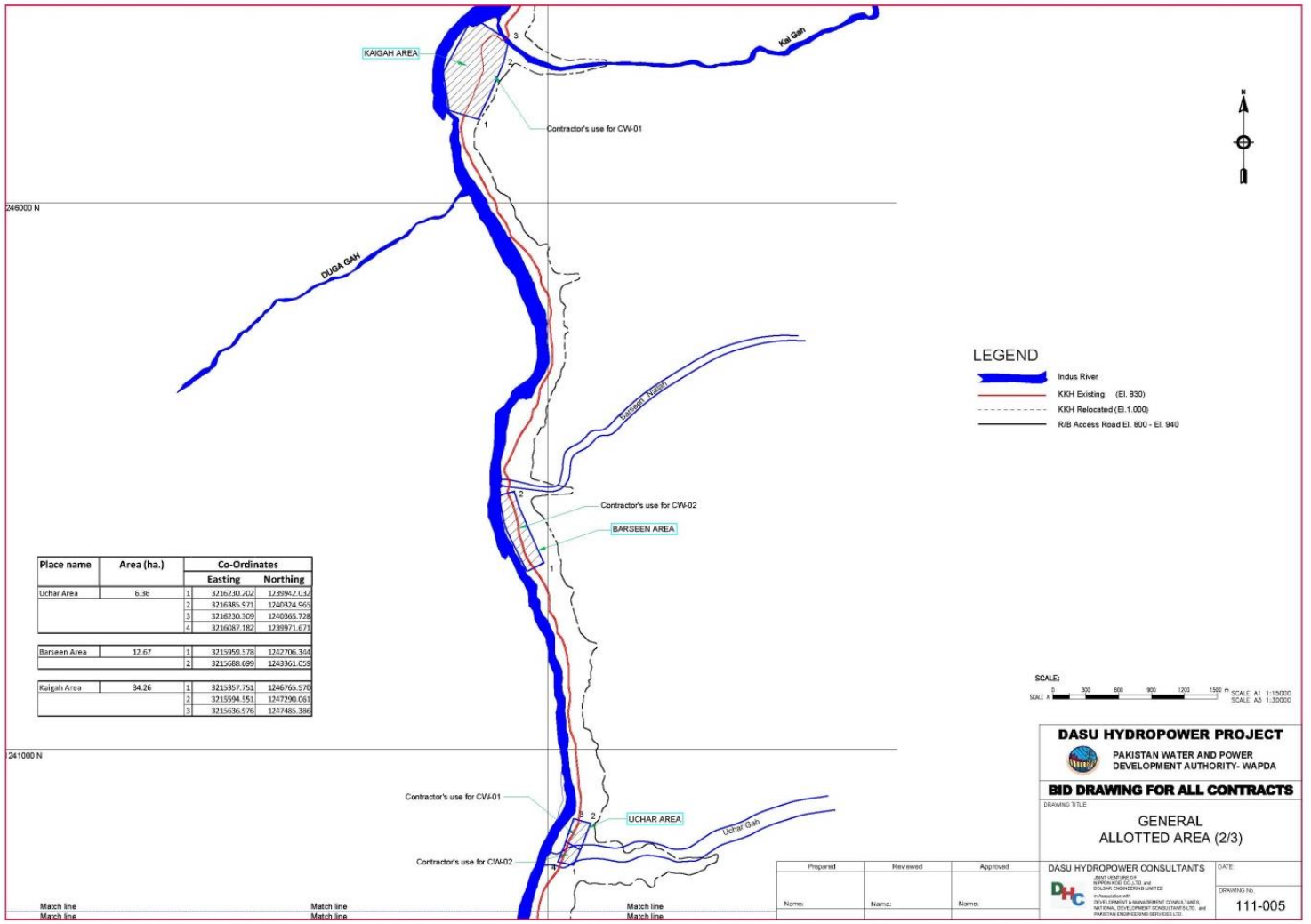


Figure 1.2: Layout of Dasu Hydropower Project



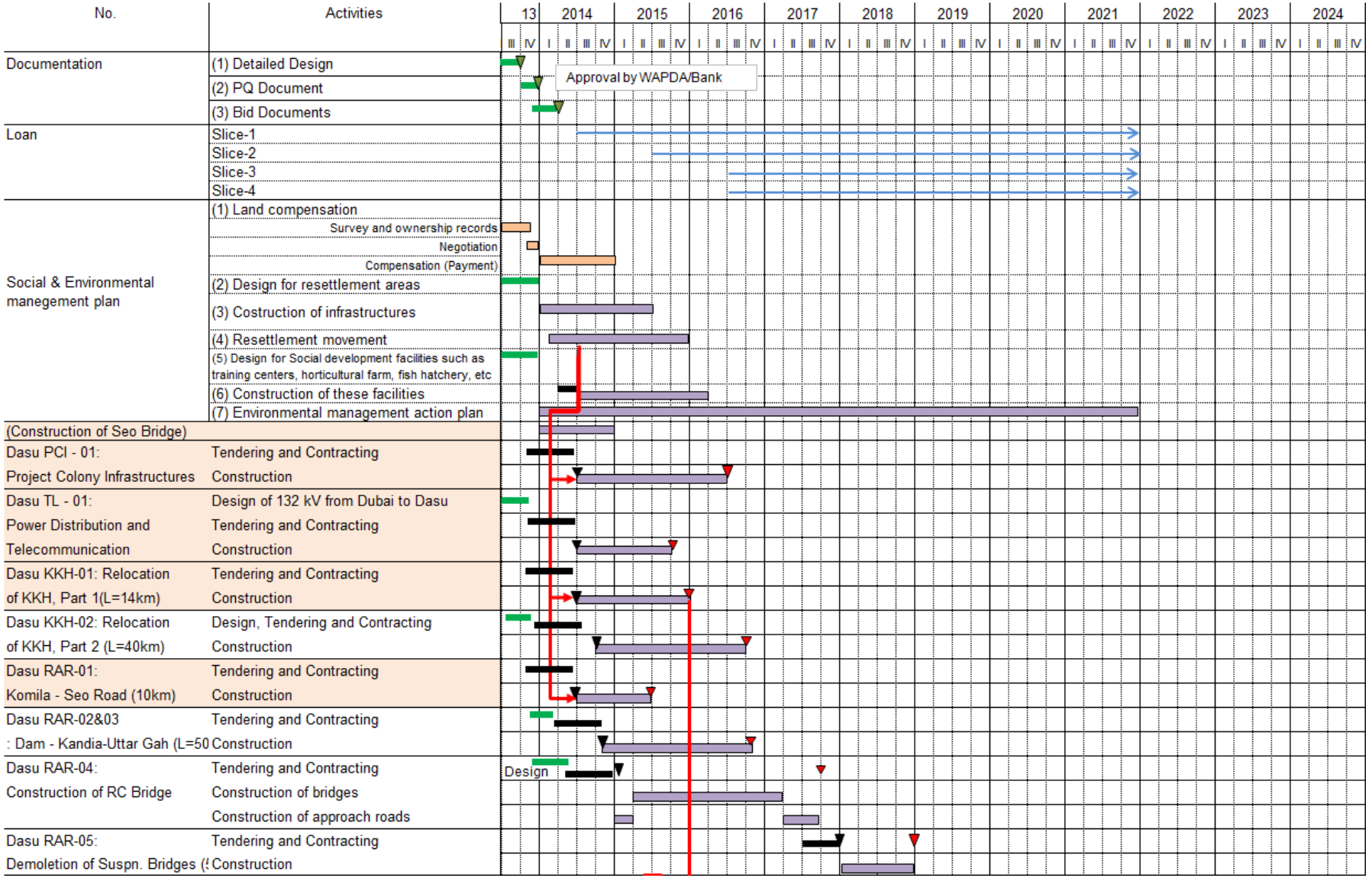
Place name	Area (ha.)		Co-Ordinates	
			Easting	Northing
Kaws Area	41.7	1	3217561.496	1232439.557
I	26.7	2	3217973.492	1232439.557
II	5	3	3217973.492	1233087.697
III	5	4	3217863.387	1233589.103
IV	5	5	3217863.387	1233789.103
		6	3217663.387	1233789.103
		7	3217561.496	1233087.697
Zal Area	88.85	1	3217851.390	1233842.812
		2	3217690.375	1234756.964
		3	3217192.388	1235517.168
Shall Area	14.08	1	3218325.985	1234487.176
		2	3218674.833	1234481.325
		3	3218731.932	1234708.028
		4	3218281.947	1234961.348
Sigio Area	90.35	1	3214942.697	1237314.928
		2	3214777.754	1237194.250
		3	3214349.858	1237744.126
		4	3215324.170	1239092.730
		5	3215722.040	1239092.700
Left Bank Area	112.73	1	3215762.450	1238724.740
		2	3216120.080	1238669.350
		3	3216071.070	1236480.130
		4	1236480.130	1236436.690
Tailrace Outlet	5.93	1	3216649.433	1235959.946
		2	3217057.450	1235983.230

Figure 1.3: Locations and Details of Temporary Facilities - 1



Place name	Area (ha.)		Co-Ordinates	
			Easting	Northing
Uchar Area	6.36	1	3216230.202	1239942.032
		2	3216385.971	1240324.963
		3	3216230.309	1240365.728
		4	3216087.182	1239971.671
Barseen Area	12.67	1	3215959.578	1242706.344
		2	3215688.699	1243361.059
Kaigah Area	34.26	1	3215857.751	1246765.576
		2	3215594.551	1247290.061
		3	3215636.976	1247485.386

Figure 1.4: Locations and Details of Temporary Facilities – 2


No.
Activities
13
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Documentation
(1) Detailed Design
Approval by WAPDA/Bank
(2) PQ Document
(3) Bid Documents
Loan
Slice-1
Slice-2
Slice-3
Slice-4
Social & Environmental manegement plan
(1) Land compensation
Survey and ownership records
Negotiation
Compensation (Payment)
(2) Design for resettlement areas
(3) Costruction of infrastructures
(4) Resettlement movement
(5) Design for Social development facilities such as training centers, horticultural farm, fish hatchery, etc
(6) Construction of these facilities
(7) Environmental management action plan
(Construction of Seo Bridge)
Dasu PCI - 01: Project Colony Infrastructures
Tendering and Contracting
Construction
Dasu TL - 01: Power Distribution and Telecommunication
Design of 132 kV from Dubai to Dasu
Tendering and Contracting
Construction
Dasu KKH-01: Relocation of KKH, Part 1(L=14km)
Tendering and Contracting
Construction
Dasu KKH-02: Relocation of KKH, Part 2 (L=40km)
Design, Tendering and Contracting
Construction
Dasu RAR-01: Komila - Seo Road (10km)
Tendering and Contracting
Construction
Dasu RAR-02&03 : Dam - Kandia-Uttar Gah (L=50
Tendering and Contracting
Construction
Dasu RAR-04: Construction of RC Bridge
Tendering and Contracting
Design
Construction of bridges
Construction of approach roads
Dasu RAR-05: Demoletion of Suspn. Bridges (
Tendering and Contracting
Construction

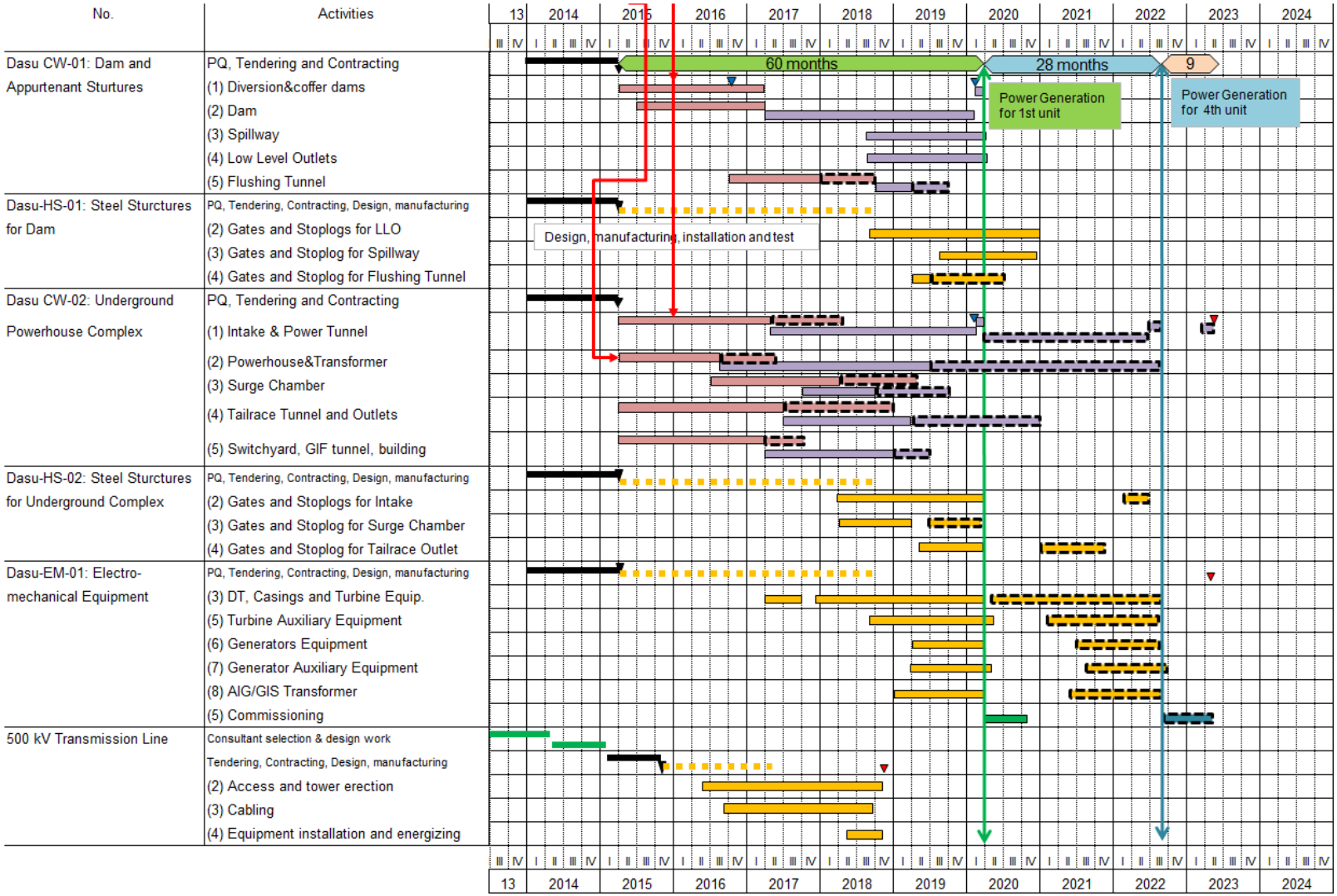


Figure 1.5: Project Construction Schedule

2. FRAMEWORK OF EMP

2.1 GUIDING PRINCIPLES OF EMP

Environmental Management Plan (EMP) is prepared for all the identified environmental impacts during pre-construction, construction and operational stages due to implementation of various Project activities in accordance with international best practices and World Bank guidelines. The methodology followed for preparing the EMP is given in Figure 2.1 and consists of the following steps:

- Deriving mitigation measures for each identified impact and risk,
- Developing a mechanism for monitoring the proposed mitigation measures,
- Estimating budget requirements for implementation mitigation and monitoring measures, and
- Identifying responsibilities of various agencies involved in the Project for implementation and monitoring of mitigation measures.
- Auditing of the implementation activities to ensure that mitigation measures are implemented appropriately
- Corrective actions if there are any non-compliances in the implementation of the mitigation measures
- Reporting mechanism.

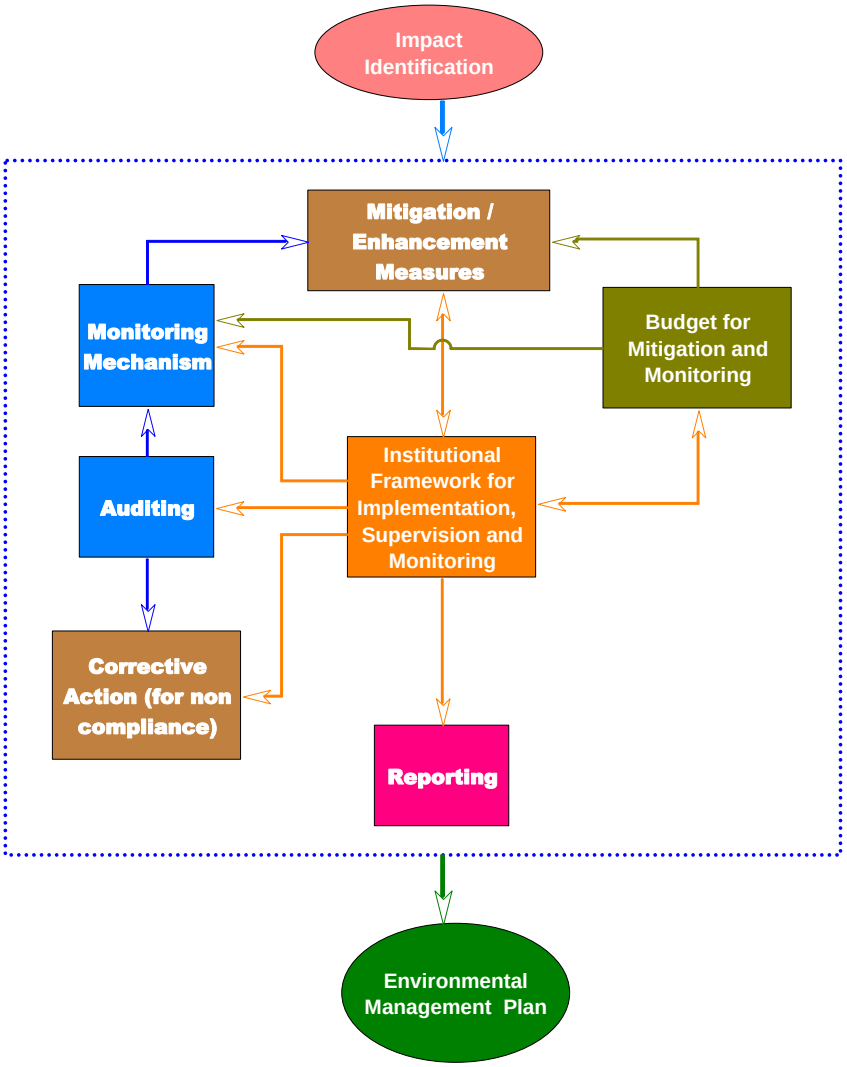


Figure 2.1: Framework for Preparation of EMP of DHP

The EMP prepared in accordance with the above framework is given in Section 11.3. Each of the components in the framework is discussed in the following sections. The strict implementation of the EMP and project management's strict enforcement of the adequate construction practices and standards will greatly reduce the negative impacts of the Project.

2.1.1 Mitigation Measures

A wide range of mitigation/protection measures are used to address various identified environmental impacts. These mitigation measures are derived after evaluation of six possible measures: three categories (viz. avoidance, modification and control/mitigation) that can be incorporated in project activity and three categories (viz. protection, relocation/compensation, and enhancement) to address receptor or environmental component. The most effective combination of all these strategies (in terms of its applicability and cost-effectiveness) are found and then incorporated in the EMP. A brief description of each of these possibilities is given below.

- Project Activities
    - Avoidance/Prevention: Avoidance/prevention means essentially keeping away from environmentally sensitive areas by locating (siting) or reducing the size of project activity
    - Modification: In some cases modification of a project activity or its implementation under special conditions (e.g., timing of activities, buffers around nesting areas) will greatly reduce the adverse impacts
    - Control/Mitigation: It is not possible or even practical to avoid all impacts. Following proper control/mitigation measures will reduce (i.e., control) the extent of impact on the environment. The best construction practices also helps in reducing the extent of impact
- Environmental Component
    - Protection: Protection/insulation of receptors from impacts will reduce the impacts that remain after control measures have been used
    - Relocation/Compensation: Compensation refers to the provision of "equivalent" environmental features
    - Enhancement: Enhancement refers to the provision of features that are an improvement over previous environmental conditions

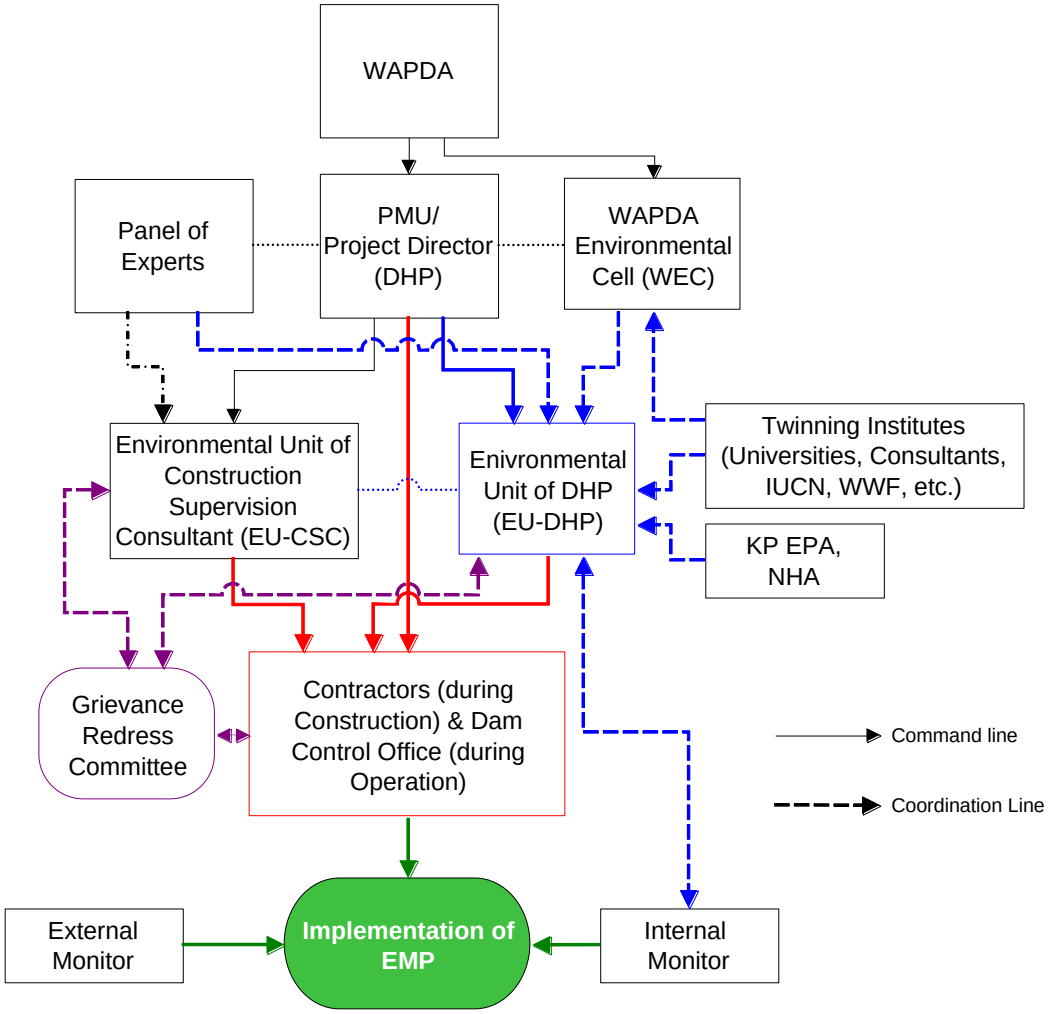
2.1.2 Institutional Framework for Implementation of EMP

Institutions responsible for executing and monitoring the environmental aspects of this Project are:

- DHP and its Project Management Unit (PMU) will be responsible for overall implementation of the Project and hiring of contractors and consultants
- A 'Safeguard Unit' will be established in PMU, which will be responsible for all required administrative and financial decisions and actions for effective and timely implementation of the safeguards. The Safeguard Unit will consists of an Environmental Unit and a 'Social and Resettlement Unit'
- The Environmental Unit in DHP (EU-DHP) will be responsible to undertake responsibility for routine and random monitoring of implementation of EMP
- As several contractors will be working simultaneously for timely and speedy implementation of the project, it is important that Construction Supervision Consultant (CSC) has an environmental unit to effectively supervise and monitor the environmental activities being implemented in the field. Environmental Unit in CSC (EU-CSC) is responsible for supervision of implementation of EMP.

- Contractors will be responsible for implementation of EMP during construction and first year of operation of the project. They also have dedicated staff for EMP implementation.
- In some cases consultants and specialist organizations will be hired to implement specific plans in EMP such as conservation areas development, fish monitoring, etc.
- Internal auditing on implementation of EMP will be taken up EU-DHP and WAPDA's Environmental Cell (WEC)
- External auditing will be taken up by an independent agency
- A Grievance Redress Committee (GRC) will be established (to deal with the complaints related to environmental and social issues (as a part of the DHP overall GRC framework – SRMP Volume 9: Grievance Redress Plan)

Organization chart of PMU of DHP and institutional framework for implementation of social and environmental safeguards is shown in Figure 2.2. An extract of the organization which demonstrates the organizational structure and how it relates to the implementation of the EMP is shown in



Note: Each box in the above figure represents an organization contributing to the 'Implementation of EMP'. Description of responsibility of each organization is given in Section 2.1.2.

Figure 2.3.

Roles and responsibilities relating to environmental management for the key positions in the Project team are given below.

2.1.2.1 Project Director of DHP (PD)

The PD/GM-CEO of DHP is the executive head of the entire Dasu Hydropower Project operations. He is responsible for necessary policy, administrative and financial decisions and actions for effective and timely implementation of the project as per the approved framework and implementation schedules. The Deputy Project Director-Safeguards will assist the PD in the execution of EMAP.

2.1.2.2 Environmental Unit of DHP (EU-DHP)

A 'Safeguard Unit' will be established in PMU, which will be headed by a Deputy Project Director. The safeguard unit will consist of two units – one 'Environmental Unit' and one 'Social and Resettlement Unit'.

Environmental Unit in DHP will consist of three sub-units (Environment, Ecology, Occupational Health and Safety) with the following Staff.

- Director - Environment
- Deputy Director - Environment
- Assistant Director - Environment (with two site engineers)

- Assistant Director - Ecology (with two support specialists - Fish expert 1, plantation expert 1)
- Assistant Director - Occupational Health and Safety (with one support specialist)

Deputy Project Director of Safeguard Unit will be responsible for overall implementation of SRMP and EMP and guiding the social and environmental units. He may delegate his/her power through the Director – Environment Unit. He will be responsible for ensuring the EMP, ECPs and bills of quantities are included in the contract documents, and approval of contractors 'environmental management action plan'.

Responsibilities of staff of Environmental Unit are briefly described below. These positions are field based and they have to reside in Dasu. Terms of reference (TOR) is prepared for all these positions and given in Annex 9.1 of Vol. 2: EIA.

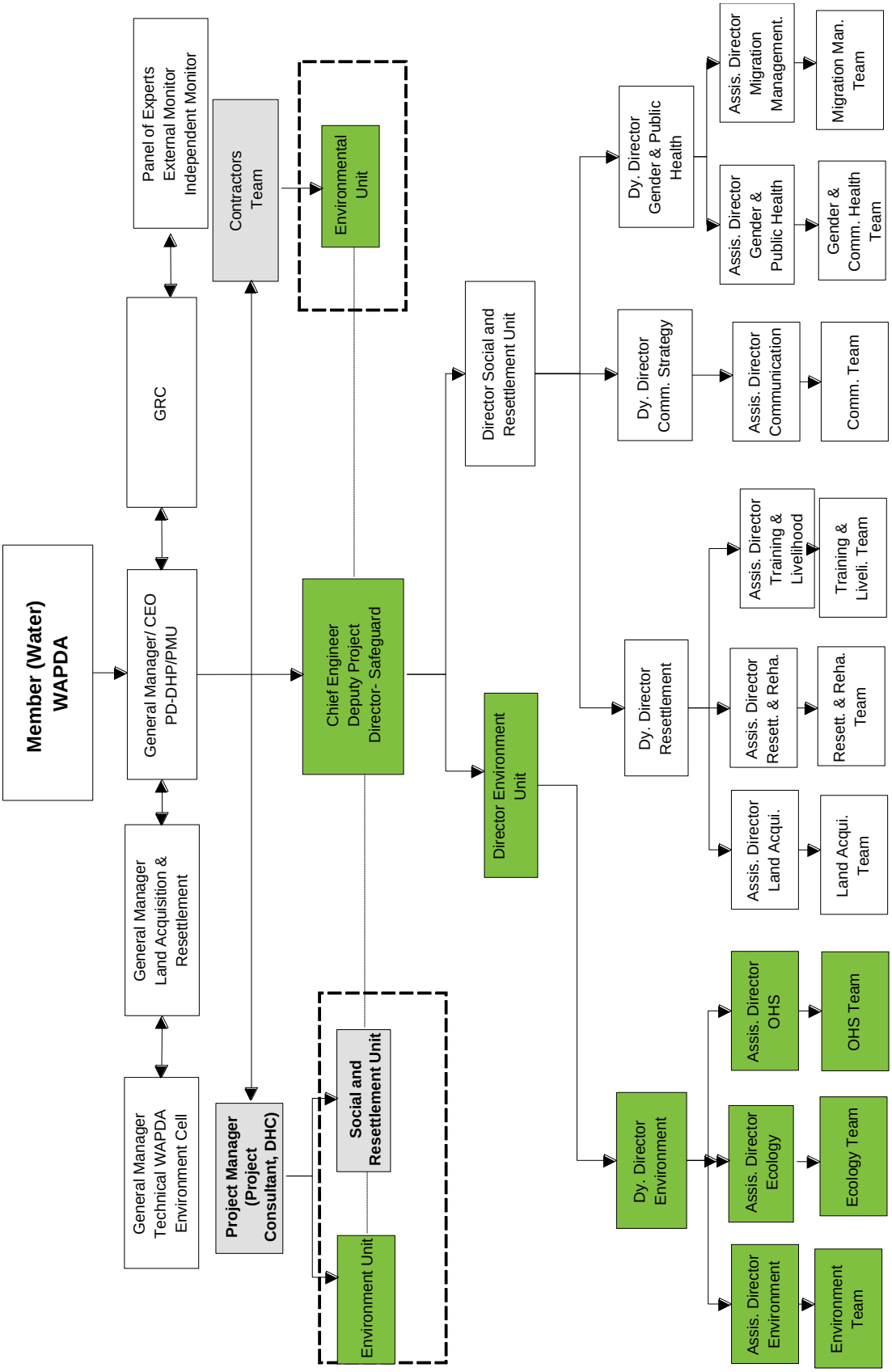
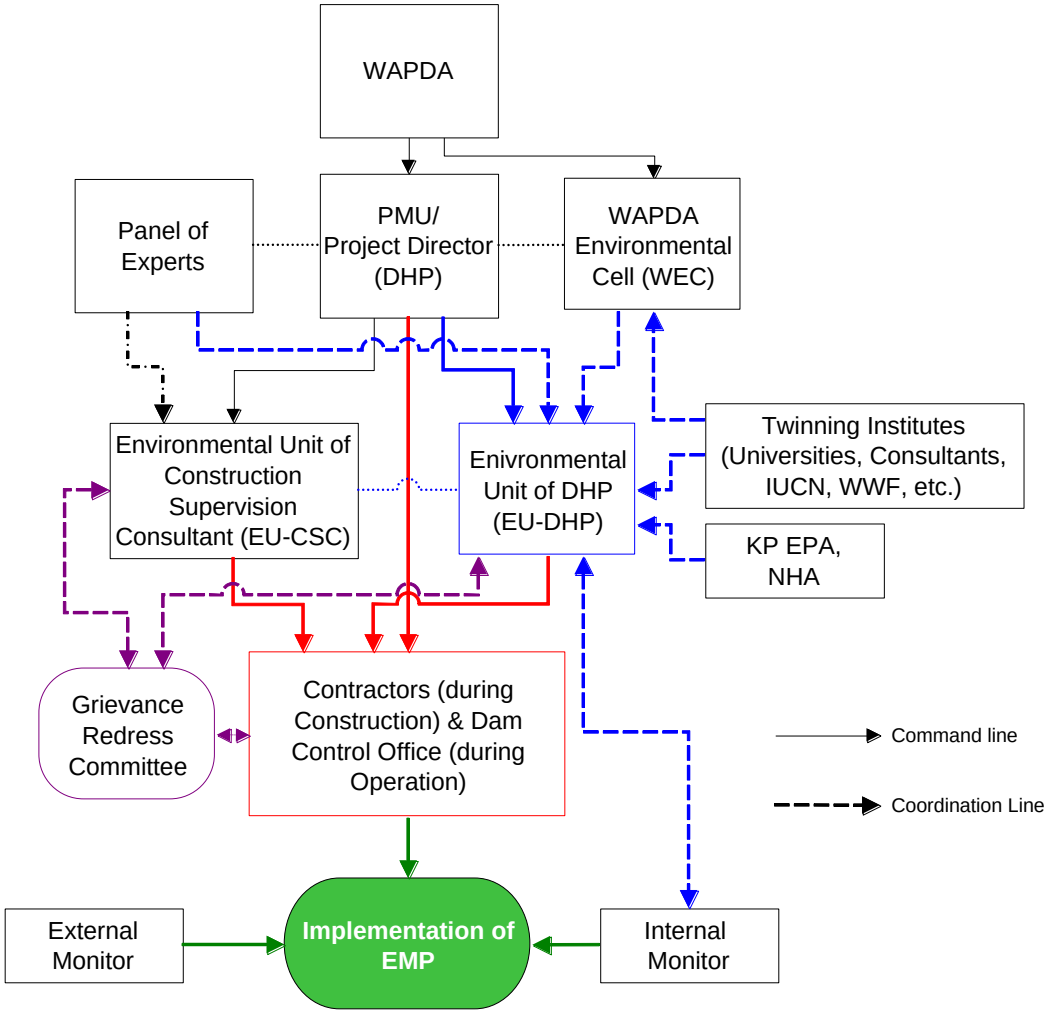


Figure 2.2: DHP Organization Chart



Note: Each box in the above figure represents an organization contributing to the 'Implementation of EMP'. Description of responsibility of each organization is given in Section 2.1.2.

Figure 2.3: Organizational Framework for Implementation of EMP

The EU-DHP Director will endorse and support the implementation of the EMP and associated policies and documentation. The Director shall be responsible to ensure appropriate resources are made available to implement the EMP and to support established systems, procedures and environmental objectives. Some specific responsibilities include:

- Overall planning, management and monitoring of EMP implementation
- Liaising with the EU-CSC, and ensuring that they perform their responsibilities effectively and adequately
- Assist in resolving disputes which may arise in respect to environmental management (if required).
- Liaising with government agencies and relevant stakeholders regarding environmental matters; overseeing the implementation of EMP;
- Coordinating appropriate responses to environmental related complaints, ensuring complaints are investigated for effective resolution;
- Coordinating the involvement of environmental specialists (from the broader project team) as the need arises throughout the construction phase.
- Liaise with the Social and Resettlement Unit and other relevant Project entities
- Liaising with WEC to update them on the EMP implementation, and seeking any technical backup

- Carryout additional studies, such as aquatic and terrestrial ecology, recommended in EMAP. Prepare necessary TORs for hiring of consultants and contractors
- Prepare monthly and quarterly reports on the status of implementation of the Project
- Conduct monthly meetings with the environmental staff of consultants and contractors on the progress of EMP implementation, issues associated with implementation, non-compliance issues, and recommended course of action. Document the minutes of the meetings and present them in the monthly reports
- Review of EMP, every six months, and if update if required in coordination with the EU-CSC

The Deputy Director of Environmental Unit will work under the overall guidance and supervision of the Director, Environmental Unit and will be directly responsible for overseeing the execution of all tasks related to EMP with teams of environmental, ecology and OHS, which will be led by respective Assistant Directors.

The Assistant Director – Environment of EU-DHP will be mainly responsible for overseeing of implementation of EMP and prepare weekly compliance reports.

The Assistant Director – Ecologist is responsible for coordinating with district forest and agriculture departments for development of nurseries for plantation in the project area, supervision of aquatic ecology studies and monitoring, developing landscaping plans for the quarry and spoil disposal areas, identifying needs for environmental enhancement measures in Kaigha CCA, conducting additional studies recommended in the terrestrial and aquatic ecology reports.

The Assistant Director – OHS is responsible for overseeing of occupational health and safety issues at the work areas.

2.1.2.3 Environmental Unit of Construction Supervision Consultant (EU-CSC)

Environmental Unit of CSC (EU-CSC) will consists of the following personnel

- Team Leader (international environmental specialist)
- Environmental Specialists (two national specialists)
- Ecologist (one international and one national)
- Occupational Health and Safety Specialist (one international and one national)
- Environmental Surveyors (two national)

The EU-CSC shall be responsible for the supervision of implementation of the EMP. It will liaise heavily with the construction team to ensure all environmental commitments are incorporated into the construction activities and work processes. Specific responsibilities include:

- Review and approve the contractors management plans
- Supervision of implementation of EMP
- Review of EMP every six months and update the EMP if required
- Supervising and supporting contractors in achieving their responsibilities as outlined in the EMP;
- Providing input and advice on activity specific work plans relating to EMP;
- Regularly reviewing and assessing environmental risks throughout the construction phase;
- Identifying and preparing environmental induction and training materials;
- Responding to environmental incidents as required;
- Managing compliance reporting as it relates to the Project.
- Liaise with DHP's EU for effective environmental management at site
- Liaise with the Resettlement Office and other relevant Project entities

- Prepare terms of references for the consultants to be hired by EU-DHP for conducting additional studies recommended in EIA.

2.1.2.4 Contractors

Each contractor will be required to have suitably qualified and experienced persons acceptably fluent in the English language, to function as environmental specialists and occupational health and safety Specialists, who will be working in close liaison with the environmental staff of PMU and CSC. Appropriate numbers of the following personnel are required in the contractor's environmental team

- Environmental Specialists
- Occupational Health and Safety Specialists
- Environmental Technicians (both for lab and field investigations)

The contractor will be responsible for implementation of measures to avoid or minimize adverse environmental impacts during construction. Contractors are required to prepare 'Construction Environmental Action Plan' (CEAP) demonstrating the manner in which they will comply with the requirements of EMP before mobilization and obtain approval from the EU-DHP and EU-CSU (see Section 3.4.1 for further details).

2.1.2.5 Dam Control Office

Dam Control Office of DHP will be responsible for implementation of EMP during O&M stage, such as release of environmental flows during winter, sediment flushing, flood management, etc.

2.1.2.6 WAPDA Environmental Cell (WEC)

WAPDA Environmental Cell (WEC) is responsible for overseeing environmental issues associated with WAPDA's hydropower projects in the country. The unit is headed by a Director General with specialists in environment, ecology, geology, soil, economy, social and gender specialists. The WEC will also conduct periodic monitoring of EMP implementation activities and advise the EU-DHP on any action necessary to comply with the implementation requirements.

2.1.2.7 External Environmental Auditors

External Auditors or External Monitoring Agency will be engaged to conduct the external and independent monitoring of the implementation of the EMP. This external monitoring agency is to carry conduct six-monthly, annual and final evaluation of the EMP implementation and recommend changes if and when necessary to the EU-DHP.

2.1.2.8 Panel of Experts

WAPDA will engage an independent panel of environment and social experts to advise DHP Safeguard Unit and other project entities on all environmental and social matters including effective implementation of EMAP and SRMP, particularly on unanticipated situations, impacts, and their mitigation. The Panel will review on a regular basis the various reports and documents produced by Safeguard Unit, Supervision Consultants and contractors; periodically visit the site to have firsthand information on the environmental and social impacts and EMP/SRMP implementation; and provide report to WAPDA on the overall environmental and social performance of the project.

2.1.2.9 Grievance Redress Committee

Several environmental issues may arise during implementation stages of the Project. Following are some of the environmental issues that could be subjected to grievances from the affected people, concerned public, construction workers and civil society members

- Soil, water, dust, noise and air pollution from construction related activities

- Traffic movement and congestion
- Waste disposal
- Lack of adequate safety at the construction areas and approach roads
- Lack of water and sanitation facilities at the construction sites/camps
- conflicts among construction workers and with local community
- Disturbances to flora and fauna
- Failure to comply with standards or contractual obligations

In order to provide an accessible mechanism to all the affected persons to raise their issues and grievances related to environmental issues, a four tier grievance redress committee (GRC) will be established. Details of the GRCs are given in SRMP Vol.: Grievance Redress Plan. Environmental staff of PMU, CSC and contractors will be part of GRC team when dealing with environmental issues related to the project. Mechanism of filing complaints will include sending text messages from the cell phones, establishment of complaint boxes at the convenient locations for the community, etc. Details of the receiving and addressing grievances are given in detail in SRMP Vol. 10.

The responsibilities of GRC include:

- review the merit of the complaints/case received for consideration;
- review the case in the light of related project activity and within the context of applicable laws/guidelines in Pakistan and/or international practices and standards;
- undertake field level investigations, if necessary for review of the case at hand; and
- review and resolve the case and recommend necessary measures or mitigation, if required.

2.1.3 Monitoring Mechanism

Monitoring of environmental components and mitigation measures during construction and operation stages is a key component of the EMP to safeguard the protection of environment. The objectives of the monitoring are to (i) ensure that the mitigation measures included in the EMP are effectively and regularly implemented (compliance monitoring); and (ii) monitor changes in the environment during various stages of the project life cycle with respect to baseline conditions (effects monitoring);. A monitoring mechanism is developed for each identified impact and it includes:

- Location of the monitoring (near the Project activity, sensitive receptors or within the Project influence area)
- Means of monitoring, i.e. parameters of monitoring and methods of monitoring (visual inspection, consultations, interviews, surveys, field measurements, or sampling and analysis)
- Frequency of monitoring (daily, weekly, monthly, seasonally, annually or during implementation of a particular activity)

The monitoring program will also include regular monitoring of construction activities for their compliance with the environmental requirements as per relevant standards, specifications and EMP; The purpose of such monitoring is to assess the performance of the undertaken mitigation measures and to immediately formulate additional mitigation measures and/or modify the existing ones aimed at meeting the environmental compliance as appropriate during construction.

The environmental parameters that may be qualitatively and quantitatively measured and compared are selected as ‘performance indicators’ and recommended for monitoring during project implementation and operation and maintenance (O&M) stages. These monitoring indicators will be continuously monitored to ensure compliance with the national or other applicable standards and comparison with the

baseline conditions established during design stage. National Environmental Quality Standards (NEQS 2000, 2009 and 2010) of Pakistan are the main performance indicators in terms of environmental protections. NEQS are given in Annex A.

The environmental monitoring requirements for the Project are detailed under each environmental aspect within the EMP and its sub-plans.

It is recommended that the contractor establishes an environmental quality laboratory at the site with all necessary equipment to measure water, air, and noise and vibration quality. All environmental monitoring equipment, such as noise meters and water quality meters should be maintained and calibrated according to manufacturer's specifications. All monitoring equipment details, status, calibration dates and maintenance should be documented and recorded.

2.1.3.1 Compliance Monitoring

The compliance monitoring of the project activities is principally a tool to ensure that the environmental and social control measures identified are strictly adhered to during the project execution. Various aspects of the EMP compliance monitoring will be to:

- Systematically observe the activities undertaken by the contractors or any other persons associated with the project.
- Verify that the activities are undertaken in compliance with the EMP.
- Document and communicate the observations to the concerned person(s) of the contractors, EU-DHP and EU-CSC, so that any corrective measures, if required, can be taken in a timely fashion.
- Maintain a record of all incidents of environmental and social significance and related actions and corrective measures.
- Maintain contact with the communities, solicit their views and concerns, and discuss them during the monthly meetings.
- Prepare periodic reports of the environmental and social performance of project.

2.1.3.2 Monitoring Predicted Effects (Effects Monitoring)

The EIA predicts the impacts of the proposed project on the basis of information available at the time of conducting the assessment and the natural processes that link various environmental and social parameters. Based on this prediction, mitigation measures are introduced such that the predicted residual effects do not exceed acceptable levels. However, there can be an element of uncertainty in such predictions, for example, due to an insufficient grasp of the processes, limitations in prediction techniques, or inadequate data on the environment. This is true for the physical, biological, as well as socioeconomic environment. Consequently, it is possible that even if the mitigation measures are implemented fully, the negative impacts of the Project could exceed predicted levels or acceptable limits.

In order to address the above concerns, effects monitoring will be undertaken during the Project activities, with the overall objective of proper management of environmental and social risks and uncertainties. Broadly, effects monitoring has the following objectives:

- To verify that the impacts of the proposed project are within acceptable limits, thus establishing credibility (public assurance);
- To immediately warn the PMU of unanticipated adverse impact or sudden changes in impact trends so that corrective actions can be undertaken, which may include modifications in the proposed activities, or the inclusion of modified or additional mitigation measures;
- To provide information to plan and control the timing, location, and level of certain project activities so that the effects are minimized; and

- To facilitate research and development by documenting the effects of the proposed project that can be used to validate impact-prediction techniques and provide a basis for more accurate predictions of future projects.

The contractor is responsible for monitoring and assessing how environmental management at each site, and for the entire project, is performing. He will monitor environmental controls employed at each site, and environmental aspects of the construction activities in general. The contractor is required to carry out routine monitoring of construction sites and construction activities in order to ensure that requirements and measures specified in the CEAP are implemented and impacts are minimized or mitigated. This will be on a site by site basis, and shall be continual frequent. This includes physical monitoring such as water quality sampling, air quality monitoring, waste tracking etc. Environmental staff of contractor is responsible for this monitoring.

2.1.4 Auditing

Internal and external environmental audits will be undertaken throughout the construction process to ensure that the Project environmental requirements and the EMP are implemented appropriately.

The auditing process should be designed to identify any non-conformances, providing an opportunity to apply corrective and / or preventative action where appropriate. The auditing schedule will be

- Internal auditing every three months on implementation of the EMP
- Internal auditing every six months on adequacy of EMP
- External (third party or independent) auditing on the project environmental performance every six months.

Internal auditing will be carried out by the EU-DHP quarterly and by WEC six months. External auditing will be conducted by the external monitoring and evaluation consultants for auditing of existing practices against the requirements of EMP. The following aspects will be covered under the external audit:

- the EMP is being adequately implemented,
- mitigation measures are being implemented and their effectiveness,
- the compliance and effects monitoring are being conducted,
- environmental and social trainings are being conducted, and
- complete documentation is being maintained.

These audits would be used to re-examine the continued appropriateness of the EMP and to provide advice on any up-dates required. Attention would be given to lessons learnt in the light of experience. In particular, consideration would be given to the monitoring programs in place to determine whether their purpose has been served and they can therefore be terminated or reduced in frequency

WAPDA Management would review the results of internal and external audits and provide commitment and resources to tackling outstanding issues. WAPDA Management would support the proposed EMU in mechanisms to manage financial payments to contractors based on performance against the items identified in the EMP.

2.1.5 Corrective Action (Non-Compliance Notice)

Any no-compliances identified on the Project during monitoring and auditing will be immediately reported to the contractor through a corrective action request. For serious non-compliance issues such as pollution, erosion, reckless treatment of nature, hazardous working conditions, etc., the Deputy Project Director – Safeguards have authority to give stop-orders to the contractor and address .those issues immediately.

For other issues, a request will be sent within one working day of any of the following:

- A major departure from agreed or approved procedure, approval conditions or Project environmental management objectives;
- A minor non-compliance with the EMP performance criteria; and/or
- Any perceived breaches of the contractual requirements.

The corrective action report from contractor in response to non-compliance notice should include details of the environmental effect, action taken to correct the problem and proposed measures to prevent the occurrence of a similar incident. The identification, reporting and rectification of environmental deficiencies by the construction workers should be encouraged at Project inductions and toolbox talks.

Regular and continuous site inspections should be undertaken by the EU-CSU in conjunction with the contractor's environment manager and EU-DHP to identify those day-to-day tasks such as the maintenance of environmental controls, the adjustment of existing environmental controls or minor modifications to practices that need to occur. A list of observations will be made during these site inspections and actions recommended to rectify issues.

Where recommended actions are suggested, priorities shall be set against these actions for site implementation. The list of actions shall be distributed to the responsible personnel, typically the Foremen or responsible Site Engineer for action.

2.1.6 Budget Estimates

Cost estimates are prepared for implementation of EMP. The details of the cost estimates and the budget during construction stage and first four years of operation stage for the mitigation measures are given in Table 6.1. The breakup of cost estimates are given in Annex B. The cost estimates for some of the mitigation measures that were already part of civil works contract or resettlement plans are not included in the EMP budget.

The cost estimates also includes the budget for environmental monitoring, consultants for EMP implementation, institutional strengthening and capacity building and environmental enhancement/compensation measures.

2.1.7 Reporting and Feedback Mechanism

The following reports to be prepared by various parties during implementation of EMP:

- Daily reports by the Contractor to the EU-CSC and EU-DHP
- Weekly reports by EU-CSC to the EU-DHP
- Monthly reports by Contractor to the EU-CSC and EU-DHP
- Monthly reports by EU-DHP for internal circulation
- Quarterly reports by EU-DHP to the World Bank and KP-EPA
- Six-monthly reports by External Auditors

Daily reports by the contractor shall include compliance issues related to the daily construction activities. Before starting of construction works, the contractor will prepare a checklist and pro-forma for preparing daily reports which will be approved by EU-CSC. The daily monitoring reports will include following compliances, but not limited to:

- Excavation, re-use and disposal quantities of earth materials
- Dust suppression
- Noise and vibration control
- Sewage and waste water releases
- Spoils and Solid waste
- Soil erosion and landslides
- Oil or hazardous waste spills

- Training
- OHS

EU-CSC will prepare weekly reports on the status of EMP implementation and environmental performance of the contractor. These reports shall be based on the contractor's reports and their supervision. EU-CSC shall assess how accurate is the factual information provided in the contractor's reports, fill any gaps identified in them, and evaluate adequacy of mitigation measures applied by contractor. CSC must highlight any cases of non-compliance with EMPs, inform on any acute issues brought up by contractor or revealed by supervisor himself, and propose corrective actions.

Contractors will prepare monthly reports on implementation of EMP against the approved programs; any difficulties encountered in the implementation of EMP and recommendations for remedying them for the future; the number and type of non-compliances and proposed corrective action; reports from sub-contractors on implementation of EMP; details of air, noise and water quality monitoring; and minutes of monthly meeting held with EU-DHP and EU-CSC.

EU-DHP will prepare brief monthly reports for internal circulation with information on the main types of activities carried out within the reporting period,

- status of any clearances/permits/licenses which are required for carrying out such activities,
- mitigation measures applied, and any environmental issues emerged in relations with suppliers, local authorities, affected communities, etc.
- findings of the monitoring programs, with emphasis on any breaches of the control standards, action levels or standards of general site management
- any emerging issues where information or data collected is substantially different from the baseline data reports in the EIA
- outstanding non-compliance issues

EU-DHP shall report quarterly to the World Bank and KP-EPA on the status of environmental compliance of construction works. The quarterly reports will include environmental mitigation measures and monitoring activities undertaken, details of monitoring data collected, analysis of monitoring results, recommended mitigation measures, environmental training conducted, and environmental regulatory violations. EU-DHP shall inform the World Bank on any major environmental issues at any time, independently from the schedule of regular reporting.

3. ENVIRONMENTAL MANAGEMENT SUB-PLANS

3.1 MANAGEMENT PLANS

The EMP is prepared as a series of sub-plans which as a whole will direct environmental management procedures and the implementation of prescribed mitigation measures during the construction and operational phases of the Project. The following sub-plans have been developed and presented in Sections 3.5 to 3.19:

- EMP Sub-Plan 1: Construction Management
- EMP Sub-Plan 2: Operational Management
- EMP Sub-Plan 3: Physiography and Geology
- EMP Sub-Plan 4: Hydrology & Surface Water Management
- EMP Sub-Plan 5: Air Quality Management
- EMP Sub-Plan 6: GHG Emission Reductions and Climate Change Monitoring
- EMP Sub-Plan 7: Noise and Vibration Management
- EMP Sub-Plan 8: Waste Management
- EMP Sub-Plan 9: Hazardous Substances Management
- EMP Sub-Plan 10: Terrestrial Ecology (Flora and Fauna) Management
- EMP Sub-Plan 11: Aquatic Ecology Management
- EMP Sub-Plan 12: Traffic Management
- EMP Sub-Plan 13: Physical Cultural and Social Resources Management
- EMP Sub-Plan 14: Occupational Health and Safety
- EMP Sub-Plan 15: Summary 'Social and Resettlement Management Plan

It is the accumulation of these sub-plans that constitutes the Project EMP. There might be some overlap between sub-plans as often several different environmental impacts can be mitigated for by a single action. The first two sub-plans on construction and operations contain directions to appropriate sub-plans. The discipline-specific sub-plans contain direction that is relevant to all phases of the Project and as such they are applicable throughout the entire Project life-cycle.

EMP related to construction impacts and mitigation measures are presented in the form of Environmental Code of Practices and explained in the following section.

3.2 ENVIRONMENTAL CODE OF PRACTICES (ECP)

The objective of the Environmental Code of Practices (ECPs) is to address all potential and general construction related impacts during implementation of the DHP. The ECPs will provide guidelines for best operating practices and environmental management guidelines to be followed by the contractors for sustainable management of all environmental issues. These ECPs shall be annexed to the general conditions of all the contracts, including subcontracts, carried out under the Project.

The list of ECPs prepared for the DHP is given below and are presented in Annex C:

- ECP 1: Waste Management
- ECP 2: Fuels and Hazardous Goods Management
- ECP 3: Water Resources Management
- ECP 4: Drainage Management
- ECP 5: Soil Quality Management
- ECP 6: Erosion and Sediment Control
- ECP 7: Top Soil Management
- ECP 8: Topography and Landscaping
- ECP 9: Quarry Areas Development & Operation
- ECP 10: Air Quality Management

- ECP 11: Noise and Vibration Management
- ECP 12: Protection of Flora
- ECP 13: Protection of Fauna
- ECP 14: Protection of Fisheries
- ECP 15: Road Transport and Road Traffic Management
- ECP 16: Construction Camp Management
- ECP 17: Cultural and Religious Issues
- ECP 18: Workers Health and Safety

The ECPs will form the part of the contract documents and will be used as monitoring tool for compliance. It is mandatory for the main contractors procured directly by the project to include these ECPs in their subcontracts. The contractor shall also comply with the guidelines given in World Bank Group Environmental, Health and Safety Guidelines, 2007 (Annex D). Contractors and subcontractors are requested to refer the EMP sub-plans given in the EIA report of the Project for further information on corrective actions, performance indicators, monitoring and auditing protocols.

3.3 ADAPTATION OF EMP DURING IMPLEMENTATION

Though the EMP and its sub plans covers all the possible impacts arising from various project activities - for a project as big as DHP, some adaptation/changes are possible during implementation. These changes may not be known at this stage. In such instances, modifications in the EMP will be carried out by the EU-CSC.

The EU-CSU will review the EMP, its operation and effective implementation at least every six months. Between the scheduled reviews, a register of issues will be maintained to ensure that issues raised by internal or external personnel associated with the Project is recorded.

The purpose of the review is to ensure that the EMP is meeting the requirements of the standards, policies and objectives and if not to amend the EMP to address any short comings. The review will consider:

- Site personnel comments;
- Audit findings;
- Environmental monitoring records;
- Community complaints;
- Details of corrective and preventative actions taken;
- Incident reports;
- Changes in organization structures and responsibilities;
- The extent of compliance with objectives and targets; and
- The effect of changes made to environmental standards and/or legislation.

Acting on the findings of the review, the EU-CSU will review the various policies and objectives and submit PD and World Bank for approval.

3.4 INCLUSION OF EMP IN CONTRACT DOCUMENTS

In order to make contractors fully aware and responsible of the implications of the EMP and to ensure its compliance, it will be ensured that environmental measures are treated appropriately and separately in the tender documentation and that payment milestones are linked to environmental performance, measured by execution of the prescribed environmental mitigation measures. Such a procedure would help ensure adequate assessments of project impacts are carried out during Project construction and operation phases, where a consistent approach will be expected on behalf of contractors that warrant data and information collected from monitoring programs are compared to baseline conditions.

The contractor would be made accountable through contract documents and/or other agreements of the obligations and importance of the environmental and social components of the Project. They would be prepared to co-operate with the executing agency, project management unit, supervising consultants and local population for the mitigation of adverse impacts. After the EMP's addition in the contract documents, the contractor will become bound to implement the EMP and to hire trained environmental management staff for implementation and effectiveness of the mitigation measures.

The contractor is to bid for executing the EMP, including the hiring of recommended staff, recommended mitigation measures and monitoring programs, as part of their Bill of Quantities.

3.4.1 Contractors Environmental Action Plan (CEAP)

The Contractors shall be required to prepare a 'Construction Environmental Action Plan' (CEAP) demonstrating the manner in which they will comply with the requirements of EMP Sub-Plans, ECPs and the World Bank Group EHS guidelines. before mobilization and obtain approval from the EU-DHP and EU-CSU. The Plans will include a series of management plans:

- Site specific sediment and erosion control plan for each construction site and quarry;
- Site specific camps management plan for each camp;
- Spoil management and disposal plan for each site;
- Waste management plan for each construction site and quarry;
- Site specific pollution control (water, air, noise) plan for each construction site and quarry;
- Site specific traffic management plan for each construction site and quarry;
- Site specific decommissioning and landscaping plans for quarry sites, spoil disposal sites, temporary roads and other disturbed areas;
- Occupational health and safety plan and training programs;
- Emergency Response Plan and Early Warning System ;
- HIV-AIDS Preventive Management Plan and training programs;
- Complaints logging system and response plan;
- Standard Operating Procedures for blasting operations;
- Standard Operating Procedures for pollution spills, and management of fuels and hazardous goods; and
- Demobilisation plan after completion of works

3.4.1.1 Contractor's Management Plans as BOQs

Preparation and implementation of above mentioned management plans in CEAP will be included as a line item in BOQ with a lump sum provision. Thus the contractor has a contractual obligation to prepare and implement CEAP. The contractor shall submit a draft CEAP six months before commencement of the work for approval of PMU and CSC and final version two months before the commencement. The CEAP will form the part of the contract documents and will be used as monitoring tool for compliance. Violation of the compliance requirements will be treated as non-compliance leading to the corrections or otherwise imposing penalty on the contractors.

Payment to the contractor for all his works should be linked to the environmental performance and compliance with the EMP.

The Project Director should be entitled to stop the entire payment to the consultant if non-compliance issues are not addressed. For serious non-compliance issues such as pollution, erosion, reckless treatment of nature, hazardous working conditions, etc., the Deputy Project Director, Safeguards have authority to give stop-orders to the contractor and address .those issues immediately.

3.5 EMP SUB-PLAN 1: CONSTRUCTION MANAGEMENT

EMP Sub-Plan 1. Construction Management					
Objective	▪ To manage construction worksites to prevent environmental harm. ▪ To develop a culture of good environmental management practices among all construction personnel.				
Performance criteria	▪ Worksites prepared in accordance with designs providing for the management and mitigation of construction impacts. ▪ Waste water discharges, air and noise quality shall comply with NEQS, EHS and other international standards ▪ Water quality in the project area should not exceed the baseline data of 2012. ▪ Construction works are managed to avoid, or mitigate and manage impacts on the amenity and environmental conditions prevailing in the vicinity of the worksites.				
Targets	▪ Zero pollution incidents. ▪ Zero impact on human and wildlife. ▪ 100% of site personnel are trained in the environmental induction.				
Impact/Issue	**Mitigation Measures/ Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
Construction Environmental Management Plans					
▪ Contractors not familiar with environmental safeguards	▪ Prequalification criteria of main contractors (dam, tunnel) shall consist of criteria to evaluate the environmental performance of the contractors. A suggested approach include their compliance with ISO 14001, 2004 Environmental Management System (EMS), OHSAH 18000 (2007) related Occupational Health and Safety (OHS) and SA 8000 (Social Accountability); and experience in working with World Bank or other donor projects for a minimum 500 million USD project.	PD	CSC	During pre-qualification of contractor	
▪ Contractors' environmental staff communication skills	▪ Contractors should employ suitably qualified and experienced persons acceptably fluent in the English language, to function as Environmental Specialist and Occupational Health and Safety Specialist. Their CVs to be included in the proposal.	PD	CSC	During evaluation of contractors proposals	
▪ Construction Environmental Action Plan (CEAP) ▪ Strategies/plans that	○ A 'Construction Environmental Action Plan' (CEAP) needs to be prepared demonstrating the manner in which the Contractor will comply with the requirements	Contractor	EU-CSU/ EU-DHP	Prior to the commencement of construction	Details of strategies to be formalised and documented;

EMP Sub-Plan 1. Construction Management					
require development pre- construction	of ECPs and the management plans proposed in Environmental Management Action Plan (EMAP). ○ The following management plans will be developed prior to the commencement of Project construction: ○ Site specific sediment and erosion control plan for each construction site and quarry; ○ Site specific camps management plan for each camp; ○ Spoil management and disposal plan for each site ○ Waste management plan for each construction site and quarry; ○ Site specific pollution control (water, air, noise) plan for each construction site and quarry; ○ Site specific traffic management plan for each construction site and quarry; ○ Site specific decommissioning and landscaping plans for quarry sites, spoil disposal sites, temporary roads and other disturbed areas; ○ Occupational health and safety plan and training programs; ○ Emergency Response Plan and Early Warning System ; ○ HIV-AIDS Preventive Management Plan and training programs; ○ Complaints logging system and response plan; ○ Standard Operating Procedures for blasting operations ○ Standard Operating Procedures for pollution spills				details of implementation of strategy to be included in monthly updates by EU-CSU

EMP Sub-Plan 1. Construction Management					
	○ Demobilisation plan after completion of works				
▪ Subcontractors procured by main contractor are not aware of EMP	▪ Main Contractors are responsible for environmental compliances of their sub-contractors. ▪ Environmental Code of Practices (ECP) should be part of contract documents of all subcontractors hired by the main contractor.	Contractor	EU-CSU/ EU-DHP	Pre-construction/ Construction	Details of subcontractors are to be included in the contractors monthly report
Monitoring					
▪ Monitoring programmes that require development pre-construction	▪ The following monitoring schedules will be developed prior to the commencement of Project construction: ○ Air, noise and water quality monitoring at each construction site/quarry site and sensitive receptor; and at the baseline monitoring stations of the EIA ○ Sediment/erosion monitoring at each construction site/quarry site; ▪ A complete laboratory at the site will be established with all necessary equipment to measure air, noise and water quality for all key parameters mentioned in NEQS ▪ Review and compilation of baseline data on fauna, including ○ Establishment of monitoring criteria (e.g. indicating species, critical areas) ○ Establishment of monitoring technology (sampling system, frequency, etc.) ○ Establishment of critical thresholds	Contractor Consultant	EU-CSU/ EU-DHP	Prior to the commencement of construction	Details of strategies to be formalised and documented; monitoring results to be included in monthly updates by EU-CSU
Training Programmes					
▪ Training programmes that require development pre-construction	▪ The following training programmes will be developed prior to the commencement of Project operations (refer Section 5.1): ○ Code of conduct for all Project personnel; ○ Tool box talks; ○ OHS issues	EU-CSU	EU-DHP	Prior to the commencement of construction	Details of educational programmes to be formalised and documented; details of

EMP Sub-Plan 1. Construction Management					
	○ Health education programme for Project personnel and local residents; ○ Environmental and wildlife awareness programme for all Project personnel.				implementation of educational programmes to be included in monthly updates by EU-CSU
Construction Phase Impacts					
▪ Construction activities will create a wide range of environmental impacts on physical, ecological, social and cultural resources	▪ Implement mitigation measures proposed in ECPs 1 to 18. ▪ Implement mitigation measures and protocols proposed in EMP sub-plans 3 to 12	Contractor	EU-CSU/ EU-DHP		Weekly monitoring by the EU-CSU along with Contractor's Environmental Manager.
▪ Personnel who are unsure of sensitive environments, potentially polluting substances, ECPs undertake works in a way that results in environmental harm.	▪ Implement a site based induction program to communicate EMP requirements of the Project to the construction personnel.	Contractor	EU-CSU	For all new personnel on first day of work	Details of inductions to be included in monthly updates to PD
▪ Local community is not kept informed about the Project related disturbances (e.g. traffic and blasting) and timeframes.	▪ Notify the local and broader community, including potentially affected businesses, residents and local government about the Project related disturbances.	Contractor	GRC	Monthly	Details of notifications to be included in monthly updates
Auditing	▪ Review the EMP every six months. ▪ Audit (internally) the implementation of the EMP every three months. ▪ Audit (externally) the Project environmental performance annually.				
Relevant Guidelines, Standards and Legislation	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007 ▪ Relevant policies mentioned in the sub-plans 3 to 12				

EMP Sub-Plan 1. Construction Management		
Potential Concern (Non Compliances)	**Corrective Action**	**Responsibility**
▪ Personnel are not being trained in the appropriate environmental constraints and environmental management measures	▪ Review the environmental induction to provide clearer instructions. ▪ Increase the frequency of environmental toolbox talks.	EU-CSU
▪ Local communities complain about the Project and its activities	▪ Develop a strategy for the public to raise grievances and complaints register, which will include – Time and date of complaint. – Personal details of the complainant, if no details are provided a note to that effect. – Details of the pollution event that led to the complaint including time, date, duration and any other information provided. – Details of the actions taken in response to the complaint. – Details of the reason the chosen actions were taken. – Communication back to complainant as to the actions undertaken to address the complaint.	GRC-Environment
▪ Environmental incidents are occurring.	▪ Review the environmental mitigation and management measures and environmental controls being applied to each work activity affected. ▪ Increase the frequency of environmental site inspections.	EU-CSU
Reporting	▪ Contractor to report daily and monthly status reports on EMP implementation and related issues with photographs ▪ EU-CSU to report weekly and monthly with respect to environmental management performance. ▪ EU-DHP to report monthly and quarterly reports on EMP implementation ▪ Community complaints register should be filed for each complaint. ▪ Quarterly reports on the water quality, air quality, noise and vibration quality at the construction sites	

3.6 EMP SUB-PLAN 2: OPERATIONS MANAGEMENT

EMP Sub-Plan 2. Operational Management					
Objective	▪ To manage operations of the Project to prevent environmental harm. ▪ To develop a culture of good environmental management practices among all Project employees.				
Performance criteria	▪ Operations are managed to avoid, or mitigate and manage impacts on the amenity and environmental conditions prevailing in the vicinity of the dams, reservoirs and supporting infrastructure. ▪ Waste water discharges, air and noise quality shall comply with NEQS 2000 ▪ Water quality in the project area should not exceed the baseline data of 2012.				
Targets	▪ Zero pollution incidents. ▪ 100% of operational personnel trained in the environmental induction. ▪ Zero impacts to wildlife as a result of Project operations. ▪ Successful implementation and maintenance of all restoration area resulting from Project implementation. ▪ Increase in the numbers of wildlife utilising the reservoirs and surrounding Protected Areas. ▪ Minimise the environmental footprint of the Project.				
Impact/Issue	**Mitigation Measures/ Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
Strategies/Plans					
▪ Strategies that require development pre-operations.	▪ An 'Operation Environmental Action Plan' (OEAP) needs to be prepared demonstrating the manner in which the Contractor/Operator will comply with the requirements of management plans proposed in EMAP. ▪ The following strategies and procedures will be developed prior to the commencement of Project operations: o Dam specific security and public access control strategy; o Dam specific GHG abatement strategy; o Dam specific waste management strategy; o Dam specific air and noise control strategy; o Dam specific traffic control strategy; o Reservoir specific sediment and erosion,	Dam Control Office	EU-DHP	Prior to the commencement of operations	Details of strategies to be formalised and document details of implementation of strategy to be included in monthly updates by EU-CSU

EMP Sub-Plan 2. Operational Management					
	and landslides control strategy; ○ Recycling strategy; ○ Environmental releases strategy;				
Monitoring					
▪ Monitoring programmes that require development pre-operations.	▪ The following monitoring programmes will be developed prior to the commencement of Project operations ○ Sediment movement and reservoir accumulation monitoring; ○ Environmental releases monitoring; ○ Seismic activity monitoring; ○ Landslide monitoring; ○ Fish monitoring; ○ Water quality monitoring ○ Watershed, glacier and flood telemetry monitoring	Dam Control Office/ EU-CSC	EU-DHP	Prior to the commencement of operations	Details of monitoring programmes to be formalised and documented, monitoring results to be included in monthly updates by EU-CSU
Training/Educational Programmes					
▪ Training/ educational programmes that require development pre-operations.	▪ The following educational programmes will be developed prior to the commencement of Project operations (ref. Section 5.1): ○ Employee induction programme on environmental awareness; ○ Employee code of conduct; ○ Wildlife education program for employees and local residents; ○ Health and Safety training programme	EU-CSC	EU-DHP	Prior to the commencement of operations	Details of educational programmes to be formalised and documented; details of implementation of programmes to be included in monthly updates by EU-CSU
Operations Phase Issues ***(to be applied in addition to all relevant sections of sub-plans 3-12)***					
▪ Operational activities will have impacts on water quality, GHG emissions, waste etc.	▪ Implement mitigation measures included EMP sub-plans 2 to 14	Dam Control Office	EU-DHP	Throughout operational life cycle of Project	Monthly monitoring
▪ Personnel who are	▪ Implement an operational induction program to	EU-DHP	WEC	For all new	Include details of inductions in

EMP Sub-Plan 2. Operational Management					
unaware of operational measures that may result in environmental harm	communicate environmental management requirements of the Project to all new operational personnel.			personnel on first day of work	monthly updates by EU-CSU to management
▪ Loss of active dam storage due to sediment deposition in the reservoirs	▪ Develop and implement a detailed monitoring programme of sediment movements in the reservoir systems, use data to optimise power generation whilst minimising environmental harm	Dam Control Office	PD	Throughout operational life cycle of Project	Include details of sediment monitoring programme in monthly operations reports
▪ Landslides in reservoir during operational phase	▪ Monitor stability of landslide prone areas during operational phases (see sub-plan 5). ▪ First filling of reservoir should be done at a slow pace of 1 m/day	EU-DHP	WEC	Throughout operational life cycle of Project	Include details of landslide stability monitoring programme in monthly reports
▪ Impacts on fish movement and its habitat	▪ Implement EMP sub-plan on Aquatic Ecology ▪ Start a reservoir fishery management program and monitor reservoir fishery production	Consultant	EU-DHP	Throughout operational life cycle of Project	Include details of fish monitoring program in monthly operations reports
Auditing	▪ Review the OEAP every six months. ▪ Audit (internally) the implementation of the OEAP every three months. ▪ Audit (externally) the Project environmental performance annually.				
Relevant Guidelines, Standards and Legislation	▪ United Nations framework on Climate Change, 1992; ▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007 ▪ Relevant policies mentioned in the sub-plans 3 to 12				

Potential Concern (Non Compliances)	Corrective Action	Responsibility
▪ Personnel are not being trained in the appropriate environmental constraints and environmental management measures	▪ Review the environmental induction to provide clearer instructions. ▪ Increase the frequency of environmental updates.	EU-DHP
▪ Local communities complain about the Project operations.	▪ Develop a strategy to clearly communicate with the community about the Project.	GRC - Environment

EMP Sub-Plan 2. Operational Management		
▪ Environmental incidents are occurring.	▪ Review the environmental mitigation and management measures and environmental controls being applied to each work activity affected. ▪ Increase the frequency of environmental site inspections.	EU-DHP
Reporting	▪ Contractors to report monthly status reports on EMP implementation, monitoring outcome and related issues with photographic record ▪ Operations EU-CSU to report monthly with respect to Project environmental management performance. ▪ Document all activities which are haltered due to environmental incidents. ▪ Community complaints register should be filed for each complaint.	

3.7 EMP SUB-PLAN 3: PHYSIOGRAPHY AND GEOLOGY

EMP Sub-Plan 3. Physiography and Geology Management					
Objective	▪ Reduce the potential for impacts resulting from topographical changes (soil erosion, landslides) and soil contamination during construction. ▪ Manage and minimise impacts of construction works on the environmental values of the Indus River. ▪ Seek to increase the recovery of construction spoil for re-use in the project works.				
Performance criteria	▪ Identify the potential for and then avoid or reduce, monitor and manage the potential impacts of erosion, landslides Manage and mitigate the impacts of spoil removal, haulage, soil disturbance, stockpiling and placement at spoil placement sites. ▪ Conduct induction and training for construction staff on procedures for recognising, remediation and management of spills and leaks of hazardous materials.				
Targets	▪ 50 percent of excavated rock (spoils) to be reused as aggregates and road fill ▪ Landscaping of all disturbed areas				
Impact/Issue	**Mitigation Measures/ Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Changes in natural topography, due to excavation, will impair the natural landscape and induce a series of impacts such as soil erosion, landslides and changes in drainage pattern	▪ The topography of the final surface of the leveled lands shall be conductive to enhance the natural draining of rainwater and floodwater. ▪ Restoration of cleared areas, quarries which are no longer in use, spoil areas, and any areas temporarily occupied during construction of works shall be undertaken using landscaping, provision of adequate drainage and revegetation ▪ spoil heaps and excavated slopes shall be compacted and protected to prevent erosion	Contractor	EU-CSU/ EU-DHP	Construction	Monthly visual inspection
▪ Landslides during excavation of weak slopes	▪ Considering of Land sliding issues in the project design by including retaining walls, cross drainage, toe protection, rock anchoring and other similar structures/measures.	Design Engineer	DHP	Pre-Construction	
	▪ During construction, any blasting activities near the potential landslide areas will be controlled and contained within defined limits. Special attention will be paid to the blasting areas, where rock mass	Contractor	EU-CSU/ EU-DHP	Construction	Monthly displacement monitoring and visual inspection of slopes/landslides

EMP Sub-Plan 3. Physiography and Geology Management					
	conditions are poor due to presence of shear zones. ▪ During excavations the concerned slopes will be stabilized and excavation started exacted from the top then gradually working down the slope. After blasting a riser, it will be stabilized by pre-designed support systems such as shotcrete, mesh and rock bolts prior to drilling the next riser for excavation. ▪ Installation of drainage systems will to prevent water entering in to these areas with adequate maintenance and monitoring. ▪ The contractor will develop Emergency Preparedness Plan and Early Warning System to set out response actions in the event of a landslide. ▪ Monitor stability of landslide prone areas at 18 identified locations along reservoir and 30 locations along relocated KKH during construction and operational phases				during construction
▪ Reservoir induced landslides	▪ Initial filling of reservoir shall be slow at the rate of 2m/day. During the sediment flushing, the fill rate of 4 m/day and emptying rate of 3 m/day is recommended to minimize the landslides ▪ Monitor stability of landslide prone areas at 18 identified locations along reservoir ▪ Stabilization of landslides by structural measures such as removal of unstable area, and anchoring works, etc. ▪ Control of drawdown rate of reservoir water level during reservoir operation ▪ Surface water drainage management ▪ Vegetation development	Contractor	EU-CSU/ EU-DHP	Construction/ Operation	Monthly displacement monitoring and visual inspection of slopes/landslides

EMP Sub-Plan 3. Physiography and Geology Management					
▪ Soil erosion from construction activities, spoil disposal sites and quarry sites	▪ Implement ECPs 6, and 7 on Erosion and Sediment Control and Top Soil Management ▪ Erosion control measures and landscaping of spoil disposal areas, quarry sites and construction areas	Contractor	EU-CSU/ EU-DHP	Construction	Monthly visual inspection
▪ Excessive Groundwater dewatering can lead to significant delays in construction of tunnels	▪ Groundwater control methods are included in the technical designs to construction process to effectively reduce the dewatering requirement to a minimum	Contractor	EU-CSU/ EU-DHP	Construction	Daily monitoring of groundwater discharges
▪ Generation of about 20 million cubic meters of spoils	▪ Minimize generation of spoils by recycling the excavated rock to the maximum extent by using them as aggregate material for concrete and road fill ▪ Carry out the necessary tests immediately after excavation, as and where required, to assess the suitability of excavated material for aggregates manufacturing. All suitable material will be transported to the crushing site at Kaigah for further processing. Contractors will carefully plan both excavation and quarrying activities to maximize the use of excavated rock as aggregates. ▪ Disposal at the approved locations, filling behind retaining walls and filling of low level areas along KKH ▪ Protection of spoils from erosion through landscaping	Contractor	EU-CSU/ EU-DHP	Construction/ Operation	Daily monitoring of soil generation and reuse
▪ Loss of active dam storage due to sediment deposition in the reservoirs.	▪ Integrated watershed management of UIB is critical for control of sedimentation in to the Indus. Detailed studies are recommended for planning, design and implementation of integrated watershed management for control of erosion and sedimentation in the UIB.	EU-DHP	WEC	Operational Phase	Monthly inspection of sedimentation records

EMP Sub-Plan 3. Physiography and Geology Management					
▪ Dam safety due to earth quakes	▪ Monitoring of seismicity in the project area ▪ Installation of dams safety monitoring equipment	DHP	Dam Safety Unit of WAPDA	Operational Phase	Daily record of seismicity and safety monitoring equipment
Auditing	▪ Audit sediment and erosion controls and review the management measures monthly ▪ Carry out formal inspections of stockpiles, work areas and adjacent areas to verify spoil and stockpile management weekly. ▪ Carry out formal inspections of hazardous substances storage and usage areas weekly.				
Relevant Guidelines, Standards and Legislation	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000, 2009 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007				

Potential Concern	Corrective Action	Responsibility
▪ New deformation due to landslide movement	▪ Implement structural measures such as (i) Partial removal of the rockslide materials from the upper slope, and (ii) Concrete retaining wall to support the toe part of the rockslide.	Contractor
▪ Land is contaminated by Project activities.	▪ Use spill containment and clean up measures to prevent spread of contamination. ▪ Manage contaminated land in accordance with specialist advice. ▪ Review the containment and control measures in place to prevent pollution.	Contractor
▪ Sediment is generated and released from the Project area.	▪ Review the sediment and erosion control plans. ▪ Reinstate damaged sediment and erosion controls as soon as practical following rainfall events.	Contractor
▪ Land is lost around the Project site through river erosion or land slide processes exacerbated by the Project.	▪ Apply the mechanism for compensation to land holders in the event that the Project causes loss of land.	PD
Reporting	▪ Daily records on soil generation, re-use and their disposal ▪ Monthly reports with details of landslide stability monitoring, sedimentation incidents, and quarry related environmental impacts ▪ Report all spills and incidents that pollute terrestrial and aquatic environments. ▪ Report on soil condition observations (such as the adequacy of sediment and erosion controls) in a monthly report.	

3.8 EMP SUB-PLAN 4: HYDROLOGY & SURFACE WATER MANAGEMENT

EMP Sub-Plan 4. Surface Water Management					
Objective	▪ To reduce potential impacts of construction on the water quality of Indus and its tributaries ▪ To reduce potential impacts on hydrology from the operation of the project with no net increase of the downstream flooding potential resulting from the Project.				
Performance criteria	▪ Waste water quality shall comply with NEQS 2000 ▪ Water quality in the project area should not exceed the baseline data of 2012. ▪ Sediment generation from the works is controlled and mobilisation of sediment into surface water systems is reduced.				
Targets	▪ No sustained or significant increase in pollutant levels in local waterways due to the Project. ▪ No environmental harm caused by hydrocarbon or chemical spills. ▪ No significant impacts to downstream ecosystems as a result of the Project.				
Impact/Issue	**Mitigation Measures/ Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Discharges from the construction yards and sites (alkaline water from batching plants and high turbidity water from tunnel construction and quarry area)	▪ Design drainage for the quarry areas, batching plant area to direct runoff into a sump/basin for inspection for pollutants prior to discharge ▪ Design settling basins for the discharges from tunnel construction areas ▪ Establish a laboratory at Dasu with all necessary facilities for chemical analysis of water for key parameters (DO, TOC, turbidity, TSS, TDS, petroleum products); along with potable conductivity, pH and turbidity meters to assess pollution from construction activities.	Contractor	EU-CSC/ EU-DHP	Pre-Construction	Details of plans to be formalised and documented
▪ Water pollution from construction activities with in the river (coffer dams, main dam), seepage water from tunnels, and discharges from all construction sites, fuel and material storage sites, soil erosion, workers camps, etc.	▪ Implement mitigation measures proposed in the following ECPs o ECP 2: Fuels and Hazardous Goods Management o ECP 3: Water Resources Management o ECP 4: Drainage Management o ECP 6: Erosion and Sediment Control ▪ Silt fences, sediment barriers or other devices will be provided to prevent migration of silt during construction within streams and river ▪ Discharge of sediment-laden construction water	Contractor	EU-CSC/ EU-DHP	Construction	Quarterly monitoring of Water Quality at downstream of various construction sites; Spot measurements for turbidity and pH at all construction sites

EMP Sub-Plan 4. Surface Water Management					
	directly into surface watercourses will be forbidden. Sediment laden construction water will be discharged into settling lagoons or tanks prior to final discharge. Settling basins will be periodically cleared so as to ensure adequate water storage. Regular waste water streams are to be passed through settling basins.				
▪ Caustic / alkaline runoff from the concrete batching area may affect receiving aquatic and / or terrestrial ecosystems	▪ Contain and treat water runoff from the batching plant area prior to discharge into any natural system. ▪ Undertake pH monitoring of site runoff to ensure alkaline runoff is not leaving the site.	Contractor	EU-CSC/ EU-DHP	Construction	Weekly monitoring of pH at the concrete batching plant areas
▪ Washing out of excess concrete, concrete laden tools and equipment may mobilise concrete slurry to aquatic environments resulting in reduced water quality	▪ Construct a designated, signposted concrete wash down bay that is fully contained and bunded for all excess concrete and concrete wash down, e.g. plastic lined. ▪ Regularly maintain the concrete washout bay, treating any water prior to release to natural systems.	Contractor	EU-CSC/ EU-DHP	Construction	Weekly visual inspection on hazardous waste spills
▪ Changes in Natural river flows of the downstream (lows flow between dam and tailrace during low flow season; and downstream of tailrace during peaking operation)	▪ Operate the dam as a true run of river by allowing the whatever flow received will be returned in the Stage 1 (pre-Basha) ▪ Maintain a minimum environmental flow of 20 m^3/s from dam and 222.5 m^3/s from tailrace during low flow season ▪ Always run one turbine during Stage 2 (post-Basha) if the dam is operated as peaking plant.	Dam Control Office	EU-DHP/ WEC	Operation	Monthly measurement of water flows during low season on downstream near Dasu
▪ Degradation of downstream erosion and ecosystems	▪ Implement a sediment monitoring and management programme in the reservoir systems to minimise sedimentation.	Consultants	EU-DHP/ WEC	Operations	Six monthly

EMP Sub-Plan 4. Surface Water Management					
▪ Changes in downstream water quality due to thermal stratification and changes in sediment load and dissolved oxygen in the reservoir	▪ Vertical monitoring of DO and temperature in the reservoir ▪ Operational protocol to release simultaneous release of waters from LLOs and spillways for mixing of surface and deep waters in the reservoir	Dam Control Office	WEC	Operation	Monthly DO and temperature monitoring of tail race water and upstream water at Basha
▪ Surges from tailrace flows due to peaking operations	▪ Develop an operational protocol to soften the rapid water level and flow variations due to peaking ▪ This will include: (i) each turbine goes from zero to full level in two or three equal steps separated in time by a few minutes. When a second turbine is started, the same procedure will be followed for each turbine in order. The same procedure will be followed when reducing the load. The start and stop procedure can be further adjusted with the monitoring results. ▪ The start and stop procedures will be proceeded by warning signs	Dam Control Office	WEC	Operation	Monitoring of river water levels from the tailrace discharge point to the downstream
Auditing	▪ Undertake monthly pH audits of site runoff to ensure alkaline runoff is not leaving the casting yards. ▪ Monitor physical river water quality quarterly with observations of visual assessment of oils, grease, floating scum and quantity of litter. ▪ Following extended wet weather or storm events monitor the sediment and erosion controls.				
Guidelines, Standards and Legislation	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007				
Potential Concern	**Corrective Action**				**Responsibility**
▪ Pollutants are observed entering surface water systems.	▪ Identify the source of pollutants and immediately implement strategies to contain and treat the discharge stream.				All site personnel.
	▪ Provide hydrocarbon spill kits at locations where pollutant sources are used and provide training to personnel on use of spill kits. ▪ Modify activity specific work practices with the aim to contain and treat any pollutants.				Contractor
▪ Significant soil erosion has occurred as a result of disturbance linked to Project activities.	▪ Identify source of sediment and stabilise subject land. ▪ Review erosion and sediment controls.				Contractor

EMP Sub-Plan 4. Surface Water Management		
▪ Drainage is not effectively conveying storm flows, leading to waterlogging in Project adjacent areas.	▪ Review the drainage design and rectify any ineffective designs. ▪ Maintain the drainage system, clearing debris after rain events.	Contractor
Reporting	▪ Report site discharge / drainage pH monitoring results in a monthly report. ▪ Report all spills and incidents that pollute aquatic environments. ▪ Report all near miss pollution incidents that have the potential to pollute aquatic environments.	

3.9 EMP SUB-PLAN 5: AIR QUALITY MANAGEMENT

EMP Sub-Plan 5. Air Quality Management					
Objective	▪ Ambient air quality is maintained at properties adjacent to worksites, quarry sites, stockpile locations and along KKH throughout the construction phase. ▪ Community concerns and complaints about air quality are addressed quickly and effectively.				
Performance criteria	▪ Avoid, mitigate and/or manage potential air quality impacts including dust, odour and vehicle emissions from construction, spoil haulage and spoil stockpiling. ▪ Air quality shall comply with NEQS 2000 ▪ Take measures to manage the potential for diminished air quality (dust, odour, plant and vehicle emissions) near construction work sites. ▪ Take corrective action in response to complaints about diminished air quality at properties adjacent to construction sites as a consequence of construction works or operation of construction vehicles.				
Targets	▪ Zero community complaints regarding diminished air quality.				
Impact/Issue	**Mitigation Measures/Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Ambient Air quality will be affected by construction traffic along KKH, access roads; and construction equipment and activities at the construction sites and quarry areas	▪ All access roads in the construction area that will be used by the project will be paved ▪ The construction and road machinery used during the construction process shall comply with NEQS requirements with respect to emission and noise pollution. ▪ Maintaining the construction equipment and vehicles as per manufacturer's recommendation will reduce the emissions from the equipment and vehicles ▪ Material such as pozzolan and cement will be covered with tarpaulin during transportation. covering of stock piles to minimize the amount of airborne dust generated from the site. ▪ Implement mitigation measures in ECP 10: Air Quality Management	Contractor	EU-CSU/EU-DHP	Construction	Quarterly monitoring of air quality by contractor. Weekly visual inspection for dust

EMP Sub-Plan 5. Air Quality Management					
▪ Dust and air pollution from the construction activities and quarry areas	▪ All dust raising locations shall be kept wet with water sprinkling. Fugitive dust emissions will be minimized by appropriate methods such as spraying water on material where required and appropriate. ▪ Development of water supply system for controlling dust from the quarry area; ▪ Continuous air monitoring will be carried out near the sensitive receptors to ensure they do not exceed ambient levels and NEQS. ▪ Implement mitigation measures in ECP 10: Air Quality Management	Contractor	EU-CSU/EU-DHP	Construction	Monthly air quality monitoring at nearby sensitive receptors
▪ Dam and surrounding areas will become hotspots of air pollution hotspot due usage of about 1100 trucks per day for transport of material from quarry sites to batching plant; and from excavation areas to spoil disposal site	▪ Use of belt conveyor system for transport of material (13 km from quarry/crushing plant to batching plan; 4 km for spoil disposal) ▪ Dust controlling system will be extended to the conveyor belt system. A belt conveyor system	Contractor	EU-CSU/EU-DHP	Construction	Monthly air quality monitoring at nearby sensitive receptors
▪ Decrease of oxygen levels and increase of carbon dioxide levels in the tunnels during construction	▪ Air quality in the tunnels should be maintained in accordance with technical specifications ▪ The quantity of fresh air pumping from outside to inside the tunnel must be boosted such that a wind velocity of 1 m/s is maintained as the minimum.	Contractor	EU-CSU/EU-DHP	Construction	Quarterly monitoring of air quality by contractor. Monthly spot measurements
▪ Removal of waste facilities and sanitation facilities may result in the production of odours that affect local people.	▪ Sanitation facilities should be decommissioned and sealed, e.g. landfills, sewage treatment, etc.	Contractor	EU-CSU/EU-DHP	Post construction	Monthly during decommissioning
▪ Demobilisation of the field camp and construction footprint may leave disturbed areas of land which generate dust that affects local people and/or crops.	▪ Stabilisation, e.g. re-vegetation/compaction of disturbed areas, should be undertaken as soon as possible following works.	Contractor	EU-CSU/EU-DHP	Post-construction	Monthly during decommissioning

EMP Sub-Plan 5. Air Quality Management		
Auditing	▪ Audit community complaints and responses with regards to the incidence of dust deposition, odours and construction vehicle emissions in relation to ambient air quality. ▪ Visual Site audits in the instance a complaint relevant to nuisance dust are received.	
Relevant Guidelines, Standards and Legislation	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007	
Potential Concern	**Corrective Action**	**Responsibility**
▪ Community complaints received in relation to Project air emissions.	▪ Conduct a review of construction activities / methods in the area, propose or adopt methods to reduce dust generation or site emissions in the event of goals being exceeded. ▪ Modify the site environmental management practices as required. ▪ Follow the status of all registered air quality complaints.	GRC - Environment
▪ Environmental recommendations, environmental constraints or environmental requirements in relation to air quality are not adequately reflected and/ or incorporated into construction activities.	▪ Commit to regular construction planning meetings to review all relevant construction activities and agree on suitable control/management measures that can be adopted to achieve nominated goals. ▪ Conduct regular site inspections of the construction site activities against relevant environmental performance criteria.	Contractor
Reporting	▪ Report on construction air quality observations in a monthly report. ▪ Documentation of all logged activities which were haltered due to adverse weather (wind) conditions. ▪ Report all air quality complaints to the EU-DHU immediately. ▪ Summarise the outcome of any complaint investigations in monthly reports. ▪ All air quality complaints received shall be recorded in a register.	

3.10 EMP SUB-PLAN 6: GHG EMISSION REDUCTIONS AND CLIMATE CHANGE MONITORING

EMP Sub-Plan 6. GHG Emission Reductions and Climate Change Monitoring					
Objective	▪ To minimise the release of GHG's from the Project during the construction phase and operation phase ▪ Monitoring of climate change and design any adaptation measures if required.				
Performance criteria	▪ Avoid, mitigate and/or manage the release of GHG's as a result of construction activities. ▪ Implement measures to reduce the release of GHG's from the Project during the operational phase ▪ Project withstands to extreme climate change events.				
Targets	▪ Measurable reductions in GHG's emissions from the Project during both construction and operational phases as a result of the implementation of proactive reduction measures. ▪ Better understanding of climate change and its impacts on DHP				
Impact/Issue	**Mitigation Measures/Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Extreme events such as floods caused by climate change	▪ A flood telemetry network is recommended in the catchment of DHP for early warning system and better management floods ▪ Glacier monitoring program for monitoring and research on the Upper Indus Basin glaciers.	Snow and Hydrology Department of WAPDA	PD	Through out Project life cycle	Online continuous data
▪ Uncertainties in climate change impacts on land slides, river erosion, etc.	▪ A follow-up monitoring and adaptive management mechanism is required to monitor and understand the climate and its impacts on the project and design any adaptation measures if required ▪ Monitoring of temperature and rainfall in the DHP catchment area with the telemetry network ▪ Establishment of a complete weather monitoring station at DHP (rainfall, snow fall, temperature, wind speed, wind direction, evaporation, etc.)	Snow and Hydrology Department of WAPDA	PD	Through out Project life cycle	Annual review of the data
▪ Emissions from construction vehicle and equipment may contribute to greenhouse gas concentrations	▪ Implement vehicle exhaust emission controls including the following: ○ Regular maintenance of vehicles, plant and machinery in accordance with manufacturer's specifications. ○ Monthly visual inspections on vehicle and plant exhausts to identify excessive emissions of smoke, and maintenance undertaken where required. ○ Approved pollution control devices to be fitted to equipment and machinery.	Contractor	EU-CSU/EU-DHP	Construction/ Operation	Monthly visual inspections

EMP Sub-Plan 6. GHG Emission Reductions and Climate Change Monitoring					
	○ Transport vehicles shall not be overloaded. ○ Switch off / throttle down all site vehicles and machinery when not in use. ○ Avoid unnecessary idling of equipment. ▪ Develop planation sites wherever feasible in the buffer areas of the reservoir, along KKH, and near permanent facilities of the project, WAPDA colony, resettlement villages, etc.				
▪ Emissions of CO_2 and CH_4 from reservoir	▪ Remove all trees from reservoir area prior to inundation. This will allow the reservoir less organic matter available for decomposition ▪ Reduce the biomass and debris quantity in the reservoir which generates GHG emissions. Ensure proper operation of trash racks at the power intake and flaps at spillway gates that are installed to collect and dispose the biomass such as logs and vegetation	Contractor	EU-DHP	Operations	Monthly monitoring of approximate biomass volumes collected
Auditing	▪ Audit all vehicles, plant and machinery used during the construction phase of the Project to ensure it is running to manufacturer's specifications and not emitting excessive GHG's due to poor maintenance. ▪ Record amount of arboreal vegetation removed from reservoir sites prior to inundation and calculate the reduction in GHG emissions resulting from this removal.				
Relevant Guidelines, Standards and Legislation	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007 ▪ United Nations framework on Climate Change, 1992				

Potential Concern	Corrective Action	Responsibility
▪ Excessive GHG emissions are observed.	▪ Stand Down relevant plant / equipment / vehicles that are producing excessive emissions. ▪ Plant / equipment / vehicles identified as generating excessive air emissions shall be repaired and more regular maintenance scheduling shall be implemented.	Contractor

Reporting	▪ Report monthly on compliance of GHG emissions abatement measures throughout construction and operational phases of Project. ▪ Report on compliance of GHG emissions reduction measures (e.g. vegetation removal) prior to inundation of reservoirs.

3.11 EMP SUB-PLAN 7: NOISE AND VIBRATION MANAGEMENT

EMP Sub-Plan 7. Noise and Vibration Management					
Objective	▪ Maintain a reasonable acoustic environment for living, in particular for sleeping, and use of properties adjacent of the area of construction influence during construction works. ▪ Residential and other structures are protected from the effects of construction vibration. ▪ Consultation with concerned property owners and occupants in the area of construction influence is effective and responsive.				
Performance criteria	▪ Compliance with NEQS and international standards on air and ground vibration ▪ Achieve a 'reasonable' noise and vibration environment within the area of construction influence.				
Targets	▪ Zero complaints from local population relating to noise or vibration disturbance ▪ No damage to infrastructure from Project related vibrations.				
Impact/Issue	**Mitigation Measures/ Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Noise and Vibration from blasting could affect the people and wildlife	▪ Perform test blasting with various charges and monitor resultant noise and vibration levels at various distances and chose optimum blast size to avoid any impacts on the nearby receptors ▪ Prior to commencement of the blasting programme (which shall be prepared in consultation with local government) the surrounding community should be notified of the timing and frequency of blasts. ▪ install and operate a siren of sufficient volume to be easily heard above the general site noise from all points within a radius of 1 km of surface blasts ▪ Blasting should only be carried out during day time.	Contractor	EU-CSC	Pre-Construction	Before, during and after blasting
▪ Traffic and construction activities may produce noise that could affect people (e.g. sleep disturbance).	▪ Implement noise control measures given in ECP 11: Noise and Vibration Management ▪ If noise standards are exceeded at sensitive receivers, adopt appropriate noise attenuation measures to reduce the noise generation from construction activities. The noise attenuation measures will include, (i) fitting of high efficiency mufflers to the noise generating equipment; and (ii) keeping acoustic enclosures around drilling equipment. . ▪ Stop the construction activities, near the settlements,	Contractor	EU-CSC	Construction	quarterly noise and vibration monitoring at sensitive receptors

EMP Sub-Plan 7. Noise and Vibration Management					
	during night times if high noise values are observed. ▪ All vehicle used in the construction activities will comply with NEQS exhaust and noise standards (85 dBA at 7.5m from the source).				
▪ Noise levels from quarry and crushing activities will affect nearby villages and community conservation area near Kaigah	In addition to above ▪ Excavation at Kaigah quarry shall be started from southern end and shall be progressed towards north, thus always maintaining a natural berm on northern and eastern side to act as acoustic shields and to avoid impacts on Kaigah village and CCA. ▪ Excavation at Gini site shall be started from the eastern side and will proceed to the western side; excavation will be carried out in a way that there will be a narrow strip of area along KKH and Gini village are maintained to act as natural berm to reduce noise and dust. ▪ Material stockpiles will also be used as acoustic shields around high noise generating equipment and crushing plants, and also along the boundaries of quarry area.	Contractor	EU-CSC	Construction	Monthly noise and vibration monitoring at sensitive receptors
Auditing	▪ Noise monitoring schedule should be reviewed on a complaints basis at the nearest sensitive receivers.				
Guidelines, Standards and Legislation	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007 ▪ Air and Ground Vibration Standards (US Department of Interior Office of Surface Mines and The Australian and New Zeeland Environment Conservation Council)				

EMP Sub-Plan 7. Noise and Vibration Management		
Potential Concern	**Corrective Action**	**Responsibility**
▪ Community complaints received in relation to Project air emissions.	▪ Conduct a review of construction activities / methods in the area, propose or adopt methods to reduce noise and vibrations in the event of standards being exceeded. ▪ Modify the site environmental management practices as required. ▪ Follow the status of all registered air quality complaints.	GRC
▪ Environmental recommendations on noise quality are not adequately reflected and/ or incorporated into construction activities.	▪ Commit to regular construction planning meetings to review all relevant construction activities and agree on suitable control/management measures that can be adopted to achieve nominated goals. ▪ Conduct regular site inspections of the construction site activities against relevant environmental performance criteria.	Contractor
Reporting	▪ Report on construction noise and vibration observations in a monthly report. ▪ Report all noise quality complaints to the EU-DHU immediately. ▪ Summarise the outcome of any complaint investigations in monthly reports. ▪ All noise and vibration related complaints received shall be recorded in a register.	

3.12 EMP SUB-PLAN 8: WASTE MANAGEMENT

EMP Sub-Plan 8. Spoil and Waste Management					
Objective	▪ To reduce the amount of waste generated by the Project through implementing the waste management hierarchy (avoidance, reuse, recycling, and waste disposal). ▪ To reduce impacts of waste on receiving environments.				
Performance criteria	▪ Waste generated from the Project is to be reused or recycled where practicable on site. ▪ Any waste products leaving the site will be by safe transport methods to an approved waste management facility. ▪ Project methods and design will aim to reduce waste generation.				
Targets	▪ 50 percent reuse of excavated material (spoils) as aggregates for concrete and road fill ▪ No environments nearby the site are impacted by Project waste.				
Impact/Issue	**Mitigation Measures/Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Huge quantities (about 20 MCM)of excess rock material will be generated from excavation at dam site, levelling of the grounds, tunnelling and relocation of KKH	▪ Minimize the generation of spoils by reusing the excavated rock to maximum extent as aggregates for concrete and fill material for roads ▪ Carry out necessary tests immediately after excavation, as and when required, to assess the suitability of excavated material for aggregate manufacturing ▪ Carefully plan both excavation and quarrying activities to maximize the use of spoils ▪ Prepare and implement spoil disposal plan ▪ Dispose excess rock material in the designated disposal site in an orderly manner (different spots to different size rocks) ▪ Disposal site shall be fenced towards the river side to arrest washing into the river ▪ Landscaping and erosion control plan for spoil hills ▪ New sites for spoil disposal, if required, to be approved by EU-DHP.	Contractor	EU-CSU/ EU-DHP	Construction	Monthly visual inspection
▪ Sites or facilities of waste disposal	▪ Appropriate hazardous, industrial and domestic waste disposal or recycling facilities must be identified or to be established	Contractor	EU-CSU/ EU-DHP	Pre-construction	Locations are identified and designs are

EMP Sub-Plan 8. Spoil and Waste Management					
					approved
▪ Waste generation may result in pollution of surrounding environments.	▪ Implement mitigation measures proposed in ECP1: Waste Management ▪ Regular maintenance of waste management facilities should be undertaken.	Contractor	EU-CSU/ EU-DHP	Construction	Monthly visual inspection
▪ Excess waste, chemicals or hazardous materials are left on site and pollute the surrounding environment.	▪ Remove all hazardous materials when the site is decommissioned. ▪ The contaminated areas at the construction yards, hazardous and fuel storage sites are to be rehabilitated to original condition.	Contractor	EU-CSU	Post-construction	Monthly visual inspection and chemical analysis if soil or water pollution found
▪ Demobilisation may leave litter and disturbed land which pollutes receiving environments.	▪ Field camps should be rehabilitated to pre-mobilisation condition, unless otherwise agreed in leasing conditions.	Contractor	EU-CSU	Post construction	Monthly visual inspection
Auditing	▪ Visually inspect waste storage areas during the weekly environment inspections. Observations should include: o detecting any leaks, spills or uncontrolled discharges; o excessive generation of waste; o visible evidence that wastes are not disposed of or collected efficiently; and o Visible evidence that wastes are not separated and stored in designated receptacles. ▪ At six-monthly intervals audit for presence and relevance of all MSDS's				
Guidelines, Standards and Legislation	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007				

Potential Concern	Corrective Action	Responsibility
▪ Large unpredicted volumes of waste are generated during the construction phase, with recycling and reuse objective not being met.	▪ Undertake waste inspections to identify areas for improvement.	EU-CSU
▪ Litter is being observed around the Project site.	▪ Provide accessible and clearly labelled bins for site personnel waste. ▪ Undertake additional staff training on waste management policy.	Contractor
▪ Poor segregation of waste is observed.	▪ Provide clearly labelled bins for general waste, recyclable metal, plastic, glass and paper while providing staff training.	Contractor

EMP Sub-Plan 8. Spoil and Waste Management		
▪ Complaints from the community	▪ Correction action	GRC - Environment
Reporting	▪ Summaries of waste information should be reported in the monthly report and should include: o Details of spoil generated, suitability for reuse, transported to crushing plants, and disposed at the disposal site. o Details of waste disposal and recycling; o Details of any poor waste management practices observed / remedied; and ▪ The implementation of any new initiatives to reduce waste on-site. ▪ Include details of the decommissioning and rehabilitation in the project completion report	

3.13 EMP SUB-PLAN 9: HAZARDOUS SUBSTANCES MANAGEMENT

EMP Sub-Plan 9. Hazardous Substances Management					
Objective	▪ To manage and mitigate any potential impacts of hazardous substances on soils, waterways and other components of the environment.				
Performance criteria	▪ To prevent any adverse impacts to the local environmental conditions from any spillage or leakage of fuels and chemicals. ▪ To ensure the correct transport, storage, handling and use of chemicals and fuels during the construction phase of the Project.				
Targets	▪ No environmental incidents from the release of hazardous substances, e.g. pollution of waterways from a spill. ▪ Training in environmental incident and spill response provided to all relevant site based Project personnel. ▪ Prevention of reoccurrences of incidents by appropriately implementing corrective and preventative actions and planning.				
Impact/Issue	**Mitigation Measures/ Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Spill Controls	▪ Develop controls and standard operating procedures for the use of fuels to prevent spills ▪ Train and designate personnel for various spill control procedures ▪ Establish fire fighting system and fire safety (fire extinguishers) at the construction sites where fire is an hazard	Contractor	EU-CSU/ EU-DHP	Pre-Construction	
▪ Potential spills from transport, storage and use hazardous and fuel sites will contaminate the surrounding environment	▪ Implement mitigation measures in ECP 2: Fuels and Hazardous Goods Management ▪ Spill kits and trained personnel are to be made available at the workshops. Drainage from the workshops is be collected and passes through oil water separators. ▪ Contain all fuel tanks in a fully bunded area with a storage capacity of at least 110% of the potential storage volume. ▪ Use auto shut down valves for fuel transfer pipes ▪ Transport of hazardous goods and fuel to be done in closed containers and ISO certified tanks	Contractor	EU-CSU/ EU-DHP	Construction	Monthly visual inspection
Auditing	▪ Check for leaking or damaged containers/drums weekly. ▪ Assess the walls and floor of storage bund for cracking monthly. ▪ Check bunded areas for visible pollution weekly. ▪ Check that all fuel and oil spills are cleaned up immediately using the available spill kits and in accordance with the instructions on the relevant material safety data sheet (MSDS).				

EMP Sub-Plan 9. Hazardous Substances Management		
	▪ Check spill kits are well maintained and complete monthly. ▪ Visual inspections shall be undertaken after rainfall events, to assess the contamination risk of overland storm waters migrating through the chemical storage areas.	
Guidelines, Standards and Legislation	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007	
Potential Concern	**Corrective Action**	**Responsibility**
▪ Spillage of hydrocarbons, oils, dangerous chemicals or other hazardous substances	▪ Clean-up, contain and dispose of spills in accordance with product specific MSDS requirements.	Contractor
	▪ Corrective Actions following a fuel or chemical spill should involve at a minimum, some of the following: o Conduct inspection and rectification depending on risk level. o Modify work practices or conduct repairs. o Conduct training and induction, issue memos. o Update procedures and documentation. o	
Reporting	▪ Monthly reports should describe any incidents along with control measures in place to manage hazardous substances on site. Any other information considered relevant should also be included, such as: o Monitoring results / observations. o Details of quantities and type of spills. o Summaries of water quality checks, and any remedial actions undertaken.	

3.14 EMP SUB-PLAN 10: TERRESTRIAL ECOLOGY (FLORA AND FAUNA) MANAGEMENT

EMP Sub-Plan 10. Terrestrial Ecology Management					
Objective	▪ Impacts to the wildlife, habitat and ecological values of the River Indus and surrounds are minimised. ▪ Potential construction impacts on native flora and fauna are reduced and disturbed areas are rehabilitated. ▪ Impact on fauna minimized				
Performance criteria	▪ Implement measures to maintain the ecological and habitat character of the River Indus and surrounds during construction. ▪ Reasonable and practicable measures are taken to reduce the potential for native fauna to be harmed. ▪ Rehabilitate and landscape work sites upon completion of construction.				
Targets	▪ No permanent vegetation loss for temporary works; ▪ No reduction in suitable habitat for key species such markhor, musk deer, etc. ▪ Development of two community managed wildlife conservation areas in the project area				
Impacts/Issues	**Mitigation Measures/Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Some data gaps in the presence and wildlife and its habitat in the project surrounding areas	▪ Carry out detailed studies to establish baseline data on terrestrial ecology and forests in Upper Indus Basin ▪ Establish vantage stations to monitor the presence and movement of Tragopan and migratory birds, breeding birds, small mammals, ungulates and otters. ▪ Revise, if required, this EMPs sub-plan or mitigation measures proposed in ECP 12 on Protection of Flora and ECP 13 on Protection of Fauna.	Wildlife Monitoring Consultants (like WWF, IUCN)	EU-CSU/ EU-DHP	Pre-Construction/ Construction	Monthly Monitoring using the methods described in the Terrestrial Ecology Report of EMAP
▪ 21,000 trees to be cut from the construction sites and reservoir inundation area	▪ A nursery will be established with the native species with a capacity to produce about 300,000 saplings with an objective to develop 100,000 trees (3 saplings for each proposed tree).	District Forest & Agriculture Departments	EU-CSU/ EU-DHP	Construction	Monthly monitoring of the saplings raised and delivered
	▪ Plantation to be developed in the buffer areas (at suitable sites) of the reservoir on the right bank, in DHPs office and colony, and at the resettlement with a target to develop about 5 trees for each tree cut. ▪ Maintain each sapling for a period of minimum 2 years with the support of local community. Community will be	District Forest & Agriculture Departments with the support of local community	EU-CSU/ EU-DHP	Construction/ Operation	Monthly monitoring of the trees planted and survived

EMP Sub-Plan 10. Terrestrial Ecology Management					
	paid for watering and raising the plantation.				
▪ Construction activities will have wide range of impacts on flora (vegetation clearance, loss of animal shelter, soil erosion)	▪ Implement mitigation measures proposed in ECP 12: Protection of Flora ▪ A public education programme should be designed and implemented to discourage cutting of trees by the construction workers	Contractor	EU-CSU/ EU-DHP	Construction	Monthly visual inspection
▪ Construction activities will have wide range of impacts on fauna (loss of habitat and habitat quality, active nests, night lighting, poaching, dust, noise and vibration, etc.)	▪ Implement mitigation measures proposed in ECP 13: Protection of Fauna ▪ Include information on wildlife protection in all construction related tool-box orientation briefings for new construction staff ▪ conducting wildlife awareness programs to the construction workers on protection of wildlife ▪ Noise attenuation and dust control measures ▪ Decommission redundant roads after completion of construction	Contractor	EU-CSU/ EU-DHP	Construction	Monthly visual inspection
▪ Increased pressure on forest products such fuel wood for increasing demand for cooking and heating from in-migrants	▪ Support the local government to establish market for supply of non-timber fuels such as LPG for cooking and heating to reduce the pressure on firewood. ▪ Strengthening management practices of community forestry activities ▪ Afforestation programs and forest regeneration	DHP and local government	EU-CSU/ EU-DHP	Pre-Construction/ Construction	Monthly visual inspection
	▪ provide non timber fuels such as LPG to the construction staff for cooking and heating purposes	Contractor	EU-CSU/ EU-DHP	Construction	Monthly visual inspection
▪ Impact on Kaigah	▪ Carry out trail blasts with various charge amounts and	Contractor	EU-CSU/	Construction	Monthly visual

EMP Sub-Plan 10. Terrestrial Ecology Management					
community conservation area from blasting and construction activities at Kaigah quarry and crushing plant	record vibrations levels at the closest boundary of the CCA and finally chose the optimum amount of blasting per event to comply with international standards (e.g. Australia). ▪ Monitor noise levels at CCA and if it exceeds the standards, acoustic enclosures for noise attenuation are recommended for crushing plant. ▪ Realigned KKH construction at Kaigah tributary shall also comply with relevant standards.		EU-DHP		inspection
	▪ Strengthening of management measures for Kaigha CCA ▪ Promote and support two community conservation areas in the project area	EU-DHP	EU-CSU/ EU-DHP	Construction	Visual inspection
▪ Improvement and protection of local wildlife habitat and its quality	▪ Develop community based protected areas and trophy hunting (similar to existing one in Kaigah) in Kandia or Laachi valley for protection of Markhor, Musk deer, and Western-horned Tragopan ▪ Kaigah trophy hunting model and such other programmes continuing in Northern Pakistan should be propagated in the area	WWF with support of local community	EU-CSU/ EU-DHP	Construction/ Operation	Monthly noise and vibration measurements
▪ Impacts of transmission lines on migratory birds	▪ Avian risk assessment studies ▪ Maintaining 1.5 meter spacing between energized components and grounded hardware; covering energized parts and hardware; ▪ Installing visibility enhancement objects such as marker balls, bird deterrents, or diverters ▪ Monitor the migratory birds migration to the reservoir	Consultants (e.g. WWF)	EU-CSU	Operation	Monthly inspection
Auditing	▪ Inspect work sites weekly and assess compliance with mitigation measure requirements for flora and fauna. ▪ Inspect and monitor the Project area on a monthly basis for the presence of pests and weeds.				
Guidelines, Standards and Legislation	▪ Forest Act of 1927 and Later Amendments ▪ KP Wildlife (Protection Preservation Conservation and Management) Act (1975) and Rules (1976)				

EMP Sub-Plan 10. Terrestrial Ecology Management		
	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007 ▪ Interim Guidelines for Potential Effects on Bird (California Department of Transportation, 2007)	
Potential Concern	**Corrective Action**	**Responsibility**
▪ Unauthorised clearing / damage to vegetation occurs.	▪ Review of current internal controls (pre-construction approvals process; survey set out; activity specific risk assessments; tool box talks) to assess where the system breakdown occurred. ▪ Develop and Implement additional or alternative controls methods if deemed necessary. ▪ Reiterate to staff the importance of environmental standards and the potential penalties associated with non-conformance.	EU-CSU
▪ Disturbed areas not reinstated / re-vegetated (rehabilitated) within nominated timeframes after the completion of construction.	▪ Review program / resources to identify timeframe constraints leading to the delay of rehabilitation. ▪ Implement temporary controls (i.e. seeding unconsolidated surfaces; compacting cut batters to 'hard'; installation and ongoing maintenance of drainage erosion and sediment control measures) where risk is evident / within close proximity to sensitive receivers.	Contractor
▪ Fauna becomes trapped or injured by Project activities or traffic	▪ Rescue and trapped fauna where possible and release to nearby habitat. ▪ Protect worksites from future instances of fauna trapping. ▪ Where fauna is injured by Project activities, seek specialist advice and pass to a local wildlife departments. ▪ Install wildlife warning signs and impose speed limits on all Project access roads and realigned KKH	Contractor
▪ Sapling mortality and lack of growth in plantation	▪ Sapling mortality will be checked and replanting for gap filling	District Forestry Dept.
Reporting	Monthly environmental reporting relevant to flora and fauna should include: ▪ Summary of fauna encounters. ▪ Details of any vegetation cleared and vegetation planted ▪ Any fauna injuries or deaths as a result of construction activities. ▪ Any remedial actions undertaken to protect flora and/or fauna.	

3.15 EMP SUB-PLAN 11: AQUATIC ECOLOGY MANAGEMENT

EMP Sub-Plan 11. Aquatic Ecology Management					
Objective	▪ Impacts to the aquatic habitat and ecological values of the River Indus and its tributaries are minimised. ▪ Potential construction impacts on fish are reduced and disturbed areas are rehabilitated.				
Performance criteria	▪ Implement measures to maintain the ecological and habitat values of the River Indus and its tributaries during construction. ▪ Reasonable and practicable measures are taken to reduce the potential for fish to be harmed due to construction related water pollution				
Targets	▪ No pollution of the River Indus and its tributaries ▪ No reduction in suitable habitat for native fish species ▪ Develop successful hatchery development for snow carps				
Impact/Issue	**Mitigation Measures/ Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Gaps in the biological knowledge of key fish species in Indus (snow carps)	▪ Long term field studies are to be conducted to obtain biology, movement patterns and seasonal habitat use (of snow carp and other native cold water species in Indus and its tributaries	Consultant or University	EU-CSU/ EU-DHP	Pre-Construction	Quarterly
▪ Adverse effect on aquatic biota by release of high concentrations of sediment, fuels/oils and other toxic compounds, and solid waste	▪ Implement mitigation measures proposed in ECPs 1 to 4, 6, 14 on water quality, waste management, and sedimentation control ▪ avoidance of coffer dam placement during the start and middle of low flow winter season when fish may be using pool areas as refuges and sediment levels are seasonally low ▪ Avoiding initial activation of diversion tunnels in winter/low flow season ▪ No dumping of excavation waste in the river	Contractor	EU-CSU/ EU-DHP	Construction	Quarterly water quality monitoring
▪ Fish entrainment and mortality when fish attempting to pass through tunnels and spillways	▪ Fish exclusion screens or fish deterrent devices on both side of the tunnels, spillways, LLOs (if justified by recommended studies on aquatic ecology)	Contractor	EU-CSU/ EU-DHP	Construction	Quarterly water quality monitoring
▪ Changes in the upstream fish habitat (in Indus and tributaries) due to reservoir formation	▪ Developing of fish hatchery with native snow carps for stocking fish in the affected tributaries and reservoir. Experience from the snow carp hatcheries established in Uttaranchal, India (Garhwal Himalaya) and Nepal (Kali Gandaki A, Plkhra, Trishuli and Godavari) are to be considered. ▪ A single facility could be used to produce juveniles for stocking streams for	EU-DHP	EU-CSU/ EU-DHP	Construction/ Operation	

EMP Sub-Plan 11. Aquatic Ecology Management					
	which spawning populations have been affected by the project , and additional fish for reservoir-stocking or to supply local grow-out facilities. The facility would require a research and development component to improve local methods and capacity for snow trout hatchery production. ▪ Maintaining spawning areas through placement of gravels/boulders and creating ripples				
▪ Impact on river habitat due to no/reduced flows between dam and tailrace during low flow season	▪ Further studies are recommended to determine the environmental flows (. Until results of those studies are available, a release of 20 m3/s from dam and 222.5 m3/s from tailrace is recommended tentatively and can be adjusted when results of further studies are available	Dam Control Office	WEC	Operation	During Flushing
▪ Impact on downstream fish due to changes in water flows and quality (temperature, DO, sediment load)	▪ Monitoring water quality and flow changes and their impact on the fish habitat; and devise additional offset measures if required ▪ Stocking of native species, through hatchery development, in the affected area	Dam Control Office	WEC	Operation	During Operation
▪ Impact on river habitat on downstream of tailrace due to reduced flows during peaking operation	▪ Operate at least one turbine and use additional water for peaking operation. This will ensure release of 222.5 m³/s from tailrace ▪ If the high release flows are moderated by improved ramp-up protocols then stranding can be addressed through improvement of ramp-down procedures ▪ Flushing during high flow season (not in low flow/winter)	Dam Control Office	WEC	Operation	During Flushing
▪ Impact on river habitat on downstream of tailrace due to reduced flows during peaking operation	▪ Operate at least one turbine and use additional water for peaking operation. This will ensure release of 222.5 m³/s from tailrace ▪ If the high release flows are moderated by improved ramp-up protocols then stranding can be addressed through improvement of ramp-down procedures	Dam Control Office	WEC	Operation	During Flushing

EMP Sub-Plan 11. Aquatic Ecology Management					
▪ Potential for reservoir fish development	▪ Native fish species (snow carp) are recommended for reservoir fisheries development. However further following studies are required to assess the potential for reservoir fisheries development: ▪ A small R&D hatchery is recommended to undertake applied research on snow carp focussing on need to increase biological knowledge related to wild fish and fish habitat management and culture. ▪ Fish, fish habitat and fisheries in Tarbela Reservoir;	Consultants/ KP Fisheries	EU-CSU/ EU-DHP	Prior to first reservoir filling	Monthly fish catch data
Auditing	▪ Limnological conditions in reservoir: Temperature-depth profiles; DO-depth profiles; turbidity and suspended solids; other water quality parameters ▪ Fish production in tributary habitat and contribution to reservoir fish populations: ▪ Fish abundance and composition in reservoir ▪ Amount of fish entrainment through outlet portals (powerhouse intakes; spillways; lower level outlets) and associated mortalities and loss from reservoir fish populations and/or effectiveness of measures to mitigate entrainment ▪ Effectiveness of reservoir fishery enhancement measures				
Guidelines, Standards and Legislation	▪ Fisheries Ordinance 1961 ▪ KP Fisheries Rule 1976 ▪ Pakistan National Conservation Strategy 1992. ▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007				
Potential Concern	**Corrective Action**				**Responsibility**
▪ Water pollution from construction activities	▪ Identify the source of pollutants and immediately implement strategies to contain and treat the discharge stream. ▪ Review the drainage design and rectify any ineffective designs.				Contractor
Reporting	▪ Monthly environmental reports with details of water related pollution ▪ Bi annual reports on fish and downstream habitat monitoring ▪ Annual reports on fisheries development in the reservoir				

3.16 EMP SUB-PLAN 12: TRAFFIC MANAGEMENT

EMP Sub-Plan 12. Traffic Management					
Objective	▪ Project related traffic does not cause impacts to local population or environment ▪ Drivers and other Project personnel operate vehicles in a safe manner ▪ No impact on KKH traffic				
Performance criteria	▪ Injuries due to traffic accidents are minimised ▪ Impacts to environment and wildlife are minimised ▪ Smooth traffic flow on KKH				
Targets	▪ Zero injuries due to Project related traffic accidents ▪ Zero traffic jams due to project related construction vehicles ▪ Minimal loss of wildlife due to traffic related encounters ▪ All Project related traffic travels within designated speed limits at all time ▪ Minimal disruption to local populous as a result of project related traffic				
Impact/ Issue	**Mitigation Measures/ Action**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ About 200 -300 constructio n vehicles will use existing KKH, which causes traffic congestion and safety hazard	▪ Establishment of traffic management committee with the relevant stakeholders (traffic agencies, local governments along KKH, contractor). Hold a one day workshop with the stakeholders to devise a plan for traffic management along KKH during construction period. ▪ A traffic unit at Dasu is proposed to control the construction related traffic inflow and outflow with sub offices along KKH at Hassanabdal, Haripur, Abbotabad, Chatter plain, Thakot, Besham, Pattan, Komela, dam site, quarry site Kaigah. These offices will be connected with telephone, fax, mobile phone and internet. ▪ The movement of traffic carrying cement or steel to be register at Hassan Abdal (junction of KKH and GT road). These will travel in small lots of 10 trucks. Hassan Abdal will inform the next stations by phone, Fax or internet. ▪ The weather conditions must be known before the start of the journey from Met office and drivers must be briefed before the start of the journey so that cargo may be protected from rain damage and driver may plan the journey accordingly. ▪ The receiving stores must be notified, who must prepare for offloading the goods. This preparation includes the location of offloading, labour for offloading together with crane or low lift fork lifters.	Contractor	EU-CSC/ EU-DHP	Pre-Constriction	Monthly inspection o process

EMP Sub-Plan 12. Traffic Management					
	▪ Traffic facilities, such as speed limits and signal lights, are to be strengthened from Hassan Abdal to Dasu ▪ Support to be provided to the local traffic authorities to engage traffic police at the busy junctions	Traffic Police Authorities	PD	Pre-Construction	Monthly inspection
	▪ Implement the mitigation measures proposed in ECP 15: Road Transport and Road Traffic Management	Contractor	EU-CSC	Construction	Monthly
▪ No rest or lay-over areas on KKH	▪ Layover spaces to be provided between Besham and Dasu (where there no layby areas) so that the drivers can stop the vehicles whenever they feel sleepy.	Project Resettlement Office	PD	Pre-Construction	Monthly inspection of vehicles
▪ Accidents as a result of poor driving practices	▪ Upgrade all Project related roads to appropriate standards for safety ▪ Signpost hazards in high risk areas ▪ Educate all nearby villages on road safety ▪ All vehicles must be maintained to manufacturer's standards including regular maintenance of tires, breaks and lights. ▪ Capacity building of drivers on defensive driving	Contractor	EU-CSU	Pre-construction/ Construction	Monthly traffic related accidents
▪ Weak carrying capacity of KKH	▪ Repair of the road as well as that of bridges including routine repair. Up-grading of the KKH has already been initiated to provide the means of transportation for the construction requirements of the Basha Dam project, which was previously planned to be constructed prior to the DHP. ▪ FWO shall increase the number of road gangs and machinery stationed for immediate removal of landslides and clearance of the road. ▪ The jurisdictions of the gangs and machinery be reviewed and made shorter for better control and tacking of the problem.	NHA	PD	Pre-construction/ Construction	Quarterly
Auditing	▪ Audit condition of all Project vehicles on a regular basis; ▪ Audit adherence to speed limits, issue fines to drivers who repeatedly speed; ▪ Investigate all deaths and injuries to humans and wildlife resulting from collisions with Project related vehicles ▪ Compliant register				
Guidelines, Standards and Legislation	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007				

EMP Sub-Plan 12. Traffic Management			
Potential Concern		**Corrective Action**	**Responsibility**
▪ Complaints related to traffic congestion and safety from community		▪ Investigations of complaints	GRC - Environment
▪ Speeding in Project related vehicles resulting in injury or death		▪ Implement disciplinary measures for repeat offenders	EU-DHP
▪ Accidents due to poorly maintained vehicles		▪ Ensure all Project vehicles undergo a monthly safety inspection, do not use any vehicle that fails this inspection	EU-CSU
▪ Accidents due to poorly maintained roads		▪ Ensure all Project related roads are well maintained	Contractor
Reporting	▪ Monthly environmental reports should include: ○ Details of any traffic related incidents ○ Details of corrective action implemented ○ Details of any disciplinary measures taken against Project personnel deemed at fault ○ Details of potential traffic hazards identified by Project personnel		

3.17 EMP SUB-PLAN 13: PHYSICAL CULTURAL RESOURCES MANAGEMENT

EMP Sub-Plan 13. Physical Cultural and Social Resources Management					
Objective	▪ Protection and preservation of cultural heritage ▪ Physical cultural resources in the area protected and respected.				
Performance criteria	▪ No historical, archaeological and cultural sites are affected by the project activities ▪ All graveyards that will be submerged are properly protected through stone/mud pitching. ▪ No community conflicts due to project related activities ▪ No stress on existing community resources due to influx of large number of construction workers				
Targets	▪ Rock carving sites are protected and fenced ▪ Minimal disruption to local populous as a result of project activities				
Issue	**Action**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ An historical old mosque with wooden structure will be submerged under reservoir	▪ The mosque at Seer Gayal will be disassembled and reassembled at a new location ▪ Additional facilities such drinking water, sanitation and termite protection measures will also be provided to the mosque	Contractor	EU-CSC/ EU-DHP	Prior to first reservoir filling	Monthly
▪ Submergence of 17 grave yards in the reservoir	▪ The graves must be protected by stone-pitching so that no floating and washing away of the bodies or skeletal remains occur.	EU-CSC	EU-DHP	Prior to first reservoir filling	Monthly
▪ Rock carvings at Shatihal are currently located in a private land and not protected and are subjected to vandalism. They have potential for further vandalism by construction workers	▪ DHP will support KP archeological department to (i) procure 25 acres of land for acquisition of land, in which rock carvings are located , (ii) fence the area, (iii) provide fiberglass sheds; (iv) develop tourist facilities and (v) documenting the importance of rock carvings and their translations	KP Archaeological Department	EU-DHC/ EU-DHP	Pre-Construction/ Construction	Monthly
	▪ No construction facilities or spoil disposal facilities are to be established near Shatial rock carvings ▪ No construction areas and construction activities will be carried out near the rock carvings site	Contractor	EU-DHC/ EU-DHP	Construction	Monthly
▪ Enhancement measures for a 400 year old historical mosque at Seo that is widely revered in the project area	▪ Construction of toilet facilities in the mosque ▪ Provision of firefighting equipment to the mosque	Community	EU-DHC/ EU-DHP	Construction	Monthly
▪ Chance finds during construction	chance-find procedures, described in Section 5 of Antiquity Act of 1975, are: ▪ Sub-section (1): Whoever discovers, or finds accidentally, any	Contractor	EU-DHC/ EU-DHP	Construction	Whenever reported

EMP Sub-Plan 13. Physical Cultural and Social Resources Management					
	movable antiquity shall inform the Director General within seven days of its being discovered or found and preserve it for the period specified in sub-section (2). ▪ Sub-section (2): If, within seven days of his being informed under sub-section (1) of the discovery of moveable antiquity or of a moveable antiquity having been found the Director General decides to take over the antiquity for purposes of custody preservation and protection the person discovering or finding its shall hand over to the Director General or a person authorized by him in writing. ▪ Sub-section (3): Where the Director General decides to take over an antiquity he may pay to the person by whom it is handed over to him such cash reward as the Advisory Committee may deem fit. ▪ Sub-section (4): If any person who discovers or finds any movable antiquity contravenes the provisions of sub-section (1) or sub-section (2), he shall be punishable with imprisonment for a term which may extend to three years, or with fine or with both or\and the court convicting such person shall direct that the antiquity in respect of which such contravention has taken place shall stand forfeited to the Federal Government.				
▪ **Auditing**	▪ Audit the development of Shatihal rock carvings. ▪ Audit the facilities at the construction work sites and workers camp sites ▪ Complaints register				
Guidelines, Standards and Legislation	▪ Pakistan Environmental Protection Act, 1997 ▪ National Environmental Quality Standards, 2000 and 2010 ▪ World Bank Group Environmental Health and Safety Guidelines (EHS Guidelines), 2007 ▪ Pakistan Antiquity Act, 1975				

Potential Concern	Corrective Action	Responsibility
▪ Complaints from the community about the construction activities and construction workers	▪ Investigate and address the necessary problems	GRC

EMP Sub-Plan 13. Physical Cultural and Social Resources Management		
▪ Lack of basic infrastructure facilities at the camp sites or Complaints from the construction workers for lack of standard facilities at the construction sites and campsites	▪ Investigate and address the necessary problems	GRC
Reporting	Monthly reports shall include information on the shifting of mosque, protection of graveyards, details of migrant construction workers and complaints on social and cultural issues	

3.18 EMP SUB-PLAN 14: OCCUPATIONAL HEALTH AND SAFETY PLAN

EMP Sub-Plan 14. Occupational Health and Safety Plan					
Objective	▪ Promote health and safety of construction workers in accordance with best international standards ▪ Comply with national employment and labour laws ▪ To anticipate and avoid adverse impacts on the health and safety of the construction workers and the community				
Performance criteria	▪ IFS performance standards on labour and working conditions				
Targets	▪ Zero accidents				
Issue/impact	**Mitigation measures/Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Rough terrain and difficult work conditions at the construction areas will create a number of occupational risks and hazards ▪ The construction activities will involve blasting, large scale excavation, underground works, operations of heavy construction machinery and vehicular traffic. These activities may pose health and safety hazards to the workers at site during the use of explosives, use of hazardous substances, lifting and handling of heavy equipment, operating machinery and electrical equipment, working near water or at height and more. ▪ Accidental fall in to the Indus will be a major risk for the construction workers because of steep slopes	▪ Each contractor will establish a comprehensive OHS Plan aimed at preventing accidents, injuries and work-related diseases. This plan will be submitted to PMU and supervision consultant for review and approval before construction. Each contractor will also prepare an Emergency Response Plan defining procedures to be followed during any emergency. This plan will be submitted to PMU and supervision consultant for review and approval.	Contractor	EU-DHP/EU-CSC	Pre-Construction	
	▪ All workers must be provided with and use appropriate personal protective equipment (PPE) such as safety boots, helmets, gloves, protective clothing, goggles, and ear protection. First aid must be provided and there would be procedures in place to access appropriate emergency facilities; ▪ Contractors will be responsible for developing procedures to address the OHS hazards. Signage related to hazards and risks must be in place at the work sites. ▪ Management procedures to address temperature stress, for instance in relation to extreme heat will be required; ▪ Health screening of employees would be a Contractor obligation prior to laborers working on site and living in the temporary accommodation facilities. The health screening would entail normal review of physical fitness and also include a review of appropriate vaccinations. Workers would be given vaccinations where required; ▪ All employees need to carry out induction health and safety training prior to commencement of work. OHS issues would be part of the employee training plan. Training would include the provision of	Contractor	EU-DHP/EU-CSC	Construction	Monthly

EMP Sub-Plan 14. Occupational Health and Safety Plan					
	appropriate written or visual materials to reinforce learning. Where illiteracy levels are high, OHS issues need to be covered more frequently than normal in toolbox talks; ▪ An emergency response team and plan must be identified. Training and drills based on the accident and emergency preparedness and response plan must be carried out quarterly. Training requirements, including for emergency preparedness, will need to be updated annually; ▪ It is essential that all personnel likely to be involved in the Project at the construction site undergo a basic training program prior to performing assigned work. ▪ Standard operation procedures for handling accidents related to electrocution, movement of plant equipment; falls from height, falling objects, working in confined spaces and dealing with hazardous materials				
▪ Increased OHS risks during construction of tunnels	In addition to above ▪ OHS protocols for tunnel construction in accordance with industry standards ▪ Maintenance of safe working conditions in the tunnels including adequate lighting, ventilation, oxygen supply ▪ Record of personnel entering and exiting the construction areas	Contractor	EU-DHP/EU-CSC	Construction	Monthly
▪ Campsites for construction workers are the important locations that have significant impacts such as health and safety hazards	▪ Implement mitigation measures in ECP 16: Construction Camp Management	Contractor	EU-DHC/ EU-DHP	Construction	Monthly
▪ Health Issues for workers and local population	▪ Ensure that periodic awareness campaign for HIV/AIDS is under taken for the project staff and workers. ▪ To accompany the resettlement process with adequate public health safeguarding for both relocated and residents population. ▪ To set and operationalize adequate and appropriate measures to minimize adverse effects on health risks of population. ▪ To keep the construction workers safe from the occupational hazards	CSC with the help of EDO,Dasu	DHP	Construction	Monthly

EMP Sub-Plan 14. Occupational Health and Safety Plan			
Auditing	Review of OHS of Protocols and implementation		
Guidelines, Standards and Legislation	▪ IFC Performance Standards World Bank Group EHS Guidelines		
Potential Concern		**Corrective Action**	**Responsibility**
▪ Unsafe working conditions and practices		Training of construction workers	Contractor
▪ Accidents		Thorough investigation on the cause of accidents and develop procedures to mitigate further accidents	Contractor
▪ Grievances from the construction workers		Investigate and address the necessary problems	GRC
Reporting	▪ Data on the OHS related incidents in the contractors monthly reports		

3.19 EMP SUB-PLAN 15: SUMMARY OF SOCIAL AND RESETTLEMENT MANAGEMENT PLAN

EMP Sub-Plan 15. Summary of Social and Resettlement Management Plan					
Objective	▪ No adverse impacts on the community and their livelihoods ▪ Social and cultural aspects of the local community and the in-migrant construction workers are not affected.				
Performance criteria	▪ Affected people living condition to be improved or restored at the pre-project level ▪ Compensation in accordance with approved entitlement matrix given in RAP				
Targets	▪ Zero grievances				
Issue/impact	**Mitigation measures/Actions**	**Responsibility for implementation**	**Responsibility for Supervision**	**Timing**	**Monitoring**
▪ Acquisition of 4643 ha of land for project interventions	▪ Compensation amount for land acquisition will be disbursed in an equitable and transparent manner. The compensation will be paid to land owner before the land is acquired. Compensation will be paid on Agreed Values which are based on prevailing market rates and rates adopted in Diamer Basha Project. For detail see RAP(reservoir and Dam)	District Revenue Officer (DRO)	DHP	Pre-Construction	Monthly
▪ Loss of property and trees of 767 households	▪ Compensation for on Replacement Values as given in RAP	DRO	DHP	Pre-construction	Monthly
▪ Loss of Income from displaced commercial premises	▪ . All the business operators will be entitled for grant against loss of business and relocation to the Resettlement Sites and new market area to be established under Management Plan for ▪ In migration and construction workers (volume 10 of social and Resettlement Management Plan).	DHP.	WAPDA	Construction	Monthly
▪ Resettlement of Affectees	▪ Residential plots will be provided o affectees in self managed resettlement sites where land and basic amenities will be developed by WAPDA. For detail see RAP (reservoir and Dam)	Project Resettlement Office	WAPDA	Pre-construction & Construction	Monthly
▪ Social/Cultural and Economic Impact on local population due to influx of construction workers and In migrants during construction period	▪ "code of conduct" for workers and In migrants will be implemented ▪ There will be separate labor colony /camp for the construction workers, away from the villages' population area. ▪ DHP Field Office will undertake community level consultations to preparing local communities and businesses in relocation planning and distribution of the in-migrants over the project construction period. ▪ Committees consisting of local maleks, business groups, civil society members and representatives of construction	Contractors/ DHP	WAPDA	Construction phase	Monthly

EMP Sub-Plan 15. Summary of Social and Resettlement Management Plan					
	contractors/labor agent(s) will be established in right and left banks. Assistant Coordination Officer (ACO) will chair the Committee. ▪ The Committees will prepare a "master" work plan to distribute the in-migrants to various locations, depending on availability of shelter/housing, access to worksite, markets, schools and other social and support services. ▪ The Committee will work with and advise the contractors and/or local labor agents to design and construct labor camp sites for housing the construction workers/in-migrants so that there is little or no conflict with the existing hamlets/village settlements. ▪ The Committee with encourage local well-off groups to build rental houses for in-migrants, as an opportunity to generate additional income for them ▪ Access to Housing/Shelter, Food Sources and Market ▪ Improvements in the Local Social Infrastructure ▪ Employment and Business Opportunities for All ▪ Community/Area Development Plan				
▪ Rights of Employment	▪ Technical and nontechnical labor will be recruited from the local area of the project equitably from various tribes/castes, and employment procedures will be transparent.	Contractors	DHP	Construction	Monthly
▪ Construction activities near religious and cultural sites	▪ Implement mitigation measures in ECP 17: Cultural and Religious Issues	Contractor	EU-DHC/ EU-DHP	Construction	Monthly
▪ Environmental management and enhancement at the resettlement villages	▪ Support the AHs in the resettled villages for operation and management of infrastructure facilities, such as waste and waste water disposal, water supply, schools, health facilities; and sanitation and hygiene promotion activities	Contractor	EU-DHC/EU-DHP	Construction	Quarterly
▪ Health Issues for workers and local population	▪ Ensure that periodic awareness campaign for HIV/AIDS is under taken for the project staff and workers. ▪ To accompany the resettlement process with adequate public	CSC with the help of EDO,Dasu	DHP	Construction	Monthly

EMP Sub-Plan 15. Summary of Social and Resettlement Management Plan					
	health safeguarding for both relocated and residents population. ▪ To set and operationalize adequate and appropriate measures to minimize adverse effects on health risks of population. ▪ To keep the construction workers safe from the occupational hazards				
▪ Gender Impacts	▪ Gender sensitization and capacity building of project staff, including district administration, This will be a continuous process through workshops and seminars. ▪ Approaching the women as per GAP and implementing GAP action plans	The GAP will be implemented by the Project Resettlement Office (PRO)	DHP	Construction	Monthly

Potential Concern	Corrective Action	Responsibility
▪ Grievances During Implementation Of SRMP	The Project will establish a four-tier GRC system for resolution of grievances and disputes related to social and environmental resettlement safeguard plans. The GRCs are to ensure accessibility, fairness and independence of the procedures.	DHP with the help of GRC

Monitoring and Reporting	▪ Monitoring and Reporting of SRMP implementation will be carried out at four levels. ▪ First, DHP will conduct regular internal monitoring through the Resettlement Monitoring Unit under the supervision of DD (Resettlement). ▪ Second, external monitoring will be conducted by an independent external expert/agency commissioned by DHP. ▪ Third, the Construction Supervision Consultants will also carry out supervision and monitoring to assist DHP and the donors. The donors themselves will also monitor the overall performance of project, including the RAP and ILRP implementation through missions. ▪ Fourth, the Panel of Experts (POE) established for this project will also periodically monitor the implementation of the projects.

4. MONITORING PROGRAM

Monitoring program during construction and operation presented in various EMP sub plans are summarized and presented in in Table 4.1.

Table 4.1: Environmental monitoring during construction and operation

Parameter	Location	Means of Monitoring	Frequency	Compliance Requirements	Responsible Agency	
					Implementation	Supervision
During Construction						
Landslides	At 37 identified landslide prone areas in EIA	Visual Inspection on stability of landslides	Fortnightly	EMP sub-plan 3	Contractor	CSC, DHP
Erosion	Earthwork areas and material storage sites	Visual inspection of erosion prevention measures and occurrence of erosion	Monthly	EMP sub-plan 3	Contractor	EU-CSC, EU-DHP
Surface water quality	In the rivers and tributaries at the downstream of the construction sites. The locations of sampling can be same locations of baseline water quality or new locations recommended by the CSC. Waste water discharges into the river from the concrete batching plants, tunneling works, etc.	Sampling and analysis of river water quality and waste water discharges for the key parameters given in NEQS (river water quality – DO, BOD, COD, Temperature, pH, Conductivity, TSS, turbidity, nitrate; ’ Waste water – BOD. TSS, turbidity, TDS, COD, grease and oil, iron, ammonia, sulfates, chlorides)	Quarterly	EMP sub-plan 4	Contractor	EU-CSC, EU-DHP
			Annually	EMP sub-plan 4	External Monitor (DHP through a nationally recognized Laboratory)	EU-CSC, EU-DHP
		Spot measurements of pH (in presence of EU CSC&DHP) Conductivity, turbidity. Visual inspection on presence of petroleum products.	Monthly	EMP sub-plan 4	Contractor	EU-CSC, EU-DHP
Air Quality (dust, smoke)	Construction sites, quarry areas along KKH and blasting areas	Visual inspection to ensure good standard equipment is in use and dust suppression measures (spraying of waters) are in place.	Weekly	EMP Sub-Plan 5	Contractor	EU-CSC, EU-DHP
	Material storage sites	Visual inspection to ensure dust suppression work plan is	Weekly	EMP Sub-Plan 5	Contractor	EU EU-CSC, EU-DHP

Parameter	Location	Means of Monitoring	Frequency	Compliance Requirements	Responsible Agency	
					Implementation	Supervision
		being implemented				
Air Quality in tunnels	At tunnels	Spot measurements for CO, NOx and SO_2 levels in the tunnels	Monthly	EMP Sub-Plan 5	Contractor	EU-DHP
Air Quality (PM10, NO2, SO2, CO_2, CO)	Near the sensitive sites and settlements at the close to the construction works and along KKH. The locations of sampling can be same locations of baseline air quality or new locations recommended by the CSC.	Air quality monitoring for 24 hours for the parameters specified in NEQS 2000	Quarterly	EMP Sub-Plan 5	Contractor	EU-CSC, EU-DHP
			Annually	EMP Sub-Plan 5	External Monitor (DHP through a nationally recognized laboratory)	EU-CSC, EU-DHP
Emissions from plant and equipment	At all the construction sites for dam, KKH and tunnels	Visual Inspection	Monthly	EMP Sub-Plan 6	Contractor	EU-CSC, EU-DHP
Noise and vibration	Near the sensitive sites and settlements at the close to the construction works and along KKH. The locations of sampling can be same locations of baseline air quality or new locations recommended by the CSC	24 hour noise monitoring	Quarterly	EMP Sub-Plan 7	Contractor	EU-CSC, EU-DHP
		24 hour noise monitoring	Annually	EMP Sub-Plan 7	External Monitor (DHP through a nationally recognized laboratory)	EU-CSC, EU-DHP
		Spot measurements	Monthly	EMP Sub-Plan 7	Contractor	EU-DHP
Waste Management	At the designated rock disposal area	Visual inspection on spoil disposal in accordance with EMP Sub plan on Waste Management	Monthly	EMP Sub-Plan 8	Contractor	EU-CSC, EU-DHP
	Construction camps and construction sites	Visual inspection that solid waste is disposed at designated sites	Monthly	EMP Sub-Plan 8	Contractor	EU-CSC, EU-DHP
Spills from Hydrocarbon	Material storage sites and construction yards	Visual Inspection for leaks and spills	Monthly	EMP Sub-Plan 9	Contractor	EU-CSC, EU-DHP

Parameter	Location	Means of Monitoring	Frequency	Compliance Requirements	Responsible Agency	
					Implementation	Supervision
and chemical storage						
Wild life (including migratory bird)	Project area	Surveys for wildlife and migratory birds in accordance with EMP Sub-Plan on Terrestrial and Ecology Management	Quarterly	EMP Sub Plan 10	DHP through nationally recognized institute	EU-CSC, EU-DHP
	Near all construction sites	Ensure the adherence of the migratory measures proposed in the EMP	Monthly	EMP Sub Plan 10	DHP through nationally recognized institute	EU-CSC, EU-DHP
Fish	Upstream and downstream of the dam	Surveys for fish in accordance with EMP Sub-Plan on Aquatic Ecology Management	Half yearly	EMP Sub Plan 11	DHP through nationally recognized institute	EU-CSC, EU-DHP, External Monitor
Traffic Safety	Along KKH and access roads to the construction areas	Visual inspection to see whether Traffic Management Plan (EMP Sub Plan 12) is implemented	Monthly	EMP Sub Plan 12	Contractor	EU-CSC, EU-DHP,
Local Roads	Approach Roads	Visual inspection to ensure local roads are not damaged	Monthly	EMP Sub Plan 12	Contractor	EU-CSC, EU-DHP,
Cultural and archeological Sites	At the physical and cultural resources identified in the EIA	Visual observation on implementation of EMP Sub Plan 13 on Physical Cultural Resources Management	Monthly	EMP Sub Plan 13	Contractor	EU-CSC, EU-DHP,, External Monitor
Drinking water and sanitation	In construction sites and construction camps	Ensure the construction workers are provided with safe water and sanitation facilities in the site	Weekly	EMP Sub Plan 13	Contractor	EU-CSC, EU-DHP,
Safety of workers	At work sites	Usage of Personal Protective equipment	Monthly	EMP Sub Plan 13	Contractor	EU-CSC, EU-DHP,
Reinstatement	All Work Sites	Visual Inspection	After	EMP Sub-Plan 1		

Parameter	Location	Means of Monitoring	Frequency	Compliance Requirements	Responsible Agency	
					Implementation	Supervision
of Work Sites			completion of all works			
Plantation	At all plantation sites	Visual inspection to ensure plantations is growing well.	Monthly	EMP Sub-Plan 10	District Forest Office with support of civil society	EU-CSC, EU-DHP,, External Monitor
Contractors Decommissioning						
Construction yards	Construction work areas and contractor yards	Visual inspection to ensure removal of all buildings and equipment from the site. The site is clean and was restored to original condition	Before contractor demobilization		Contractor	EU-CSC, EU-DHP,
Construction camps	Construction camps	Visual inspection to ensure removal of all buildings and equipment from the site. The site is clean and was restored to original condition	Before contractor demobilization		Contractor	EU-CSC, EU-DHP,
During Operation						
Surface Water Quality	Upstream and downstream of the dam	Sampling and analysis for sediment load, DO and temperature	Half Yearly	EMP Sub-Plan 4	DHP through national laboratory	CSC, External Monitor
	In the reservoir	In situ measurements on DO and Temperature at different depths in the reservoir	Quarterly	EMP Sub-Plan 4	DHP through national laboratory	CSC, External Monitor
Environmental flows	Downstream of dam	Measurements of discharges to the downstream	Monthly	EMP Sub-Plan 4	DHP	External Monitor
Migratory birds	Reservoir area	Surveys for migratory birds in accordance with EMP Sub-Plan on Terrestrial and Ecology Management	Half Yearly	EMP Sub Plan 10	DHP through nationally recognized institute	EU-DHP, External Monitor
Fish	Upstream and downstream	Surveys for fish in accordance	Half yearly	EMP Sub Plan 11	DHP through	EU-DHP,

Parameter	Location	Means of Monitoring	Frequency	Compliance Requirements	Responsible Agency	
					Implementation	Supervision
	of the dam	with EMP Sub-Plan on Aquatic Ecology Management Limological conditions in the reservoir			nationally institute	External Monitor
	Reservoir fisheries	Monthly data on fish catches	Monthly	EMP Sub Plan 11	Fisheries Contractor	EU-DHP,
	Downstream of Dam	Effect of sediment deposition in the on downstream habitat	Half yearly	EMP Sub Plan 11	DHP through nationally institute	EU-DHP, External Monitor
		Effectiveness of minimum flows, in the dam-to-tailrace outlet segment	Yearly	EMP Sub Plan 11	DHP through nationally institute	EU-DHP, External Monitor
Dam Safety	At the dam site	Monitoring of data from dam safety equipment	Quarterly	EMP Sub Plan 2	DHP	Dam Safety Organization of WAPDA
		Survey, inspection and testing	Yearly	EMP Sub Plan 2	Dam Safety Organization of WAPDA	DHP
		Survey, inspection and testing	Once in 3 years	EMP Sub Plan 2	External Monitor (through an internationally recognized institute)	DHP

5. CAPACITY BUILDING PROGRAMS

5.1 ENVIRONMENTAL AWARENESS AND TRAINING

The objective of the environmental awareness and training program is to provide all personnel working on the Project with:

- An understanding of what their responsibilities are as outlined in the EMP;
- A means of developing a culture of compliance with the Project environmental requirements; and
- A means to improve the environmental awareness of the workforce through the education of Project field personnel.

5.1.1 Project Induction

A site specific environmental Project induction will be developed by the EU-CSU. An environmental training register will be kept, maintained and used to verify that all personnel working on-site have completed the environmental induction.

The content of the site induction is to include, but not be limited to:

- An overview of the Project environmental policy;
- Relevant details of the EMP including potential significant impacts;
- Identification of relevant Project stakeholders;
- Conditions of any environmental licenses, permits and approvals;
- Roles and responsibilities of all personnel in achieving environmental conformance;
- Any identified environmental sensitive areas;
- Definition and management of environmental incidents and operation of pollution / spill control equipment;
- Definition and management of waste and an explanation of a waste minimization and recycling strategy;
- Processes for refueling and the management and use of hazardous substances; and
- Response to environmental incidents.

5.1.2 Construction Environmental Toolbox Talks

A toolbox talk involves the dissemination of information to Project personnel at the field level. Generally toolbox talks focus on safety aspects with reference to certain Project jobs or tasks. They can be used to disseminate environmental management information. Environmental toolbox talks should cover aspects such as:

- Explanation of new project requirements;
- Explanation of the key environmental risks associated with an activity or specific procedures which could have potential environmental impacts;
- Explanation of mitigation strategies with reference to an activity or specific procedures which could have potential environmental impacts;
- Reminder of the importance of specific or generic environmental commitments;
- To obtain feedback related to environmental issues; or
- Any other purpose related to the implementation of the EMP.

Toolbox training will help to ensure that relevant information is communicated to the workforce and will also provide a forum for feedback on issues of interest or concern. Toolbox training will generally be prepared and delivered by the Contractor but may also be delivered by EU-CSC. Possible Toolbox Talk topics include:

- Management of works in and near waterways;
- Noise and vibration minimization

- Wildlife conservation;;
- Soil erosion and sediment control; and
- Waste management, minimization and recycling.

A register of toolbox talks and attendance records shall be maintained on-site.

5.2 CAPACITY BUILDING OF WEC AND PMU

A series of capacity building programs are recommended for WEC and PMU/DHP to improve their capacity in understanding and managing environmental impacts with DHP and other future hydropower development projects in Pakistan. The training programs will cover

- Social and Environmental issues with the construction and operation of DHP, and addressing their impacts
- Monitoring and auditing of implementation of EMPs during construction and operation of DHP
- Social and Environmental laws & regulations, norms, procedures and guidelines of Pakistan, World Bank and other international financiers
- Catchment management and sedimentation control
- Preparation of environmental documentation
- Reservoir fisheries development and management
- Climate change impacts and adaptive planning
- Early flood warning system
- Hydropower reservoir impacts on geomorphology and sedimentation
- Hydropower impacts on migratory birds
- GIS, MIS, database management Methods of sampling and testing various environmental parameters

DHP will be associated with set of esteemed international organizations (IUCN, WWF, etc.) and education/training institutes (Punjab University, WAPDA Engineering Academy, etc.) which will act as ‘twinning institutions’ for capacity building and development. These institutions will support DHP and WEC with providing their laboratories for analysis, trained human resources, and other technical facilities available with them. These training programs can be conducted biannually basis.

Some of the senior representatives should receive environmental and social safeguard training under a recognized program (national and/or overseas).

DHP will establish and maintain MIS system in the implementation of the Project. DHP will hire the services of MIS specialists for development and maintenance of MIS system.

6. COST ESTIMATES

6.1 EMP COST ESTIMATES

The cost estimates for various mitigation, monitoring and management plans proposed in the EMP are presented in the Table 6.1. The table also includes resources required for implementing these plans and the phase (pre-construction, construction and operation) of the Project. The cost estimates also include the budget for environmental monitoring, consultants for EMP implementation, institutional strengthening and capacity building and environmental enhancement/compensation measures. Detailed breakup cost estimates are shown in Annex B. These costs will be financed by the Project and will be included in the overall project costs of the DHP during operation. Further an environmental fund with the revenue of DHP for long term environmental development activities in the Project Area.

Table 6.1: Cost Estimates of EMP

S.No	Description of the Plan	Objective of the Plan	Resources Required	Implementation Period	Budget in USD	Ref.
A	**Contractors Bill of Quantities for Implementation of EMP**					
1.1	Contractors implementation of EMP	Contractor will prepare and implement following plans (Contractors Environmental Action Plan) in accordance with Project's EMP and World Bank Group EHS Guidelines : • Site specific sediment and erosion control plan for each construction site and quarry; • Site specific camps management plan for each camp; • Spoil management and disposal plan for each site; • Waste management plan for each construction site and quarry; • Site specific pollution control (water, air, noise) plan for each construction site and quarry; • Site specific traffic management plan for each construction site and quarry; • Site specific decommissioning and landscaping plans for quarry sites, spoil disposal sites, temporary roads and other disturbed areas; • Occupational health and safety plan and training programs; • Emergency Response Plan and Early Warning System ; • HIV-AIDS Preventive Management Plan and training programs; • Complaints logging system and response plan; • Standard Operating Procedures for blasting operations; • Standard Operating Procedures for pollution spills, and management of fuels and hazardous goods; and • Demobilisation plan after completion of works		All Phases of Construction	24,285,000	Table A1 of Annex B
1.2	Environmental Staff of Contractors	To ensure contractors have dedicated environmental staff to implement EMP	Environmental Specialist & OHS specialist and other required staff to implement CEAP			

S.No	Description of the Plan	Objective of the Plan	Resources Required	Implementation Period	Budget in USD	Ref.
2	Water Quality Laboratory	Monitoring of water and waste water quality	Laboratory establishment by contractor with necessary equipment to monitor water and waste water quality	2015-2022 (Phase1&2 Construction)	540,000	Table A2 of Annex B
3	Air, Noise, Vibration and Potable Water Quality Equipment	Spot measurements for air, noise and water quality meters will assist supervision staff to ensure compliance with EMP	10 sets of portable kits for pH, turbidity, noise, vibration, conductivity meter, PM, CO, NOx and CO_2 with equipment operator	2015-2022 (Phase1&2 Construction)	441,000	Table A3 of Annex B
Sub Total: A. Environmental Staff and Consultants					**25,266,000**	
B	**PMU Budget on Environmental Staff and Implementation of Mitigation and Monitoring Measures**					
1	Environmental Staff of EU-DHP	Environmental staff of WAPDA's Project Management Unit of DHP	Environmental, Ecology and OHS specialists	2014-2025 (Phase1&2 Construction and Operation)	2.900.000	Table B1 of Annex B
2	Environmental Staff of Construction Supervision Consultant	Environmental specialists (national and international) will be hired under Construction Supervision Consultant for effective implementation of EMP	3 international (intermittent – 2 years each) and 3 national (5 years) environmental specialists will be hired.	2015-2022 (Construction)	4,338,000	Table B2 of Annex B
3	Panel of Experts – Social and Environment	To advise DHP on EMP and SRMP implementation issues	International experts on social and environment	2015-2022 (Phase1&2 Construction)	425,000	Table B3 of Annex B
4	External Monitoring Consultants	Air, noise and water quality at the construction sites shall comply with NEQS	External monitoring of air, noise and water quality annually	2015-2022 (Phase1&2 Construction)	500,000	Table B4 of Annex B
5	Internal Auditing	Internal Auditing by WAPDA Environmental Cell	Travel and field allowances	2015-2022 (Phase1&2 Construction)	200,000	Table B5 of Annex B
Sub Total: B. PMU Budget on Environmental Staff and Consultants					**8,363,000**	

S.No	Description of the Plan	Objective of the Plan	Resources Required	Implementation Period	Budget in USD	Ref.
C. Aquatic Ecology						
1	Studies to establish detailed baseline data on the native fish species in Upper Indus Basin, their biology and migration pattern; and long term monitoring – construction, construction and operation stages of the Project	To understand the fish movement upstream and downstream of the dam to assess the requirement of provisions for fish passage and fish screens at spill way/intake if required	A one year continuous study will be undertaken by a team of experts (fish expert, surveyors, and technical assistants) through field (tagging of fishes) and laboratory studies.	2014-2015 (pre-construction)	233,000	Table C1 of Annex B
		To obtain movement patterns and seasonal habitat use (especially over-wintering habitat in the Indus River main-stem) of snow carp and catfish to assess the environmental flow requirements from the dam	Quarterly monitoring by a fish expert (with support of surveyor and a technical assistant) through field and laboratory studies	2015-2019 (Construction)	335,000	Table C1 of Annex B
		Monitoring of fish condition in the reservoir and tributaries, fish entrainment, effectiveness reservoir fishery, etc.	Same as above for a period of 5 years. The study will be continued further if required from revenue of fish hatcheries	2020-2025 (Operation)	400,000	Table C1 of Annex B
2	Fish capture and stocking	Design, installation and operation of methods for capture of brood stock fish and supply to hatcheries and stocking of fingerlings in the tributaries and Indus	Cost of facilities	2015-2019 (Construction)	200,000	Table C2 of Annex B
		Operation of facilities	Vehicles, training and operational protocols	2020-2030 (Operation)	500,000	Table C2 of Annex B
3	Installation of screens to avoid injury to fish at various outlets.	Installation of fish deterrent devices or screens at spillway entrance, intake to lower level outlets and penstocks to powerhouse gates, end of tail race	Cost of civil and mechanical works	2015-2019 (Construction)	400,000	Table C3 of Annex B
4	Fish Hatchery and R&D	Given weakness in biological	An R&D hatchery with all necessary	2018-2025	2,034,800	Table C4 of

S.No	Description of the Plan	Objective of the Plan	Resources Required	Implementation Period	Budget in USD	Ref.
	facility	knowledge of indigenous fish species, a R&D hatchery is recommended to undertake applied research.	civil works, facilities and human resources. 2 years of research and 5 years O&M costs are included in the budget. The budget for the hatchery maintenance after 5 years comes from the revenue of reservoir fisheries	Construction and Operation		Annex B
5	Fish habitat improvement of the tributaries	Improvement of fish habitats in the tributaries	Construction of pools/riffles in tributaries and staff for collection of brooders and leaving them in pools	2020-2025	108,000	Table C5 of Annex B
6	Capacity building of local Fisheries Departments	The objective is to build capacity for KP Fisheries Department, for reservoir fisheries management and community awareness programs for habitat protection	Training and awareness programs	2020-2025 (Operation)	100,000	Table C6 of Annex B
Sub-Total: C. Aquatic Ecology					**4,310,800**	
D. Terrestrial Ecology						
1	Tree Plantation	A compensation plan for the loss of 21,000 trees with 5-10 new trees for each affected tree. 100,000 trees and planned in the buffer areas of the reservoir.	Nursery to be established for 300,000 saplings (3 saplings for each tree to be planted). Tree plantation and conservation for 3 years with support of local community	2015-2019 (Construction)	1,620,000	Table D1 of Annex B
2	Strengthening of Community Protected Area in Kaigah and studies for developing new CCAs	Strengthening management of Kaigah CCA and conducting additional studies to develop new CCAs, Additional studies for establishing baseline condition for migratory birds. Capacity building programs for forest and wildlife departments	Conservation agencies like WWF and IUCN will be involved to conduct feasibility studies and establish conservation areas.	2016-2025 (Construction and Operation)	1,000,000	

S.No	Description of the Plan	Objective of the Plan	Resources Required	Implementation Period	Budget in USD	Ref.
3	Afforestation and forest regeneration program	Supporting local communities in the management of community forestry Enhancement of forest cover in the project area	Nursery and plantation programs to be designed with the support of district and provincial government forest departments	2022 onwards	3,000,000	
Sub-Total; D. Terrestrial Ecology					**5,620,000**	
E. Physical Cultural Resources						
1	Protection of Shatial Rock Carvings	Protection of designated archeological sites in the project area and construction of tourist facilities	Procurement of land, construction of fencing, office and tourist facilities; hiring and training of guides.	Pre-Construction and Construction (2015-2016)	1,539,435	Table E1 of Annex B
2	Relocation of historical mosque at Seer Gayal	Disassembling and reassembling of historical wooden mosque at Seer Gayal that will be submerged under reservoir.	Procurement of land at new site, and civil works for dismantling and re-erection.	2016-2017 (Construction)	29,000	Table E1 of Annex B
3	Protection of Graveyards that will be submerged in reservoir	Protect the graveyards with civil works to avoid the bodies to float in to the reservoir.	Civil works Stone pitching and mud plastering will be done and religious ceremony will be held in every graveyard	2017-2018 (Construction)	6,240	Table E1 of Annex B
4	Enhancement of Seo Mosque	Enhance the facilities at 400 year old and widely revered mosque in the project area	Civil works for enhancement facilities including toilets and firefighting facilities.	2015-2016 (Construction)	25,880	Table E1 of Annex B
5	Chance finds	Retaining a consultant to advise WAPDA in dealing with chance finds	Retaining archeologist	2014-2022	48,000	Table E1 of Annex B
Sub Total: E. Physical and Cultural Resources					**1,648,555**	
F. KKH Traffic Management						
1	Traffic Management	Traffic management along KKH to	Establishment of traffic units at Dasu	2016-2019	389,200	Table F1 of

S.No	Description of the Plan	Objective of the Plan	Resources Required	Implementation Period	Budget in USD	Ref.
		avoid any traffic congestion and accidents.	and along KKH with necessary staff and communication facilities for traffic control	(Phase1 Construction)		Annex B
Sub Total: F. KKH Traffic Management					**389,200**	
G. Climate Change, GLOFs and Sedimentation in UIB						
1	Early Flood Warning and Climate Monitoring	Establish flood telemetry network in Dasu catchment for early warning of floods and better management of floods	Installation of 18 telemetric equipment with automatic recorders (river level, rainfall, temperature) and network connection. Operational expenses (including training and staff remunerations) for a period of 10 years	2014-2020 (Construction)	2,500,000	Table G1 of Annex B
2	Glacier Monitoring Program	Glacier monitoring program for monitoring and research on the Upper Indus Basin glaciers	Facility construction and procurement of equipment	2015-2020 (Construction)	4,000,000	
3	Integrated Watershed Development Studies	Identifying and implementing possible solutions for control of sedimentation in UIB	Procurement of consultants and conducting studies and implementation of plans for control of sedimentation and landslides in UIB	2016-2025	4,000,000	
Sub Total: G. Climate Change, GLOFs and Sedimentation in UIB					**10,500,000**	
H. Capacity Building						
1	Capacity Building of environmental staff of DHP and WAPDA Environmental Cell (WEC)	Capacity building programs through association with universities or organizations	Twinning arrangements with the institutions and universities for regular training.	2014-2025 (Construction and Operation)	200,000	
		Training through special programs at national level	National level training programs	2014-2025	200,000	
		International training to the key	International training programs	(Construction	200,000	

S.No	Description of the Plan	Objective of the Plan	Resources Required	Implementation Period	Budget in USD	Ref.
		staff		and Operation)		
Sub-Total: H. Capacity Building					**600,000**	
I. Institutional Strengthening						
1	Establishment of GIS/MIS	GIS and MIS capability enhancement of DHP/WEC	Procurement of equipment, software and manpower	2014-2019 (Construction)	100,000	
2	Institutional strengthening of WEC	Providing computers, software and portable environmental testing equipment	Procurement of computer, software and instruments	2014-2016	200,000	
Sub-Total: I. Institutional Strengthening					**300,000**	
J. Environmental Management and Enhancement of Resettlement Villages						
1	Environmental Management and Enhancement of the Resettlement Villages	Support the AHs in the resettled villages for operation and management of infrastructure facilities, such as waste and waste water disposal, water supply, schools, health facilities; and sanitation and hygiene promotion activities	At 35 villages at the rate of 500 USD per month per 10 years	2015-2022	2,100,000	Table J of Annex B
Sub-Total: J. Environmental Management of Resettlement Villages					**2,100,100**	
K. Studies and Measures to Address Cumulative and Induced Impacts						
1	Studies and measures to address cumulative and induced impacts in Upper Indus Basin	Comprehensive research and implement best management practices described in Vol 7: Cumulative and Induced Impact Assessment		2015 onwards	10,000,000	
Sub-Total: K. Studies and Measures to Address Cumulative and Induced Impacts						
	Grand Total				**69,097,555**	

ANNEXES

List of Annexes

Annex A: National Environmental Quality Standards (NEQS)

Annex B: Cost Estimates of EMP

Annex C: Environmental Code of Practices

Annex D: World Bank Group/IFS EHS Guidelines

Annex – A

NATIONAL ENVIRONMENTAL QUALITY STANDARDS (NEQS 2000, 2009 and 2010)

Table1: NEQS for Municipal and Liquid Industrial Effluents[1, 2]
(mg/l, unless otherwise defined)

No.	Parameter	Standards		
		Into Inland Waters	**Into Sewage Treatment[5]**	**Into Sea[( )]**
1.	Temperature increase[7]	=<3°C	=<3°C	=<3°C
2.	pH value	6 to 9	6 to 9	6 to 9
3.	Five-day bio-chemical oxygen demand $(BOD)_5$ at 20°C[1]	80	250	80[8]
4.	Chemical oxygen demand (COD)[1]	150	400	400
5.	Total suspended solids (TSS)	200	400	200
6.	Total dissolved solids (TDS)	3,500	3,500	3,500
7.	Grease and oil	10	10	10
8.	Phenolic compounds (as phenol)	0.1	0.3	0.3
9.	Chlorides (as Cl')	1,000	1,000	SC[9]
10.	Fluorides (as F')	10	10	10
11.	Cyanide total (as CN')	1.0	1.0	1.0
12.	Anionic detergents (as MBAS)[2]	20	20	20
13.	Sulfates (SO_4)	600	1,000	SC[9]
14.	Sulfides (s')	1.0	1.0	1.0
15.	Ammonia (NH_3)	40	40	40
16.	Pesticides[3]	0.15	0.15	0.15
17.	Cadmium[4]	0.1	0.1	0.1
18.	Chromium (trivalent and hexavalent)[4]	1.0	1.0	1.0
19.	Copper[4]	1.0	1.0	1.0
20.	Lead[4]	0.5	0.5	0.5
21.	Mercury[4]	0.01	0.01	0.01
22.	Selenium[4]	0.5	0.5	0.5
23.	Nickel[4]	1.0	1.0	1.0
24.	Silver[4]	1.0	1.0	1.0
25.	Total toxic metals	2.0	2.0	2.0
26.	Zinc	5.0	5.0	5.0
27.	Arsenic[4]	1.0	1.0	1.0
28.	Barium[4]	1.5	1.5	1.5
29.	Iron	8.0	8.0	8.0
30.	Manganese	1.5	1.5	1.5
31.	Boron[4]	6.0	6.0	6.0
32.	Chlorine	1.0	1.0	1.0

Explanations:

1. Assuming minimum dilution 1:10 discharge, lower ratio would attract progressively stringent standards to be determined by the Federal Environmental Protection Agency. By 1:10 dilution means, for example that for each one cubic meter of treated effluent, the recipient water body should have 10 cubic meter of water for dilution of this effluent.
2. Methylene Blue Active substances assuming surfactant as biodegradable
3. Pesticides include herbicides, fungicides, and insecticides
4. Subject to total toxic metals discharge should not exceed level given at S. No. 25
5. Applicable only when and where sewage treatment is operational and BOD = 80 mg/l is achieved by the sewage treatment system.
6. Provided discharge is not at shore and not within 10 miles of mangrove or other important estuaries.
7. The effluent should not result in temperature increase of more than $3^{o}C$ at the edge of the zone where initial mixing and dilution take place in the receiving body. In case zone is not define, use 100 m from the point of discharge
8. ** The value for industry is 200 mg/l
9. *** Discharge concentration at or below sea concentration (SC)
10. Dilution of liquid effluents to bring them to the NEQS limiting values is not permissible through fresh water mixing with the effluent before discharging into the environment.
11. The concentration of pollutants in water being used will be subtracted from the effluent for calculating the NEQS limits.
12. Modified Benzene Alkyl Sulfate assuming surfacetant as biodegradable.

Table 2: NEQS for Gaseous Emissions

No.	Parameter	Source of Emission		Standards
1.	Smoke	Smoke opacity not to exceed		40% or 2 on Ringlemann Scale or equivalent smoke number
2.	Particulate matter[1]	(a)	Boilers and furnaces:	
		i)	Oil-fired	300
		ii)	Coal-fired	500
		iii)	Cement kilns	300
		(b) Grinding, crushing, clinker coolers and related processes, metallurgical processes, converters, blast furnaces and cupolas		500
3.	Hydrogen chloride	Any		400
4.	Chlorine	Any		150
5.	Hydrogen fluoride	Any		150
6.	Hydrogen sulfide	Any		10
7.	Sulfur oxides[2, 3]	Sulfuric acid/sulfonic acid plants		5,000
		Other plants except power plants operating on oil and coal		1,700
8.	Carbon monoxide	Any		800
9.	Lead	Any		50
10.	Mercury	Any		10
11.	Cadmium	Any		20
12.	Arsenic	Any		20
13.	Copper	Any		50
14.	Antimony	Any		20
15.	Zinc	Any		200
16.	Oxides of nitrogen[3]	Nitric acid manufacturing unit		3,000
		Gas-fired		400
		Oil-fired		600
		Coal-fired		1,200

1. Based on the assumption that the size of the particulate is 10 micron or more.
2. Based on 1 per cent sulfur content in fuel oil. Higher content of sulfur will cause standards to be pro-rated.
3. In respect of emissions of sulfur dioxide and nitrogen oxides, the power plants operating on oil and coal as fuel shall in addition to National Environmental Quality Standards (NEQS) special above, comply with the following standards.
4. Pakistan Standards for Sulfur Dioxide and Nitrogen Oxides for Power Plants Operating on Oil and Coal

Table 3: NEQS for Sulfur Dioxide

Sulfur Dioxide Background Levels (mg/m^3)			Standards	
			Criterion I	Criterion II
Background Air Quality (SO_2 basis)	**Annual Average**	**Maximum 24-Hour Interval**	**Max. SO_2 Emissions (TPD)**	**Max. Allowable 1-Year Average Ground Level Increment to Ambient (mg/m^3)**
Unpolluted	< 50	< 200	500	50
Moderately polluted[1]				
Low	50	200	500	50
High	100	400	100	10
Very polluted[2]	> 100	> 400	100	10

1. For intermediate values between 50 and 100 $\mu g/m^3$ linear interpretation should be used.
2. No project with sulfur dioxide emissions will be recommended.

Table 4: NEQS for Nitrogen Oxides

Annual arithmetic mean of ambient air concentrations of nitrogen oxides (expressed as NO_2) should not exceed		100 $\mu g/m^3$ (0.05 ppm)
Maximum emission levels for stationary source discharges, before mixing with the atmosphere: For fuel fired steam generators		
	Liquid fossil fuel	130 ng/J of heat input
	Solid fossil fuel	300 ng/J of heat input
	Lignite fossil fuel	260 ng/J of heat input

Table 5: NEQS for Noise

S No.	Category of Area/Zone	Effective from Ist July, 2010		Effective from Ist July, 2012	
		Limit in dB(A) Leq*			
		Day time	Night time	Day time	Night time
1.	Residential are (A)	65	50	55	45
2.	Commercial are (B)	70	60	65	55
3.	Industrial area (C)	80	75	75	65
4.	Silence zone (D)	55	45	50	45

Note:

1. Day time hours: 6 .00 am to 10.00 pm
2. Night Time hours: 10.00 pm to 6.00 am
3. Silence zone: Zones which are declared as such by the competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts and courts.
4. Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.
5. dB(A) Leq: time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

Table 6: NEQS for Ambient Air

Pollutants	Time-weighted Average	Concentration in Ambient Air		Method of Measurement
		Effective from 1st July 2010	Effective from 1st January 2013	
Sulfur Dioxide (SO_2)	Annual Average*	80 μg/m^3	80 μg/m^3	-Ultra Violet Fluorescence method
	24 hours**	120 μg/m^3	120 μg/m^3	
Oxide of Nitrogen as (NO)	Annual Average*	40 μg/m^3	40 μg/m^3	-Gas Phase Chemiluminescence
	24 hours**	40 μg/m^3	40 μg/m^3	
Oxide of Nitrogen as (NO_2)	Annual Average*	40 μg/m^3	40 μg/m^3	-Gas Phase Chemiluminescence
	24 hours**	40 μg/m^3	80 μg/m^3	
O_3	1 hour	180 μg/m^3	130 μg/m^3	-Non dispersive UV absorption method
Suspended Particulate Matter (SPM)	Annual Average*	400 μg/m^3	360 μg/m^3	-High Volume Sampling, (Average flow rate not less than 1.1 m^3/min)
	24 hours**	550 μg/m^3	500 μg/m^3	
Respirable particulate Matter. PM_{10}	Annual Average*	200 μg/m^3	120 μg/m^3	-β Ray Absorption method
	24 hours**	250 μg/m^3	150 μg/m^3	
Respirable Particulate Matter. $PM_{2.5}$	Annual Average*	25 μg/m^3	15 μg/m^3	-β Ray Absorption method
	24 hours**	40 μg/m^3	35 μg/m^3	
	1 hour	25 μg/m^3	15 μg/m^3	
Lead (Pb)	Annual Average*	1.5 μg/m^3	1 μg/m^3	ASS Method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	2 μg/m^3	1.5 μg/m^3	
Carbon Monoxide (CO)	8 hours**	5 mg/m^3	5 mg/m^3	Non Dispersive Infra Red (NDIR) method
	1 hour	10 mg/m^3	10 mg/m^3	

* Annual arithmetic mean of minimum 104 instruments in a year taken twice a week 24 hourly at uniform interval

** 24 hourly /8 hourly values should be met 98% of the in a year. 2% of the time, it may exceed but not on two consecutive days.

Table 7: NEQS for Drinking Water

Properties/ Parameters	Standard Values For Pakistan	Who Guidelines	Remarks
Bacterial			
All water intended for drinking (e.Coli or Thermo tolerant Coliform bacteria)	Must not be detectable in any 100 ml sample	Must not be detectable in any 100 ml sample	Most Asian countries also follow WHO standards
Treated water entering the distribution system (E.Coli or thermo tolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml sample	Must not be detectable in any 100 ml sample	Most Asian countries also follow WHO standards
Treated water in the distribution system (E.coli or thermo tolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml sample In case of large supplies, where sufficient samples are examined, must not be present in 95% of the samples taken throughout any 12-month period.	Must not be detectable in any 100 ml sample In case of large supplies, where sufficient samples are examined, must not be present in 95% of the samples taken throughout any 12-month period.	Most Asian countries also follow WHO standards
Physical			
Colour	≤15 TCU	≤15 TCU	
Taste	Non objectionable/Acceptable	Non objectionable/Acceptable	
Odour	Non objectionable/Acceptable	Non objectionable/Acceptable	
Turbidity	< 5 NTU	< 5 NTU	
Total hardness as CaCO3	< 500 mg/l	–	
TDS	< 1000	< 1000	
pH	6.5 – 8.5	6.5 – 8.5	
Chemical			
Essential Inorganic	mg/Litre	mg/Litre	
Aluminium (Al) mg/1	<0.2	0.2	
Antimony (Sb)	<0.005 (P)	0.02	
Arsenic (As)	< 0.05 (P)	0.01	Standard for Pakistan similar to most Asian developing countries
Barium (Ba)	0.7	0.7	
Boron (B)	0.3	0.3	
Cadmium (Cd)	0.01	0.003	Standard for Pakistan similar to most Asian developing countries
Chloride (Cl)	<250	250	
Chromium (Cr)	<0.05	0.05	
Copper (Cu)	2	2	
Toxic Inorganic	mg/Litre	mg/Litre	
Cyanide (CN)	<0.05	0.07	Standard for Pakistan similar to Asian developing countries

Properties/ Parameters	Standard Values For Pakistan	Who Guidelines	Remarks
Fluoride (F)*	<1.5	1.5	
Lead (Pb)	<0.05	0.01	Standard for Pakistan similar to most Asian developing countries
Manganese (Mn)	< 0.5	0.5	
Mercury (Hg)	<0.001	0.001	
Nickel (Ni)	<0.02	0.02	
Nitrate (NO3)*	<50	50	
Nitrite (NO2)*	<3 (P)	3	
Selenium (Se)	0.01(P)	0.01	
Residual chlorine	0.2-0.5 at consumer end 0.5-1.5 at source	–	
Zinc (Zn)	5.0	3	Standard for Pakistan similar to most Asian developing countries
* indicates priority health related inorganic constituents which need regular monitoring.			
Organic			
Pesticides mg/L		PSQCA No. 4639-2004, Page No. 4 Table No. 3 Serial No. 20- 58 may be consulted.***	Annex II
Phenolic compounds (as Phenols) mg/L		< 0.002	
Polynuclear aromatic hydrocarbons (as PAH) g/L		0.01 (By GC/MS method)	
Radioactive			
Alpha Emitters bq/L or pCi	0.1	0.1	
Beta emitters	1	1	

*** PSQCA: Pakistan Standards Quality Control Authority.

Proviso:

1. The existing drinking water treatment infrastructure is not adequate to comply with WHO guidelines. The arsenic concentrations in South Punjab and in some parts of Sindh have been found high then Revised WHO guidelines. It will take some time to control arsenic through treatment process. Lead concentration in the proposed standards is higher than WHO Guidelines. As the piping system for supply of drinking water in urban centres are generally old and will take significant resources and time to get them replaced. In the recent past, lead was completely phased out from petroleum products to cut down lead entering into environment. These steps will enable to achieve WHO Guidelines for Arsenic, Lead, Cadmium and Zinc. However, for the bottled water, WHO limits for Arsenic, Lead, Cadmium and Zinc will be applicable and PSQCA Standards for all the remaining parameters.

Table 7: NEQS for Motor Vehicle Exhaust and Noise

Table 7.1: For in Use Vehicles

Sr. No	Parameter	Standards (maximum permissible limit)	Measuring method
1	Smoke	40 % or 2 on the ringlemann scale during engine acceleration mode	To be compared with ringlemann chart at a distance of 6 meters or more
2	Carbon Monoxide	6 %	Under idling conditions: Non dispersive infrared detection through gas analyzer
3	Noise	85 db (A)	Sound meter at 7.5 meters from the source

Table 7.2: For New Vehicles (Diesel)

(a) Emission Standards for Passenger Cars and Light Commercial Vehicles (g/Km)

Type of Vehicle	Category/Class	Tiers	CO	HC+ NOx	PM	Measuring Method
Passenger Cars	M1: with reference mass (RW) upto 2500 kg. Cars with RW over 2500 kg to meet NI category standards	Pak-II IDI	1.0	0.7	0.08	NEDC (ECE 15 + EUDCL)
		Pak-II DI	1.0	0.9	0.10	
Light Commercial Vehicles	N1-I (RW<1250 kg)	Pak-II IDI	1.0	0.70	0.08	
		Pak-II DI	1.0	0.90	0.10	
	N1-II (1250 kg<RW<1700 kg)	Pak-II IDI	1.25	1.0	0.12	
		Pak-II DI	1.25	1.3	0.14	
	N1-III (RW>1700 kg)	Pak-II IDI	1.50	1.2	0.17	
		Pak-II DI	1.50	1.6	0.20	

Parameter	Standards (maximum permissible limit)	Measuring Method
Noise	85 db (A)	Sound-meter at 7.5 meters from the source

(b) Emission Standards for Heavy Duty Diesel Engines and Large Goods Vehicles (g/Kwh)

Type of Vehicle	Category/Class	Tiers	CO	HC+	NOx	PM	Measuring Method
Heavy Duty Diesel Engines	Trucks and Buses	Pak-II	4.0	1.1	7.0	0.15	ECE-R-49
Large Goods Vehicles	N2 (2000 and up)	Pak-II	4.0	7.0	1.10	0.15	EDC

Parameter	Standards (maximum permissible limit)	Measuring Method
Noise	85 db (A)	Sound-meter at 7.5 meters from the source

Table 7.3: For New Vehicles (Petrol)

Emission Standards for Petrol Vehicles (g/km)

Type of Vehicle	Category/Class	Tiers	CO	HC+ Nox	Measuring Method
Passenger Cars	M1: with reference mass (RW) upto 2500 kg. Cars with RW over 2500 kg to meet N1 category standards	Pak-II IDI	2.20	0.5	NEDC (ECE 15 + EUDCL)
Light Commercial Vehicles	N1-I (RW<1250 kg)	Pak-II	2.20	0.5	
	N1-II (1250 kg<RW<1700 kg)	Pak-II	4.0	0.65	
	N1-III (RW>1700 kg)	Pak-II	5.0	0.08	
Motor Rickshaws and motor cycles	2,4 strokes<150cc	Pak-II	5.5	1.5	ECER 40
	2,4 strokes>150cc	Pak-II	5.5	1.3	

Parameter	Standards (maximum permissible limit)	Measuring Method
Noise	85 db (A)	Sound-meter at 7.5 meters from the source

Explanation:

DI: Direct Injection

IDI: Indirect Injection

EUDCL: Extra urban driving cycle

NEDC: New European driving cycle

ECE: urban driving cycle

M: Vehicle designed and constructed for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat.

N: Motor vehicles with at least four wheels designed and constructed for the carriage of goods.

*: New models mean both model and engine type change

OTHER RELEVANT INTERNATIONAL STANDARDS

California Department of Transportation, 2007

Interim Guidelines for Potential Effects on Birds from Different Noise Sources

Noise Source Type	Hearing Damage	TTS	Masking
Distance to the Source	Very Close	Close	Far
Single Impulse (e.g., blast)	140 dB(A)	NA	NA
Multiple Impulse (e.g., jackhammer, pile driver)	125 dB(A)	NA	ambient dB(A)
Non-Strike Continuous (e.g., construction noise)	None	93 dB(A)	ambient dB(A)
Highway Noise	None	93 dB(A)	ambient dB(A)
Alarms (97 dB/100 ft)	None	NA	NA

International Standards on Air and Ground Vibration

Blast Size used at Kaigah quarry (kg)	Air Blast (dBL)	Ground Vibration (mm/s)
International Standards		
USA	133	25
Canada	128	12.5
Australia	115	5

Annex – B

EMP COST ESTIMATES

A. Contractors Bills of Quantities

Table A1- Environmental Staff of Contractors

S.No.	Description	Year	Unit	Quantity	Rate. USD	Amount, USD
1	Development and implementation of management plans (CEAP) in accordance with Project's EMP and WorldBank Group EHS guidelines					
2	Environmental staff of contractors (Environmental Specialist, OHS specialist, and other necessary staff to carryout the above activites)	2014-2025		Lumpsum	1% of civil works (1780 million USD) and 0.5% of mechanical or electro-mechanical works (1297 million USD)	24,285,000
	Total					**24,285,000**

Table A2- Water Quality Laboratory

Sr. No.	Description	Year	Unit	Quantity	Rate. USD	Amount, USD
1	Water Quality Lab for testing of Key NEQS parameters for Water and Waste Water Quality	2015-2022	Lump sum	1	200,000	200,000
2	Chemicals and maintenance	2015-2022	Years	10	10,000	100,000
3	Technician	2015-2022	Months	120	2,000	240,000
	Total					**540,000**

Table A3 - Portable Air, Noise, Vibration and Water Quality Meters

Sr. No.	Description	Year	Unit	Quantity	Rate. USD	Amount, USD
I	**Air Quality Meters**	2015-2022				
1	PM		Numbers	10	2,500	25,000
2	SO2		Numbers	10	2,500	25,000
3	Nox		Numbers	10	2,500	25,000
4	CO		Numbers	10	2,500	25,000
5	CO2		Numbers	10	2,500	25,000
II	**Noise Quality Meters**					
1	Noise Meter		Numbers	10	1,000	10,000
2	Vibration Meter (air)		Numbers	10	2,500	25,000
3	Vibration Meter (Ground)		Numbers	10	1,000	10,000
III	**Water Quality Meters**					

Sr. No.	Description	Year	Unit	Quantity	Rate. USD	Amount, USD
1	Turbidity		Numbers	10	1,000	10,000
2	Conductivity		Numbers	10	500	5,000
3	pH		Numbers	10	500	5,000
4	Temperature		Numbers	10	100	1,000
5	DO		Numbers	10	1,000	10,000
IV	Technicians	2015-2022	Months	120	2,000	240,000
	Total					**441,000**

B. PMU Budget on Environmental Staff and Consultants

Table B1- Environmental Staff of EU-DHP (Project Management Unit of WAPDA at Dasu)

Sr. No.	Description	Year	Unit	Quantity	Rate. USD	Amount, USD
1	Deputy Project Director	2014-2025	Month	120	600	72,000
2	Director	2014-2025	Month	120	2,400	288,000
3	Deputy Director	2014-2025	Month	120	2,000	240,000
4	Asst. Director - Environment	2014-2025	Month	120	1,700	204,000
5	Site Engineer 2	2014-2025	Month	240	1,500	720,000
6	Asst. Director Ecology	2014-2025	Month	120	1,700	204,000
7	Fish expert	2014-2025	Month	120	1,500	180,000
8	Plantation expert	2014-2019	Month	72	1,500	108,000
9	Assistant director OHS	2014-2025	Month	120	1,700	204,000
10	Health and safety specialist	2014-2025	Month	120	1,500	180,000
11	Equipment/ office facilities	2014-2015				250,000
12	Vehicles	2014-2015				250,000
	Total					**2,900,000**

Note: The remuneration rates are double the regular WAPDA wages

Table B2- Environmental Staff of EU-CSC (Construction Supervision Consultant)

Sr. No.	Description	Year	Unit	Quantity	Rate. USD	Amount, USD
1	International Environmental Specialist - Lead (intermittent for 3 years)	2015-2022	Month	36	30,000	1.080.000
2	International Environmental Specialist - OHS(intermittent)	2015-2022	Month	26	30,000	780,000
3	International Ecologist - Intermittent	2015-2022	Month	16	30,000	480,000
4	Environment Specialist (Nat) (2 persons for 7 years)	2015-2022	Month	204	4,000	816000
5	Ecologist (nat) (one person for 6 years)	2015-2022	Month	84	4,000	624,000

Sr. No.	Description	Year	Unit	Quantity	Rate. USD	Amount, USD
6	Occupational Health and Safety Specialist (Nat) (1 person for 7 years	2015-2022	Month	120	4,000	480,000
7	Surveyors (Nat) (2 persons for 5 years each)	2015-2022	Month	156	500	78,000
	Total					**4,338,000**

Table B3- Panel of Experts

Sr. No.	Description	Year	Unit	Quantity	Rate. USD	Amount, USD
1	POE - Environmental Specialist (2 weeks for every 6 months)	2014-2025	Month	10	25,000	250,000
2	POE - Social and Resettlement Specialist (2 weeks for every 6 months)	2014-2016	Month	3	25,000	75,000
3	Travel Expenses					100,000
	Total					**425,000**

Table B4- External Auditing (Third Party) Consultants

Sr. No.	Description	Year	Unit	Quantity	Rate. USD	Amount, USD
1	Air Quality Monitoring	2014-2025	20 Sites/yr	10	15,000	150,000
2	Water Quality Monitoring	2014-2025	20 Sites/yr	10	15,000	150,000
3	Noise and Vibration Monitoring	2014-2025	20 Sites/yr	10	5,000	50,000
4	Auditing of Work Practices and EMP Compliance Issues	2014-2025	Months	10	15,000	150,000
	Total					**500,000**

Table B5 - Internal Auditing (by WEC)

Sr. No.	Description	Year	Unit	Quantity	Rate. USD	Amount, USD
1	Travel and Field Expenses	2014-2025	Quarterly	40	5,000	200,000
	Total					**200,000**

C. Aquatic Ecology

Table C1: Fish Studies and Monitoring

Description	Year	Unit	Quantity	Rate. USD	Amount, USD
I. Fish Biological Study					
Team Leader	2014-2015	Months	12	5000	60000
Sr Survey Officer	2014-2015	Months	12	3000	36000
Data Collector	2014-2015	Months	12	2000	24000
Technical Assistant 1	2014-2015	Months	12	1500	18000
Technical Assistant 2	2014-2015	Months	12	1500	18000
Field work (25 months)	2014-2015	days per month	10	100	12,000
Water Quality Testing (25 months)		Samples / month	50	100	60,000
Consultations and meetings					5,000
Sub Total					**233,000**
II- Seasonal Fish Habitat use					
Team Leader	2015-2019	month	20	5000	100,000
Sr Survey Officer	2015-2019	month	20	3000	60,000
Technical Assistant 1	2015-2019	month	20	1500	30,000
Technical Assistant 2	2015-2019	month	20	1500	30,000
Field work	2015-2019	days per month	10	200	40,000
Laboratory	2015-2019	Samples / month	50	75	75,000
Sub Total					**335,000**
III. Downstream Reservoir Fish Monitoring					
Team Leader	2020-2025	Month	25	5000	125000
Fish Expert 1	2020-2025	Month	25	4000	100000
Fish Expert 2	2020-2025	Month	25	3000	75000
Field work	2020-2025	days per month	10	150	37,500
Laboratory	2020-2025	Samples / month	50	50	62500
Sub Total					**400,000**
Grand Total					**968,000**

Table C2: Design and Implementation of fish capture and Stocking

Description	Year	Unit	Quantity	Rate. USD	Amount, USD
Capture and handling equipment	2015-2019				130,000
Fish containers					20,000
Oxygen cylinders					20,000

Description	Year	Unit	Quantity	Rate. USD	Amount, USD
Vehicles					30,000
Operation cost of fish	2020-2030	Year	10	50,000	500,000
Total					**700,000**

Table C3: Installation of fish deterrent devices or exclusion screens.

Description	Year	Unit	Quantity	Rate. USD	Amount, USD
Installation of fish deterrent or exclusion screens.	2015-2019			400,000	400,000
Total					**400,000**

Table C4: Fish Hatchery and R&D facility

Description	Year	Unit	Quantity	Rate. USD	Amount, USD
Land cost	2018-2025	acres	10	60000	600,000
Civil works	2018-2025	Lump sum			300,000
laboratory	2018-2025	Lump sum			200,000
Operation costs	2018-2025	Year	5	147240	736,200
Fish landing facilities	2018-2025				198,600
Total					**2,034,800**

Supporting Table for Table C4: Operating cost of hatchery

Description	Year	Unit	Quantity	Rate. USD	Amount, USD
Asst. Director		year	5	1,700	102,000
Fisheries Asst. 2		year	5	1,400	168,000
Supervisor 1		year	5	270	16,200
Fishermen 4		year	5	250	60,000
Guard 6		year	5	250	90,000
Watchers 3		year	5	200	36,000
Sweeper 1		year	5	150	9,000
Electricity bill		year	5	1,500	90,000
Driver		year	5	200	12,000
Vehicle maintenance		year	5	500	30,000
lab operations		year	5	250	15,000
Fish feed		year	5	500	30,000
breeder fish		year	5	50	3,000
Miscellaneous		year	5	1,000	60,000
maintenance		year	5	250	15,000
Total					736,200

Supporting Table for Table C4: Construction of fish landing facilities

Description	Year	Unit	Quantity	Rate. USD	Amount, USD
Office		No	1		50,000
Store		No	1		50,000
Guards 2		No	2	150	3,600
Guard room		No	1		20,000
Gettie for boat anchoring		No	1		50,000
Maintenance					25,000
Total					**198,600**

Table C5: Enhancement measures for Fish Habitat Near the Tributaries

Description	Year	Unit	Quantity	Rate. USD	Amount, USD
construction of pools/riffles in tributaries	2020-2025	No	6	15,000	90,000
staff for collection of brooders and leaving them in pools	2020-2025	No	6	150	10,800
Total					**100,800**

Table C6 : Capacity building of KP Fisheries Department

Description	Year	Unit	Quantity	Rate. USD	Amount, USD
Capacity building for assisting with field studies and biodiversity management	2020-2025			50,000	50,000
Capacity building for reservoir fisheries management	2020-2025			50,000	50,000
Total					**100,000**

D. Terrestrial Ecology

Table D1-Tree plantation and forest management plan

Description	Year	Unit	Quantity	Rate. USD	Amount, USD
Sapling	2014-2016	No	300,000	0.4	120,000
Tree plantation and maintenance for 3 years	2016-2020	No	100,000	15	1,500,000
Total					**1,620,000**

E. Physical Cultural Resources

Table E1: Physical Cultural Resources

	Item	Unit	Quantity	Rate. PKR	Amount, PKR	USD
I	**Procurement and Protection of Shatial Rock Carvings**					
1	Land Acquisition	Ha(Acres)	10(25)	According to agreement between Director Revenue office and DOAM KP	125,800,000	1,258,000
2	Fencing	meters	1250	100 (including charges)	125,000	1,250
3		Poles	417 (with poles for every 3m)	500	208,500	2,085
4	Gate	Number	1	Lump sum	50,000	500
5	Facilities for office and tourists (office, information centre, visitors' toilet, visitors pavilion, etc.)	Square meters	5,000	5,000	25,000,000	250,000
6	Cleaning of Carvings with chemicals and providing fibreglass facilities	Number	46	30,000	1,380,000	13,800
7	Training of 3 local persons for 6 months as guides at Tourism Dept., Shadman Lahore	Number	3	100,000 (including tuition fees, accommo-dation and stipend)	300,000	3,000
8	Salaries for 2 security staff for 3 years by WAPDA (later will be by KP DOAM)	Year	3	360,000 (15,000 per month / staff)	1,080,000	10,800
	Sub Total I				**153,943,500**	**1,539,435**
II	**Seo Mosque**					
1	Anti-termite chemicals for protection of timber (2640 square meters of timber and 1217 square meters of ground)	Litres	62	4,000	248,000	2,480

	Item	Unit	Quantity	Rate. PKR	Amount, PKR	USD
	Rental charges (12 days) for Tools for injection (injector machine and spray machine), their transport from Lahore and labour charges	Days	12	20,0000 (incl. daily rental charge for machine/day is 5,000)	240,000	2,400
2	Fire fighting equipment (fire extinguishers)				100,000	1,000
3	Timber Precision/Polish	Lump sum			1,000,000	10,000
4	Water supply, sanitation facilities and ablution facilities	Lump sum			1,000,000	10,000
	Sub Total II				**2,588,000**	**25,880**
III	**Seer Gayal Mosque**					
1	Dismantling mosque structure and transporting to new site	Lump sum			400,000	4,000
2	Land acquisition of 505 square meter (1 canal) for relocation site of mosque	Lump sum			500,000	5,000
3	Foundation and reassembling and new material provision, water supply, sanitation, etc.	Lump sum			2,000,000	20,000
	Sub-Total III				**2,900,000**	**29,000**
IV	**Protection of Graveyards**					
1	Provision of mud, and mud pitching	Grave	320 graves in 16 graveyards	700	224,000	2,240
2	Religious ceremony at each graveyard (including food for 100 people and bringing of religious leaders for Quran recitation)	Grave yard	16	25,000	400,000	4,000
	Sub-Total IV				**624,000**	**6,240**
V	**Chance Finds**					
1	Services of an archaeological expert over a period of one year (spread	Month	12	400,000	4,800,000	48,000

	Item	Unit	Quantity	Rate. PKR	Amount, PKR	USD
	over 6 year of constructions phase)					
	Grand Total				**164,855,500**	**1,648,555**

F. KKH Traffic Management

Table F1 – KKH Traffic Management

Sr. No.	Description	Year	Unit	Quantity	Rate. USD	Amount, USD
1	Traffic Manager	2015-2022	Month	72	600	43,200
2	Traffic Clerk	2015-2022	Month	72	300	21,600
3	Guards 2	2015-2022	Month	72	150	10,800
4	Sub Offices on rent Dasu, Pattan, Besham, Thakot, Abbotabad, Haripur. (6 years at 6 offices)	2015-2022	Monthly	432	400	172,800
5	Furniture	2015-2022	Set	6	1000	12,000
6	Utility Bills	2015-2022	Month	72	400	28,800
7	Stationary	2015-2022	Lump sum			100,000
	Total					**389,200**

G. Climate Change, GLOFs and Sedimentation in UIB

Table G1: Flood Telemetry Network

Description	Year	Unit	Quantity	Rate. USD	Amount, USD
Telemetric Equipment (Procurement of Radio Telemetric equipment complete including sensors, spares, towers, field testing and servicing equipment etc.)		Set	20	75,000	1,500,000
Training (Foreign Training of electronics staff for installation and maintenance of telemetric equipment.)		Number of Staff	4	25,000	100,000
Installation of 18 nos. telemetric stations.		Set	18	17,000	306,000
Vehicles (4x4 D/C P/U vehicles)		Number	2	50,000	100,000
Staff (Remuneration of staff and operation expenses for about 10 years)		Number	4	120,000	480,000
Weather Station (Rain Gauge, Snow Gauge, Evaporation Pan, Wind velocity and direction, sunshine, humidity and temperature recorder)		Set	1	25000	25,000
Staff (remuneration of Meteorologist and operational expenses for 10 years)		Number	1	120000	120,000
Total					**2,631,000**

J. Environmental Management and Enhancement of Resettlement Villages

Table J1. Environmental management and Enhancement of the Resettlement Villages

Description	Year	Unit	Quantity	Rate. USD	Amount, USD	Remarks
Operation and management of solid waste and liquid waste facilities in the village, and also at schools and BHU	10	Villages	14	6000	840,000	500 USD per month for the period of 10 years for 14 villages.
Water supply treatment and maintenance	10	Villages	14	1200	168,000	100 USD per month for the period of 10 years for 14 villages.
Environmental Officer at each village	10	Villages	14	3000	420,000	250 USD per month for the period of 10 years for 14 villages.
Water supply and sanitation operator at each village	10	Villages	14	2400	336,000	200 USD per month for the period of 10 years for 14 villages.
Sanitation and hygiene promotion activities	10	14 villages	1	1000	10,000	1000 USD per year for the period of 10 years for 14 villages.
Cleaner/Sweeper/Gardener	10	Villages	14	2400	336,000	200 USD per month for the period of 10 years for 14 villages.
Total					**2,110,000**	

Annex – C

ENVIRONMENTAL CODE OF PRACTICES

Introduction

The objective of the Environmental Code of Practices (ECPs) is to address all potential and general construction related impacts during implementation of the Dasu Hydropower Project (the Project or DHP). The ECPs will provide guidelines for best operating practices and environmental management guidelines to be followed by the contractors for sustainable management of all environmental issues. These ECPs shall be annexed to the general conditions of all the contracts, including subcontracts, carried out under the Project.

The list of ECPs prepared for the DHP is given below:

- ECP 1: Waste Management
- ECP 2: Fuels and Hazardous Goods Management
- ECP 3: Water Resources Management
- ECP 4: Drainage Management
- ECP 5: Soil Quality Management
- ECP 6: Erosion and Sediment Control
- ECP 7: Top Soil Management
- ECP 8: Topography and Landscaping
- ECP 9: Quarry Areas Development & Operation
- ECP 10: Air Quality Management
- ECP 11: Noise and Vibration Management
- ECP 12: Protection of Flora
- ECP 13: Protection of Fauna
- ECP 14: Protection of Fisheries
- ECP 15: Road Transport and Road Traffic Management
- ECP 16: Construction Camp Management
- ECP 17: Cultural and Religious Issues
- ECP 18: Workers Health and Safety

Contractors will prepare site specific management plans, namely Construction Environmental Action Plan (CEAP), in compliance with World Bank and Government of Pakistan guidelines and based on the guidance given in the ECPs. The CEAP will form the part of the contract documents and will be used as monitoring tool for compliance. It is mandatory for the main contractors procured directly by the project to include these ECPs in their subcontracts. Violation of the compliance requirements will be treated as non-compliance leading to the corrections or otherwise imposing penalty on the contractors. Contractors and subcontractors are requested to refer the Environmental Management Plan given in the EIA report of the Project for further information on corrective actions, performance indicators, and monitoring, auditing and reporting protocols.

ECP 1: Waste Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
General Waste	Soil and water pollution from the improper management of wastes and excess materials from the construction sites.	The Contractor shall • Develop waste management plan for various specific waste streams (e.g., reusable waste, flammable waste, construction debris, food waste etc.) prior to commencing of construction and submit to supervision consultant for approval. • Organize disposal of all wastes generated during construction in the designated disposal sites approved by the Project. • Minimize the production of waste materials by 3R (Reduce, Recycle and Reuse) approach. • Segregate and reuse or recycle all the wastes, wherever practical. • Vehicles transporting solid waste shall be covered with tarps or nets to prevent spilling waste along the route. • Train and instruct all personnel in waste management practices and procedures as a component of the environmental induction process. • Provide refuse containers at each worksite. • Request suppliers to minimize packaging where practicable. • Place a high emphasis on good housekeeping practices. • Maintain all construction sites in a cleaner, tidy and safe condition and provide and maintain appropriate facilities as temporary storage of all wastes before transportation and final disposal. • Potable water should be supplied in bulk containers to reduce the quantity of plastic waste (plastic bottles). Plastic bag use should be avoided.
Hazardous Waste	Health hazards and environmental impacts due to improper waste management practices	The Contractor shall • Collect chemical wastes in 200 liter drums (or similar sealed container), appropriately labeled for safe transport to an approved chemical waste depot. • Store, transport and handle all chemicals avoiding potential environmental pollution. • Store all hazardous wastes appropriately in bunded areas away from water courses. • Make available Material Safety Data Sheets (MSDS) for hazardous materials on-site during construction. • Collect hydrocarbon wastes, including lube oils, for safe transport off-site for reuse, recycling, treatment or disposal at approved locations. • Construct concrete or other impermeable flooring to prevent seepage in case of spills.

ECP 2: Fuels and Hazardous Goods Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Fuels and hazardous goods.	Materials used in construction have a potential to be a source of contamination. Improper storage and handling of fuels, lubricants, chemicals and hazardous goods/materials on-site, and potential spills from these goods may harm the environment or health of construction workers.	The Contractor shall • Prepare spill control procedures and submit the plan for supervision consultant approval. • Train the relevant construction personnel in handling of fuels and spill control procedures. • Store dangerous goods in bunded areas on top of a sealed plastic sheet away from watercourses. • Refueling shall occur only within bunded areas. • Store and use fuels in accordance with material safety data sheets (MSDS). Make available MSDS for chemicals and dangerous goods on-site. • Transport waste of dangerous goods, which cannot be recycled, to a designated disposal site. • Provide absorbent and containment material (e.g., absorbent matting) where hazardous material are used and stored; and ensure personnel trained in the correct use. • Provide protective clothing, safety boots, helmets, masks, gloves, goggles, to the construction personnel, appropriate to materials in use. • Make sure all containers, drums, and tanks that are used for storage are in good condition and are labeled with expiry date. Any container, drum, or tank that is dented, cracked, or rusted might eventually leak. Check for leakage regularly to identify potential problems before they occur. • Store and use fuels in accordance with material safety data sheets (MSDSs). • Store all liquid fuels in fully bunded storage containers, with appropriate volumes, a roof, a collection point and appropriate filling/decanting point. • Store hazardous materials above flood level considered for construction purposes • Put containers and drums in temporary storages in clearly marked areas, where they will not be run over by vehicles or heavy machinery. The area shall preferably slope or drain to a safe collection area in the event of a spill. • Take all precautionary measures when handling and storing fuels and lubricants, avoiding environmental pollution. • Avoid the use of material with greater potential for contamination by substituting them with more environmentally friendly materials.

ECP 3: Water Resources Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Hazardous material and Waste	Water pollution from the storage, handling and disposal of hazardous materials and general construction waste, and accidental spillage	The Contractor shall • Follow the management guidelines proposed in ECPs 1 and 2. • Minimize the generation of sediment, oil and grease, excess nutrients, organic matter, litter, debris and any form of waste (particularly petroleum and chemical wastes). These substances must not enter waterways or storm water systems.
Discharge from construction sites	Construction activities, sewerages from construction sites and work camps may affect the surface water quality. The construction works will modify groundcover and topography changing the surface water drainage patterns of the area. These changes in hydrological regime lead to increased rate of runoff, increase in sediment and contaminant loading, increased flooding, and effect habitat of fish and other aquatic biology.	The Contractor shall • Install temporary drainage works (channels and bunds) in areas required for sediment and erosion control and around storage areas for construction materials. • Install temporary sediment basins, where appropriate, to capture sediment-laden run-off from site. • Divert runoff from undisturbed areas around the construction site. • Stockpile materials away from drainage lines • Prevent all solid and liquid wastes entering waterways by collecting solid waste, oils, chemicals, bitumen spray waste and wastewaters from brick, concrete and asphalt cutting where possible and transport to a approved waste disposal site or recycling depot. • Wash out ready-mix concrete agitators and concrete handling equipment at washing facilities off site or into approved bunded areas on site. Ensure that tires of construction vehicles are cleaned in the washing bay (constructed at the entrance of the construction site) to remove the mud from the wheels. This should be done in every exit of each construction vehicle to ensure the local roads are kept clean.
Soil erosion and siltation	Soil erosion and dust from the material stockpiles will increase the sediment and contaminant loading of surface water bodies.	The Contractor shall • Stabilize the cleared areas not used for construction activities with vegetation or appropriate surface water treatments as soon as practicable following earthwork to minimize erosion. • Ensure that roads used by construction vehicles are swept regularly to remove dust and sediment. • Water the loose material stockpiles, access roads and bare soils on an as required basis to minimize dust. Increase the watering frequency during periods of high risk (e.g. high winds).
Construction activities in water bodies	Construction works in the water bodies will increase	The Contractor Shall • Dewater sites by pumping water to a sediment basin prior to release off site – do not pump

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	sediment and contaminant loading, and effect habitat of fish and other aquatic biology.	directly off site. • Monitor the water quality in the runoff from the site or areas affected by dredge/excavation plumes, and improve work practices as necessary. • Protect water bodies from sediment loads by silt screen or other barriers. • Minimize the generation of sediment, oil and grease, excess nutrients, organic matter, litter, debris and any form of waste (particularly petroleum and chemical wastes). These substances must not enter waterways or storm water systems. • Do not discharge cement and water curing used for cement concrete directly into water courses and drainage inlets.
Drinking water	Untreated surface water is not suitable for drinking purposes due to presence of suspended solids and ecoli.	The Contractor Shall • Provide the drinking water that meets NEQS standards. Drinking water to be chlorinated at source, and ensure presence of residual chlorine 0.1 ~ 0.25 ppm as minimum after 30 minutes of chlorine contact time.

ECP 4: Drainage Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Excavation and earth works, and construction yards	Lack of proper drainage for rainwater/liquid waste or wastewater owing to the construction activities harms environment in terms of water and soil contamination, and mosquito growth.	The Contractor shall • Prepare a drainage management plan and submit the plan for supervision consultant approval. • Prepare a program to prevent/avoid standing waters, which supervision consultant will verify in advance and confirm during implementation. • Provide alternative drainage for rainwater if the construction works/earth-fillings cut the established drainage line. • Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connecting to the existing established drainage lines already there. • Rehabilitate road drainage structures immediately if damaged by contractors' road transports. • Build new drainage lines as appropriate and required for wastewater from construction yards connecting to the available nearby recipient water bodies. Ensure wastewater quality conforms to NEQS, before it is being discharged into the recipient water bodies. • Ensure that there will be no water stagnation at the construction sites and camps.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Provide appropriate silt collector and silt screen at the inlet and manholes and periodically clean the drainage system to avoid drainage congestion. • Protect natural slopes of drainage channels to ensure adequate storm water drains. • Regularly inspect and maintain all drainage channels to assess and alleviate any drainage congestion problem.
Ponding of water	Health hazards due to mosquito breeding	• Do not allow ponding of water especially near the waste storage areas and construction camps. • Discard all the storage containers that are capable of storing of water, after use or store them in inverted position.

ECP 5: Soil Quality Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Storage of hazardous and toxic chemicals	Spillage of hazardous and toxic chemicals will contaminate the soils	The Contractor shall • Strictly manage the wastes management plans proposed in ECP1 and storage of materials in ECP2. • Construct appropriate spill contaminant facilities for all fuel storage areas. • Establish and maintain a hazardous material register detailing the location and quantities of hazardous substances including the storage, and their disposals. • Train personnel and implement safe work practices for minimizing the risk of spillage. • Identify the cause of contamination, if it is reported, and contain the area of contamination. The impact may be contained by isolating the source or implementing controls around the affected site. • Remediate the contaminated land using the most appropriate available method.
Construction material stock piles	Erosion from construction material stockpiles may contaminate the soils	The Contractor shall • Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds.

ECP 6: Erosion and Sediment Control

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Clearing of construction sites	Cleared areas and slopes are susceptible for erosion of top soils,	The Contractor shall • Prepare site specific erosion and sediment control plan and submit the plan for supervision consultant approval.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	which affects the growth of vegetation and causes ecological imbalance.	• Reinstate and protect cleared areas as soon as possible. • Cover unused area of disturbed or exposed surfaces immediately with mulch/grass turf/tree plantations.
Construction activities and material stockpiles	The impact of soil erosion are (i) Increased run off and sedimentation causing a greater flood hazard to the downstream, and (ii) destruction of aquatic environment by erosion and/or deposition of sediment damaging the spawning grounds of fish	The Contractor shall • Locate stockpiles away from drainage lines. • Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds. • Remove debris from drainage paths and sediment control structures. • Cover the loose sediments of construction material and water them if required. • Divert natural runoff around construction areas prior to any site disturbance. • Install protective measures on site prior to construction, for example, sediment traps. • Install 'cut off drains' on large cut/fill batter slopes to control water runoff speed and hence erosion. • Observe the performance of drainage structures and erosion controls during rain and modify as required.
Soil erosion and siltation	Soil erosion and dust from the material stockpiles will increase the sediment and contaminant loading of surface water bodies.	The Contractor shall • Stabilize the cleared areas not used for construction activities with vegetation or appropriate surface water treatments as soon as practicable following earthwork to minimize erosion. • Ensure that roads used by construction vehicles are swept regularly to remove sediment. • Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust. Increase the watering frequency during periods of high risk (e.g. high winds).

ECP 7: Top Soil Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Land clearing and earth works	Earthworks will impact the fertile top soils that are enriched with nutrients required for plant growth or agricultural development.	The Contractor shall • Strip the top soil to a depth of 15 cm and store in stock piles of height not exceeding 2m. • Remove unwanted materials from top soil like grass, roots of trees and similar others. • The stockpiles will be done in slopes of 2:1 to reduce surface runoff and enhance percolation through the mass of stored soil. • Locate topsoil stockpiles in areas outside drainage lines and protect from erosion.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Construct diversion channels and silt fences around the topsoil stockpiles to prevent erosion and loss of topsoil. • Spread the topsoil to maintain the physico-chemical and biological activity of the soil. The stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites. • Prior to the re-spreading of topsoil, the ground surface will be ripped to assist the bunding of the soil layers, water penetration and revegetation
Transport	Vehicular movement outside ROW or temporary access roads will affect the soil fertility of the agricultural lands	• Limit equipment and vehicular movements to within the approved construction zone. • Plan construction access to make use, if possible, of the final road alignment.

ECP 8: Topography and Landscaping

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Land clearing and earth works	Construction activities especially earthworks will change topography and disturb the natural rainwater/flood water drainage as well as will change the local landscape.	The Contractor shall • Ensure the topography of the final surface of all raised lands (construction yards, approach roads and rails, access roads, etc.) are conducive to enhance natural draining of rainwater/flood water. • Keep the final or finished surface of all the raised lands free from any kind of depression that causes water logging. • Undertake mitigation measures for erosion control/prevention by grass-turfing and tree plantation, where there is a possibility of rain-cut that will change the shape of topography. • Cover immediately the uncovered open surface that has no use of construction activities with grass-cover and tree plantation to prevent soil erosion and bring improved landscaping. • Reinstate the natural landscape of the ancillary construction sites after completion of works.

ECP 9: Quarry Areas Development & Operation

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Development and operation of borrow areas	Borrow areas will have impacts on local topography, landscaping and natural drainage.	The Contractor shall • Prepare quarry area management plan and submit the plan for supervision consultant approval. • Use only approved quarry and borrow sites • Identify new borrow and quarry areas in

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		consultation with Project Director, if required. • Reuse excavated or disposed material available in the project to the maximum extent possible. • Store top soil for reinstatement and landscaping. • Develop surface water collection and drainage systems, anti-erosion measures (berms, revegetation etc.) and retaining walls and gabions where required. Implement mitigation measures in ECP 3: Water Resources Management, ECP 6: Erosion and Sediment Control • The use of explosive should be used in as much minimum quantity as possible to reduce noise, vibration and dust. • Control dust and air quality deterioration by application of watering and implementing mitigation measures proposed in ECP 10: Air Quality Management • Noise and vibration control by ECP 11: Noise and Vibration Management.

ECP 10: Air Quality Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Air quality can be adversely affected by vehicle exhaust emissions and combustion of fuels.	The Contractor shall • • Prepare air quality management plan and submit the plan for supervision consultant approval. • Fit vehicles with appropriate exhaust systems and emission control devices. Maintain these devices in good working condition. • Operate the vehicles in a fuel efficient manner. • Cover hauls vehicles carrying dusty materials moving outside the construction site. • Impose speed limits on all vehicle movement at the worksite to reduce dust emissions. • Control the movement of construction traffic. • Water construction materials prior to loading and transport. • Service all vehicles regularly to minimize emissions. • Limit the idling time of vehicles not more than 2 minutes.
Construction machinery	Air quality can be adversely affected by emissions from machinery and combustion of fuels.	The Contractor shall • Fit machinery with appropriate exhaust systems and emission control devices. Maintain these devices in good working condition in accordance with the specifications defined by their manufacturers to maximize combustion efficiency and

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		minimize the contaminant emissions. Proof or maintenance register shall be required by the equipment suppliers and contractors/subcontractors. • Focus special attention on containing the emissions from generators. • Machinery causing excess pollution (e.g. visible smoke) will be banned from construction sites. • Service all equipment regularly to minimize emissions. • Provide filtering systems, duct collectors or humidification or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all its stages, including unloading, collection, aggregate handling, cement dumping, circulation of trucks and machinery inside the installations.
Construction activities	Dust generation from construction sites, material stockpiles and access roads is a nuisance in the environment and can be a health hazard, and also can affect the local crops;	The Contractor shall • Water the material stockpiles, access roads and bare soils on an as required basis to minimize the potential for environmental nuisance due to dust. Increase the watering frequency during periods of high risk (e.g. high winds). Stored materials such as gravel and sand shall be covered and confined to avoid their being wind-drifted. • Minimize the extent and period of exposure of the bare surfaces. • Restore disturbed areas as soon as practicable by vegetation/grass-turfing. • Store the cement in silos and minimize the emissions from silos by equipping them with filters. • Establish adequate locations for storage, mixing and loading of construction materials, in a way that dust dispersion is prevented because of such operations. • Not water as dust suppression on potentially contaminated areas so that a liquid waste stream will be generated. • Crushing of rocky and aggregate materials shall be wet-crushed, or performed with particle emission control systems. • Not permit the burning of solid waste.

ECP 11: Noise and Vibration Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Noise quality will be deteriorated due to vehicular traffic	The Contractor shall • • Prepare a noise and vibration management plan and submit the plan for supervision

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		consultant approval. • Maintain all vehicles in order to keep it in good working order in accordance with manufactures maintenance procedures. • Make sure all drivers will comply with the traffic codes concerning maximum speed limit, driving hours, etc. • Organize the loading and unloading of trucks, and handling operations for the purpose of minimizing construction noise on the work site.
Construction machinery	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall • Appropriately site all noise generating activities to avoid noise pollution to local residents. • Use the quietest available plant and equipment. • Maintain all equipment in order to keep it in good working order in accordance with manufactures maintenance procedures. Equipment suppliers and contractors shall present proof of maintenance register of their equipment. • Install acoustic enclosures around generators to reduce noise levels. • Fit high efficiency mufflers to appropriate construction equipment. • Avoid the unnecessary use of alarms, horns and sirens.
Construction activity	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall • Notify adjacent landholders prior any typical noise events outside of daylight hours. • Educate the operators of construction equipment on potential noise problems and the techniques to minimize noise emissions. • Employ best available work practices on-site to minimize occupational noise levels. • Install temporary noise control barriers where appropriate. • Notify affected people if major noisy activities will be undertaken, e.g. blasting. • Plan activities on site and deliveries to and from site to minimize impact. • Monitor and analyze noise and vibration results and adjust construction practices as required. • Avoid undertaking the noisiest activities, where possible, when working at night near the residential areas.

ECP 12: Protection of Flora

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Vegetation clearance	Local flora are important to provide shelters for the birds, offer fruits and/or timber/fire wood, protect soil erosion and overall keep the environment very friendly to human-living. As such damage to flora has wide range of adverse environmental impacts.	The Contractor shall • Prepare a plan for ptotection of flora and submit the plan for supervision consultant approval. • Minimize disturbance to surrounding vegetation. • Use appropriate type and minimum size of machine to avoid disturbance to adjacent vegetations. • Get approval from supervision consultant for clearance of vegetation. • Make selective and careful pruning of trees where possible to reduce need of tree removal. • Control noxious weeds by disposing of at designated dump site or burn on site. • Clear only the vegetation that needs to be cleared in accordance with the engineering plans and designs. These measures are applicable to both the construction areas as well as to any associated activities such as sites for stockpiles, disposal of fill a, etc. • Not burn off cleared vegetation – where feasible, chip or mulch and reuse it for the rehabilitation of affected areas, temporary access tracks or landscaping. Mulch provides a seed source, can limit embankment erosion, retains soil moisture and nutrients, and encourages re-growth and protection from weeds. • Return topsoil and mulched vegetation (in areas of native vegetation) to approximately the same area of the roadside it came from. • Avoid work within the drip-line of trees to prevent damage to the tree roots and compacting the soil. • Minimize the length of time the ground is exposed or excavation left open by clearing and re-vegetate the area at the earliest practically possible. • Ensure excavation works occur progressively and re-vegetation done at the earliest • Provide adequate knowledge to the workers regarding nature protection and the need of avoid felling trees during construction • Supply appropriate fuel in the work camps to prevent fuel wood collection.

ECP 13: Protection of Fauna

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities	The location of construction activities can result	The Contractor shall • • Prepare a plan for ptotection of fauna and submit the plan for supervision consultant

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	in the loss of wild life habitat and habitat quality,	approval. • Limit the construction works within the designated sites allocated to the contractors. • check the site for animals trapped in, or in danger from site works and use a qualified person to relocate the animal.
	Impact on migratory birds, its habitat and its active nests	The Contractor shall • Not be permitted to destruct active nests or eggs of migratory birds. • Minimize the tree removal during the bird breeding season. If works must be continued during the bird breeding season, a nest survey will be conducted by a qualified biologist prior to commence of works to identify and locate active nests. • If bird nests are located/ detected within the ledges and roadside embankments then those areas should be avoided. • Petroleum products should not come in contact with the natural and sensitive ecosystems. Contractor must minimize the release of oil, oil wastes or any other substances harmful to migratory birds' habitats, to any waters, wetlands or any areas frequented by migratory birds.
Vegetation clearance	Clearance of vegetation may impact shelter, feeding and/or breeding and/or physical destruction and severing of habitat areas	The Contractor shall • Restrict the tree removal to the minimum numbers required. • Relocate hollows, where appropriate. • Fell the hollow bearing trees in a manner which reduces the potential for fauna mortality. Felled trees will be inspected after felling for fauna and if identified and readily accessible will be removed and relocated or rendered assistance if injured. After felling, hollow bearing trees will remain unmoved overnight to allow animals to move of their own volition.
Night time lighting	Lighting from construction sites and construction camps may affect the visibility of night time migratory birds that use the moon and stars for navigation during their migrations.	The Contractor shall • Use lower wattage flat lens fixtures that direct light down and reduce glare, thus reducing light pollution, • Avoid flood lights unless they are absolutely required. • Use motion sensitive lighting to minimize unneeded lighting. • Use, if possible, green lights that are considered as bird's friendly lighting instead of white or red colored lights. • Install light shades or plan the direction of lights to reduce light spilling outside the construction area.
Construction camps	Illegal poaching	The Contractor shall • Provide adequate knowledge to the workers

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		regarding protection of flora and fauna, and relevant government regulations and punishments for illegal poaching. • Ensure that staff and Subcontractors are trained and empowered to identify, address and report potential environmental problems.

ECP 14: Protection of Fish

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities in River	The main potential impacts to fisheries are hydrocarbon spills and leaks from riverine transport and disposal of wastes into the river	The Contractor shall • Prepare a plan for ptotection of fish and submit the plan for supervision consultant approval. • Ensure the construction equipment used in the river are well maintained and do not have oil leakage to contaminate river water. • Contain oil immediately on river in case of accidental spillage from equipment; make an emergency oil spill containment plan to be supported with enough equipments, materials and human resources. • Do not dump wastes, be it hazardous or non-hazardous into the nearby water bodies or in the river.
Construction activities on the land	The main potential impacts to aquatic flora and fauna River are increased suspended solids from earthworks erosion, sanitary discharge from work camps, and hydrocarbon spills	The Contractor shall • follow mitigation measures proposed in ECP 3 : Water Resources Management and EC4: Drainage Management.

ECP 15: Road Transport and Road Traffic Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Increased traffic use of road by construction vehicles will affect the movement of normal road traffics and the safety of the road-users.	The Contractor shall • • Prepare a traffic management plan and submit the plan for supervision consultant approval. • Strictly follow the Project's 'Traffic Management Plan' and work with close coordination with the Traffic Management Unit. • Prepare and submit additional traffic plan, if any of his traffic routes are not covered in the Project's Traffic Management Plan, and requires traffic diversion and management. • Include in the traffic plan to ensure uninterrupted traffic movement during

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		construction: detailed drawings of traffic arrangements showing all detours, temporary road, temporary bridges temporary diversions, necessary barricades, warning signs / lights, road signs etc. • Provide signs at strategic locations of the roads complying with the schedules of signs contained in the Pakistan Traffic Regulations.
	Accidents and spillage of fuels and chemicals	The Contractor shall • Restrict truck deliveries, where practicable, to day time working hours. • Restrict the transport of oversize loads. • Operate vehicles, if possible, to non-peak periods to minimize traffic disruptions. • Enforce on-site speed limit.

ECP 16: Construction Camp Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Siting and Location of construction camps	Campsites for construction workers are the important locations that have significant impacts such as health and safety hazards on local resources and infrastructure of nearby communities.	The Contractor shall • • Prepare a construction camp management plan and submit the plan for supervision consultant's approval. • Locate the construction camps with in the designed sites or at areas which are acceptable from environmental, cultural or social point of view; and approved by the supervision consultant. • Consider the location of construction camps away from communities in order to avoid social conflict in using the natural resources such as water or to avoid the possible adverse impacts of the construction camps on the surrounding communities. • Submit to the supervision consultant for approval a detailed layout plan for the development of the construction camp showing the relative locations of all temporary buildings and facilities that are to be constructed together with the location of site roads, fuel storage areas (for use in power supply generators), solid waste management and dumping locations, and drainage facilities, prior to the development of the construction camps. • Local authorities responsible for health, religious and security shall be duly informed on the set up of camp facilities so as to

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		maintain effective surveillance over public health, social and security matters.
Construction Camp Facilities	Lack of proper infrastructure facilities , such as housing, water supply and sanitation facilities will increase pressure on the local services and generate substandard living standards and health hazards.	Contractor shall provide the following facilities in the campsites • Adequate housing for all workers. • Safe and reliable water supply, which should meet NEQS. Drinking water to be chlorinated at source, and ensure presence of residual chlorine 0.1 ~ 0.25 ppm as minimum after 30 minutes of chlorine contact time (WHO guideline). • Hygienic sanitary facilities and sewerage system. The toilets and domestic waste water will be collected through a common sewerage. Provide separate latrines and bathing places for males and females with total isolation by location. The minimum number of toilet facilities required is one toilet for every ten persons. • Treatment facilities for sewerage of toilet and domestic wastes. • Storm water drainage facilities. • Paved internal roads. • Provide child crèches for women working construction site. The crèche should have facilities for dormitory, kitchen, indoor and outdoor play area. Schools should be attached to these crèches so that children are not deprived of education whose mothers are construction workers. • Provide in-house community/common entertainment facilities. Dependence of local entertainment outlets by the construction camps to be discouraged/prohibited to the extent possible.
Disposal of waste	Management of wastes is crucial to minimize impacts on the environment	The Contractor shall • Ensure proper collection and disposal of solid wastes within the construction camps. • Insist waste separation by source; organic wastes in one container and inorganic wastes in another container at household level. • Store inorganic wastes in a safe place within the household and clear organic wastes on daily basis to waste collector. Establish waste collection, transportation and disposal systems with the manpower and equipments/vehicles needed. • Do not establish site specific landfill sites. All solid waste will be collected and removed from the work camps and disposed in approval waste disposal sites.
Fuel supplies for cooking	Illegal sourcing of fuel wood by	The Contractor shall • Provide fuel to the construction camps for

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
purposes	construction workers will impact the natural flora and fauna	their domestic purpose, in order to discourage them to use fuel wood or other biomass. • Made available alternative fuels like natural gas or kerosene on ration to the workforce to prevent them using biomass for cooking. • Conduct awareness campaigns to educate workers on preserving the protecting the biodiversity and wildlife of the project area, and relevant government regulations and punishments on wildlife protection.
Health and Hygiene	There will be a potential for diseases to be transmitted including malaria, exacerbated by inadequate health and safety practices. There will be an increased risk of work crews spreading sexually transmitted infections and HIV/AIDS.	The Contractor shall • Provide adequate health care facilities within construction sites. • Provide first aid facility round the clock. Maintain stock of medicines in the facility and appoint fulltime designated first aider or nurse. • Provide ambulance facility for the laborers during emergency to be transported to nearest hospitals. • Initial health screening of the laborers coming from outside areas. • Train all construction workers in basic sanitation and health care issues and safety matters, and on the specific hazards of their work. • Provide HIV awareness programming, including STI (sexually transmitted infections) and HIV information, education and communication for all workers on regular basis. • Provide adequate drainage facilities throughout the camps to ensure that disease vectors such as stagnant water bodies and puddles do not form. Regular mosquito repellant sprays during rainy season in offices and construction camps and yards. • Not dispose food waste openly as that will attract rats and stray dogs. • Carryout short training sessions on best hygiene practices to be mandatorily participated by all workers. Place display boards at strategic locations within the camps containing messages on best hygienic practices.
Safety	In adequate safety facilities to the construction camps may create security problems and fire hazards	The Contractor shall • Provide appropriate security personnel (police or private security guards) and enclosures to prevent unauthorized entry in to the camp area. • Maintain register to keep a track on a head count of persons present in the camp at any given time. • Encourage use of flameproof material for the construction of labor housing / site office.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		Also, ensure that these houses/rooms are of sound construction and capable of withstanding wind storms/cyclones. • Provide appropriate type of fire fighting equipments suitable for the construction camps • Display emergency contact numbers clearly and prominently at strategic places in camps. • Communicate the roles and responsibilities of laborers in case of emergency in the monthly meetings with contractors.
Site Restoration	Restoration of the construction camps to original condition requires demolition of construction camps.	The Contractor shall • Dismantle and remove from the site all facilities established within the construction camp including the perimeter fence and lockable gates at the completion of the construction work. • Dismantle camps in phases and as the work gets decreased and not wait for the entire work to be completed. • Give prior notice to the laborers before demolishing their camps/units. • Maintain the noise levels within the national standards during demolition activities. • Different contractors should be hired to demolish different structures to promote recycling or reuse of demolished material. • Reuse the demolition debris to a maximum extent. Dispose remaining debris at the designated waste disposal site. • Handover the construction camps with all built facilities as it is if agreement between both parties (contactor and land-owner) has been made so. • Restore the site to its condition prior to commencement of the works or to an agreed condition with the landowner.

ECP 17: Cultural and Religious Issues

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities near religious and cultural sites	Disturbance from construction works to the cultural and religious sites, and contractors lack of knowledge on cultural issues cause social disturbances.	The Contractor shall • Communicate to the public through community consultation regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restriction. • Not block access to cultural and religious sites, wherever possible. • Restrict all construction activities within the foot prints of the construction sites. • Stop construction works that produce noise (particularly during prayer time) should there

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		be any mosque/religious/educational institutions close to the construction sites and users make objections. • Take special care and use appropriate equipment when working next to a cultural/religious institution. • Stop work immediately and notify the site manager if, during construction, an archaeological or burial site is discovered. It is an offence to recommence work in the vicinity of the site until approval to continue is given. • Provide separate prayer facilities to the construction workers. • Show appropriate behavior with all construction workers especially women and elderly people. • Allow the workers to participate in praying during construction time. • Resolve cultural issues in consultation with local leaders and supervision consultants. • Establish a mechanism that allows local people to raise grievances arising from the construction process. • Inform the local authorities responsible for health, religious and security duly informed before commencement of civil works so as to maintain effective surveillance over public health, social and security matters.

ECP 18: Worker Health and Safety

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Best practices	Construction works may pose health and safety risks to the construction workers and site visitors leading to severe injuries and deaths. The population in the proximity of the construction site and the construction workers will be exposed to a number of (i) biophysical health risk factors, (e.g. noise, dust, chemicals, construction material, solid waste, waste water, vector transmitted diseases etc), (ii)	The Contractor shall • Prepare an Occupational Health and Safety plan and submit the plan for supervision consultant's approval. • Implement suitable safety standards for all workers and site visitors which should not be less than those laid down on the international standards (e.g. International Labor Office guideline on 'Safety and Health in Construction; World Bank Group's 'Environmental Health and Safety Guidelines') and contractor's own national standards or statutory regulations, in addition to complying with Pakistan standards. • Provide the workers with a safe and healthy work environment, taking into account inherent risks in its particular construction activity and specific classes of hazards in the work areas. • Provide personal protection equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, protective clothing, goggles, full-face eye shields, and ear protection. Maintain the PPE properly by cleaning dirty

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	risk factors resulting from human behavior (e.g. STD, HIV etc) and (iii) road accidents from construction traffic.	ones and replacing them with the damaged ones. • Safety procedures include provision of information, training and protective clothing to workers involved in hazardous operations and proper performance of their job. • Appoint an environment, health and safety manager to look after the health and safety of the workers. • Inform the local authorities responsible for health, religious and security duly informed before commencement of civil works and establishment of construction camps so as to maintain effective surveillance over public health, social and security matters.
	Child and pregnant labor	The Contractor shall • not hire children of less than 14 years of age and pregnant women or women who delivered a child within 8 preceding weeks.
Accidents	Lack of first aid facilities and health care facilities in the immediate vicinity will aggravate the health conditions of the victims	The Contractor shall • Ensure health care facilities and first aid facilities are readily available. Appropriately equipped first-aid stations should be easily accessible throughout the place of work. • Document and report occupational accidents, diseases, and incidents. • Prevent accidents, injury, and disease arising from, associated with, or occurring in the course of work by minimizing, so far as reasonably practicable, the causes of hazards, in a manner consistent with good international industry practice. • Identify potential hazards to workers, particularly those that may be life-threatening and provide necessary preventive and protective measures. • Provide awareness to the construction drivers to strictly follow the driving rules. • Provide adequate lighting in the construction area, inside the tunnels, inside the powerhouse cavern and along the roads.
Construction Camps	Lack of proper infrastructure facilities, such as housing, water supply and sanitation facilities will increase pressure on the local services and generate substandard living standards and health hazards.	The Contractor shall provide the following facilities in the campsites to improve health and hygienic conditions as mentioned in ECP 16 Construction Camp Management • Adequate ventilation facilities • Safe and reliable water supply. • Hygienic sanitary facilities and sewerage system. • Treatment facilities for sewerage of toilet and domestic wastes • Storm water drainage facilities. • Recreational and social facilities

Project Activity/ Impact Source	**Environmental Impacts**	**Mitigation Measures/ Management Guidelines**
		• Safe storage facilities for petroleum and other chemicals in accordance with ECP 2 • Solid waste collection and disposal system in accordance with ECP1. • Arrangement for trainings • Paved internal roads. • Security fence at least 2 m height. • Sick bay and first aid facilities
Water and sanitation facilities at the construction sites	Lack of Water sanitation facilities at construction sites cause inconvenience to the construction workers and affect their personal hygiene.	The contractor shall • Provide portable toilets at the construction sites, if about 25 people are working the whole day for a month. Location of portable facilities should be at least 6 m away from storm drain system and surface waters. These portable toilets should be cleaned once a day and all the sewerage should be pumped from the collection tank once a day and should be brought to the common septic tank for further treatment. • Provide safe drinking water facilities to the construction workers at all the construction sites.
Other ECPs	Potential risks on health and hygiene of construction workers and general public	The Contractor shall follow the following ECPs to reduce health risks to the construction workers and nearby community • ECP 2: Fuels and Hazardous Goods Management • ECP 4: Drainage Management • ECP 10: Air Quality Management • ECP 11: Noise and Vibration Management • ECP 15: Road Transport and Road Traffic Management
Trainings	Lack of awareness and basic knowledge in health care among the construction workforce, make them susceptible to potential diseases.	The Contractor shall • Train all construction workers in basic sanitation and health care issues (e.g., how to avoid malaria and transmission of sexually transmitted infections (STI) HIV/AIDS. • Train all construction workers in general health and safety matters, and on the specific hazards of their work. Training should consist of basic hazard awareness, site specific hazards, safe work practices, and emergency procedures for fire, evacuation, and natural disaster, as appropriate. • Implement malaria, HIV/AIDS and STI education campaign targeting all workers hired, international and national, female and male, skilled, semi- and unskilled occupations, at the time of recruitment and thereafter pursued throughout the construction phase on ongoing and regular basis. This should be complemented by easy access to condoms at the workplace as well as to voluntary counseling and testing.

Annex – D

WORLD BANK GROUP/IFC ENVIRONMENTAL HEALTH AND SAFETY GUIDELINES, 2007

Environmental, Health, and Safety General Guidelines

Introduction

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP)[1]. When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These **General EHS Guidelines** are designed to be used together with the relevant **Industry Sector EHS Guidelines** which provide guidance to users on EHS issues in specific industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary. A complete list of industry-sector guidelines can be found at: www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines

The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment[2] in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account. The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

The **General EHS Guidelines** are organized as follows:

[1] Defined as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity as well as varying levels of financial and technical feasibility.

[2] For IFC, such assessment is carried out consistent with Performance Standard 1, and for the World Bank, with Operational Policy 4.01.

General Approach to the Management of EHS Issues at the Facility or Project Level

Effective management of environmental, health, and safety (EHS) issues entails the inclusion of EHS considerations into corporate- and facility-level business processes in an organized, hierarchical approach that includes the following steps:

- Identifying EHS project hazards[3] and associated risks[4] as early as possible in the facility development or project cycle, including the incorporation of EHS considerations into the site selection process, product design process, engineering planning process for capital requests, engineering work orders, facility modification authorizations, or layout and process change plans.
- Involving EHS professionals, who have the experience, competence, and training necessary to assess and manage EHS impacts and risks, and carry out specialized environmental management functions including the preparation of project or activity-specific plans and procedures that incorporate the technical recommendations presented in this document that are relevant to the project.
- Understanding the likelihood and magnitude of EHS risks, based on:
    - The nature of the project activities, such as whether the project will generate significant quantities of emissions or effluents, or involve hazardous materials or processes;
    - The potential consequences to workers, communities, or the environment if hazards are not adequately managed, which may depend on the proximity of project activities to people or to the environmental resources on which they depend.
- Prioritizing risk management strategies with the objective of achieving an overall reduction of risk to human health and the environment, focusing on the prevention of irreversible and / or significant impacts.
- Favoring strategies that eliminate the cause of the hazard at its source, for example, by selecting less hazardous materials or processes that avoid the need for EHS controls.
- When impact avoidance is not feasible, incorporating engineering and management controls to reduce or minimize the possibility and magnitude of undesired consequences, for example, with the application of pollution controls to reduce the levels of emitted contaminants to workers or environments.
- Preparing workers and nearby communities to respond to accidents, including providing technical and financial resources to effectively and safely control such events, and restoring workplace and community environments to a safe and healthy condition.
- Improving EHS performance through a combination of ongoing monitoring of facility performance and effective accountability.

[3] Defined as "threats to humans and what they value" (Kates, et al., 1985).

[4] Defined as "quantitative measures of hazard consequences, usually expressed as conditional probabilities of experiencing harm" (Kates, et. al., 1985)

1.0 Environmental

1.1 Air Emissions and Ambient Air Quality

Applicability and Approach

This guideline applies to facilities or projects that generate emissions to air at any stage of the project life-cycle. It complements the industry-specific emissions guidance presented in the Industry Sector Environmental, Health, and Safety (EHS) Guidelines by providing information about common techniques for emissions management that may be applied to a range of industry sectors. This guideline provides an approach to the management of significant sources of emissions, including specific guidance for assessment and monitoring of impacts. It is also intended to provide additional information on approaches to emissions management in projects located in areas of poor air quality, where it may be necessary to establish project-specific emissions standards.

Emissions of air pollutants can occur from a wide variety of activities during the construction, operation, and decommissioning phases of a project. These activities can be categorized based on the spatial characteristic of the source including point sources, fugitive sources, and mobile sources and, further, by process, such as combustion, materials storage, or other industry sector-specific processes.

Where possible, facilities and projects should avoid, minimize, and control adverse impacts to human health, safety, and the environment from emissions to air. Where this is not possible, the generation and release of emissions of any type should be managed through a combination of:

- Energy use efficiency
- Process modification
- Selection of fuels or other materials, the processing of which may result in less polluting emissions
- Application of emissions control techniques

The selected prevention and control techniques may include one or more methods of treatment depending on:

- Regulatory requirements
- Significance of the source
- Location of the emitting facility relative to other sources
- Location of sensitive receptors
- Existing ambient air quality, and potential for degradation of the airshed from a proposed project
- Technical feasibility and cost effectiveness of the available options for prevention, control, and release of emissions

Ambient Air Quality

General Approach

Projects with significant[5,6] sources of air emissions, and potential for significant impacts to ambient air quality, should prevent or minimize impacts by ensuring that:

- Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards[9] by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines[10] (see Table 1.1.1), or other internationally recognized sources[11];
- Emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. As a general rule, this Guideline suggests 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same airshed.[12]

At facility level, impacts should be estimated through qualitative or quantitative assessments by the use of baseline air quality assessments and atmospheric dispersion models to assess potential ground level concentrations. Local atmospheric, climatic, and air quality data should be applied when modeling dispersion, protection against atmospheric downwash, wakes, or eddy effects of the source, nearby[13] structures, and terrain features. The dispersion model applied should be internationally recognized, or comparable. Examples of acceptable emission estimation and dispersion modeling approaches for point and fugitive sources are

Table 1.1.1: WHO Ambient Air Quality Guidelines[7],[8]

	Averaging Period	Guideline value in µg/m³
Sulfur dioxide (SO_2)	24-hour 10 minute	125 (Interim target-1) 50 (Interim target-2) 20 (guideline) 500 (guideline)
Nitrogen dioxide (NO_2)	1-year 1-hour	40 (guideline) 200 (guideline)
Particulate Matter PM_{10}	1-year 24-hour	70 (Interim target-1) 50 (Interim target-2) 30 (Interim target-3) 20 (guideline) 150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (guideline)
Particulate Matter $PM_{2.5}$	1-year 24-hour	35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (guideline) 75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) 25 (guideline)
Ozone	8-hour daily maximum	160 (Interim target-1) 100 (guideline)

[5] Significant sources of point and fugitive emissions are considered to be general sources which, for example, can contribute a net emissions increase of one or more of the following pollutants within a given airshed: PM10: 50 tons per year (tpy); NOx: 500 tpy; SO2: 500 tpy; or as established through national legislation; and combustion sources with an equivalent heat input of 50 MWth or greater. The significance of emissions of inorganic and organic pollutants should be established on a project-specific basis taking into account toxic and other properties of the pollutant.

[6] United States Environmental Protection Agency, Prevention of Significant Deterioration of Air Quality, 40 CFR Ch. 1 Part 52.21. Other references for establishing significant emissions include the European Commission. 2000. "Guidance Document for EPER implementation." http://ec.europa.eu/environment/ippc/eper/index.htm ; and Australian Government. 2004. "National Pollutant Inventory Guide." http://www.npi.gov.au/handbooks/pubs/npiguide.pdf

[7] World Health Organization (WHO). Air Quality Guidelines Global Update, 2005. PM 24-hour value is the 99th percentile.

[8] Interim targets are provided in recognition of the need for a staged approach to achieving the recommended guidelines.

[9] Ambient air quality standards are ambient air quality levels established and published through national legislative and regulatory processes, and ambient quality guidelines refer to ambient quality levels primarily developed through clinical, toxicological, and epidemiological evidence (such as those published by the World Health Organization).

[10] Available at World Health Organization (WHO). http://www.who.int/en

[11] For example the United States National Ambient Air Quality Standards (NAAQS) (http://www.epa.gov/air/criteria.html) and the relevant European Council Directives (Council Directive 1999/30/EC of 22 April 1999 / Council Directive 2002/3/EC of February 12 2002).

[12] US EPA Prevention of Significant Deterioration Increments Limits applicable to non-degraded airsheds.

included in Annex 1.1.1. These approaches include screening models for single source evaluations (SCREEN3 or AIRSCREEN), as well as more complex and refined models (AERMOD OR ADMS). Model selection is dependent on the complexity and geo-morphology of the project site (e.g. mountainous terrain, urban or rural area).

Projects Located in Degraded Airsheds or Ecologically Sensitive Areas

Facilities or projects located within poor quality airsheds[14], and within or next to areas established as ecologically sensitive (e.g. national parks), should ensure that any increase in pollution levels is as small as feasible, and amounts to a fraction of the applicable short-term and annual average air quality guidelines or standards as established in the project-specific environmental assessment. Suitable mitigation measures may also include the relocation of significant sources of emissions outside the airshed in question, use of cleaner fuels or technologies, application of comprehensive pollution control measures, offset activities at installations controlled by the project sponsor or other facilities within the same airshed, and buy-down of emissions within the same airshed.

Specific provisions for minimizing emissions and their impacts in poor air quality or ecologically sensitive airsheds should be established on a project-by-project or industry-specific basis. Offset provisions outside the immediate control of the project sponsor or buy-downs should be monitored and enforced by the local agency responsible for granting and monitoring emission permits. Such provisions should be in place prior to final commissioning of the facility / project.

Point Sources

Point sources are discrete, stationary, identifiable sources of emissions that release pollutants to the atmosphere. They are typically located in manufacturing or production plants. Within a given point source, there may be several individual 'emission points' that comprise the point source.[15]

Point sources are characterized by the release of air pollutants typically associated with the combustion of fossil fuels, such as nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), and particulate matter (PM), as well as other air pollutants including certain volatile organic compounds (VOCs) and metals that may also be associated with a wide range of industrial activities.

Emissions from point sources should be avoided and controlled according to good international industry practice (GIIP) applicable to the relevant industry sector, depending on ambient conditions, through the combined application of process modifications and emissions controls, examples of which are provided in Annex 1.1.2. Additional recommendations regarding stack height and emissions from small combustion facilities are provided below.

Stack Height

The stack height for all point sources of emissions, whether 'significant' or not, should be designed according to GIIP (see Annex 1.1.3) to avoid excessive ground level concentrations due to downwash, wakes, and eddy effects, and to ensure reasonable diffusion to minimize impacts. For projects where there are multiple sources of emissions, stack heights should be established with due consideration to emissions from all other project sources, both point and fugitive. Non-significant sources of emissions,

[13] "Nearby" generally considers an area within a radius of up to 20 times the stack height.

[14] An airshed should be considered as having poor air quality if nationally legislated air quality standards or WHO Air Quality Guidelines are exceeded significantly.

[15] Emission points refer to a specific stack, vent, or other discrete point of pollution release. This term should not be confused with point source, which is a regulatory distinction from area and mobile sources. The characterization of point sources into multiple emissions points is useful for allowing more detailed reporting of emissions information.

including small combustion sources,[16] should also use GIIP in stack design.

Small Combustion Facilities Emissions Guidelines

Small combustion processes are systems designed to deliver electrical or mechanical power, steam, heat, or any combination of these, regardless of the fuel type, with a total, rated heat input capacity of between three Megawatt thermal (MWth) and 50 MWth.

The emissions guidelines in Table 1.1.2 are applicable to small combustion process installations operating more than 500 hours per year, and those with an annual capacity utilization of more than 30 percent. Plants firing a mixture of fuels should compare emissions performance with these guidelines based on the sum of the relative contribution of each applied fuel[17]. Lower emission values may apply if the proposed facility is located in an ecologically sensitive airshed, or airshed with poor air quality, in order to address potential cumulative impacts from the installation of more than one small combustion plant as part of a distributed generation project.

[16] Small combustion sources are those with a total rated heat input capacity of 50MWth or less.

[17] The contribution of a fuel is the percentage of heat input (LHV) provided by this fuel multiplied by its limit value.

Table 1.1.2 - Small Combustion Facilities Emissions Guidelines (3MWth – 50MWth) – (in mg/Nm^3 or as indicated)				
Combustion Technology / Fuel	**Particulate Matter (PM)**	**Sulfur Dioxide (SO_2)**	**Nitrogen Oxides (NOx)**	**Dry Gas, Excess O_2 Content (%)**
Engine				
Gas	N/A	N/A	200 (Spark Ignition) 400 (Dual Fuel) 1,600 (Compression Ignition)	15
Liquid	50 or up to 100 if justified by project specific considerations (e.g. Economic feasibility of using lower ash content fuel, or adding secondary treatment to meet 50, and available environmental capacity of the site)	1.5 percent Sulfur or up to 3.0 percent Sulfur if justified by project specific considerations (e.g. Economic feasibility of using lower S content fuel, or adding secondary treatment to meet levels of using 1.5 percent Sulfur, and available environmental capacity of the site)	If bore size diameter [mm] < 400: 1460 (or up to 1,600 if justified to maintain high energy efficiency.) If bore size diameter [mm] > or = 400: 1,850	15
Turbine				
Natural Gas =3MWth to < 15MWth	N/A	N/A	42 ppm (Electric generation) 100 ppm (Mechanical drive)	15
Natural Gas =15MWth to < 50MWth	N/A	N/A	25 ppm	15
Fuels other than Natural Gas =3MWth to < 15MWth	N/A	0.5 percent Sulfur or lower percent Sulfur (e.g. 0.2 percent Sulfur) if commercially available without significant excess fuel cost	96 ppm (Electric generation) 150 ppm (Mechanical drive)	15
Fuels other than Natural Gas =15MWth to < 50MWth	N/A	0.5% S or lower % S (0.2%S) if commercially available without significant excess fuel cost	74 ppm	15
Boiler				
Gas	N/A	N/A	320	3
Liquid	50 or up to 150 if justified by environmental assessment	2000	460	3
Solid	50 or up to 150 if justified by environmental assessment	2000	650	6

Notes: -N/A/ - no emissions guideline; Higher performance levels than these in the Table should be applicable to facilities located in urban / industrial areas with degraded airsheds or close to ecologically sensitive areas where more stringent emissions controls may be needed.; MWth is heat input on HHV basis; Solid fuels include biomass; Nm^3 is at one atmosphere pressure, 0°C.; MWth category is to apply to the entire facility consisting of multiple units that are reasonably considered to be emitted from a common stack except for NOx and PM limits for turbines and boilers. Guidelines values apply to facilities operating more than 500 hours per year with an annual capacity utilization factor of more than 30 percent.

Fugitive Sources

Fugitive source air emissions refer to emissions that are distributed spatially over a wide area and not confined to a specific discharge point. They originate in operations where exhausts are not captured and passed through a stack. Fugitive emissions have the potential for much greater ground-level impacts per unit than stationary source emissions, since they are discharged and dispersed close to the ground. The two main types of fugitive emissions are Volatile Organic Compounds (VOCs) and particulate matter (PM). Other contaminants (NO_x, SO_2 and CO) are mainly associated with combustion processes, as described above. Projects with potentially significant fugitive sources of emissions should establish the need for ambient quality assessment and monitoring practices.

Open burning of solid wastes, whether hazardous or non-hazardous, is not considered good practice and should be avoided, as the generation of polluting emissions from this type of source cannot be controlled effectively.

Volatile Organic Compounds (VOCs)

The most common sources of fugitive VOC emissions are associated with industrial activities that produce, store, and use VOC-containing liquids or gases where the material is under pressure, exposed to a lower vapor pressure, or displaced from an enclosed space. Typical sources include equipment leaks, open vats and mixing tanks, storage tanks, unit operations in wastewater treatment systems, and accidental releases. Equipment leaks include valves, fittings, and elbows which are subject to leaks under pressure. The recommended prevention and control techniques for VOC emissions associated with equipment leaks include:

- Equipment modifications, examples of which are presented in Annex 1.1.4;
- Implementing a leak detection and repair (LDAR) program that controls fugitive emissions by regularly monitoring to detect leaks, and implementing repairs within a predefined time period.[18]

For VOC emissions associated with handling of chemicals in open vats and mixing processes, the recommended prevention and control techniques include:

- Substitution of less volatile substances, such as aqueous solvents;
- Collection of vapors through air extractors and subsequent treatment of gas stream by removing VOCs with control devices such as condensers or activated carbon absorption;
- Collection of vapors through air extractors and subsequent treatment with destructive control devices such as:
  - Catalytic Incinerators: Used to reduce VOCs from process exhaust gases exiting paint spray booths, ovens, and other process operations
  - Thermal Incinerators: Used to control VOC levels in a gas stream by passing the stream through a combustion chamber where the VOCs are burned in air at temperatures between 700º C to 1,300º C
  - Enclosed Oxidizing Flares: Used to convert VOCs into CO_2 and H_2O by way of direct combustion
- Use of floating roofs on storage tanks to reduce the opportunity for volatilization by eliminating the headspace present in conventional storage tanks.

Particulate Matter (PM)

The most common pollutant involved in fugitive emissions is dust or particulate matter (PM). This is released during certain operations, such as transport and open storage of solid materials, and from exposed soil surfaces, including unpaved roads.

[18] For more information, see Leak Detection and Repair Program (LDAR), at: http://www.ldar.net

Recommended prevention and control of these emissions sources include:

- Use of dust control methods, such as covers, water suppression, or increased moisture content for open materials storage piles, or controls, including air extraction and treatment through a baghouse or cyclone for material handling sources, such as conveyors and bins;
- Use of water suppression for control of loose materials on paved or unpaved road surfaces. Oil and oil by-products is not a recommended method to control road dust. Examples of additional control options for unpaved roads include those summarized in Annex 1.1.5.

Ozone Depleting Substances (ODS)

Several chemicals are classified as ozone depleting substances (ODSs) and are scheduled for phase-out under the Montreal Protocol on Substances that Deplete the Ozone Layer.[19] No new systems or processes should be installed using CFCs, halons, 1,1,1-trichloroethane, carbon tetrachloride, methyl bromide or HBFCs. HCFCs should only be considered as interim / bridging alternatives as determined by the host country commitments and regulations.[20]

Mobile Sources – Land-based

Similar to other combustion processes, emissions from vehicles include CO, NO_x, SO_2, PM and VOCs. Emissions from on-road and off-road vehicles should comply with national or regional programs. In the absence of these, the following approach should be considered:

- Regardless of the size or type of vehicle, fleet owners / operators should implement the manufacturer recommended engine maintenance programs;
- Drivers should be instructed on the benefits of driving practices that reduce both the risk of accidents and fuel consumption, including measured acceleration and driving within safe speed limits;
- Operators with fleets of 120 or more units of heavy duty vehicles (buses and trucks), or 540 or more light duty vehicles[21] (cars and light trucks) within an airshed should consider additional ways to reduce potential impacts including:
  - Replacing older vehicles with newer, more fuel efficient alternatives
  - Converting high-use vehicles to cleaner fuels, where feasible
  - Installing and maintaining emissions control devices, such as catalytic converters
  - Implementing a regular vehicle maintenance and repair program

Greenhouse Gases (GHGs)

Sectors that may have potentially significant emissions of greenhouse gases (GHGs)[22] include energy, transport, heavy industry (e.g. cement production, iron / steel manufacturing, aluminum smelting, petrochemical industries, petroleum refining, fertilizer manufacturing), agriculture, forestry and waste management. GHGs may be generated from direct emissions

[19] Examples include: chlorofluorocarbons (CFCs); halons; 1,1,1-trichloroethane (methyl chloroform); carbon tetrachloride; hydrochlorofluorocarbons (HCFCs); hydrobromofluorocarbons (HBFCs); and methyl bromide. They are currently used in a variety of applications including: domestic, commercial, and process refrigeration (CFCs and HCFCs); domestic, commercial, and motor vehicle air conditioning (CFCs and HCFCs); for manufacturing foam products (CFCs); for solvent cleaning applications (CFCs, HCFCs, methyl chloroform, and carbon tetrachloride); as aerosol propellants (CFCs); in fire protection systems (halons and HBFCs); and as crop fumigants (methyl bromide).

[20] Additional information is available through the Montreal Protocol Secretariat web site available at: http://ozone.unep.org/

[21] The selected fleet size thresholds are assumed to represent potentially significant sources of emissions based on individual vehicles traveling 100,000 km / yr using average emission factors.

[22] The six greenhouse gases that form part of the Kyoto Protocol to the United Nations Framework Convention on Climate Change include carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulfur hexafluoride (SF_6).

from facilities within the physical project boundary and indirect emissions associated with the off-site production of power used by the project.

Recommendations for reduction and control of greenhouse gases include:

- Carbon financing;[23]
- Enhancement of energy efficiency (see section on 'Energy Conservation');
- Protection and enhancement of sinks and reservoirs of greenhouse gases;
- Promotion of sustainable forms of agriculture and forestry;
- Promotion, development and increased use of renewable forms of energy;
- Carbon capture and storage technologies;[24]
- Limitation and / or reduction of methane emissions through recovery and use in waste management, as well as in the production, transport and distribution of energy (coal, oil, and gas).

Monitoring

Emissions and air quality monitoring programs provide information that can be used to assess the effectiveness of emissions management strategies. A systematic planning process is recommended to ensure that the data collected are adequate for their intended purposes (and to avoid collecting unnecessary data). This process, sometimes referred to as a data quality objectives process, defines the purpose of collecting the data, the decisions to be made based on the data and the consequences of making an incorrect decision, the time and geographic boundaries, and the quality of data needed to make a correct decision.[25] The air quality monitoring program should consider the following elements:

- *Monitoring parameters*: The monitoring parameters selected should reflect the pollutants of concern associated with project processes. For combustion processes, indicator parameters typically include the quality of inputs, such as the sulfur content of fuel.
- *Baseline calculations*: Before a project is developed, baseline air quality monitoring at and in the vicinity of the site should be undertaken to assess background levels of key pollutants, in order to differentiate between existing ambient conditions and project-related impacts.
- *Monitoring type and frequency*: Data on emissions and ambient air quality generated through the monitoring program should be representative of the emissions discharged by the project over time. Examples of time-dependent variations in the manufacturing process include batch process manufacturing and seasonal process variations. Emissions from highly variable processes may need to be sampled more frequently or through composite methods. Emissions monitoring frequency and duration may also range from continuous for some combustion process operating parameters or inputs (e.g. the quality of fuel) to less frequent, monthly, quarterly or yearly stack tests.
- *Monitoring locations*: Ambient air quality monitoring may consists of off-site or fence line monitoring either by the project sponsor, the competent government agency, or by collaboration between both. The location of ambient air

[23] Carbon financing as a carbon emissions reduction strategy may include the host government-endorsed Clean Development Mechanism or Joint Implementation of the United Nations Framework Convention on Climate Change.

[24] Carbon dioxide capture and storage (CCS) is a process consisting of the separation of CO_2 from industrial and energy-related sources; transport to a storage location; and long-term isolation from the atmosphere, for example in geological formations, in the ocean, or in mineral carbonates (reaction of CO_2 with metal oxides in silicate minerals to produce stable carbonates). It is the object of intensive research worldwide (Intergovernmental Panel on Climate Change (IPCC), Special Report, Carbon Dioxide Capture and Storage (2006).

[25] See, for example, United States Environmental Protection Agency, Guidance on Systematic Planning Using the Data Quality Objectives Process EPA QA/G-4, EPA/240/B-06/001 February 2006.

quality monitoring stations should be established based on the results of scientific methods and mathematical models to estimate potential impact to the receiving airshed from an emissions source taking into consideration such aspects as the location of potentially affected communities and prevailing wind directions.

- *Sampling and analysis methods*: Monitoring programs should apply national or international methods for sample collection and analysis, such as those published by the International Organization for Standardization,[26] the European Committee for Standardization,[27] or the U.S. Environmental Protection Agency.[28] Sampling should be conducted by, or under, the supervision of trained individuals. Analysis should be conducted by entities permitted or certified for this purpose. Sampling and analysis Quality Assurance / Quality Control (QA/QC) plans should be applied and documented to ensure that data quality is adequate for the intended data use (e.g., method detection limits are below levels of concern). Monitoring reports should include QA/QC documentation.

Monitoring of Small Combustion Plants Emissions

- Additional recommended monitoring approaches for **boilers**:

  Boilers with capacities between =3 MWth and < 20 MWth:

  - Annual Stack Emission Testing: SO_2, NO_x and PM. For gaseous fuel-fired boilers, only NO_x. SO_2 can be calculated based on fuel quality certification if no SO_2 control equipment is used.
  - If Annual Stack Emission Testing demonstrates results consistently and significantly better than the required levels, frequency of Annual Stack Emission Testing can be reduced from annual to every two or three years.
  - Emission Monitoring: None

  Boilers with capacities between =20 MWth and < 50 MWth

  - Annual Stack Emission Testing: SO_2, NO_x and PM. For gaseous fuel-fired boilers, only NO_x. SO_2 can be calculated based on fuel quality certification (if no SO_2 control equipment is used)
  - Emission Monitoring: SO_2. Plants with SO_2 control equipment: Continuous. NO_x: Continuous monitoring of either NO_x emissions or indicative NO_x emissions using combustion parameters. PM: Continuous monitoring of either PM emissions, opacity, or indicative PM emissions using combustion parameters / visual monitoring.

- Additional recommended monitoring approaches for **turbines**:
  - Annual Stack Emission Testing: NO_x and SO_2 (NO_x only for gaseous fuel-fired turbines).
  - If Annual Stack Emission Testing results show constantly (3 consecutive years) and significantly (e.g. less than 75 percent) better than the required levels, frequency of Annual Stack Emission Testing can be reduced from annual to every two or three years.
  - Emission Monitoring: NO_x: Continuous monitoring of either NO_x emissions or indicative NO_x emissions using combustion parameters.SO_2: Continuous monitoring if SO_2 control equipment is used.

- Additional recommended monitoring approaches for **engines**:
  - Annual Stack Emission Testing: NO_x ,SO_2 and PM (NO_x only for gaseous fuel-fired diesel engines).

[26] An on-line catalogue of ISO standards relating to the environment, health protection, and safety is available at: http://www.iso.org/iso/en/CatalogueListPage.CatalogueList?ICS1=13&ICS2=&ICS3=&scopelist=

[27] An on-line catalogue of European Standards is available at: http://www.cen.eu/catweb/cwen.htm .

[28] The National Environmental Methods Index provides a searchable clearinghouse of U.S. methods and procedures for both regulatory and non-regulatory monitoring purposes for water, sediment, air and tissues, and is available at http://www.nemi.gov/.

- If Annual Stack Emission Testing results show constantly (3 consecutive years) and significantly (e.g. less than 75 percent) better than the required levels, frequency of Annual Stack Emission Testing can be reduced from annual to every two or three years.
- Emission Monitoring: NO_x: Continuous monitoring of either NO_x emissions or indicative NO_x emissions using combustion parameters. SO_2: Continuous monitoring if SO_2 control equipment is used. PM: Continuous monitoring of either PM emissions or indicative PM emissions using operating parameters.

Annex 1.1.1 – Air Emissions Estimation and Dispersion Modeling Methods

The following is a partial list of documents to aid in the estimation of air emissions from various processes and air dispersion models:

Australian Emission Estimation Technique Manuals
http://www.npi.gov.au/handbooks/

Atmospheric Emission Inventory Guidebook, UN / ECE / EMEP and the European Environment Agency
http://www.aeat.co.uk/netcen/airqual/TFEI/unece.htm

Emission factors and emission estimation methods, US EPA Office of Air Quality Planning & Standards
http://www.epa.gov/ttn/chief

Guidelines on Air Quality Models (Revised), US Environmental Protection Agency (EPA), 2005
http://www.epa.gov/scram001/guidance/guide/appw_05.pdf

Frequently Asked Questions, Air Quality Modeling and Assessment Unit (AQMAU), UK Environment Agency
http://www.environment-agency.gov.uk/subjects/airquality/236092/?version=1&lang=_e

OECD Database on Use and Release of Industrial Chemicals
http://www.olis.oecd.org/ehs/urchem.nsf/

Annex 1.1.2 – Illustrative Point Source Air Emissions Prevention and Control Technologies

Principal Sources and Issues	General Prevention / Process Modification Approach	Control Options	Reduction Efficiency (%)	Gas Condition	Comments
Particulate Matter (PM)					
Main sources are the combustion of fossil fuels and numerous manufacturing processes that collect PM through air extraction and ventilation systems. Volcanoes, ocean spray, forest fires and blowing dust (most prevalent in dry and semiarid climates) contribute to background levels.	Fuel switching (e.g. selection of lower sulfur fuels) or reducing the amount of fine particulates added to a process.	Fabric Filters	99 - 99.7%	Dry gas, temp <400F	Applicability depends on flue gas properties including temperature, chemical properties, abrasion and load. Typical air to cloth ratio range of 2.0 to 3.5 cfm/ft^2 Achievable outlet concentrations of 23 mg/Nm^3
		Electrostatic Precipitator (ESP)	97 – 99%	Varies depending of particle type	Precondition gas to remove large particles. Efficiency dependent on resistivity of particle. Achievable outlet concentration of 23 mg/Nm^3
		Cyclone	74 – 95%	None	Most efficient for large particles. Achievable outlet concentrations of 30 - 40 mg/Nm^3
		Wet Scrubber	93 – 95%	None	Wet sludge may be a disposal problem depending on local infrastructure. Achievable outlet concentrations of 30 - 40 mg/Nm3
Sulfur Dioxide (SO_2)					
Mainly produced by the combustion of fuels such as oil and coal and as a by-product from some chemical production or wastewater treatment processes.	Control system selection is heavily dependent on the inlet concentration. For SO2 concentrations in excess of 10%, the stream is passed through an acid plant not only to lower the SO2 emissions but also to generate high grade sulfur for sale. Levels below 10% are not rich enough for this process and should therefore utilize absorption or 'scrubbing,' where SO2 molecules are captured into a liquid phase or adsorption, where SO2 molecules are captured on the surface of a solid adsorbent.	Fuel Switching	>90%		Alternate fuels may include low sulfur coal, light diesel or natural gas with consequent reduction in particulate emissions related to sulfur in the fuel. Fuel cleaning or beneficiation of fuels prior to combustion is another viable option but may have economic consequences.
		Sorbent Injection	30% - 70%		Calcium or lime is injected into the flue gas and the SO_2 is adsorbed onto the sorbent
		Dry Flue Gas Desulfurization	70%-90%		Can be regenerable or throwaway.
		Wet Flue Gas Desulfurization	>90%		Produces gypsum as a by-product

Annex 1.1.2: Illustrative Point Source Air Emissions Prevention and Control Technologies (continued)

Oxides of Nitrogen (NOx)		Percent Reduction by Fuel Type			Comments
Associated with combustion of fuel. May occur in several forms of nitrogen oxide; namely nitric oxide (NO), nitrogen dioxide (NO_2) and nitrous oxide (N_2O), which is also a greenhouse gas. The term NOx serves as a composite between NO and NO_2 and emissions are usually reported as NOx. Here the NO is multiplied by the ratio of molecular weights of NO_2 to NO and added to the NO_2 emissions. Means of reducing NOx emissions are based on the modification of operating conditions such as minimizing the resident time at peak temperatures, reducing the peak temperatures by increasing heat transfer rates or minimizing the availability of oxygen.	**Combustion modification** (Illustrative of boilers)	**Coal**	**Oil**	**Gas**	These modifications are capable of reducing NOx emissions by 50 to 95%. The method of combustion control used depends on the type of boiler and the method of firing fuel.
	Low-excess-air firing	10–30	10–30	10–30	
	Staged Combustion	20–50	20–50	20–50	
	Flue Gas Recirculation	N/A	20–50	20–50	
	Water/Steam Injection	N/A	10–50	N/A.	
	Low-NOx Burners	30–40	30–40	30–40	
	Flue Gas Treatment	**Coal**	**Oil**	**Gas**	Flue gas treatment is more effective in reducing NOx emissions than are combustion controls. Techniques can be classified as SCR, SNCR, and adsorption. SCR involves the injection of ammonia as a reducing agent to convert NOx to nitrogen in the presence of a catalyst in a converter upstream of the air heater. Generally, some ammonia slips through and is part of the emissions. SNCR also involves the injection of ammonia or urea based products without the presence of a catalyst.
	Selective Catalytic Reduction (SCR)	60–90	60–90	60–90	
	Selective Non-Catalytic Reduction (SNCR)	N/A	30–70	30–70	

Note: Compiled by IFC based on inputs from technical experts.

Annex 1.1.3 - Good International Industry Practice (GIIP) Stack Height

(Based on United States 40 CFR, part 51.100 (ii)).

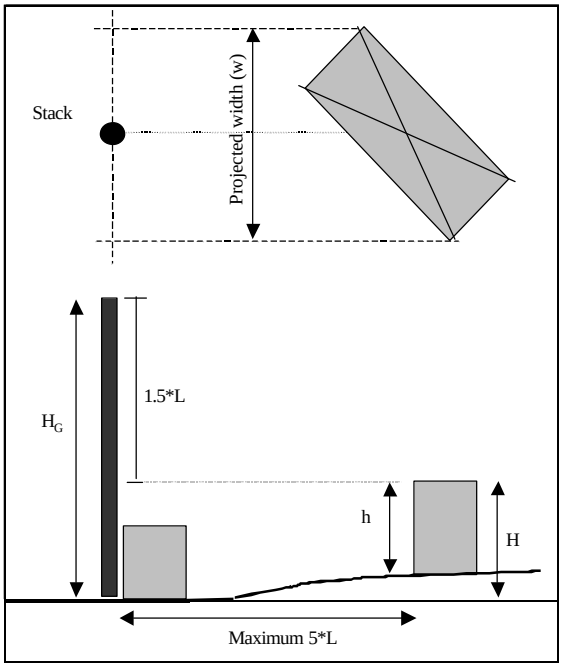
$H_G = H + 1.5L$; where

H_G = GEP stack height measured from the ground level elevation at the base of the stack

H = Height of nearby structure(s) above the base of the stack.

L = Lesser dimension, height (h) or width (w), of nearby structures

"Nearby structures" = Structures within/touching a radius of 5L but less than 800 m.



Annex 1.1.4 - Examples of VOC Emissions Controls

Equipment Type	Modification	Approximate Control Efficiency (%)
Pumps	Seal-less design	100[29]
	Closed-vent system	90[30]
	Dual mechanical seal with barrier fluid maintained at a higher pressure than the pumped fluid	100
Compressors	Closed-vent system	90
	Dual mechanical seal with barrier fluid maintained at a higher pressure than the compressed gas	100
Pressure Relief Devices	Closed-vent system	Variable[31]
	Rupture disk assembly	100
Valves	Seal-less design	100
Connectors	Weld together	100
Open-ended Lines	Blind, cap, plug, or second valve	100
Sampling Connections	Closed-loop sampling	100
Note: Examples of technologies are provided for illustrative purposes. The availability and applicability of any particular technology will vary depending on manufacturer specifications.		

29 Seal-less equipment can be a large source of emissions in the event of equipment failure.
30 Actual efficiency of a closed-vent system depends on percentage of vapors collected and efficiency of control device to which the vapors are routed.
31 Control efficiency of closed vent-systems installed on a pressure relief device may be lower than other closed-vent systems.

Annex 1.1.5 - Fugitive PM Emissions Controls

Control Type	Control Efficiency
Chemical Stabilization	0% - 98%
Hygroscopic salts Bitumens/adhesives	60% - 96%
Surfactants	0% - 68%
Wet Suppression – Watering	12% - 98%
Speed Reduction	0% - 80%
Traffic Reduction	Not quantified
Paving (Asphalt / Concrete)	85% - 99%
Covering with Gravel, Slag, or "Road Carpet"	30% - 50%
Vacuum Sweeping	0% - 58%
Water Flushing/Broom Sweeping	0% - 96%

1.2 Energy Conservation

Applicability and Approach

This guideline applies to facilities or projects that consume energy in process heating and cooling; process and auxiliary systems, such as motors, pumps, and fans; compressed air systems and heating, ventilation and air conditioning systems (HVAC); and lighting systems. It complements the industry-specific emissions guidance presented in the Industry Sector Environmental, Health, and Safety (EHS) Guidelines by providing information about common techniques for energy conservation that may be applied to a range of industry sectors.

Energy management at the facility level should be viewed in the context of overall consumption patterns, including those associated with production processes and supporting utilities, as well as overall impacts associated with emissions from power sources. The following section provides guidance on energy management with a focus on common utility systems often representing technical and financially feasible opportunities for improvement in energy conservation. However, operations should also evaluate energy conservation opportunities arising from manufacturing process modifications.

Energy Management Programs

Energy management programs should include the following elements:

- Identification, and regular measurement and reporting of principal energy flows within a facility at unit process level
- Preparation of mass and energy balance;
- Definition and regular review of energy performance targets, which are adjusted to account for changes in major influencing factors on energy use
- Regular comparison and monitoring of energy flows with performance targets to identify where action should be taken to reduce energy use
- Regular review of targets, which may include comparison with benchmark data, to confirm that targets are set at appropriate levels

Energy Efficiency

For any energy-using system, a systematic analysis of energy efficiency improvements and cost reduction opportunities should include a hierarchical examination of opportunities to**:**

- Demand/Load Side Management by reducing loads on the energy system
- Supply Side Management by:
  - Reduce losses in energy distribution
  - Improve energy conversion efficiency
  - Exploit energy purchasing opportunities
  - Use lower-carbon fuels

Common opportunities in each of these areas are summarized below.[32]

Process Heating

Process heating is vital to many manufacturing processes, including heating for fluids, calcining, drying, heat treating, metal heating, melting, melting agglomeration, curing, and forming[33].

In process heating systems, a system heat and mass balance will show how much of the system's energy input provides true process heating, and quantify fuel used to satisfy energy losses caused by excessive parasitic loads, distribution, or conversion losses. Examination of savings opportunities should be directed by the results of the heat and mass balance, though the following techniques are often valuable and cost-effective.

Heating Load Reduction

- Ensure adequate insulation to reduce heat losses through furnace/oven etc. structure
- Recover heat from hot process or exhaust streams to reduce system loads
- In intermittently-heated systems, consider use of low thermal mass insulation to reduce energy required to heat the system structure to operating temperature
- Control process temperature and other parameters accurately to avoid, for example, overheating or overdrying
- Examine opportunities to use low weight and/or low thermal mass product carriers, such as heated shapers, kiln cars etc.
- Review opportunities to schedule work flow to limit the need for process reheating between stages
- Operate furnaces/ovens at slight positive pressure, and maintain air seals to reduce air in-leakage into the heated system, thereby reducing the energy required to heat unnecessary air to system operating temperature
- Reduce radiant heat losses by sealing structural openings and keep viewing ports closed when not in use
- Where possible, use the system for long runs close to or at operating capacity
- Consider use of high emissivity coatings of high temperature insulation, and consequent reduction in process temperature
- Near net weight and shape heat designs
- Robust Quality assurance on input material
- Robust Scheduled maintenance programs

Heat Distribution Systems

Heat distribution in process heating applications typically takes place through steam, hot water, or thermal fluid systems. Losses can be reduced through the following actions:

- Promptly repair distribution system leaks
- Avoid steam leaks despite a perceived need to get steam through the turbine. Electricity purchase is usually cheaper overall, especially when the cost to treat turbine-quality boiler feed water is included. If the heat-power ratio of the distribution process is less than that of power systems, opportunities should be considered to increase the ratio; for example, by using low-pressure steam to drive absorption cooling systems rather than using electrically-driven vapor-compression systems.
- Regularly verify correct operation of steam traps in steam systems, and ensure that traps are not bypassed. Since

[32] Additional guidance on energy efficiency is available from sources such as Natural Resources Canada (NRCAN http://oee.nrcan.gc.ca/commercial/financial-assistance/new-buildings/mnecb.cfm?attr=20); the European Union (EUROPA. http://europa.eu.int/scadplus/leg/en/s15004.htm), and United States Department of Energy (US DOE, http://www.eere.energy.gov/consumer/industry/process.html).

[33] US DOE. http://www.eere.energy.gov/consumer/industry/process.html

steam traps typically last approximately 5 years, 20% should be replaced or repaired annually

- Insulate distribution system vessels, such as hot wells and de-aerators, in steam systems and thermal fluid or hot water storage tanks
- Insulate all steam, condensate, hot water and thermal fluid distribution pipework, down to and including 1" (25 mm) diameter pipe, in addition to insulating all hot valves and flanges
- In steam systems, return condensate to the boiler house for re-use, since condensate is expensive boiler-quality water and valuable beyond its heat content alone
- Use flash steam recovery systems to reduce losses due to evaporation of high-pressure condensate
- Consider steam expansion through a back-pressure turbine rather than reducing valve stations
- Eliminate distribution system losses by adopting point-of-use heating systems

Energy Conversion System Efficiency Improvements

The following efficiency opportunities should be examined for process furnaces or ovens, and utility systems, such as boilers and fluid heaters:

- Regularly monitor CO, oxygen or CO2 content of flue gases to verify that combustion systems are using the minimum practical excess air volumes
- Consider combustion automation using oxygen-trim controls
- Minimize the number of boilers or heaters used to meet loads. It is typically more efficient to run one boiler at 90% of capacity than two at 45%. Minimize the number of boilers kept at hot–standby
- Use flue dampers to eliminate ventilation losses from hot boilers held at standby
- Maintain clean heat transfer surfaces; in steam boilers, flue gases should be no more than 20 K above steam temperature)
- In steam boiler systems, use economizers to recover heat from flue gases to pre-heat boiler feed water or combustion air
- Consider reverse osmosis or electrodialysis feed water treatment to minimize the requirement for boiler blowdown
- Adopt automatic (continuous) boiler blowdown
- Recover heat from blowdown systems through flash steam recovery or feed-water preheat
- Do not supply excessive quantities of steam to the de-aerator
- With fired heaters, consider opportunities to recover heat to combustion air through the use of recuperative or regenerative burner systems
- For systems operating for extended periods (> 6000 hours/year), cogeneration of electrical power, heat and /or cooling can be cost effective
- Oxy Fuel burners
- Oxygen enrichment/injection
- Use of turbolators in boilers
- Sizing design and use of multiple boilers for different load configurations
- Fuel quality control/fuel blending

Process Cooling

The general methodology outlined above should be applied to process cooling systems. Commonly used and cost-effective measures to improve process cooling efficiency are described below.

Load Reduction

- Ensure adequate insulation to reduce heat gains through cooling system structure and to below-ambient temperature refrigerant pipes and vessels
- Control process temperature accurately to avoid overcooling
- Operate cooling tunnels at slight positive pressure and maintain air seals to reduce air in-leakage into the cooled system, thus reducing the energy required to cool this unnecessary air to system operating temperature
- Examine opportunities to pre-cool using heat recovery to a process stream requiring heating, or by using a higher temperature cooling utility
- In cold and chill stores, minimize heat gains to the cooled space by use of air curtains, entrance vestibules, or rapidly opening/closing doors. Where conveyors carry products into chilled areas, minimize the area of transfer openings, for example, by using strip curtains
- Quantify and minimize "incidental" cooling loads, for example, those due to evaporator fans, other machinery, defrost systems and lighting in cooled spaces, circulation fans in cooling tunnels, or secondary refrigerant pumps (e.g. chilled water, brines, glycols)
- Do not use refrigeration for auxiliary cooling duties, such as compressor cylinder head or oil cooling
- While not a thermal load, ensure there is no gas bypass of the expansion valve since this imposes compressor load while providing little effective cooling
- In the case of air conditioning applications, energy efficiency techniques include:
  - Placing air intakes and air-conditioning units in cool, shaded locations
  - Improving building insulation including seals, vents, windows, and doors
  - Planting trees as thermal shields around buildings
  - Installing timers and/or thermostats and/or enthalpy-based control systems
  - Installing ventilation heat recovery systems[34]

Energy Conversion

The efficiency of refrigeration service provision is normally discussed in terms of Coefficient of Performance ("COP"), which is the ratio of cooling duty divided by input power. COP is maximized by effective refrigeration system design and increased refrigerant compression efficiency, as well as minimization of the temperature difference through which the system works and of auxiliary loads (i.e. those in addition to compressor power demand) used to operate the refrigeration system.

System Design

- If process temperatures are above ambient for all, or part, of the year, use of ambient cooling systems, such as provided by cooling towers or dry air coolers, may be appropriate, perhaps supplemented by refrigeration in summer conditions.
- Most refrigeration systems are electric-motor driven vapor compression systems using positive displacement or centrifugal compressors. The remainder of this guideline relates primarily to vapor-compression systems. However, when a cheap or free heat source is available (e.g. waste heat from an engine-driven generator—low-pressure steam

[34] More information on HVAC energy efficiency can be found at the British Columbia Building Corporation (Woolliams, 2002. http://www.greenbuildingsbc.com/new_buildings/pdf_files/greenbuild_strategies_guide.pdf), NRCAN's EnerGuide (http://oee.nrcan.gc.ca/equipment/english/index.cfm?PrintView=N&Text=N) and NRCAN's Energy Star Programs (http://oee.nrcan.gc.ca/energystar/english/consumers/heating.cfm?text=N&printview=N#AC), and the US Energy Star Program (http://www.energystar.gov/index.cfm?c=guidelines.download_guidelines).

that has passed through a back-pressure turbine), absorption refrigeration may be appropriate.

- Exploit high cooling temperature range: precooling by ambient and/or 'high temperature' refrigeration before final cooling can reduce refrigeration capital and running costs. High cooling temperature range also provides an opportunity for countercurrent (cascade) cooling, which reduces refrigerant flow needs.
- Keep 'hot' and 'cold' fluids separate, for example, do not mix water leaving the chiller with water returning from cooling circuits.
- In low-temperature systems where high temperature differences are inevitable, consider two-stage or compound compression, or economized screw compressors, rather than single-stage compression.

Minimizing Temperature Differences

A vapor-compression refrigeration system raises the temperature of the refrigerant from somewhat below the lowest process temperature (the evaporating temperature) to provide process cooling, to a higher temperature (the condensing temperature), somewhat above ambient, to facilitate heat rejection to the air or cooling water systems. Increasing evaporating temperature typically increases compressor cooling capacity without greatly affecting power consumption. Reducing condensing temperature increases evaporator cooling capacity and substantially reduces compressor power consumption.

Elevating Evaporating Temperature

- Select a large evaporator to permit relatively low temperature differences between process and evaporating temperatures. Ensure that energy use of auxiliaries (e.g. evaporator fans) does not outweigh compression savings. In air-cooling applications, a design temperature difference of 6-10 K between leaving air temperature and evaporating temperature is indicative of an appropriately sized evaporator. When cooling liquids, 2K between leaving liquid and evaporating temperatures can be achieved, though a 4K difference is generally indicative of a generously-sized evaporator.
- Keep the evaporator clean. When cooling air, ensure correct defrost operation. In liquid cooling, monitor refrigerant/process temperature differences and compare with design expectations to be alert to heat exchanger contamination by scale or oil.
- Ensure oil is regularly removed from the evaporator, and that oil additions and removals balance.
- Avoid the use of back-pressure valves.
- Adjust expansion valves to minimize suction superheat consistent with avoidance of liquid carry-over to compressors.
- Ensure that an appropriate refrigerant charge volume is present.

Reducing Condensing Temperature

- Consider whether to use air-cooled or evaporation-based cooling (e.g. evaporative or water cooled condensers and cooling towers). Air-cooled evaporators usually have higher condensing temperatures, hence higher compressor energy use, and auxiliary power consumption, especially in low humidity climates. If a wet system is used, ensure adequate treatment to prevent growth of *legionella* bacteria.
- Whichever basic system is chosen, select a relatively large condenser to minimize differences between condensing and the heat sink temperatures. Condensing temperatures with air cooled or evaporative condensers should not be more than 10K above design ambient condition, and a 4K approach in a liquid-cooled condenser is possible.

- Avoid accumulation of non-condensable gases in the condenser system. Consider the installation of refrigerated non-condensable purgers, particularly for systems operating below atmospheric pressure.
- Keep condensers clean and free from scale. Monitor refrigerant/ambient temperature differences and compare with design expectations to be alert to heat exchanger contamination.
- Avoid liquid backup, which restricts heat transfer area in condensers. This can be caused by installation errors such as concentric reducers in horizontal liquid refrigerant pipes, or "up and over" liquid lines leading from condensers.
- In multiple condenser applications, refrigerant liquid lines should be connected via drop-leg traps to the main liquid refrigerant line to ensure that hot gases flow to all condensers.
- Avoid head pressure control to the extent possible. Head pressure control maintains condensing temperature at, or near, design levels. It therefore prevents reduction in compressor power consumption, which accompanies reduced condensing temperature, by restricting condenser capacity (usually by switching off the condenser, or cooling tower fans, or restricting cooling water flow) under conditions of less severe than design load or ambient temperature conditions. Head pressure is often kept higher than necessary to facilitate hot gas defrost or adequate liquid refrigerant circulation. Use of electronic rather than thermostatic expansion valves, and liquid refrigerant pumps can permit effective refrigerant circulation at much reduced condensing temperatures.
- Site condensers and cooling towers with adequate spacing so as to prevent recirculation of hot air into the tower.

Refrigerant Compression Efficiency

- Some refrigerant compressors and chillers are more efficient than others offered for the same duty. Before purchase, identify the operating conditions under which the compressor or chiller is likely to operate for substantial parts of its annual cycle. Check operating efficiency under these conditions, and ask for estimates of annual running cost. Note that refrigeration and HVAC systems rarely run for extended periods at design conditions, which are deliberately extreme. Operational efficiency under the most commonly occurring off-design conditions is likely to be most important.
- Compressors lose efficiency when unloaded. Avoid operation of multiple compressors at part-load conditions. Note that package chillers can gain coefficient of performance (COP) when slightly unloaded, as loss of compressor efficiency can be outweighed by the benefits of reduced condensing and elevated evaporating temperature. However, it is unlikely to be energy efficient to operate a single compressor-chiller at less than 50% of capacity.
- Consider turndown efficiency when specifying chillers. Variable speed control or multiple compressor chillers can be highly efficient at part loads.
- Use of thermal storage systems (e.g., ice storage) can avoid the need for close load-tracking and, hence, can avoid part-loaded compressor operation.

Refrigeration System Auxiliaries

Many refrigeration system auxiliaries (e.g. evaporator fans and chilled water pumps) contribute to refrigeration system load, so reductions in their energy use have a double benefit. General energy saving techniques for pumps and fans, listed in the next section of these guidelines, should be applied to refrigeration auxiliaries.

Additionally, auxiliary use can be reduced by avoidance of part-load operation and in plant selection (e.g. axial fan evaporative condensers generally use less energy than equivalent centrifugal fan towers).

Under extreme off-design conditions, reduction in duty of cooling system fans and pumps can be worthwhile, usually when the lowest possible condensing pressure has been achieved.

Compressed Air Systems

Compressed air is the most commonly found utility service in industry, yet in many compressed air systems, the energy contained in compressed air delivered to the user is often 10% or less of energy used in air compression. Savings are often possible through the following techniques:

Load reduction

- Examine each true user of compressed air to identify the air volume needed and the pressure at which this should be delivered.
- Do not mix high volume low pressure and low volume high pressure loads. Decentralize low volume high-pressure applications or provide dedicated low-pressure utilities, for example, by using fans rather than compressed air.
- Review air use reduction opportunities, for example:
    - Use air amplifier nozzles rather than simple open-pipe compressed air jets
    - Consider whether compressed air is needed at all
    - Where air jets are required intermittently (e.g. to propel product), consider operating the jet via a process-related solenoid valve, which opens only when air is required
    - Use manual or automatically operated valves to isolate air supply to individual machines or zones that are not in continuous use
    - Implement systems for systematic identification and repair of leaks
    - All condensate drain points should be trapped. Do not leave drain valves continuously 'cracked open'
    - Train workers never to direct compressed air against their bodies or clothing to dust or cool themselves down.

Distribution

- Monitor pressure losses in filters and replace as appropriate
- Use adequately sized distribution pipework designed to minimize pressure losses

1.3 Wastewater and Ambient Water Quality

Applicability and Approach

This guideline applies to projects that have either direct or indirect discharge of process wastewater, wastewater from utility operations or stormwater to the environment. These guidelines are also applicable to industrial discharges to sanitary sewers that discharge to the environment without any treatment. Process wastewater may include contaminated wastewater from utility operations, stormwater, and sanitary sewage. It provides information on common techniques for wastewater management, water conservation, and reuse that can be applied to a wide range of industry sectors. This guideline is meant to be complemented by the industry-specific effluent guidelines presented in the Industry Sector Environmental, Health, and Safety (EHS) Guidelines. Projects with the potential to generate process wastewater, sanitary (domestic) sewage, or stormwater should incorporate the necessary precautions to avoid, minimize, and control adverse impacts to human health, safety, or the environment.

In the context of their overall ESHS management system, facilities should:

- Understand the quality, quantity, frequency and sources of liquid effluents in its installations. This includes knowledge about the locations, routes and integrity of internal drainage systems and discharge points
- Plan and implement the segregation of liquid effluents principally along industrial, utility, sanitary, and stormwater categories, in order to limit the volume of water requiring specialized treatment. Characteristics of individual streams may also be used for source segregation.
- Identify opportunities to prevent or reduce wastewater pollution through such measures as recycle/reuse within their facility, input substitution, or process modification (e.g. change of technology or operating conditions/modes).
- Assess compliance of their wastewater discharges with the applicable: (i) discharge standard (if the wastewater is discharged to a surface water or sewer), and (ii) water quality standard for a specific reuse (e.g. if the wastewater is reused for irrigation).

Additionally, the generation and discharge of wastewater of any type should be managed through a combination of:

- Water use efficiency to reduce the amount of wastewater generation
- Process modification, including waste minimization, and reducing the use of hazardous materials to reduce the load of pollutants requiring treatment
- If needed, application of wastewater treatment techniques to further reduce the load of contaminants prior to discharge, taking into consideration potential impacts of cross-media transfer of contaminants during treatment (e.g., from water to air or land)

When wastewater treatment is required prior to discharge, the level of treatment should be based on:

- Whether wastewater is being discharged to a sanitary sewer system, or to surface waters
- National and local standards as reflected in permit requirements and sewer system capacity to convey and treat wastewater if discharge is to sanitary sewer
- Assimilative capacity of the receiving water for the load of contaminant being discharged wastewater if discharge is to surface water
- Intended use of the receiving water body (e.g. as a source of drinking water, recreation, irrigation, navigation, or other)
- Presence of sensitive receptors (e.g., endangered species) or habitats
- Good International Industry Practice (GIIP) for the relevant industry sector

General Liquid Effluent Quality

Discharge to Surface Water

Discharges of process wastewater, sanitary wastewater, wastewater from utility operations or stormwater to surface water should not result in contaminant concentrations in excess of local ambient water quality criteria or, in the absence of local criteria, other sources of ambient water quality.[35] Receiving water use[36] and assimilative capacity[37], taking other sources of discharges to the receiving water into consideration, should also influence the acceptable pollution loadings and effluent discharge quality. Additional considerations that should be included in the setting of project-specific performance levels for wastewater effluents include:

- Process wastewater treatment standards consistent with applicable Industry Sector EHS Guidelines. Projects for which there are no industry-specific guidelines should reference the effluent quality guidelines of an industry sector with suitably analogous processes and effluents;
- Compliance with national or local standards for sanitary wastewater discharges or, in their absence, the indicative guideline values applicable to sanitary wastewater discharges shown in Table 1.3.1 below;
- Temperature of wastewater prior to discharge does not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use and assimilative capacity among other considerations.

Discharge to Sanitary Sewer Systems

Discharges of industrial wastewater, sanitary wastewater, wastewater from utility operations or stormwater into public or private wastewater treatment systems should:

- Meet the pretreatment and monitoring requirements of the sewer treatment system into which it discharges.
- Not interfere, directly or indirectly, with the operation and maintenance of the collection and treatment systems, or pose a risk to worker health and safety, or adversely impact

[35] An example is the US EPA National Recommended Water Quality Criteria http://www.epa.gov/waterscience/criteria/wqcriteria.html

[36] Examples of receiving water uses as may be designated by local authorities include: drinking water (with some level of treatment), recreation, aquaculture, irrigation, general aquatic life, ornamental, and navigation. Examples of health-based guideline values for receiving waters include World Health Organization (WHO) guidelines for recreational use (http://www.who.int/water_sanitation_health/dwq/guidelines/en/index.html)

[37] The assimilative capacity of the receiving water body depends on numerous factors including, but not limited to, the total volume of water, flow rate, flushing rate of the water body and the loading of pollutants from other effluent sources in the area or region. A seasonally representative baseline assessment of ambient water quality may be required for use with established scientific methods and mathematical models to estimate potential impact to the receiving water from an effluent source.

characteristics of residuals from wastewater treatment operations.

- Be discharged into municipal or centralized wastewater treatment systems that have adequate capacity to meet local regulatory requirements for treatment of wastewater generated from the project. Pretreatment of wastewater to meet regulatory requirements before discharge from the project site is required if the municipal or centralized wastewater treatment system receiving wastewater from the project does not have adequate capacity to maintain regulatory compliance.

Land Application of Treated Effluent

The quality of treated process wastewater, wastewater from utility operations or stormwater discharged on land, including wetlands, should be established based on local regulatory requirements. . Where land is used as part of the treatment system and the ultimate receptor is surface water, water quality guidelines for surface water discharges specific to the industry sector process should apply.[38] Potential impact on soil, groundwater, and surface water, in the context of protection, conservation and long term sustainability of water and land resources should be assessed when land is used as part of any wastewater treatment system.

Septic Systems

Septic systems are commonly used for treatment and disposal of domestic sanitary sewage in areas with no sewerage collection networks, Septic systems should only be used for treatment of sanitary sewage, and unsuitable for industrial wastewater treatment. When septic systems are the selected form of wastewater disposal and treatment, they should be:

- Properly designed and installed in accordance with local regulations and guidance to prevent any hazard to public health or contamination of land, surface or groundwater.
- Well maintained to allow effective operation.
- Installed in areas with sufficient soil percolation for the design wastewater loading rate.
- Installed in areas of stable soils that are nearly level, well drained, and permeable, with enough separation between the drain field and the groundwater table or other receiving waters.

Wastewater Management

Wastewater management includes water conservation, wastewater treatment, stormwater management, and wastewater and water quality monitoring.

Industrial Wastewater

Industrial wastewater generated from industrial operations includes process wastewater, wastewater from utility operations,, runoff from process and materials staging areas, and miscellaneous activities including wastewater from laboratories, equipment maintenance shops, etc.. The pollutants in an industrial wastewater may include acids or bases (exhibited as low or high pH), soluble organic chemicals causing depletion of dissolved oxygen, suspended solids, nutrients (phosphorus, nitrogen), heavy metals (e.g. cadmium, chromium, copper, lead, mercury, nickel, zinc), cyanide, toxic organic chemicals, oily materials, and volatile materials. , as well as from thermal characteristics of the discharge (e.g., elevated temperature). Transfer of pollutants to another phase, such as air, soil, or the sub-surface, should be minimized through process and engineering controls.

Process Wastewater – – Examples of treatment approaches typically used in the treatment of industrial wastewater are summarized in Annex 1.3.1. While the choice of treatment

[38] Additional guidance on water quality considerations for land application is available in the WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater. Volume 2: Wastewater Use in Agriculture http://www.who.int/water_sanitation_health/wastewater/gsuweg2/en/index.html

technology is driven by wastewater characteristics, the actual performance of this technology depends largely on the adequacy of its design, equipment selection, as well as operation and maintenance of its installed facilities. Adequate resources are required for proper operation and maintenance of a treatment facility, and performance is strongly dependent on the technical ability and training of its operational staff. One or more treatment technologies may be used to achieve the desired discharge quality and to maintain consistent compliance with regulatory requirements. The design and operation of the selected wastewater treatment technologies should avoid uncontrolled air emissions of volatile chemicals from wastewaters. Residuals from industrial wastewater treatment operations should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.

Wastewater from Utilities Operations - Utility operations such as cooling towers and demineralization systems may result in high rates of water consumption, as well as the potential release of high temperature water containing high dissolved solids, residues of biocides, residues of other cooling system anti-fouling agents, etc. Recommended water management strategies for utility operations include:

- Adoption of water conservation opportunities for facility cooling systems as provided in the Water Conservation section below;
- Use of heat recovery methods (also energy efficiency improvements) or other cooling methods to reduce the temperature of heated water prior to discharge to ensure the discharge water temperature does not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors and assimilative capacity among other considerations;
- Minimizing use of antifouling and corrosion inhibiting chemicals by ensuring appropriate depth of water intake and use of screens. Least hazardous alternatives should be used with regards to toxicity, biodegradability, bioavailability, and bioaccumulation potential. Dose applied should accord with local regulatory requirements and manufacturer recommendations;
- Testing for residual biocides and other pollutants of concern should be conducted to determine the need for dose adjustments or treatment of cooling water prior to discharge.

Stormwater Management - Stormwater includes any surface runoff and flows resulting from precipitation, drainage or other sources. Typically stormwater runoff contains suspended sediments, metals, petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAHs), coliform, etc. Rapid runoff, even of uncontaminated stormwater, also degrades the quality of the receiving water by eroding stream beds and banks. In order to reduce the need for stormwater treatment, the following principles should be applied:

- Stormwater should be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge
- Surface runoff from process areas or potential sources of contamination should be prevented
- Where this approach is not practical, runoff from process and storage areas should be segregated from potentially less contaminated runoff
- Runoff from areas without potential sources of contamination should be minimized (e.g. by minimizing the area of impermeable surfaces) and the peak discharge rate should

be reduced (e.g. by using vegetated swales and retention ponds);

- Where stormwater treatment is deemed necessary to protect the quality of receiving water bodies, priority should be given to managing and treating the first flush of stormwater runoff where the majority of potential contaminants tend to be present;
- When water quality criteria allow, stormwater should be managed as a resource, either for groundwater recharge or for meeting water needs at the facility;
- Oil water separators and grease traps should be installed and maintained as appropriate at refueling facilities, workshops, parking areas, fuel storage and containment areas.
- Sludge from stormwater catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.

Sanitary Wastewater

Sanitary wastewater from industrial facilities may include effluents from domestic sewage, food service, and laundry facilities serving site employees. Miscellaneous wastewater from laboratories, medical infirmaries, water softening etc. may also be discharged to the sanitary wastewater treatment system. Recommended sanitary wastewater management strategies include:

- Segregation of wastewater streams to ensure compatibility with selected treatment option (e.g. septic system which can only accept domestic sewage);
- Segregation and pretreatment of oil and grease containing effluents (e.g. use of a grease trap) prior to discharge into sewer systems;
- If sewage from the industrial facility is to be discharged to surface water, treatment to meet national or local standards for sanitary wastewater discharges or, in their absence, the indicative guideline values applicable to sanitary wastewater discharges shown in Table 1.3.1;
- If sewage from the industrial facility is to be discharged to either a septic system, or where land is used as part of the treatment system, treatment to meet applicable national or local standards for sanitary wastewater discharges is required.
- Sludge from sanitary wastewater treatment systems should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.

Table 1.3.1 Indicative Values for Treated Sanitary Sewage Discharges[a]

Pollutants	Units	Guideline Value
pH	pH	6 – 9
BOD	mg/l	30
COD	mg/l	125
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN[b] / 100 ml	400[a]

Notes:
[a] Not applicable to centralized, municipal, wastewater treatment systems which are included in EHS Guidelines for Water and Sanitation.
[b] MPN = Most Probable Number

Emissions from Wastewater Treatment Operations

Air emissions from wastewater treatment operations may include hydrogen sulfide, methane, ozone (in the case of ozone disinfection), volatile organic compounds (e.g., chloroform generated from chlorination activities and other volatile organic compounds (VOCs) from industrial wastewater), gaseous or volatile chemicals used for disinfection processes (e.g., chlorine and ammonia), and bioaerosols. Odors from treatment facilities can also be a nuisance to workers and the surrounding community. Recommendations for the management of emissions are presented in the Air Emissions and Ambient Air Quality section of this document and in the EHS Guidelines for Water and Sanitation.

Residuals from Wastewater Treatment Operations

Sludge from a waste treatment plant needs to be evaluated on a case-by-case basis to establish whether it constitutes a hazardous or a non-hazardous waste and managed accordingly as described in the Waste Management section of this document.

Occupational Health and Safety Issues in Wastewater Treatment Operations

Wastewater treatment facility operators may be exposed to physical, chemical, and biological hazards depending on the design of the facilities and the types of wastewater effluents managed. Examples of these hazards include the potential for trips and falls into tanks, confined space entries for maintenance operations, and inhalation of VOCs, bioaerosols, and methane, contact with pathogens and vectors, and use of potentially hazardous chemicals, including chlorine, sodium and calcium hypochlorite, and ammonia. Detailed recommendations for the management of occupational health and safety issues are presented in the relevant section of this document. Additional guidance specifically applicable to wastewater treatment systems is provided in the EHS Guidelines for Water and Sanitation.

Monitoring

A wastewater and water quality monitoring program with adequate resources and management oversight should be developed and implemented to meet the objective(s) of the monitoring program. The wastewater and water quality monitoring program should consider the following elements:

- *Monitoring parameters*: The parameters selected for monitoring should be indicative of the pollutants of concern from the process, and should include parameters that are regulated under compliance requirements;

- *Monitoring type and frequency*: Wastewater monitoring should take into consideration the discharge characteristics from the process over time. Monitoring of discharges from processes with batch manufacturing or seasonal process variations should take into consideration of time-dependent

variations in discharges and, therefore, is more complex than monitoring of continuous discharges. Effluents from highly variable processes may need to be sampled more frequently or through composite methods. Grab samples or, if automated equipment permits, composite samples may offer more insight on average concentrations of pollutants over a 24-hour period. Composite samplers may not be appropriate where analytes of concern are short-lived (e.g., quickly degraded or volatile).

- *Monitoring locations*: The monitoring location should be selected with the objective of providing representative monitoring data. Effluent sampling stations may be located at the final discharge, as well as at strategic upstream points prior to merging of different discharges. Process discharges should not be diluted prior or after treatment with the objective of meeting the discharge or ambient water quality standards.

- *Data quality*: Monitoring programs should apply internationally approved methods for sample collection, preservation and analysis. Sampling should be conducted by or under the supervision of trained individuals. Analysis should be conducted by entities permitted or certified for this purpose. Sampling and Analysis Quality Assurance/Quality Control (QA/QC) plans should be prepared and, implemented. QA/QC documentation should be included in monitoring reports.

Annex 1.3.1 - Examples of Industrial Wastewater Treatment Approaches

Pollutant/Parameter	Control Options / Principle	Common End of Pipe Control Technology
pH	Chemical, Equalization	Acid/Base addition, Flow equalization
Oil and Grease / TPH	Phase separation	Dissolved Air Floatation, oil water separator, grease trap
TSS - Settleable	Settling, Size Exclusion	Sedimentation basin, clarifier, centrifuge, screens
TSS - Non-Settleable	Floatation, Filtration - traditional and tangential	Dissolved air floatation, Multimedia filter, sand filter, fabric filter, ultrafiltration, microfiltration
Hi - BOD (> 2 Kg/m^3)	Biological - Anaerobic	Suspended growth, attached growth, hybrid
Lo - BOD (< 2 Kg/m^3)	Biological - Aerobic, Facultative	Suspended growth, attached growth, hybrid
COD - Non-Biodegradable	Oxidation, Adsorption, Size Exclusion	Chemical oxidation, Thermal oxidation, Activated Carbon, Membranes
Metals - Particulate and Soluble	Coagulation, flocculation, precipitation, size exclusion	Flash mix with settling, filtration - traditional and tangential
Inorganics / Non-metals	Coagulation, flocculation, precipitation, size exclusion, Oxidation, Adsorption	Flash mix with settling, filtration - traditional and tangential, Chemical oxidation, Thermal oxidation, Activated Carbon, Reverse Osmosis, Evaporation
Organics - VOCs and SVOCs	Biological - Aerobic, Anaerobic, Facultative; Adsorption, Oxidation	Biological : Suspended growth, attached growth, hybrid; Chemical oxidation, Thermal oxidation, Activated Carbon
Emissions – Odors and VOCs	Capture – Active or Passive; Biological; Adsorption, Oxidation	Biological : Attached growth; Chemical oxidation, Thermal oxidation, Activated Carbon
Nutrients	Biological Nutrient Removal, Chemical, Physical, Adsorption	Aerobic/Anoxic biological treatment, chemical hydrolysis and air stripping, chlorination, ion exchange
Color	Biological - Aerobic, Anaerobic, Facultative; Adsorption, Oxidation	Biological Aerobic, Chemical oxidation, Activated Carbon
Temperature	Evaporative Cooling	Surface Aerators, Flow Equalization
TDS	Concentration, Size Exclusion	Evaporation, crystallization, Reverse Osmosis
Active Ingredients/Emerging Contaminants	Adsorption, Oxidation, Size Exclusion, Concentration	Chemical oxidation, Thermal oxidation, Activated Carbon, Ion Exchange, Reverse Osmosis, Evaporation, Crystallization
Radionuclides	Adsorption,Size Exclusion, Concentration	Ion Exchange, Reverse Osmosis, Evaporation, Crystallization
Pathogens	Disinfection, Sterilization	Chlorine, Ozone, Peroxide, UV, Thermal
Toxicity	Adsorption, Oxidation, Size Exclusion, Concentration	Chemical oxidation, Thermal oxidation, Activated Carbon, Evaporation, crystallization, Reverse Osmosis

1.4 Water Conservation

Applicability and Approach

Water conservation programs should be implemented commensurate with the magnitude and cost of water use. These programs should promote the continuous reduction in water consumption and achieve savings in the water pumping, treatment and disposal costs. Water conservation measures may include water monitoring/management techniques; process and cooling/heating water recycling, reuse, and other techniques; and sanitary water conservation techniques.

General recommendations include:

- Storm/Rainwater harvesting and use
- Zero discharge design/Use of treated waste water to be included in project design processes
- Use of localized recirculation systems in plant/facility/shops (as opposed to centralized recirculation system), with provision only for makeup water
- Use of dry process technologies e.g. dry quenching
- Process water system pressure management
- Project design to have measures for adequate water collection, spill control and leakage control system

Water Monitoring and Management

The essential elements of a water management program involve:

- Identification, regular measurement, and recording of principal flows within a facility;
- Definition and regular review of performance targets, which are adjusted to account for changes in major factors affecting water use (e.g. industrial production rate);
- Regular comparison of water flows with performance targets to identify where action should be taken to reduce water use.

Water measurement (metering) should emphasize areas of greatest water use. Based on review of metering data, 'unaccounted' use–indicating major leaks at industrial facilities–could be identified.

Process Water Reuse and Recycling

Opportunities for water savings in industrial processes are highly industry-specific. However, the following techniques have all been used successfully, and should be considered in conjunction with the development of the metering system described above.

- *Washing Machines:* Many washing machines use large quantities of hot water. Use can increase as nozzles become enlarged due to repeated cleaning and /or wear. Monitor machine water use, compare with specification, and replace nozzles when water and heat use reaches levels warranting such work.
- *Water reuse:* Common water reuse applications include countercurrent rinsing, for example in multi-stage washing

and rinsing processes, or reusing waste water from one process for another with less exacting water requirements. For example, using bleaching rinse water for textile washing, or bottle-washer rinse water for bottle crate washing, or even washing the floor. More sophisticated reuse projects requiring treatment of water before reuse are also sometimes practical.

- *Water jets/sprays:* If processes use water jets or sprays (e.g. to keep conveyors clean or to cool product) review the accuracy of the spray pattern to prevent unnecessary water loss.
- *Flow control optimization:* Industrial processes sometimes require the use of tanks, which are refilled to control losses. It is often possible to reduce the rate of water supply to such tanks, and sometimes to reduce tank levels to reduce spillage. If the process uses water cooling sprays, it may be possible to reduce flow while maintaining cooling performance. Testing can determine the optimum balance.
    - If hoses are used in cleaning, use flow controls to restrict wasteful water flow
    - Consider the use of high pressure, low volume cleaning systems rather than using large volumes of water sprayed from hosepipes
    - Using flow timers and limit switches to control water use
    - Using 'clean-up' practices rather than hosing down

Building Facility Operations

Consumption of building and sanitary water is typically less than that used in industrial processes. However, savings can readily be identified, as outlined below:

- Compare daily water use per employee to existing benchmarks taking into consideration the primary use at the facility, whether sanitary or including other activities such as showering or catering
- Regularly maintain plumbing, and identify and repair leaks
- Shut off water to unused areas
- Install self-closing taps, automatic shut-off valves, spray nozzles, pressure reducing valves, and water conserving fixtures (e.g. low flow shower heads, faucets, toilets, urinals; and spring loaded or sensored faucets)
- Operate dishwashers and laundries on full loads, and only when needed
- Install water-saving equipment in lavatories, such as low-flow toilets

Cooling Systems

Water conservation opportunities in cooling systems include:

- Use of closed circuit cooling systems with cooling towers rather than once-through cooling systems
- Limiting condenser or cooling tower blowdown to the minimum required to prevent unacceptable accumulation of dissolved solids
- Use of air cooling rather than evaporative cooling, although this may increase electricity use in the cooling system
- Use of treated waste water for cooling towers
- Reusing/recycling cooling tower blowdown

Heating Systems

Heating systems based on the circulation of low or medium pressure hot water (which do not consume water) should be closed. If they do consume water, regular maintenance should be conducted to check for leaks. However, large quantities of water may be used by steam systems, and this can be reduced by the following measures:

- Repair of steam and condensate leaks, and repair of all failed steam traps
- Return of condensate to the boilerhouse, and use of heat exchangers (with condensate return) rather than direct steam injection where process permits
- Flash steam recovery
- Minimizing boiler blowdown consistent with maintaining acceptably low dissolved solids in boiler water. Use of reverse osmosis boiler feed water treatment substantially reduces the need for boiler blowdown
- Minimizing deaerator heating

1.5 Hazardous Materials Management

Applicability and Approach

These guidelines apply to projects that use, store, or handle any quantity of hazardous materials (Hazmats), defined as materials that represent a risk to human health, property, or the environment due to their physical or chemical characteristics. Hazmats can be classified according to the hazard as explosives; compressed gases, including toxic or flammable gases; flammable liquids; flammable solids; oxidizing substances; toxic materials; radioactive material; and corrosive substances. Guidance on the transport of hazardous materials is covered in Section 3 of this document.

When a hazardous material is no longer usable for its original purpose and is intended for disposal, but still has hazardous properties, it is considered a *hazardous waste* (see Section 1.4).

This guidance is intended to be applied in conjunction with traditional occupational health and safety and emergency preparedness programs which are included in Section 2.0 on Occupational Health and Safety Management, and Section 3.7 on Emergency Preparedness and Response. Guidance on the Transport of Hazardous Materials is provided in Section 3.5.

This section is divided into two main subsections:

General Hazardous Materials Management: Guidance applicable to all projects or facilities that handle or store any quantity of hazardous materials.

Management of Major Hazards: Additional guidance for projects or facilities that store or handle hazardous materials at, or above, threshold quantities[39], and thus require special treatment to prevent accidents such as fire, explosions, leaks or spills, and to prepare and respond to emergencies.

The overall objective of hazardous materials management is to avoid or, when avoidance is not feasible, minimize uncontrolled releases of hazardous materials or accidents (including explosion and fire) during their production, handling, storage and use. This objective can be achieved by:

[39] For examples, threshold quantities should be those established for emergency planning purposes such as provided in the US Environmental Protection Agency. *Protection of Environment* (Title Threshold quantities are provided in the US Environmental Protection Agency. *Protection of Environment* (Title 40 CFR Parts 68, 112, and 355).

- Establishing hazardous materials management priorities based on hazard analysis of risky operations identified through Social and Environmental Assessment;
- Where practicable, avoiding or minimizing the use of hazardous materials. For example, non-hazardous materials have been found to substitute asbestos in building materials, PCBs in electrical equipment, persistent organic pollutants (POPs) in pesticides formulations, and ozone depleting substances in refrigeration systems;
- Preventing uncontrolled releases of hazardous materials to the environment or uncontrolled reactions that might result in fire or explosion;
- Using engineering controls (containment, automatic alarms, and shut-off systems) commensurate with the nature of hazard;
- Implementing management controls (procedures, inspections, communications, training, and drills) to address residual risks that have not been prevented or controlled through engineering measures.

General Hazardous Materials Management

Projects which manufacture, handle, use, or store hazardous materials should establish management programs that are commensurate with the potential risks present. The main objectives of projects involving hazardous materials should be the protection of the workforce and the prevention and control of releases and accidents. These objectives should be addressed by integrating prevention and control measures, management actions, and procedures into day-to-day business activities. Potentially applicable elements of a management program include the following:

Hazard Assessment

The level of risk should be established through an on-going assessment process based on:

- The types and amounts of hazardous materials present in the project. This information should be recorded and should include a summary table with the following information:
  - Name and description (e.g. composition of a mixture) of the Hazmat
  - Classification (e.g. code, class or division) of the Hazmat
  - Internationally accepted regulatory reporting threshold quantity or national equivalent[40] of the Hazmat
  - Quantity of Hazmat used per month
  - Characteristic(s) that make(s) the Hazmat hazardous (e.g. flammability, toxicity)
- Analysis of potential spill and release scenarios using available industry statistics on spills and accidents where available
- Analysis of the potential for uncontrolled reactions such as fire and explosions
- Analysis of potential consequences based on the physical-geographical characteristics of the project site, including aspects such as its distance to settlements, water resources, and other environmentally sensitive areas

Hazard assessment should be performed by specialized professionals using internationally-accepted methodologies such as Hazardous Operations Analysis (HAZOP), Failure Mode and Effects Analysis (FMEA), and Hazard Identification (HAZID).

Management Actions

The management actions to be included in a Hazardous Materials Management Plan should be commensurate with the level of

[40] Threshold quantities are provided in the US Environmental Protection Agency. *Protection of Environment* (Title 40 CFR Parts 68, 112, and 355).

potential risks associated with the production, handling, storage, and use of hazardous materials.

Release Prevention and Control Planning

Where there is risk of a spill of uncontrolled hazardous materials, facilities should prepare a spill control, prevention, and countermeasure plan as a specific component of their Emergency Preparedness and Response Plan (described in more detail in Section 3.7). The plan should be tailored to the hazards associated with the project, and include:

- Training of operators on release prevention, including drills specific to hazardous materials as part of emergency preparedness response training
- Implementation of inspection programs to maintain the mechanical integrity and operability of pressure vessels, tanks, piping systems, relief and vent valve systems, containment infrastructure, emergency shutdown systems, controls and pumps, and associated process equipment
- Preparation of written Standard Operating Procedures (SOPs) for filling USTs, ASTs or other containers or equipment as well as for transfer operations by personnel trained in the safe transfer and filling of the hazardous material, and in spill prevention and response
- SOPs for the management of secondary containment structures, specifically the removal of any accumulated fluid, such as rainfall, to ensure that the intent of the system is not accidentally or willfully defeated
- Identification of locations of hazardous materials and associated activities on an emergency plan site map
- Documentation of availability of specific personal protective equipment and training needed to respond to an emergency
- Documentation of availability of spill response equipment sufficient to handle at least initial stages of a spill and a list of external resources for equipment and personnel, if necessary, to supplement internal resources
- Description of response activities in the event of a spill, release, or other chemical emergency including:
  - Internal and external notification procedures
  - Specific responsibilities of individuals or groups
  - Decision process for assessing severity of the release, and determining appropriate actions
  - Facility evacuation routes
  - Post-event activities such as clean-up and disposal, incident investigation, employee re-entry, and restoration of spill response equipment.

Occupational Health and Safety

The Hazardous Materials Management Plan should address applicable, essential elements of occupational health and safety management as described in Section 2.0 on Occupational Health and Safety, including:

- Job safety analysis to identify specific potential occupational hazards and industrial hygiene surveys, as appropriate, to monitor and verify chemical exposure levels, and compare with applicable occupational exposure standards[41]
- Hazard communication and training programs to prepare workers to recognize and respond to workplace chemical hazards. Programs should include aspects of hazard identification, safe operating and materials handling procedures, safe work practices, basic emergency procedures, and special hazards unique to their jobs.

[41] Including: Threshold Limit Value (TLV®) occupational exposure guidelines and Biological Exposure Indices (BEIs®), American Conference of Governmental Industrial Hygienists (ACGIH), http://www.acgih.org/TLV/; U.S. National Institute for Occupational Health and Safety (NIOSH), http://www.cdc.gov/niosh/npg/; Permissible Exposure Limits (PELs), U.S. Occupational Safety and Health Administration (OSHA), http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992; Indicative Occupational Exposure Limit Values, European Union, http://europe.osha.eu.int/good_practice/risks/ds/oel/; and other similar sources.

Training should incorporate information from Material Safety Data Sheets[42] (MSDSs) for hazardous materials being handled. MSDSs should be readily accessible to employees in their local language.

- Definition and implementation of permitted maintenance activities, such as hot work or confined space entries
- Provision of suitable personal protection equipment (PPE) (footwear, masks, protective clothing and goggles in appropriate areas), emergency eyewash and shower stations, ventilation systems, and sanitary facilities
- Monitoring and record-keeping activities, including audit procedures designed to verify and record the effectiveness of prevention and control of exposure to occupational hazards, and maintaining accident and incident investigation reports on file for a period of at least five years

Process Knowledge and Documentation

The Hazardous Materials Management Plan should be incorporated into, and consistent with, the other elements of the facility ES/OHS MS and include:

- Written process safety parameters (i.e., hazards of the chemical substances, safety equipment specifications, safe operation ranges for temperature, pressure, and other applicable parameters, evaluation of the consequences of deviations, etc.)
- Written operating procedures
- Compliance audit procedures

[42] MSDSs are produced by the manufacturer, but might not be prepared for chemical intermediates that are not distributed in commerce. In these cases, employers still need to provide workers with equivalent information.

Preventive Measures

Hazardous Materials Transfer

Uncontrolled releases of hazardous materials may result from small cumulative events, or from more significant equipment failure associated with events such as manual or mechanical transfer between storage systems or process equipment. Recommended practices to prevent hazardous material releases from processes include:

- Use of dedicated fittings, pipes, and hoses specific to materials in tanks (e.g., all acids use one type of connection, all caustics use another), and maintaining procedures to prevent addition of hazardous materials to incorrect tanks
- Use of transfer equipment that is compatible and suitable for the characteristics of the materials transferred and designed to ensure safe transfer
- Regular inspection, maintenance and repair of fittings, pipes and hoses
- Provision of secondary containment, drip trays or other overflow and drip containment measures, for hazardous materials containers at connection points or other possible overflow points.

Overfill Protection

Overfills of vessels and tanks should be prevented as they are among the most common causes of spills resulting in soil and water contamination, and among the easiest to prevent. Recommended overfill protection measures include:

- Prepare written procedures for transfer operations that includes a checklist of measures to follow during filling operations and the use of filling operators trained in these procedures
- Installation of gauges on tanks to measure volume inside
- Use of dripless hose connections for vehicle tank and fixed connections with storage tanks

- Provision of automatic fill shutoff valves on storage tanks to prevent overfilling
- Use of a catch basin around the fill pipe to collect spills
- Use of piping connections with automatic overfill protection (float valve)
- Pumping less volume than available capacity into the tank or vessel by ordering less material than its available capacity
- Provision of overfill or over pressure vents that allow controlled release to a capture point

Reaction, Fire, and Explosion Prevention

Reactive, flammable, and explosive materials should also be managed to avoid uncontrolled reactions or conditions resulting in fire or explosion. Recommended prevention practices include:

- Storage of incompatible materials (acids, bases, flammables, oxidizers, reactive chemicals) in separate areas, and with containment facilities separating material storage areas
- Provision of material-specific storage for extremely hazardous or reactive materials
- Use of flame arresting devices on vents from flammable storage containers
- Provision of grounding and lightning protection for tank farms, transfer stations, and other equipment that handles flammable materials
- Selection of materials of construction compatible with products stored for all parts of storage and delivery systems, and avoiding reuse of tanks for different products without checking material compatibility
- Storage of hazardous materials in an area of the facility separated from the main production works. Where proximity is unavoidable, physical separation should be provided using structures designed to prevent fire, explosion, spill, and other emergency situations from affecting facility operations
- Prohibition of all sources of ignition from areas near flammable storage tanks

Control Measures

Secondary Containment (Liquids)

A critical aspect for controlling accidental releases of liquid hazardous materials during storage and transfer is the provision of secondary containment. It is not necessary for secondary containment methods to meet long term material compatibility as with primary storage and piping, but their design and construction should hold released materials effectively until they can be detected and safely recovered. Appropriate secondary containment structures consist of berms, dikes, or walls capable of containing the larger of 110 percent of the largest tank or 25% percent of the combined tank volumes in areas with above-ground tanks with a total storage volume equal or greater than 1,000 liters and will be made of impervious, chemically resistant material. Secondary containment design should also consider means to prevent contact between incompatible materials in the event of a release.

Other secondary containment measures that should be applied depending on site-specific conditions include:

- Transfer of hazardous materials from vehicle tanks to storage in areas with surfaces sufficiently impervious to avoid loss to the environment and sloped to a collection or a containment structure not connected to municipal wastewater/stormwater collection system
- Where it is not practical to provide permanent, dedicated containment structures for transfer operations, one or more alternative forms of spill containment should be provided, such as portable drain covers (which can be deployed for the duration of the operations), automatic shut-off valves on storm water basins, or shut off valves in drainage or sewer facilities, combined with oil-water separators

- Storage of drummed hazardous materials with a total volume equal or greater than 1,000 liters in areas with impervious surfaces that are sloped or bermed to contain a minimum of 25 percent of the total storage volume
- Provision of secondary containment for components (tanks, pipes) of the hazardous material storage system, to the extent feasible
- Conducting periodic (e.g. daily or weekly) reconciliation of tank contents, and inspection of visible portions of tanks and piping for leaks;
- Use of double-walled, composite, or specially coated storage and piping systems particularly in the use of underground storage tanks (USTs) and underground piping. If double-walled systems are used, they should provide a means of detecting leaks between the two walls.

Storage Tank and Piping Leak Detection

Leak detection may be used in conjunction with secondary containment, particularly in high-risk locations[43]. Leak detection is especially important in situations where secondary containment is not feasible or practicable, such as in long pipe runs. Acceptable leak detection methods include:

- Use of automatic pressure loss detectors on pressurized or long distance piping
- Use of approved or certified integrity testing methods on piping or tank systems, at regular intervals
- Considering the use of SCADA[44] if financially feasible

[43] High-risk locations are places where the release of product from the storage system could result in the contamination of drinking water source or those located in water resource protection areas as designated by local authorities.

[44] Supervisory Control and Data Acquisition

Underground Storage Tanks (USTs)[45]

Although there are many environmental and safety advantages of underground storage of hazardous materials, including reduced risk of fire or explosion, and lower vapor losses into the atmosphere, leaks of hazardous materials can go undetected for long periods of time with potential for soil and groundwater contamination. Examples of techniques to manage these risks include:

- Avoiding use of USTs for storage of highly soluble organic materials
- Assessing local soil corrosion potential, and installing and maintaining cathodic protection (or equivalent rust protection) for steel tanks
- For new installations, installing impermeable liners or structures (e.g., concrete vaults) under and around tanks and lines that direct any leaked product to monitoring ports at the lowest point of the liner or structure
- Monitoring the surface above any tank for indications of soil movement
- Reconciling tank contents by measuring the volume in store with the expected volume, given the stored quantity at last stocking, and deliveries to and withdrawals from the store
- Testing integrity by volumetric, vacuum, acoustic, tracers, or other means on all tanks at regular intervals
- Considering the monitoring groundwater of quality down gradient of locations where multiple USTs are in use
- Evaluating the risk of existing UST in newly acquired facilities to determine if upgrades are required for USTs that will be continued to be used, including replacement with new systems or permanent closure of abandoned USTs. Ensuring that new USTs are sited away from wells,

[45] Additional details on the management of USTs is provided in the EHS Guidelines for Retail Petroleum Stations.

reservoirs and other source water protection areas and floodplains, and maintained so as to prevent corrosion.

Management of Major Hazards

In addition to the application of the above-referenced guidance on prevention and control of releases of hazardous materials, projects involving production, handling, and storage of hazardous materials *at or above threshold limits*[46] should prepare a Hazardous Materials Risk Management Plan, in the context of its overall ES/OHS MS, containing all of the elements presented below.[47] The objective of this guidance is the prevention and control of catastrophic releases of toxic, reactive, flammable, or explosive chemicals that may result in toxic, fire, or explosion hazards.[48]

Management Actions

- *Management of Change:* These procedures should address:
  - The technical basis for changes in processes and operations
  - The impact of changes on health and safety
  - Modification to operating procedures
  - Authorization requirements
  - Employees affected
  - Training needs
- *Compliance Audit*: A compliance audit is a way to evaluate compliance with the prevention program requirements for each process. A compliance audit covering each element of the prevention measures (see below) should be conducted at least every three years and should include:
  - Preparation of a report of the findings
  - Determination and documentation of the appropriate response to each finding
  - Documentation that any deficiency has been corrected
- *Incident Investigation:* Incidents can provide valuable information about site hazards and the steps needed to prevent accidental releases. An incident investigation mechanism should include procedures for:
  - Initiation of the investigation promptly
  - Summarizing the investigation in a report
  - Addressing the report findings and recommendations
  - A review of the report with staff and contractors
- *Employee Participation:* A written plan of action should describe an active employee participation program for the prevention of accidents.
- *Contractors:* There should be a mechanism for contractor control which should include a requirement for them to develop hazard materials management procedures that meet the requirements of the hazardous materials management plan. Their procedures should be consistent with those of the contracting company and the contractor workforce should undergo the same training. Additionally, procedures should require that contractors are:
  - Provided with safety performance procedures and safety and hazard information
  - Observe safety practices
  - Act responsibly
  - Have access to appropriate training for their employees
  - Ensure that their employees know process hazards and applicable emergency actions

[46] Threshold quantities should be those established for emergency planning purposes such as provided in the US Environmental Protection Agency. *Protection of Environment* (Title 40 CFR Parts 300-399 and 700 to 789).

[47] For further information and guidance, please refer to International Finance Corporation (IFC) Hazardous Materials Risk Management Manual. Washington, D.C. December 2000.

[48] The approach to the management of major hazards is largely based on an approach to Process Safety Management developed by the American Institute of Chemical Engineers.

- Prepare and submit training records for their employees to the contracting company
- Inform their employees about the hazards presented by their work
- Assess trends of repeated similar incidents
- Develop and implement procedures to manage repeated similar incidents

- *Training*: Project employees should be provided training on Hazmat management. The training program should include:
  - A list of employees to be trained
  - Specific training objectives
  - Mechanisms to achieve the objectives (i.e., hands-on workshops, videos, etc.)
  - The means to determine whether the training program is effective
  - Training procedures for new hires and refresher courses for existing employees

Preventive Measures

The purpose of preventive measures is to ensure that safety-related aspects of the process and equipment are considered, limits to be placed on the operations are well known, and accepted standards and codes are adopted, where they apply.

- *Process Safety Information:* Procedures should be prepared for each hazardous materials and include:
  - Compilation of Material Safety Data Sheets (MSDS)
  - Identification of maximum intended inventories and safe upper/lower parameters
  - Documentation of equipment specifications and of codes and standards used to design, build and operate the process

- *Operating Procedures:* SOPs should be prepared for each step of all processes or operations within the project (e.g. initial startup, normal operations, temporary operations, emergency shutdown, emergency operations, normal shutdown, and start-up following a normal or emergency shutdown or major change). These SOPs should include special considerations for Mazmats used in the process or operations (e.g. temperature control to prevent emissions of a volatile hazardous chemical; diversion of gaseous discharges of hazardous pollutants from the process to a temporary storage tank in case of emergency).

Other procedures to be developed include impacts of deviations, steps to avoid deviations, prevention of chemical exposure, exposure control measures, and equipment inspections.

Mechanical Integrity of process equipment, piping and instrumentation: Inspection and maintenance procedures should be developed and documented to ensure mechanical integrity of equipment, piping, and instrumentation and prevent uncontrolled releases of hazardous materials from the project. These procedures should be included as part of the project SOPs. The specific process components of major interest include pressure vessels and storage tanks, piping systems, relief and vent systems and devices, emergency shutdown systems, controls, and pumps. Recommended aspects of the inspection and maintenance program include:

- Developing inspection and maintenance procedures
- Establishing a quality assurance plan for equipment, maintenance materials, and spare parts
- Conducting employee training on the inspection and maintenance procedures
- Conducting equipment, piping, and instrumentation inspections and maintenance
- Identifying and correcting identified deficiencies

- Evaluating the inspection and maintenance results and, if necessary, updating the inspection and maintenance procedures
- Reporting the results to management.

- *Hot Work Permit:* Hot work operations – such as brazing, torch-cutting, grinding, soldering, and welding – are associated with potential health, safety, and property hazards resulting from the fumes, gases, sparks, and hot metal and radiant energy produced during hot work. Hot work permit is required for any operation involving open flames or producing heat and/or sparks. The section of SOPs on hot work should include the responsibility for hot work permitting, personal protection equipment (PPE), hot work procedures, personnel training, and recordkeeping.
- *Pre-Start Review:* Procedures should be prepared to carry out pre-start reviews when a modification is significant enough to require a change in safety information under the management of change procedure. The procedures should:
  - Confirm that the new or modified construction and/or equipment meet design specifications
  - Ensure that procedures for safety, operation, maintenance, and emergency are adequate
  - Include a process hazard assessment, and resolve or implement recommendations for new process
  - Ensure that training for all affected employees is being conducted

Emergency Preparedness and Response

When handling hazardous materials, procedures and practices should be developed allowing for quick and efficient responses to accidents that could result in human injury or damage to the environment. An Emergency Preparedness and Response Plan, incorporated into and consistent with, the facility's overall ES/OHS MS, should be prepared to cover the following:[49]

- *Planning Coordination:* Procedures should be prepared for:
  - Informing the public and emergency response agencies
  - Documenting first aid and emergency medical treatment
  - Taking emergency response actions
  - Reviewing and updating the emergency response plan to reflect changes, and ensuring that employees are informed of such changes
- *Emergency Equipment:* Procedures should be prepared for using, inspecting, testing, and maintaining the emergency response equipment.
- *Training:* Employees and contractors should be trained on emergency response procedures.

Community Involvement and Awareness

When hazardous materials are in use above threshold quantities, the management plan should include a system for community awareness, notification and involvement that should be commensurate with the potential risks identified for the project during the hazard assessment studies. This should include mechanisms for sharing the results of hazard and risk assessment studies in a timely, understandable and culturally sensitive manner with potentially affected communities that provides a means for public feedback. Community involvement activities should include:

- Availability of general information to the potentially affected community on the nature and extent of project operations, and the prevention and control measures in place to ensure no effects to human health

[49] For a comprehensive treatment of the development of emergency response plans in conjunction with communities refer to the Awareness and Preparedness for Emergencies at Local Level (APELL) Guidelines available at: http://www.uneptie.org/pc/apell/publications/handbooks.html

- The potential for off-site effects to human health or the environment following an accident at planned or existing hazardous installations
- Specific and timely information on appropriate behavior and safety measures to be adopted in the event of an accident including practice drills in locations with higher risks
- Access to information necessary to understand the nature of the possible effect of an accident and an opportunity to contribute effectively, as appropriate, to decisions concerning hazardous installations and the development of community emergency preparedness plans.

1.6 Waste Management

Applicability and Approach

These guidelines apply to projects that generate, store, or handle any quantity of waste across a range of industry sectors. It is not intended to apply to projects or facilities where the primary business is the collection, transportation, treatment, or disposal of wastes. Specific guidance for these types of facilities is presented in the Environmental Health and Safety (EHS) Guidelines for Waste Management Facilities.

A *waste* is any solid, liquid, or contained gaseous material that is being discarded by disposal, recycling, burning or incineration. It can be byproduct of a manufacturing process or an obsolete commercial product that can no longer be used for intended purpose and requires disposal.

Solid (non-hazardous) wastes generally include any garbage, refuse. Examples of such waste include domestic trash and garbage; inert construction / demolition materials; refuse, such as metal scrap and empty containers (except those previously used to contain hazardous materials which should, in principle, be managed as a hazardous waste); and residual waste from industrial operations, such as boiler slag, clinker, and fly ash.

Hazardous waste shares the properties of a hazardous material (e.g. ignitability, corrosivity, reactivity, or toxicity), or other physical, chemical, or biological characteristics that may pose a potential risk to human health or the environment if improperly managed. Wastes may also be defined as "hazardous" by local regulations or international conventions, based on the origin of the waste and its inclusion on hazardous waste lists, or based on its characteristics.

Sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility, and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial operations needs to be evaluated on a case-by-case basis to establish whether it constitutes a hazardous or a non-hazardous waste.

Facilities that generate and store wastes should practice the following:

- Establishing waste management priorities at the outset of activities based on an understanding of potential Environmental, Health, and Safety (EHS) risks and impacts and considering waste generation and its consequences
- Establishing a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes.
- Avoiding or minimizing the generation waste materials, as far as practicable
- Where waste generation cannot be avoided but has been minimized, recovering and reusing waste

- Where waste can not be recovered or reused, treating, destroying, and disposing of it in an environmentally sound manner

General Waste Management

The following guidance applies to the management of non-hazardous and hazardous waste. Additional guidance specifically applicable to hazardous wastes is presented below. Waste management should be addressed through a Waste management system that addresses issues linked to waste minimization, generation, transport, disposal, and monitoring.

Waste Management Planning

Facilities that generate waste should characterize their waste according to composition, source, types of wastes produced, generation rates, or according to local regulatory requirements. Effective planning and implementation of waste management strategies should include:

- Review of new waste sources during planning, siting, and design activities, including during equipment modifications and process alterations, to identify expected waste generation, pollution prevention opportunities, and necessary treatment, storage, and disposal infrastructure
- Collection of data and information about the process and waste streams in existing facilities, including characterization of waste streams by type, quantities, and potential use/disposition
- Establishment of priorities based on a risk analysis that takes into account the potential EHS risks during the waste cycle and the availability of infrastructure to manage the waste in an environmentally sound manner
- Definition of opportunities for source reduction, as well as reuse and recycling
- Definition of procedures and operational controls for on-site storage
- Definition of options / procedures / operational controls for treatment and final disposal

Waste Prevention

Processes should be designed and operated to prevent, or minimize, the quantities of wastes generated and hazards associated with the wastes generated in accordance with the following strategy:

- Substituting raw materials or inputs with less hazardous or toxic materials, or with those where processing generates lower waste volumes
- Applying manufacturing process that convert materials efficiently, providing higher product output yields, including modification of design of the production process, operating conditions, and process controls[50]
- Instituting good housekeeping and operating practices, including inventory control to reduce the amount of waste resulting from materials that are out-of-date, off-specification, contaminated, damaged, or excess to plant needs
- Instituting procurement measures that recognize opportunities to return usable materials such as containers and which prevents the over ordering of materials
- Minimizing hazardous waste generation by implementing stringent waste segregation to prevent the commingling of non-hazardous and hazardous waste to be managed

[50] Examples of waste prevention strategies include the concept of Lean Manufacturing found at http://www.epa.gov/epaoswer/hazwaste/minimize/lean.htm

Recycling and Reuse

In addition to the implementation of waste prevention strategies, the total amount of waste may be significantly reduced through the implementation of recycling plans, which should consider the following elements:

- Evaluation of waste production processes and identification of potentially recyclable materials
- Identification and recycling of products that can be reintroduced into the manufacturing process or industry activity at the site
- Investigation of external markets for recycling by other industrial processing operations located in the neighborhood or region of the facility (e.g., waste exchange)
- Establishing recycling objectives and formal tracking of waste generation and recycling rates
- Providing training and incentives to employees in order to meet objectives

Treatment and Disposal

If waste materials are still generated after the implementation of feasible waste prevention, reduction, reuse, recovery and recycling measures, waste materials should be treated and disposed of and all measures should be taken to avoid potential impacts to human health and the environment. Selected management approaches should be consistent with the characteristics of the waste and local regulations, and may include one or more of the following:

- On-site or off-site biological, chemical, or physical treatment of the waste material to render it non-hazardous prior to final disposal
- Treatment or disposal at permitted facilities specially designed to receive the waste. Examples include: composting operations for organic non-hazardous wastes; properly designed, permitted and operated landfills or incinerators designed for the respective type of waste; or other methods known to be effective in the safe, final disposal of waste materials such as bioremediation.

Hazardous Waste Management

Hazardous wastes should always be segregated from non-hazardous wastes. If generation of hazardous waste can not be prevented through the implementation of the above general waste management practices, its management should focus on the prevention of harm to health, safety, and the environment, according to the following additional principles:

- Understanding potential impacts and risks associated with the management of any generated hazardous waste during its complete life cycle
- Ensuring that contractors handling, treating, and disposing of hazardous waste are reputable and legitimate enterprises, licensed by the relevant regulatory agencies and following good international industry practice for the waste being handled
- Ensuring compliance with applicable local and international regulations[51]

Waste Storage

Hazardous waste should be stored so as to prevent or control accidental releases to air, soil, and water resources in area location where:

[51] International requirements may include host-country commitments under the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their disposal (http://www.basel.int/) and Rotterdam Convention on the prior Inform Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (http://www.pic.int/)

- Waste is stored in a manner that prevents the commingling or contact between incompatible wastes, and allows for inspection between containers to monitor leaks or spills. Examples include sufficient space between incompatibles or physical separation such as walls or containment curbs
- Store in closed containers away from direct sunlight, wind and rain
- Secondary containment systems should be constructed with materials appropriate for the wastes being contained and adequate to prevent loss to the environment
- Secondary containment is included wherever liquid wastes are stored in volumes greater than 220 liters. The available volume of secondary containment should be at least 110 percent of the largest storage container, or 25 percent of the total storage capacity (whichever is greater), in that specific location
- Provide adequate ventilation where volatile wastes are stored.

Hazardous waste storage activities should also be subject to special management actions, conducted by employees who have received specific training in handling and storage of hazardous wastes:

- Provision of readily available information on chemical compatibility to employees, including labeling each container to identify its contents
- Limiting access to hazardous waste storage areas to employees who have received proper training
- Clearly identifying (label) and demarcating the area, including documentation of its location on a facility map or site plan
- Conducting periodic inspections of waste storage areas and documenting the findings
- Preparing and implementing spill response and emergency plans to address their accidental release (additional information on Emergency Plans in provided in Section 3 of this document)
- Avoiding underground storage tanks and underground piping of hazardous waste

Transportation

On-site and Off-site transportation of waste should be conducted so as to prevent or minimize spills, releases, and exposures to employees and the public. All waste containers designated for off-site shipment should be secured and labeled with the contents and associated hazards, be properly loaded on the transport vehicles before leaving the site, and be accompanied by a shipping paper (i.e., manifest) that describes the load and its associated hazards, consistent with the guidance provided in Section 3.4 on the Transport of Hazardous Materials.

Treatment and Disposal

In addition to the recommendations for treatment and disposal applicable to general wastes, the following issues specific to hazardous wastes should be considered:

Commercial or Government Waste Contractors

In the absence of qualified commercial or government-owned waste vendors (taking into consideration proximity and transportation requirements), facilities generating waste should consider using:

- Have the technical capability to manage the waste in a manner that reduces immediate and future impact to the environment
- Have all required permits, certifications, and approvals, of applicable government authorities

- Have been secured through the use of formal procurement agreements

In the absence of qualified commercial or government-owned waste disposal operators (taking into consideration proximity and transportation requirements), project sponsors should consider using:

- Installing on-site waste treatment or recycling processes
- As a final option, constructing facilities that will provide for the environmental sound long-term storage of wastes on-site (as described elsewhere in the General EHS Guidelines) or at an alternative appropriate location up until external commercial options become available

Small Quantities of Hazardous Waste

Hazardous waste materials are frequently generated in small quantities by many projects through a variety of activities such as equipment and building maintenance activities. Examples of these types of wastes include: spent solvents and oily rags, empty paint cans, chemical containers; used lubricating oil; used batteries (such as nickel-cadmium or lead acid); and lighting equipment, such as lamps or lamp ballasts. These wastes should be managed following the guidance provided in the above sections.

Monitoring

Monitoring activities associated with the management of hazardous and non-hazardous waste should include:

- Regular visual inspection of all waste storage collection and storage areas for evidence of accidental releases and to verify that wastes are properly labeled and stored. When significant quantities of hazardous wastes are generated and stored on site, monitoring activities should include:
  - Inspection of vessels for leaks, drips or other indications of loss
  - Identification of cracks, corrosion, or damage to tanks, protective equipment, or floors
  - Verification of locks, emergency valves, and other safety devices for easy operation (lubricating if required and employing the practice of keeping locks and safety equipment in standby position when the area is not occupied)
  - Checking the operability of emergency systems
  - Documenting results of testing for integrity, emissions, or monitoring stations (air, soil vapor, or groundwater)
  - Documenting any changes to the storage facility, and any significant changes in the quantity of materials in storage
- Regular audits of waste segregation and collection practices
- Tracking of waste generation trends by type and amount of waste generated, preferably by facility departments
- Characterizing waste at the beginning of generation of a new waste stream, and periodically documenting the characteristics and proper management of the waste, especially hazardous wastes
- Keeping manifests or other records that document the amount of waste generated and its destination
- Periodic auditing of third party treatment, and disposal services including re-use and recycling facilities when significant quantities of hazardous wastes are managed by third parties. Whenever possible, audits should include site visits to the treatment storage and disposal location

- Regular monitoring of groundwater quality in cases of Hazardous Waste on site storage and/or pretreatment and disposal
- Monitoring records for hazardous waste collected, stored, or shipped should include:
  - Name and identification number of the material(s) composing the hazardous waste
  - Physical state (i.e., solid, liquid, gaseous or a combination of one, or more, of these)
  - Quantity (e.g., kilograms or liters, number of containers)
  - Waste shipment tracking documentation to include, quantity and type, date dispatched, date transported and date received, record of the originator, the receiver and the transporter
  - Method and date of storing, repacking, treating, or disposing at the facility, cross-referenced to specific manifest document numbers applicable to the hazardous waste
  - Location of each hazardous waste within the facility, and the quantity at each location

1.7 Noise

Applicability

This section addresses impacts of noise beyond the property boundary of the facilities. Worker exposure to noise is covered in Section 2.0 on Occupational Health and Safety.

Prevention and Control

Noise prevention and mitigation measures should be applied where predicted or measured noise impacts from a project facility or operations exceed the applicable noise level guideline at the most sensitive point of reception.[52] The preferred method for controlling noise from stationary sources is to implement noise control measures at source.[53] Methods for prevention and control of sources of noise emissions depend on the source and proximity of receptors. Noise reduction options that should be considered include:

- Selecting equipment with lower sound power levels
- Installing silencers for fans
- Installing suitable mufflers on engine exhausts and compressor components
- Installing acoustic enclosures for equipment casing radiating noise
- Improving the acoustic performance of constructed buildings, apply sound insulation
- Installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m^2 in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective
- Installing vibration isolation for mechanical equipment
- Limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas
- Re-locating noise sources to less sensitive areas to take advantage of distance and shielding
- Siting permanent facilities away from community areas if possible
- Taking advantage of the natural topography as a noise buffer during facility design
- Reducing project traffic routing through community areas wherever possible
- Planning flight routes, timing and altitude for aircraft (airplane and helicopter) flying over community areas
- Developing a mechanism to record and respond to complaints

Noise Level Guidelines

Noise impacts should not exceed the levels presented in Table 1.7.1, or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.

[52] A point of reception or receptor may be defined as any point on the premises occupied by persons where extraneous noise and/or vibration are received. Examples of receptor locations may include: permanent or seasonal residences; hotels / motels; schools and daycares; hospitals and nursing homes; places of worship; and parks and campgrounds.

[53] At the design stage of a project, equipment manufacturers should provide design or construction specifications in the form of *"Insertion Loss Performance"* for silencers and mufflers, and "*Transmission Loss Performance"* for acoustic enclosures and upgraded building construction.

Table 1.7.1- Noise Level Guidelines[54]		
	One Hour L_{Aeq} (dBA)	
Receptor	Daytime 07:00 - 22:00	Nighttime 22:00 - 07:00
Residential; institutional; educational[55]	55	45
Industrial; commercial	70	70

Highly intrusive noises, such as noise from aircraft flyovers and passing trains, should not be included when establishing background noise levels.

Monitoring

Noise monitoring[56] may be carried out for the purposes of establishing the existing ambient noise levels in the area of the proposed or existing facility, or for verifying operational phase noise levels.

Noise monitoring programs should be designed and conducted by trained specialists. Typical monitoring periods should be sufficient for statistical analysis and may last 48 hours with the use of noise monitors that should be capable of logging data continuously over this time period, or hourly, or more frequently, as appropriate (or else cover differing time periods within several days, including weekday and weekend workdays). The type of acoustic indices recorded depends on the type of noise being monitored, as established by a noise expert. Monitors should be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface (e.g., wall). In general, the noise level limit is represented by the background or ambient noise levels that would be present in the absence of the facility or noise source(s) under investigation.

[54] Guidelines values are for noise levels measured out of doors. Source: Guidelines for Community Noise, World Health Organization (WHO), 1999.

[55] For acceptable indoor noise levels for residential, institutional, and educational settings refer to WHO (1999).

[56] Noise monitoring should be carried out using a Type 1 or 2 sound level meter meeting all appropriate IEC standards.

1.8 Contaminated Land

Applicability and Approach

This section provides a summary of management approaches for land contamination due to anthropogenic releases of hazardous materials, wastes, or oil, including naturally occurring substances. Releases of these materials may be the result of historic or current site activities, including, but not limited to, accidents during their handling and storage, or due to their poor management or disposal.

Land is considered contaminated when it contains hazardous materials or oil concentrations above background or naturally occurring levels.

Contaminated lands may involve surficial soils or subsurface soils that, through leaching and transport, may affect groundwater, surface water, and adjacent sites. Where subsurface contaminant sources include volatile substances, soil vapor may also become a transport and exposure medium, and create potential for contaminant infiltration of indoor air spaces of buildings.

Contaminated land is a concern because of:

- The potential risks to human health and ecology (e.g. risk of cancer or other human health effects, loss of ecology);
- The liability that it may pose to the polluter/business owners (e.g., cost of remediation, damage of business reputation and/or business-community relations) or affected parties (e.g. workers at the site, nearby property owners).

Contamination of land should be avoided by preventing or controlling the release of hazardous materials, hazardous wastes, or oil to the environment. When contamination of land is suspected or confirmed during any project phase, the cause of the uncontrolled release should be identified and corrected to avoid further releases and associated adverse impacts.

Contaminated lands should be managed to avoid the risk to human health and ecological receptors. The preferred strategy for land decontamination is to reduce the level of contamination at the site while preventing the human exposure to contamination.

To determine whether risk management actions are warranted, the following assessment approach should be applied to establish whether the three risk factors of 'Contaminants', 'Receptors', and 'Exposure Pathways' co-exist, or are likely to co-exist, at the project site under current or possible future land use:

- *Contaminant(s)*: Presence of hazardous materials, waste, or oil in any environmental media at potentially hazardous concentrations
- *Receptor(s)*: Actual or likely contact of humans, wildlife, plants, and other living organisms with the contaminants of concern
- *Exposure pathway(s)*: A combination of the route of migration of the contaminant from its point of release (e.g., leaching into potable groundwater) and exposure routes

(e.g., ingestion, transdermal absorption), which would allow receptor(s) to come into actual contact with contaminants

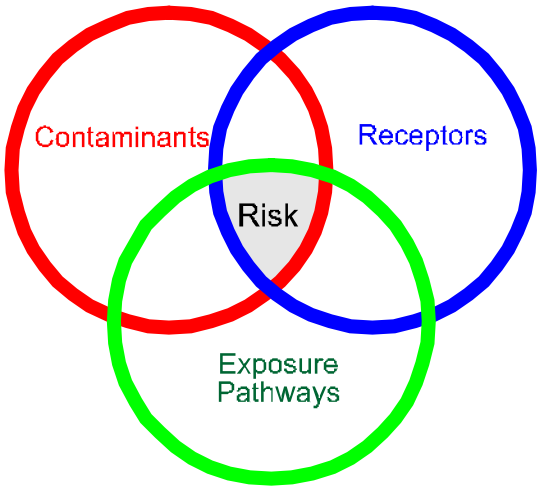


FIGURE 1.8.1: Inter-Relationship of Contaminant Risk Factors

When the three risk factors are considered to be present (in spite of limited data) under current or foreseeable future conditions, the following steps should be followed (as described in the remaining parts of this section):

1) Risk screening;
2) Interim risk management;
3) Detailed quantitative risk assessment; and
4) Permanent risk reduction measures.

Risk Screening

This step is also known as "problem formulation" for environmental risk assessment. Where there is potential evidence of contamination at a site, the following steps are recommended:

- Identification of the location of suspected highest level of contamination through a combination of visual and historical operational information;
- Sampling and testing of the contaminated media (soils or water) according to established technical methods applicable to suspected type of contaminant[57,58];
- Evaluation of the analytical results against the local and national contaminated sites regulations. In the absence of such regulations or environmental standards, other sources of risk-based standards or guidelines should be consulted to obtain comprehensive criteria for screening soil concentrations of pollutants.[59]
- Verification of the potential human and/or ecological receptors and exposure pathways relevant to the site in question

The outcome of risk-screening may reveal that there is no overlap between the three risk-factors as the contaminant levels identified are below those considered to pose a risk to human health or the environment. Alternatively, interim or permanent

[57] BC MOE. http://www.env.gov.bc.ca/epd/epdpa/contam_sites/guidance

[58] Massachusetts Department of Environment. http://www.mass.gov/dep/cleanup

[59] These may include the USEPA Region 3 Risk-Based Concentrations (RBCs). http://www.epa.gov/reg3hwmd/risk/human/index.htm. These RBCs are considered acceptable for specific land use and contaminant exposure scenarios as they have been developed by governments using risk assessment techniques for use as general targets in the site remediation. Separate PRGs have been developed or adopted for soil, sediment or groundwater, and often a distinction is made between land uses (as noted earlier) because of the need for more stringent guidelines for residential and agricultural versus commercial/industrial landuse. The RBC Tables contains Reference Doses (RfDs) and Cancer Slope Factors (CSFs) for about 400 chemicals. These toxicity factors have been combined with "standard" exposure scenarios to calculate RBCs--chemical concentrations corresponding to fixed levels of risk (i.e., a Hazard Quotient (HQ) of 1, or lifetime cancer risk of 1E-6, whichever occurs at a lower concentration) in water, air, fish tissue, and soil for individual chemical substances. The primary use of RBCs is for chemical screening during baseline risk assessment (see EPA Regional Guidance EPA/903/R-93-001, "Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening"). Additional useful soil quality guidelines can also be obtained from Lijzen et al. 2001.

risk reduction measures may need to be taken with, or without, more detailed risk assessment activities, as described below.

Interim Risk Management

Interim risk management actions should be implemented at any phase of the project life cycle if the presence of land contamination poses an "imminent hazard", i.e., representing an immediate risk to human health and the environment if contamination were allowed to continue, even a short period of time. Examples of situations considered to involve imminent hazards include, but are not restricted to:

- Presence of an explosive atmosphere caused by contaminated land
- Accessible and excessive contamination for which short-term exposure and potency of contaminants could result in acute toxicity, irreversible long term effects, sensitization, or accumulation of persistent biocumulative and toxic substances
- Concentrations of pollutants at concentrations above the Risk Based Concentrations (RBCs[60]) or drinking water standards in potable water at the point of abstraction

Appropriate risk reduction should be implemented as soon as practicable to remove the condition posing the imminent hazard.

Detailed Risk Assessment

As an alternative to complying with numerical standards or preliminary remediation goals, and depending on local regulatory requirements, a detailed site-specific, environmental risk assessment may be used to develop strategies that yield acceptable health risks, while achieving low level contamination on-site. An assessment of contaminant risks needs to be considered in the context of current and future land use, and development scenarios (e.g., residential, commercial, industrial, and urban parkland or wilderness use).

A detailed quantitative risk assessment builds on risk screening (problem formulation). It involves first, a detailed site investigation to identify the scope of contamination.[61] Site investigation programs should apply quality assurance/quality control (QA/QC) measures to ensure that data quality is adequate for the intended data use (e.g., method detection limits are below levels of concern). The site investigation in turn should be used to develop a *conceptual site model* of how and where contaminants exist, how they are transported, and where routes of exposure occur to organisms and humans. The risk factors and conceptual site model provide a framework for assessing contaminant risks.

Human or ecological risk assessments facilitate risk management decisions at contaminated sites. Specific risk assessment objectives include:

- Identifying relevant human and ecological receptors (e.g., children, adults, fish, wildlife)
- Determining if contaminants are present at levels that pose potential human health and/or ecological concerns (e.g., levels above applicable regulatory criteria based on health or environmental risk considerations)
- Determining how human or ecological receptors are exposed to the contaminants (e.g., ingestions of soil, dermal contact, inhalation of dust)

[60] For example, USEPA Region 3 Risk-Based Concentrations (RBCs). http://www.epa.gov/reg3hwmd/risk/human/index.htm.

[61] Examples include processes defined by the American Society of Testing and Materials (ASTM) Phase II ESA Process; the British Columbia Ministry of Environment Canada (BC MOE) http://www.env.gov.bc.ca/epd/epdpa/contam_sites/guidance); and the Massachusetts Department of Environment http://www.mass.gov/dep/cleanup.

- Identifying the types of adverse effects that might result from exposure to the contaminants (e.g., effect on target organ, cancer, impaired growth or reproduction) in the absence of regulatory standards
- Quantifying the magnitude of health risks to human and ecological receptors based on a quantitative analysis of contaminant exposure and toxicity (e.g. calculate lifetime cancer risk or ratios of estimated exposure rates compared to safe exposure rates)
- Determining how current and proposed future land use influence the predicted risks (e.g. change of land use from industrial to residential with more sensitive receptors such as children)
- Quantifying the potential environmental and/or human health risks from off-site contaminant migration (e.g., consider if leaching and groundwater transport, or surface water transport results in exposure at adjacent lands/receptors)
- Determining if the risk is likely to remain stable, increase, or decrease with time in the absence of any remediation (e.g., consider if the contaminant is reasonably degradable and likely to remain in place, or be transported to other media)[62]

Addressing these objectives provides a basis to develop and implement risk reduction measures (e.g., clean-up, on-site controls) at the site. If such a need exists, the following additional objectives become relevant:

- Determining where, and in what conceptual manner, risk reduction measures should be implemented
- Identifying the preferred technologies (including engineering controls) needed to implement the conceptual risk reduction measures
- Developing a monitoring plan to ascertain whether risk reduction measures are effective
- Considering the need and appropriateness for institutional controls (e.g. deed restriction, land use restrictions) as part of a comprehensive approach

Permanent Risk Reduction Measures

The *risk factors* and *conceptual site model* within the contaminant risk approach described also provide a basis to manage and mitigate environmental contaminant health risks. The underlying principle is to reduce, eliminate, or control any or all of the three risk factors illustrated in Figure 1.8.1. A short list of examples of risk mitigation strategies is provided below, although actual strategies should be developed based on site-specific conditions, and the practicality of prevailing factors and site constraints. Regardless of the management options selected, the action plan should include, whenever possible, *contaminant source reduction* (i.e., net improvement of the site) as part of the overall strategy towards managing health risks at contaminated sites, as this alone provides for improved environmental quality.

Figure 1.8.2 presents a schematic of the inter-relationship of risk factors and example strategies to mitigate contaminant health risk by modifying the conditions of one or more risk factors to ultimately reduce contaminant exposure to the receptor. The selected approach should take into consideration the technical and financial feasibility (e.g. operability of a selected technology given the local availability of technical expertise and equipment and its associated costs).

Example risk mitigation strategies for contaminant source and exposure concentrations include:

[62] An example of a simplified quantitative risk assessment method is the ASTM E1739-95(2002) Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites and the ASTM E2081-00(2004)e1 Standard Guide for Risk-Based Corrective Action (at chemical release sites).

- Soil, sediment, and sludge:
  - In situ biological treatment (aerobic or anaerobic)
  - In situ physical/chemical treatment (e.g., soil vapor extraction with off-gas treatment, chemical oxidation)
  - In situ thermal treatment (e.g., steam injection, 6-phase heating)
  - Ex situ biological treatment (e.g., excavation and composting)
  - Ex situ physical/chemical treatment (e.g., excavation and stabilization)
  - Ex situ thermal treatment (e.g., excavation and thermal desorption or incineration)
  - Containment (e.g. landfill)
  - Natural attenuation
  - Other treatment processes
- Groundwater, surface water, and leachate:
  - In situ biological treatment (aerobic and/or aerobic)
  - In situ physical/chemical treatment (e.g., air sparging, zero-valent iron permeable reactive barrier)
  - Ex situ biological, physical, and or chemical treatment (i.e., groundwater extraction and treatment)
  - Containment (e.g., slurry wall or sheet pile barrier)
  - Natural attenuation
  - Other treatment processes
- Soil vapor intrusion:
  - Soil vapor extraction to reduce VOC contaminant source in soil
  - Installation of a sub-slab depressurization system to prevent migration of soil vapor into the building
  - Creating a positive pressure condition in buildings
  - Installation (during building construction) of an impermeable barrier below the building and/or an alternative flow pathway for soil vapor beneath building foundations (e.g., porous media and ventilation to shunt vapors away from building)

Example risk mitigation strategies for receptors include:

- Limiting or preventing access to contaminant by receptors (actions targeted at the receptor may include signage with instructions, fencing, or site security)
- Imposing health advisory or prohibiting certain practices leading to exposure such as fishing, crab trapping, shellfish collection
- Educating receptors (people) to modify behavior in order to reduce exposure (e.g., improved work practices, and use of protective clothing and equipment)

Example risk mitigation strategies for exposure pathways include:

- Providing an alternative water supply to replace, for example, a contaminated groundwater supply well
- Capping contaminated soil with at least 1m of clean soil to prevent human contact, as well as plant root or small mammal penetration into contaminated soils
- Paving over contaminated soil as an interim measure to negate the pathway of direct contact or dust generation and inhalation
- Using an interception trench and pump, and treat technologies to prevent contaminated groundwater from discharging into fish streams

The above-reference containment measures should also be considered for immediate implementation in situations where source reduction measures are expected to take time.

Occupational Health and Safety Considerations

Investigation and remediation of contaminated lands requires that workers be mindful of the occupational exposures that could arise from working in close contact with contaminated soil or other environmental media (e.g., groundwater, wastewater, sediments, and soil vapor). Occupational health and safety precautions should be exercised to minimize exposure, as described in Section 2 on Occupational Health and Safety. In addition, workers on contaminated sites should receive special health and safety training specific to contaminated site investigation and remediation activities.[63]

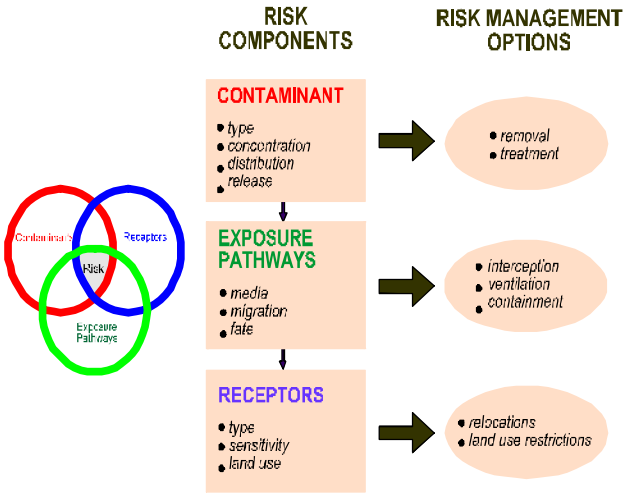


FIGURE 1.8.2: Inter-Relationship of Risk Factors and Management Options

[63] For example, US Occupational Safety and Health Agency (OSHA) regulations found at 40 CFR 1910.120. http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9765

2.0 Occupational Health and Safety

Applicability and Approach

Employers and supervisors are obliged to implement all reasonable precautions to protect the health and safety of workers. This section provides guidance and examples of reasonable precautions to implement in managing principal risks to occupational health and safety. Although the focus is placed on the operational phase of projects, much of the guidance also applies to construction and decommissioning activities. Companies should hire contractors that have the technical capability to manage the occupational health and safety issues of their employees, extending the application of the hazard management activities through formal procurement agreements.

Preventive and protective measures should be introduced according to the following order of priority:

- *Eliminating the hazard* by removing the activity from the work process. Examples include substitution with less hazardous chemicals, using different manufacturing processes, etc;
- *Controlling the hazard* at its source through use of engineering controls. Examples include local exhaust ventilation, isolation rooms, machine guarding, acoustic insulating, etc;
- *Minimizing the hazard* through design of safe work systems and administrative or institutional control measures. Examples include job rotation, training safe work procedures, lock-out and tag-out, workplace monitoring, limiting exposure or work duration, etc.
- *Providing appropriate personal protective equipment (PPE)* in conjunction with training, use, and maintenance of the PPE.

The application of prevention and control measures to occupational hazards should be based on comprehensive job

safety or job hazard analyses. The results of these analyses should be prioritized as part of an action plan based on the likelihood and severity of the consequence of exposure to the identified hazards. An example of a qualitative risk ranking or analysis matrix to help identify priorities is described in Table 2.1.1.

Table 2.1.1. Risk Ranking Table to Classify Worker Scenarios Based on Likelihood and Consequence

Likelihood	Consequences				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Catas-trophic 5
A. Almost certain	L	M	E	E	E
B. Likely	L	M	H	E	E
C. Moderate	L	M	H	E	E
D. Unlikely	L	L	M	H	E
E. Rare	L	L	M	H	H

Legend
E: extreme risk; immediate action required
H: high risk; senior management attention needed
M: moderate risk; management responsibility should be specified
L: low risk; manage by routine procedures

2.1 General Facility Design and Operation

Integrity of Workplace Structures

Permanent and recurrent places of work should be designed and equipped to protect OHS:

- Surfaces, structures and installations should be easy to clean and maintain, and not allow for accumulation of hazardous compounds.
- Buildings should be structurally safe, provide appropriate protection against the climate, and have acceptable light and noise conditions.
- Fire resistant, noise-absorbing materials should, to the extent feasible, be used for cladding on ceilings and walls.
- Floors should be level, even, and non-skid.
- Heavy oscillating, rotating or alternating equipment should be located in dedicated buildings or structurally isolated sections.

Severe Weather and Facility Shutdown

- Work place structures should be designed and constructed to withstand the expected elements for the region and have an area designated for safe refuge, if appropriate.
- Standard Operating Procedures (SOPs) should be developed for project or process shut-down, including an evacuation plan. Drills to practice the procedure and plan should also be undertaken annually.

Workspace and Exit

- The space provided for each worker, and in total, should be adequate for safe execution of all activities, including transport and interim storage of materials and products.
- Passages to emergency exits should be unobstructed at all times. Exits should be clearly marked to be visible in total darkness. The number and capacity of emergency exits should be sufficient for safe and orderly evacuation of the greatest number of people present at any time, and there should be a minimum two exits from any work area.

- Facilities also should be designed and built taking into account the needs of disabled persons.

Fire Precautions

The workplace should be designed to prevent the start of fires through the implementation of fire codes applicable to industrial settings. Other essential measures include:

- Equipping facilities with fire detectors, alarm systems, and fire-fighting equipment. The equipment should be maintained in good working order and be readily accessible. It should be adequate for the dimensions and use of the premises, equipment installed, physical and chemical properties of substances present, and the maximum number of people present.
- Provision of manual firefighting equipment that is easily accessible and simple to use
- Fire and emergency alarm systems that are both audible and visible

The IFC Life and Fire Safety Guideline should apply to buildings accessible to the public (See Section 3.3).

Lavatories and Showers

- Adequate lavatory facilities (toilets and washing areas) should be provided for the number of people expected to work in the facility and allowances made for segregated facilities, or for indicating whether the toilet facility is "In Use" or "Vacant". Toilet facilities should also be provided with adequate supplies of hot and cold running water, soap, and hand drying devices.
- Where workers may be exposed to substances poisonous by ingestion and skin contamination may occur, facilities for showering and changing into and out of street and work clothes should be provided.

Potable Water Supply

- Adequate supplies of potable drinking water should be provided from a fountain with an upward jet or with a sanitary means of collecting the water for the purposes of drinking
- Water supplied to areas of food preparation or for the purpose of personal hygiene (washing or bathing) should meet drinking water quality standards

Clean Eating Area

- Where there is potential for exposure to substances poisonous by ingestion, suitable arrangements are to be made for provision of clean eating areas where workers are not exposed to the hazardous or noxious substances

Lighting

- Workplaces should, to the degree feasible, receive natural light and be supplemented with sufficient artificial illumination to promote workers' safety and health, and enable safe equipment operation. Supplemental 'task lighting' may be required where specific visual acuity requirements should be met.
- Emergency lighting of adequate intensity should be installed and automatically activated upon failure of the principal artificial light source to ensure safe shut-down, evacuation, etc.

Safe Access

- Passageways for pedestrians and vehicles within and outside buildings should be segregated and provide for easy, safe, and appropriate access
- Equipment and installations requiring servicing, inspection, and/or cleaning should have unobstructed, unrestricted, and ready access
- Hand, knee and foot railings should be installed on stairs, fixed ladders, platforms, permanent and interim floor openings, loading bays, ramps, etc.

- Openings should be sealed by gates or removable chains
- Covers should, if feasible, be installed to protect against falling items
- Measures to prevent unauthorized access to dangerous areas should be in place

First Aid

- The employer should ensure that qualified first-aid can be provided at all times. Appropriately equipped first-aid stations should be easily accessible throughout the place of work
- Eye-wash stations and/or emergency showers should be provided close to all workstations where immediate flushing with water is the recommended first-aid response
- Where the scale of work or the type of activity being carried out so requires, dedicated and appropriately equipped first-aid room(s) should be provided. First aid stations and rooms should be equipped with gloves, gowns, and masks for protection against direct contact with blood and other body fluids
- Remote sites should have written emergency procedures in place for dealing with cases of trauma or serious illness up to the point at which patient care can be transferred to an appropriate medical facility.

Air Supply

- Sufficient fresh air should be supplied for indoor and confined work spaces. Factors to be considered in ventilation design include physical activity, substances in use, and process-related emissions. Air distribution systems should be designed so as not to expose workers to draughts
- Mechanical ventilation systems should be maintained in good working order. Point-source exhaust systems required for maintaining a safe ambient environment should have local indicators of correct functioning.
- Re-circulation of contaminated air is not acceptable. Air inlet filters should be kept clean and free of dust and microorganisms. Heating, ventilation and air conditioning (HVAC) and industrial evaporative cooling systems should be equipped, maintained and operated so as to prevent growth and spreading of disease agents (e.g. *Legionnella pneumophilia*) or breeding of vectors (e.g. mosquitoes and flies) of public health concern.

Work Environment Temperature

- The temperature in work, rest room and other welfare facilities should, during service hours, be maintained at a level appropriate for the purpose of the facility.

2.2 Communication and Training

OHS Training

- Provisions should be made to provide OHS orientation training to all new employees to ensure they are apprised of the basic site rules of work at / on the site and of personal protection and preventing injury to fellow employees.
- Training should consist of basic hazard awareness, site-specific hazards, safe work practices, and emergency procedures for fire, evacuation, and natural disaster, as appropriate. Any site-specific hazard or color coding in use should be thoroughly reviewed as part of orientation training.

Visitor Orientation

- If visitors to the site can gain access to areas where hazardous conditions or substances may be present, a visitor orientation and control program should be established to ensure visitors do not enter hazard areas unescorted.

New Task Employee and Contractor Training

- The employer should ensure that workers and contractors, prior to commencement of new assignments, have received adequate training and information enabling them to

understand work hazards and to protect their health from hazardous ambient factors that may be present.
The training should adequately cover:

- Knowledge of materials, equipment, and tools
- Known hazards in the operations and how they are controlled
- Potential risks to health
- Precautions to prevent exposure
- Hygiene requirements
- Wearing and use of protective equipment and clothing
- Appropriate response to operation extremes, incidents and accidents

Basic OHS Training

- A basic occupational training program and specialty courses should be provided, as needed, to ensure that workers are oriented to the specific hazards of individual work assignments. Training should generally be provided to management, supervisors, workers, and occasional visitors to areas of risks and hazards.
- Workers with rescue and first-aid duties should receive dedicated training so as not to inadvertently aggravate exposures and health hazards to themselves or their co-workers. Training would include the risks of becoming infected with blood–borne pathogens through contact with bodily fluids and tissue.
- Through appropriate contract specifications and monitoring, the employer should ensure that service providers, as well as contracted and subcontracted labor, are trained adequately before assignments begin.

Area Signage

- Hazardous areas (electrical rooms, compressor rooms, etc), installations, materials, safety measures, and emergency exits, etc. should be marked appropriately.
- Signage should be in accordance with international standards and be well known to, and easily understood by workers, visitors and the general public as appropriate.

Labeling of Equipment

- All vessels that may contain substances that are hazardous as a result of chemical or toxicological properties, or temperature or pressure, should be labeled as to the contents and hazard, or appropriately color coded.
- Similarly, piping systems that contain hazardous substances should be labeled with the direction of flow and contents of the pipe, or color coded whenever the pipe passing through a wall or floor is interrupted by a valve or junction device.

Communicate Hazard Codes

- Copies of the hazard coding system should be posted outside the facility at emergency entrance doors and fire emergency connection systems where they are likely to come to the attention of emergency services personnel.
- Information regarding the types of hazardous materials stored, handled or used at the facility, including typical maximum inventories and storage locations, should be shared proactively with emergency services and security personnel to expedite emergency response when needed.
- Representatives of local emergency and security services should be invited to participate in periodic (annual) orientation tours and site inspections to ensure familiarity with potential hazards present.

2.3 Physical Hazards

Physical hazards represent potential for accident or injury or illness due to repetitive exposure to mechanical action or work activity. Single exposure to physical hazards may result in a wide range of injuries, from minor and medical aid only, to disabling, catastrophic, and/or fatal. Multiple exposures over prolonged

periods can result in disabling injuries of comparable significance and consequence.

Rotating and Moving Equipment

Injury or death can occur from being trapped, entangled, or struck by machinery parts due to unexpected starting of equipment or unobvious movement during operations. Recommended protective measures include:

- Designing machines to eliminate trap hazards and ensuring that extremities are kept out of harm's way under normal operating conditions. Examples of proper design considerations include two-hand operated machines to prevent amputations or the availability of emergency stops dedicated to the machine and placed in strategic locations. Where a machine or equipment has an exposed moving part or exposed pinch point that may endanger the safety of any worker, the machine or equipment should be equipped with, and protected by, a guard or other device that prevents access to the moving part or pinch point. Guards should be designed and installed in conformance with appropriate machine safety standards.[64]
- Turning off, disconnecting, isolating, and de-energizing (Locked Out and Tagged Out) machinery with exposed or guarded moving parts, or in which energy can be stored (e.g. compressed air, electrical components) during servicing or maintenance, in conformance with a standard such as CSA Z460 Lockout or equivalent ISO or ANSI standard
- Designing and installing equipment, where feasible, to enable routine service, such as lubrication, without removal of the guarding devices or mechanisms

[64] For example: CSA Z432.04 Safe Guarding of Machinery, CSA Z434 Robot Safety, ISO 11161 Safety of Machinery – Integrated Manufacturing Systems or ISO 14121 Safety of Machinery – Principals of Risk Management or equivalent ANSI standard.

Noise

Noise limits for different working environments are provided in Table 2.3.1.

- No employee should be exposed to a noise level greater than 85 dB(A) for a duration of more than 8 hours per day without hearing protection. In addition, no unprotected ear should be exposed to a peak sound pressure level (instantaneous) of more than 140 dB(C).
- The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reach 140 dB(C), or the average maximum sound level reaches 110dB(A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85 dB(A).
- Although hearing protection is preferred for any period of noise exposure in excess of 85 dB(A), an equivalent level of protection can be obtained, but less easily managed, by limiting the duration of noise exposure. For every 3 dB(A) increase in sound levels, the 'allowed' exposure period or duration should be reduced by 50 percent.[65]
- Prior to the issuance of hearing protective devices as the final control mechanism, use of acoustic insulating materials, isolation of the noise source, and other engineering controls should be investigated and implemented, where feasible
- Periodic medical hearing checks should be performed on workers exposed to high noise levels

Vibration

Exposure to hand-arm vibration from equipment such as hand and power tools, or whole-body vibrations from surfaces on which the worker stands or sits, should be controlled through choice of equipment, installation of vibration dampening pads or devices, and limiting the duration of exposure. Limits for vibration and

[65] The American Conference of Governmental Industrial Hygienists (ACGIH), 2006

action values, (i.e. the level of exposure at which remediation should be initiated) are provided by the ACGIH[66]. Exposure levels should be checked on the basis of daily exposure time and data provided by equipment manufacturers.

Electrical

Exposed or faulty electrical devices, such as circuit breakers, panels, cables, cords and hand tools, can pose a serious risk to workers. Overhead wires can be struck by metal devices, such as poles or ladders, and by vehicles with metal booms. Vehicles or grounded metal objects brought into close proximity with overhead wires can result in arcing between the wires and the object, without actual contact. Recommended actions include:

Table 2.3.1. Noise Limits for Various Working Environments

Location /activity	Equivalent level LA_{eq},8h	Maximum LA_{max},fast
Heavy Industry (no demand for oral communication)	85 dB(A)	110 dB(A)
Light industry (decreasing demand for oral communication)	50-65 dB(A)	110 dB(A)
Open offices, control rooms, service counters or similar	45-50 dB(A)	-
Individual offices (no disturbing noise)	40-45 dB(A)	-
Classrooms, lecture halls	35-40 dB(A)	-
Hospitals	30-35 dB(A)	40 dB(A)

- Marking all energized electrical devices and lines with warning signs
- Locking out (de-charging and leaving open with a controlled locking device) and tagging-out (warning sign placed on the lock) devices during service or maintenance
- Checking all electrical cords, cables, and hand power tools for frayed or exposed cords and following manufacturer recommendations for maximum permitted operating voltage of the portable hand tools
- Double insulating / grounding all electrical equipment used in environments that are, or may become, wet; using equipment with ground fault interrupter (GFI) protected circuits
- Protecting power cords and extension cords against damage from traffic by shielding or suspending above traffic areas
- Appropriate labeling of service rooms housing high voltage equipment ('electrical hazard') and where entry is controlled or prohibited (see also Section 3 on Planning, Siting, and Design);
- Establishing "No Approach" zones around or under high voltage power lines in conformance with Table 2.3.2
- Rubber tired construction or other vehicles that come into direct contact with, or arcing between, high voltage wires may need to be taken out of service for periods of 48 hours and have the tires replaced to prevent catastrophic tire and wheel assembly failure, potentially causing serious injury or death;
- Conducting detailed identification and marking of all buried electrical wiring prior to any excavation work

[66] ACGIH, 2005

Table 2.3.2. No Approach Zones for High Voltage Power Lines	
Nominal phase-to-phase voltage rating	Minimum distance
750 or more volts, but no more than 150,000 volts	3 meters
More than 150,000 volts, but no more than 250,000 volts	4.5 meters
More than 250,000 volts	6 meters

Eye Hazards

Solid particles from a wide variety of industrial operations, and / or a liquid chemical spray may strike a worker in the eye causing an eye injury or permanent blindness. Recommended measures include:

- Use of machine guards or splash shields and/or face and eye protection devices, such as safety glasses with side shields, goggles, and/or a full face shield. Specific Safe Operating Procedures (SOPs) may be required for use of sanding and grinding tools and/or when working around liquid chemicals. Frequent checks of these types of equipment prior to use to ensure mechanical integrity is also good practice. Machine and equipment guarding should conform to standards published by organizations such as CSA, ANSI and ISO (see also Section 2.3 on Rotating and Moving Equipment and 2.7 on Personal Protective Equipment).
- Moving areas where the discharge of solid fragments, liquid, or gaseous emissions can reasonably be predicted (e.g. discharge of sparks from a metal cutting station, pressure relief valve discharge) away from places expected to be occupied or transited by workers or visitors. Where machine or work fragments could present a hazard to transient workers or passers-by, extra area guarding or proximity restricting systems should be implemented, or PPE required for transients and visitors.
- Provisions should be made for persons who have to wear prescription glasses either through the use overglasses or prescription hardened glasses.

Welding / Hot Work

Welding creates an extremely bright and intense light that may seriously injur a worker's eyesight. In extreme cases, blindness may result. Additionally, welding may produce noxious fumes to which prolonged exposure can cause serious chronic diseases. Recommended measures include:

- Provision of proper eye protection such as welder goggles and/or a full-face eye shield for all personnel involved in, or assisting, welding operations. Additional methods may include the use of welding barrier screens around the specific work station (a solid piece of light metal, canvas, or plywood designed to block welding light from others). Devices to extract and remove noxious fumes at the source may also be required.
- Special hot work and fire prevention precautions and Standard Operating Procedures (SOPs) should be implemented if welding or hot cutting is undertaken outside established welding work stations, including 'Hot Work Permits, stand-by fire extinguishers, stand-by fire watch, and maintaining the fire watch for up to one hour after welding or hot cutting has terminated. Special procedures are required for hotwork on tanks or vessels that have contained flammable materials.

Industrial Vehicle Driving and Site Traffic

Poorly trained or inexperienced industrial vehicle drivers have increased risk of accident with other vehicles, pedestrians, and equipment. Industrial vehicles and delivery vehicles, as well as private vehicles on-site, also represent potential collision scenarios. Industrial vehicle driving and site traffic safety practices include:

- Training and licensing industrial vehicle operators in the safe operation of specialized vehicles such as forklifts, including safe loading/unloading, load limits
- Ensuring drivers undergo medical surveillance
- Ensuring moving equipment with restricted rear visibility is outfitted with audible back-up alarms
- Establishing rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures (e.g. prohibiting operation of forklifts with forks in down position), and control of traffic patterns or direction
- Restricting the circulation of delivery and private vehicles to defined routes and areas, giving preference to 'one-way' circulation, where appropriate

Working Environment Temperature

Exposure to hot or cold working conditions in indoor or outdoor environments can result temperature stress-related injury or death. Use of personal protective equipment (PPE) to protect against other occupational hazards can accentuate and aggravate heat-related illnesses. Extreme temperatures in permanent work environments should be avoided through implementation of engineering controls and ventilation. Where this is not possible, such as during short-term outdoor work, temperature-related stress management procedures should be implemented which include:

- Monitoring weather forecasts for outdoor work to provide advance warning of extreme weather and scheduling work accordingly
- Adjustment of work and rest periods according to temperature stress management procedures provided by ACGIH[67], depending on the temperature and workloads
- Providing temporary shelters to protect against the elements during working activities or for use as rest areas
- Use of protective clothing
- Providing easy access to adequate hydration such as drinking water or electrolyte drinks, and avoiding consumption of alcoholic beverages

Ergonomics, Repetitive Motion, Manual Handling

Injuries due to ergonomic factors, such as repetitive motion, over-exertion, and manual handling, take prolonged and repeated exposures to develop, and typically require periods of weeks to months for recovery. These OHS problems should be minimized or eliminated to maintain a productive workplace. Controls may include:

- Facility and workstation design with 5th to 95th percentile operational and maintenance workers in mind
- Use of mechanical assists to eliminate or reduce exertions required to lift materials, hold tools and work objects, and requiring multi-person lifts if weights exceed thresholds
- Selecting and designing tools that reduce force requirements and holding times, and improve postures
- Providing user adjustable work stations
- Incorporating rest and stretch breaks into work processes, and conducting job rotation
- Implementing quality control and maintenance programs that reduce unnecessary forces and exertions
- Taking into consideration additional special conditions such as left handed persons

Working at Heights

Fall prevention and protection measures should be implemented whenever a worker is exposed to the hazard of falling more than two meters; into operating machinery; into water or other liquid; into hazardous substances; or through an opening in a work surface. Fall prevention / protection measures may also be warranted on a case-specific basis when there are risks of falling from lesser heights. Fall prevention may include:

[67] ACGIH, 2005

- Installation of guardrails with mid-rails and toe boards at the edge of any fall hazard area
- Proper use of ladders and scaffolds by trained employees
- Use of fall prevention devices, including safety belt and lanyard travel limiting devices to prevent access to fall hazard area, or fall protection devices such as full body harnesses used in conjunction with shock absorbing lanyards or self-retracting inertial fall arrest devices attached to fixed anchor point or horizontal life-lines
- Appropriate training in use, serviceability, and integrity of the necessary PPE
- Inclusion of rescue and/or recovery plans, and equipment to respond to workers after an arrested fall

Illumination

Work area light intensity should be adequate for the general purpose of the location and type of activity, and should be supplemented with dedicated work station illumination, as needed. The minimum limits for illumination intensity for a range of locations/activities appear in Table 2.3.3.

Table 2.3.3. Minimum Limits For Workplace Illumination Intensity

Location / Activity	Light Intensity
Emergency light	10 lux
Outdoor non working areas	20 lux
Simple orientation and temporary visits (machine storage, garage, warehouse)	50 lux
Workspace with occasional visual tasks only (corridors, stairways, lobby, elevator, auditorium, etc.)	100 lux
Medium precision work (simple assembly, rough machine works, welding, packing, etc.)	200 lux
Precision work (reading, moderately difficult assembly, sorting, checking, medium bench and machine works, etc.), offices.	500 lux
High precision work (difficult assembly, sewing, color inspection, fine sorting etc.)	1,000 – 3,000 lux

Controls should include:

- Use of energy efficient light sources with minimum heat emission
- Undertaking measures to eliminate glare / reflections and flickering of lights
- Taking precautions to minimize and control optical radiation including direct sunlight. Exposure to high intensity UV and IR radiation and high intensity visible light should also be controlled
- Controlling laser hazards in accordance with equipment specifications, certifications, and recognized safety standards. The lowest feasible class Laser should be applied to minimize risks.

2.4 Chemical Hazards

Chemical hazards represent potential for illness or injury due to single acute exposure or chronic repetitive exposure to toxic, corrosive, sensitizing or oxidative substances. They also represent a risk of uncontrolled reaction, including the risk of fire and explosion, if incompatible chemicals are inadvertently mixed. Chemical hazards can most effectively be prevented through a hierarchical approach that includes:

- Replacement of the hazardous substance with a less hazardous substitute
- Implementation of engineering and administrative control measures to avoid or minimize the release of hazardous substances into the work environment keeping the level of exposure below internationally established or recognized limits
- Keeping the number of employees exposed, or likely to become exposed, to a minimum

- Communicating chemical hazards to workers through labeling and marking according to national and internationally recognized requirements and standards, including the International Chemical Safety Cards (ICSC), Materials Safety Data Sheets (MSDS), or equivalent. Any means of written communication should be in an easily understood language and be readily available to exposed workers and first-aid personnel
- Training workers in the use of the available information (such as MSDSs), safe work practices, and appropriate use of PPE

Air Quality

Poor air quality due to the release of contaminants into the work place can result in possible respiratory irritation, discomfort, or illness to workers. Employers should take appropriate measures to maintain air quality in the work area. These include:

- Maintaining levels of contaminant dusts, vapors and gases in the work environment at concentrations below those recommended by the ACGIH[68] as TWA-TLV's (threshold limit value)—concentrations to which most workers can be exposed repeatedly (8 hours/day, 40 hrs/week, week-after-week), without sustaining adverse health effects.
- Developing and implementing work practices to minimize release of contaminants into the work environment including:
  - Direct piping of liquid and gaseous materials
  - Minimized handling of dry powdered materials;
  - Enclosed operations
  - Local exhaust ventilation at emission / release points
  - Vacuum transfer of dry material rather than mechanical or pneumatic conveyance
  - Indoor secure storage, and sealed containers rather than loose storage
- Where ambient air contains several materials that have similar effects on the same body organs (additive effects), taking into account combined exposures using calculations recommended by the ACGIH[69]
- Where work shifts extend beyond eight (8) hours, calculating adjusted workplace exposure criteria recommended by the ACGIH[70]

Fire and Explosions

Fires and or explosions resulting from ignition of flammable materials or gases can lead to loss of property as well as possible injury or fatalities to project workers. Prevention and control strategies include:

- Storing flammables away from ignition sources and oxidizing materials. Further, flammables storage area should be:
  - Remote from entry and exit points into buildings
  - Away from facility ventilation intakes or vents
  - Have natural or passive floor and ceiling level ventilation and explosion venting
  - Use spark-proof fixtures
  - Be equipped with fire extinguishing devices and self-closing doors, and constructed of materials made to withstand flame impingement for a moderate period of time
- Providing bonding and grounding of, and between, containers and additional mechanical floor level ventilation if materials are being, or could be, dispensed in the storage area
- Where the flammable material is mainly comprised of dust, providing electrical grounding, spark detection, and, if needed, quenching systems

[68] ACGIH, 2005

[69] ACGIH, 2005.

[70] ACGIH, 2005.

- Defining and labeling fire hazards areas to warn of special rules (e.g. prohibition in use of smoking materials, cellular phones, or other potential spark generating equipment)
- Providing specific worker training in handling of flammable materials, and in fire prevention or suppression

Corrosive, oxidizing, and reactive chemicals

Corrosive, oxidizing, and reactive chemicals present similar hazards and require similar control measures as flammable materials. However, the added hazard of these chemicals is that inadvertent mixing or intermixing may cause serious adverse reactions. This can lead to the release of flammable or toxic materials and gases, and may lead directly to fires and explosions. These types of substances have the additional hazard of causing significant personal injury upon direct contact, regardless of any intermixing issues. The following controls should be observed in the work environment when handling such chemicals:

- Corrosive, oxidizing and reactive chemicals should be segregated from flammable materials and from other chemicals of incompatible class (acids vs. bases, oxidizers vs. reducers, water sensitive vs. water based, etc.), stored in ventilated areas and in containers with appropriate secondary containment to minimize intermixing during spills
- Workers who are required to handle corrosive, oxidizing, or reactive chemicals should be provided with specialized training and provided with, and wear, appropriate PPE (gloves, apron, splash suits, face shield or goggles, etc).
- Where corrosive, oxidizing, or reactive chemicals are used, handled, or stored, qualified first-aid should be ensured at all times. Appropriately equipped first-aid stations should be easily accessible throughout the place of work, and eye-wash stations and/or emergency showers should be provided close to all workstations where the recommended first-aid response is immediate flushing with water

Asbestos Containing Materials (ACM)

The use of asbestos containing materials (ACM) should be avoided in new buildings or as a new material in remodeling or renovation activities. Existing facilities with ACM should develop an asbestos management plan which clearly identifies the locations where the ACM is present, its condition (e.g. whether it is in friable form with the potential to release fibers), procedures for monitoring its condition, procedures to access the locations where ACM is present to avoid damage, and training of staff who can potentially come into contact with the material to avoid damage and prevent exposure. The plan should be made available to all persons involved in operations and maintenance activities. Repair or removal and disposal of existing ACM in buildings should only be performed by specially trained personnel[71] following host country requirements, or in their absence, internationally recognized procedures.[72]

2.5 Biological Hazards

Biological agents represent potential for illness or injury due to single acute exposure or chronic repetitive exposure. Biological hazards can be prevented most effectively by implementing the following measures:

- If the nature of the activity permits, use of any harmful biological agents should be avoided and replaced with an agent that, under normal conditions of use, is not dangerous or less dangerous to workers. If use of harmful agents can not be avoided, precautions should be taken to keep the risk of exposure as low as possible and maintained below internationally established and recognized exposure limits.

[71] Training of specialized personnel and the maintenance and removal methods applied should be equivalent to those required under applicable regulations in the United States and Europe (examples of North American training standards are available at: http://www.osha.gov/SLTC/asbestos/training.html)

[72] Examples include the American Society for Testing and Materials (ASTM) E 1368 - Standard Practice for Visual Inspection of Asbestos Abatement Projects; E 2356 - Standard Practice for Comprehensive Building Asbestos Surveys; and E 2394 - Standard Practice for Maintenance, Renovation and Repair of Installed Asbestos Cement Products.

- Work processes, engineering, and administrative controls should be designed, maintained, and operated to avoid or minimize release of biological agents into the working environment. The number of employees exposed or likely to become exposed should be kept at a minimum.
- The employer should review and assess known and suspected presence of biological agents at the place of work and implement appropriate safety measures, monitoring, training, and training verification programs.
- Measures to eliminate and control hazards from known and suspected biological agents at the place of work should be designed, implemented and maintained in close co-operation with the local health authorities and according to recognized international standards.

Biological agents should be classified into four groups[73]:

- ***Group 1:*** Biological agents unlikely to cause human disease, and consequently only require controls similar to those required for hazardous or reactive chemical substances;
- ***Group 2:*** Biological agents that can cause human disease and are thereby likely to require additional controls, but are unlikely to spread to the community;
- ***Group 3***: Biological agents that can cause severe human disease, present a serious hazard to workers, and may present a risk of spreading to the community, for which there usually is effective prophylaxis or treatment available and are thereby likely to require extensive additional controls;
- ***Group 4:*** Biological agents that can cause severe human disease, are a serious hazard to workers, and present a high risk of spreading to the community, for which there is usually no effective prophylaxis or treatment available and are thereby likely to require very extensive additional controls.

The employer should at all times encourage and enforce the highest level of hygiene and personal protection, especially for activities employing biological agents of Groups 3 and 4 above. Work involving agents in Groups 3 and 4 should be restricted only to those persons who have received specific verifiable training in working with and controlling such materials.

Areas used for the handling of Groups 3 and 4 biological agents should be designed to enable their full segregation and isolation in emergency circumstances, include independent ventilation systems, and be subject to SOPs requiring routine disinfection and sterilization of the work surfaces.

HVAC systems serving areas handling Groups 3 and 4 biological agents should be equipped with High Efficiency Particulate Air (HEPA) filtration systems. Equipment should readily enable their disinfection and sterilization, and maintained and operated so as to prevent growth and spreading of disease agents, amplification of the biological agents, or breeding of vectors e.g. mosquitoes and flies of public health concern.

[73] World Health Organization (WHO) Classification of Infective Microorganisms by Risk Group (2004).

2.6 Radiological Hazards

Radiation exposure can lead to potential discomfort, injury or serious illness to workers. Prevention and control strategies include:

- Places of work involving occupational and/or natural exposure to ionizing radiation should be established and operated in accordance with recognized international safety standards and guidelines.[74] The acceptable effective dose limits appear Table 2.6.1.
- Exposure to non-ionizing radiation (including static magnetic fields; sub-radio frequency magnetic fields; static electric fields; radio frequency and microwave radiation; light and near-infrared radiation; and ultraviolet radiation) should be controlled to internationally recommended limits[75].

Table 2.6.1. Acceptable Effective Dose Limits for Workplace Radiological Hazards

Exposure	Workers (min.19 years of age)	Apprentices and students (16-18 years of age)
Five consecutive year average – effective dose	20 mSv/year	
Single year exposure – effective dose	50 mSv/year	6 mSv/year
Equivalent dose to the lens of the eye	150 mSv/year	50 mSv/year
Equivalent dose to the extremities (hands, feet) or the skin	500 mSv/year	150 mSv/year

- In the case of both ionizing and non-ionizing radiation, the preferred method for controlling exposure is shielding and limiting the radiation source. Personal protective equipment is supplemental only or for emergency use. Personal protective equipment for near-infrared, visible and ultraviolet range radiation can include appropriate sun block creams, with or without appropriate screening clothing.

2.7 Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE) provides additional protection to workers exposed to workplace hazards in conjunction with other facility controls and safety systems.

PPE is considered to be a last resort that is above and beyond the other facility controls and provides the worker with an extra level of personal protection. Table 2.7.1 presents general examples of occupational hazards and types of PPE available for different purposes. Recommended measures for use of PPE in the workplace include:

- Active use of PPE if alternative technologies, work plans or procedures cannot eliminate, or sufficiently reduce, a hazard or exposure
- Identification and provision of appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors, without incurring unnecessary inconvenience to the individual
- Proper maintenance of PPE, including cleaning when dirty and replacement when damaged or worn out. Proper use of PPE should be part of the recurrent training programs for employees

[74] International Basic Safety Standard for protection against Ionizing Radiation and for the Safety of Radiation Sources and its three interrelated Safety Guides.

IAEA. http://www-ns.iaea.org/standards/documents/default.asp?sub=160

[75] For example ACGIH (2005) and International Commission for Non-Ionizing Radiation (ICNIRP).

- Selection of PPE should be based on the hazard and risk ranking described earlier in this section, and selected according to criteria on performance and testing established by recognized organizations[76].

Table 2.7.1. Summary of Recommended Personal Protective Equipment According to Hazard

Objective	Workplace Hazards	Suggested PPE
Eye and face protection	Flying particles, molten metal, liquid chemicals, gases or vapors, light radiation.	Safety Glasses with side-shields, protective shades, etc.
Head protection	Falling objects, inadequate height clearance, and overhead power cords.	Plastic Helmets with top and side impact protection.
Hearing protection	Noise, ultra-sound.	Hearing protectors (ear plugs or ear muffs).
Foot protection	Falling or rolling objects, pointed objects. Corrosive or hot liquids.	Safety shoes and boots for protection against moving & falling objects, liquids and chemicals.
Hand protection	Hazardous materials, cuts or lacerations, vibrations, extreme temperatures.	Gloves made of rubber or synthetic materials (Neoprene), leather, steel, insulating materials, etc.
Respiratory protection	Dust, fogs, fumes, mists, gases, smokes, vapors.	Facemasks with appropriate filters for dust removal and air purification (chemicals, mists, vapors and gases). Single or multi-gas personal monitors, if available.
	Oxygen deficiency	Portable or supplied air (fixed lines). On-site rescue equipment.
Body/leg protection	Extreme temperatures, hazardous materials, biological agents, cutting and laceration.	Insulating clothing, body suits, aprons etc. of appropriate materials.

2.8 Special Hazard Environments

Special hazard environments are work situations where all of the previously described hazards may exist under unique or especially hazardous circumstances. Accordingly, extra precautions or rigor in application of precautions is required.

Confined Space

A confined space is defined as a wholly or partially enclosed space not designed or intended for human occupancy and in which a hazardous atmosphere could develop as a result of the contents, location or construction of the confined space or due to work done in or around the confined space. A "permit-required" confined space is one that also contains physical or atmospheric hazards that could trap or engulf the person.[77]

Confined spaces can occur in enclosed or open structures or locations. Serious injury or fatality can result from inadequate preparation to enter a confined space or in attempting a rescue from a confined space. Recommended management approaches include:

- Engineering measures should be implemented to eliminate, to the degree feasible, the existence and adverse character of confined spaces.
- Permit-required confined spaces should be provided with permanent safety measures for venting, monitoring, and rescue operations, to the extent possible. The area adjoining an access to a confined space should provide ample room for emergency and rescue operations.

[76] Examples include the American National Standards Institute (ANSI), http://www.ansi.org/; National Institute for Occupational Safety and Health[76] (NIOSH), http://www.cdc.gov/niosh/homepage.html; Canadian Standards Association[76] (CSA), http://www.csa.ca/Default.asp?language=english; Mine Safety and Health Administration[76] (MSHA), http://www.msha.gov.

[77] US OSHA CFR 1910.146

- Access hatches should accommodate 90% of the worker population with adjustments for tools and protective clothing. The most current ISO and EN standards should be consulted for design specifications;
- Prior to entry into a permit-required confined space:
  - Process or feed lines into the space should be disconnected or drained, and blanked and locked-out.
  - Mechanical equipment in the space should be disconnected, de-energized, locked-out, and braced, as appropriate.
  - The atmosphere within the confined space should be tested to assure the oxygen content is between 19.5 percent and 23 percent, and that the presence of any flammable gas or vapor does not exceed 25 percent of its respective Lower Explosive Limit (LEL).
  - If the atmospheric conditions are not met, the confined space should be ventilated until the target safe atmosphere is achieved, or entry is only to be undertaken with appropriate and additional PPE.
- Safety precautions should include Self Contained Breathing Apparatus (SCBA), life lines, and safety watch workers stationed outside the confined space, with rescue and first aid equipment readily available.
- Before workers are required to enter a permit-required confined space, adequate and appropriate training in confined space hazard control, atmospheric testing, use of the necessary PPE, as well as the serviceability and integrity of the PPE should be verified. Further, adequate and appropriate rescue and / or recovery plans and equipment should be in place before the worker enters the confined space.

Lone and Isolated Workers

A lone and isolated worker is a worker out of verbal and line of sight communication with a supervisor, other workers, or other persons capable of providing aid and assistance, for continuous periods exceeding one hour. The worker is therefore at increased risk should an accident or injury occur.

- Where workers may be required to perform work under lone or isolated circumstances, Standard Operating Procedures (SOPs) should be developed and implemented to ensure all PPE and safety measures are in place before the worker starts work. SOPs should establish, at a minimum, verbal contact with the worker at least once every hour, and ensure the worker has a capability for summoning emergency aid.
- If the worker is potentially exposed to highly toxic or corrosive chemicals, emergency eye-wash and shower facilities should be equipped with audible and visible alarms to summon aid whenever the eye-wash or shower is activated by the worker and without intervention by the worker.

2.9 Monitoring

Occupational health and safety monitoring programs should verify the effectiveness of prevention and control strategies. The selected indicators should be representative of the most significant occupational, health, and safety hazards, and the implementation of prevention and control strategies. The occupational health and safety monitoring program should include:

- *Safety inspection, testing and calibration:* This should include regular inspection and testing of all safety features and hazard control measures focusing on engineering and personal protective features, work procedures, places of work, installations, equipment, and tools used. The inspection should verify that issued PPE continues to provide adequate protection and is being worn as required. All instruments installed or used for monitoring and recording of working environment parameters should be regularly tested and calibrated, and the respective records maintained.
- *Surveillance of the working environment:* Employers should document compliance using an appropriate combination of

portable and stationary sampling and monitoring instruments. Monitoring and analyses should be conducted according to internationally recognized methods and standards. Monitoring methodology, locations, frequencies, and parameters should be established individually for each project following a review of the hazards. Generally, monitoring should be performed during commissioning of facilities or equipment and at the end of the defect and liability period, and otherwise repeated according to the monitoring plan.

- *Surveillance of workers health:* When extraordinary protective measures are required (for example, against biological agents Groups 3 and 4, and/or hazardous compounds), workers should be provided appropriate and relevant health surveillance prior to first exposure, and at regular intervals thereafter. The surveillance should, if deemed necessary, be continued after termination of the employment.
- *Training:* Training activities for employees and visitors should be adequately monitored and documented (curriculum, duration, and participants). Emergency exercises, including fire drills, should be documented adequately. Service providers and contractors should be contractually required to submit to the employer adequate training documentation before start of their assignment.

Accidents and Diseases monitoring

- The employer should establish procedures and systems for reporting and recording:
  - Occupational accidents and diseases
  - Dangerous occurrences and incidents

  These systems should enable workers to report immediately to their immediate supervisor any situation they believe presents a serious danger to life or health.
- The systems and the employer should further enable and encourage workers to report to management all:
  - Occupational injuries and near misses
  - Suspected cases of occupational disease
  - Dangerous occurrences and incidents
- All reported occupational accidents, occupational diseases, dangerous occurrences, and incidents together with near misses should be investigated with the assistance of a person knowledgeable/competent in occupational safety. The investigation should:
  - Establish what happened
  - Determine the cause of what happened
  - Identify measures necessary to prevent a recurrence
- Occupational accidents and diseases should, at a minimum, be classified according to Table 2.10.1. Distinction is made between fatal and non-fatal injuries. The two main categories are divided into three sub-categories according to time of death or duration of the incapacity to work. The total work hours during the specified reporting period should be reported to the appropriate regulatory agency.

Table 2.9.1. Occupational Accident Reporting

a. Fatalities (number)	**b. Non-fatal injuries** (number) [78]	**c. Total time lost** non-fatal injuries (days)
a.1 Immediate	**b.1** Less than one day	
a.2 Within a month	**b.2** Up to 3 days	**c.1** Category b.2
a.3 Within a year	**b.3** More than 3 days	**c.2** Category b.3

[78] The day on which an incident occurs is not included in b.2 and b.3.

3.0 Community Health and Safety

This section complements the guidance provided in the preceding environmental and occupational health and safety sections, specifically addressing some aspects of project activities taking place outside of the traditional project boundaries, but nonetheless related to the project operations, as may be applicable on a project basis. These issues may arise at any stage of a project life cycle and can have an impact beyond the life of the project.

3.1 Water Quality and Availability

Groundwater and surface water represent essential sources of drinking and irrigation water in developing countries, particularly in rural areas where piped water supply may be limited or unavailable and where available resources are collected by the consumer with little or no treatment. Project activities involving wastewater discharges, water extraction, diversion or impoundment should prevent adverse impacts to the quality and availability of groundwater and surface water resources.

Water Quality

Drinking water sources, whether public or private, should at all times be protected so that they meet or exceed applicable national acceptability standards or in their absence the current edition of WHO Guidelines for Drinking-Water Quality. Air emissions, wastewater effluents, oil and hazardous materials, and wastes should be managed according to the guidance provided in the respective sections of the General EHS Guidelines with the objective of protecting soil and water resources.

Where the project includes the delivery of water to the community or to users of facility infrastructure (such as hotel hosts and hospital patients), where water may be used for drinking, cooking, washing, and bathing, water quality should comply with national acceptability standards or in their absence the current edition of with WHO Drinking Water Guidelines. Water quality for more sensitive well-being-related demands such as water used in health care facilities or food production may require more stringent, industry-specific guidelines or standards, as applicable. Any dependency factors associated with the deliver of water to the local community should be planned for and managed to ensure the sustainability of the water supply by involving the community in its management to minimize the dependency in the long-term.

Water Availability

The potential effect of groundwater or surface water abstraction for project activities should be properly assessed through a combination of field testing and modeling techniques, accounting for seasonal variability and projected changes in demand in the project area.

Project activities should not compromise the availability of water for personal hygiene needs and should take account of potential future increases in demand. The overall target should be the availability of 100 liters per person per day although lower levels may be used to meet basic health requirements.[79] Water volume requirements for well-being-related demands such as water use in health care facilities may need to be higher.

3.2 Structural Safety of Project Infrastructure

Hazards posed to the public while accessing project facilities may include:

- Physical trauma associated with failure of building structures
- Burns and smoke inhalation from fires
- Injuries suffered as a consequence of falls or contact with heavy equipment
- Respiratory distress from dust, fumes, or noxious odors
- Exposure to hazardous materials

Reduction of potential hazards is best accomplished during the design phase when the structural design, layout and site modifications can be adapted more easily. The following issues should be considered and incorporated as appropriate into the planning, siting, and design phases of a project:

- Inclusion of buffer strips or other methods of physical separation around project sites to protect the public from major hazards associated with hazardous materials incidents or process failure, as well as nuisance issues related to noise, odors, or other emissions
- Incorporation of siting and safety engineering criteria to prevent failures due to natural risks posed by earthquakes, tsunamis, wind, flooding, landslides and fire. To this end, all project structures should be designed in accordance with engineering and design criteria mandated by site-specific risks, including but not limited to seismic activity, slope stability, wind loading, and other dynamic loads
- Application of locally regulated or internationally recognized building codes[80] to ensure structures are designed and constructed in accordance with sound architectural and engineering practice, including aspects of fire prevention and response
- Engineers and architects responsible for designing and constructing facilities, building, plants and other structures should certify the applicability and appropriateness of the structural criteria employed.

International codes, such as those compiled by the International Code Council (ICC)[81], are intended to regulate the design, construction, and maintenance of a built environment and contain detailed guidance on all aspects of building safety, encompassing methodology, best practices, and documenting compliance. Depending on the nature of a project, guidance provided in the ICC or comparable codes should be followed, as appropriate, with respect to:

- Existing structures
- Soils and foundations
- Site grading
- Structural design
- Specific requirements based on intended use and occupancy
- Accessibility and means of egress
- Types of construction
- Roof design and construction
- Fire-resistant construction
- Flood-resistant construction

[79] World Health Organization (WHO) defines 100 liters/capita/day as the amount required to meet all consumption and hygiene needs. Additional information on lower service levels and potential impacts on health are described in "Domestic Water Quantity, Service Level and Health" 2003. http://www.who.int/water_sanitation_health/diseases/wsh0302/en/index.html

[80] ILO-OSH, 2001. http://www.ilo.org/public/english/protection/safework/cops/english/download/e000013.pdf

[81] ICC, 2006.

- Construction materials
- Interior environment
- Mechanical, plumbing and electrical systems
- Elevators and conveying systems
- Fire safety systems
- Safeguards during construction
- Encroachments into public right-of-way

Although major design changes may not be feasible during the operation phase of a project, hazard analysis can be undertaken to identify opportunities to reduce the consequences of a failure or accident. Illustrative management actions, applicable to hazardous materials storage and use, include:

- Reducing inventories of hazardous materials through inventory management and process changes to greatly reduce or eliminate the potential off-site consequences of a release
- Modifying process or storage conditions to reduce the potential consequences of an accidental off-site release
- Improving shut-down and secondary containment to reduce the amount of material escaping from containment and to reduce the release duration
- Reducing the probability that releases will occur through improved site operations and control, and through improvements in maintenance and inspection
- Reducing off-site impacts of releases through measures intended to contain explosions and fires, alert the public, provide for evacuation of surrounding areas, establish safety zones around a site, and ensure the provision of emergency medical services to the public

3.3 Life and Fire Safety (L&FS)

Applicability and Approach

All new buildings accessible to the public should be designed, constructed, and operated in full compliance with local building codes, local fire department regulations, local legal/insurance requirements, and in accordance with an internationally accepted life and fire safety (L&FS) standard. The Life Safety Code[82], which provides extensive documentation on life and fire safety provisions, is one example of an internationally accepted standard and may be used to document compliance with the Life and Fire Safety objectives outlined in these guidelines. With regard to these objectives:

- Project sponsors' architects and professional consulting engineers should demonstrate that affected buildings meet these life and fire safety objectives.
- Life and fire safety systems and equipment should be designed and installed using appropriate prescriptive standards and/or performance based design, and sound engineering practices.
- Life and fire safety design criteria for all existing buildings should incorporate all local building codes and fire department regulations.

These guidelines apply to buildings that are accessible to the public. Examples of such buildings include:

- Health and education facilities
- Hotels, convention centers, and leisure facilities
- Retail and commercial facilities
- Airports, other public transport terminals, transfer facilities

Specific Requirements for New Buildings

The nature and extent of life and fire safety systems required will depend on the building type, structure, construction, occupancy, and exposures. Sponsors should prepare a Life and Fire Safety Master Plan identifying major fire risks, applicable codes, standards and regulations, and mitigation measures. The Master

[82] US NFPA. http://www.nfpa.org/catalog/product.asp?category%5Fname=&pid=10106&target%5Fpid=10106&src%5Fpid=&link%5Ftype=search

Plan should be prepared by a suitably qualified professional, and adequately cover, but not be limited to, the issues addressed briefly in the following points. The suitably qualified professional selected to prepare the Master Plan is responsible for a detailed treatment of the following illustrative, and all other required, issues.

Fire Prevention

Fire prevention addresses the identification of fire risks and ignition sources, and measures needed to limit fast fire and smoke development. These issues include:

- Fuel load and control of combustibles
- Ignition sources
- Interior finish flame spread characteristics
- Interior finish smoke production characteristics
- Human acts, and housekeeping and maintenance

Means of Egress

Means of Egress includes all design measures that facilitate a safe evacuation by residents and/or occupants in case of fire or other emergency, such as:

- Clear, unimpeded escape routes
- Accessibility to the impaired/handicapped
- Marking and signing
- Emergency lighting

Detection and Alarm Systems

These systems encompass all measures, including communication and public address systems needed to detect a fire and alert:

- Building staff
- Emergency response teams
- Occupants
- Civil defense

Compartmentation

Compartmentation involves all measures to prevent or slow the spread of fire and smoke, including:

- Separations
- Fire walls
- Floors
- Doors
- Dampers
- Smoke control systems

Fire Suppression and Control

Fire suppression and control includes all automatic and manual fire protection installations, such as:

- Automatic sprinkler systems
- Manual portable extinguishers
- Fire hose reels

Emergency Response Plan

An Emergency Response Plan is a set of scenario–based procedures to assist staff and emergency response teams during real life emergency and training exercises. This chapter of the Fire and Life Safety Master Plan should include an assessment of local fire prevention and suppression capabilities.

Operation and Maintenance

Operation and Maintenance involves preparing schedules for mandatory regular maintenance and testing of life and fire safety features to ensure that mechanical, electrical, and civil structures and systems are at all times in conformance with life and fire safety design criteria and required operational readiness.

L&FS Master Plan Review and Approval

- A suitably qualified professional prepares and submits a Life and Fire Safety (L&FS) Master Plan, including preliminary drawings and specifications, and certifies that the design

meets the requirements of these L&FS guidelines. The findings and recommendations of the review are then used to establish the conditions of a Corrective Action Plan and a time frame for implementing the changes.

- The suitably qualified professional conducts a review as part of the project completion test at the time of life and fire safety systems testing and commissioning, and certifies that construction of these systems has been carried out in accordance with the accepted design. The findings and recommendations of the review are used as the basis for establishing project completion or to establish the conditions of a Pre-Completion Corrective Action Plan and a time frame for implementing the changes.

Specific Requirements for Existing Buildings

- All life and fire safety guideline requirements for new buildings apply to existing buildings programmed for renovation. A suitably qualified professional conducts a complete life and fire safety review of existing buildings slated for renovation. The findings and recommendations of the review are used as the basis to establish the scope of work of a Corrective Action Plan and a time frame for implementing the changes.
- If it becomes apparent that life and fire safety conditions are deficient in an existing building that is not part of the project or that has not been programmed for renovation, a life and fire safety review of the building may be conducted by a suitably qualified professional. The findings and recommendations of the review are used as the basis to establish the scope of work of a Corrective Action Plan and a time frame for implementing the changes.

Other Hazards

- Facilities, buildings, plants, and structures should be situated to minimize potential risks from forces of nature (e.g. earthquakes, tsunamis, floods, windstorms, and fires from surrounding areas).
- All such structures should be designed in accordance with the criteria mandated by situation-, climatic-, and geology-specific location risks (e.g. seismic activity, wind loading, and other dynamic loads).
- Structural engineers and architects responsible for facilities, buildings, plants and structures should certify the applicability and appropriateness of the design criteria employed.
- National or regional building regulations typically contain fire safety codes and standards[83] or these standards are found in separate Fire Codes.[84,85] Generally, such codes and regulations incorporate further compliance requirements with respect to methodology, practice, testing, and other codes and standards[86]. Such nationally referenced material constitutes the acceptable fire life safety code.

3.4 Traffic Safety

Traffic accidents have become one of the most significant causes of injuries and fatalities among members of the public worldwide. Traffic safety should be promoted by all project personnel during displacement to and from the workplace, and during operation of project equipment on private or public roads. Prevention and control of traffic related injuries and fatalities should include the adoption of safety measures that are protective of project workers and of road users, including those who are most vulnerable to road traffic accidents[87]. Road safety initiatives proportional to the scope and nature of project activities should include:

[83] For example, Australia, Canada, South Africa, United Kingdom

[84] Réglementation Incendie [des ERP]

[85] USA NFPA, 2006.

[86] Prepared by National Institutes and Authorities such as American Society for Testing and Materials (ASTM), British Standards (BS), German Institute of Standardization (DIN), and French Standards (NF)

[87] Additional information on vulnerable users of public roads in developing countries is provided by Peden et al., 2004.

- Adoption of best transport safety practices across all aspects of project operations with the goal of preventing traffic accidents and minimizing injuries suffered by project personnel and the public. Measures should include:
  - Emphasizing safety aspects among drivers
  - Improving driving skills and requiring licensing of drivers
  - Adopting limits for trip duration and arranging driver rosters to avoid overtiredness
  - Avoiding dangerous routes and times of day to reduce the risk of accidents
  - Use of speed control devices (governors) on trucks, and remote monitoring of driver actions
- Regular maintenance of vehicles and use of manufacturer approved parts to minimize potentially serious accidents caused by equipment malfunction or premature failure.

Where the project may contribute to a significant increase in traffic along existing roads, or where road transport is a significant component of a project, recommended measures include:

- Minimizing pedestrian interaction with construction vehicles
- Collaboration with local communities and responsible authorities to improve signage, visibility and overall safety of roads, particularly along stretches located near schools or other locations where children may be present. Collaborating with local communities on education about traffic and pedestrian safety (e.g. school education campaigns)[88]
- Coordination with emergency responders to ensure that appropriate first aid is provided in the event of accidents
- Using locally sourced materials, whenever possible, to minimize transport distances. Locating associated facilities such as worker camps close to project sites and arranging worker bus transport to minimizing external traffic
- Employing safe traffic control measures, including road signs and flag persons to warn of dangerous conditions

3.5 Transport of Hazardous Materials

General Hazardous Materials Transport

- Projects should have procedures in place that ensure compliance with local laws and international requirements applicable to the transport of hazardous materials, including:
  - IATA requirements[89] for air transport
  - IMDG Code[90] sea transport
  - UN Model Regulations[91] of other international standards as well as local requirements for land transport
  - Host-country commitments under the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their disposal and Rotterdam Convention on the prior Inform Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, if applicable to the project activities
- The procedures for transportation of hazardous materials (Hazmats) should include:
  - Proper labeling of containers, including the identify and quantity of the contents, hazards, and shipper contact information
  - Providing a shipping document (e.g. shipping manifest) that describes the contents of the load and its associated hazards in addition to the labeling of the containers. The shipping document should establish a chain-of-custody using multiple signed copies to show that the waste was properly shipped, transported and received by the recycling or treatment/disposal facility

[88] Additional sources of information for implementation of road safety measures is available at WHO, 1989, Ross et al., 1991, Tsunokawa and Hoban, 1997, and OECD, 1999

[89] IATA, 2005. www.iata.org

[90] IMO. www.imo.org/safety

[91] United Nations. Transport of Dangerous Goods - Model Regulations. 14th Revised Edition. Geneva 2005. http://www.unece.org/trans/danger/publi/unrec/rev14/14files_e.html

- Ensuring that the volume, nature, integrity and protection of packaging and containers used for transport are appropriate for the type and quantity of hazardous material and modes of transport involved
- Ensuring adequate transport vehicle specifications
- Training employees involved in the transportation of hazardous materials regarding proper shipping procedures and emergency procedures
- Using labeling and placarding (external signs on transport vehicles), as required
- Providing the necessary means for emergency response on call 24 hours/day

Major Transportation Hazards

Guidance related to major transportation hazards should be implemented in addition to measures presented in the preceding section for preventing or minimizing the consequences of catastrophic releases of hazardous materials, which may result in toxic, fire, explosion, or other hazards during transportation.

In addition to these aforementioned procedures, projects which transport hazardous materials *at or above the threshold quantities*[92] should prepare a Hazardous Materials Transportation Plan containing all of the elements presented below[93].

Hazard Assessment

The hazard assessment should identify the potential hazard involved in the transportation of hazardous materials by reviewing:

- The hazard characteristics of the substances identified during the screening stage
- The history of accidents, both by the company and its contractors, involving hazardous materials transportation
- The existing criteria for the safe transportation of hazardous materials, including environmental management systems used by the company and its contractors

This review should cover the management actions, preventive measures and emergency response procedures described below. The hazard assessment helps to determine what additional measures may be required to complete the plan.

Management Actions

- *Management of Change:* These procedures should address:
  - The technical basis for changes in hazardous materials offered for transportation, routes and/or procedures
  - The potential impact of changes on health and safety
  - Modification required to operating procedures
  - Authorization requirements
  - Employees affected
  - Training needs
- *Compliance Audit:* A compliance audit evaluates compliance with prevention requirements for each transportation route or for each hazardous material, as appropriate. A compliance audit covering each element of the prevention measures (see below) should be conducted at least every three years. The audit program should include:
  - Preparation of a report of the findings
  - Determination and documentation of the appropriate response to each finding
  - Documentation that any deficiency has been corrected.
- *Incident Investigation:* Incidents can provide valuable information about transportation hazards and the steps needed to prevent accidental releases. The implementation of incident investigation procedures should ensure that:
  - Investigations are initiated promptly
  - Summaries of investigations are included in a report
  - Report findings and recommendations are addressed

[92] Threshold quantities for the transport of hazardous materials are found in the UN – Transport of Dangerous Goods – Model Regulations cited above.

[93] For further information and guidance, please refer to International Finance Corporation (IFC) Hazardous Materials Transportation Manual. Washington, D.C. December 2000.

- Reports are reviewed with staff and contractors

- *Employee Participation:* There should be a written plan of action regarding the implementation of active employee participation in the prevention of accidents.

- *Contractors:* The plan should include procedures to ensure that:
  - The contractor is provided with safety performance procedures and safety and hazard information
  - Contractors observe safety practices
  - Verify that the contractor acts responsibly

  The plan should also include additional procedures to ensure the contractors will:
  - Ensure appropriate training for their employees
  - Ensure their employees know process hazards and applicable emergency actions
  - Prepare and submit training records
  - Inform employees about the hazards presented by their work

- *Training:* Good training programs on operating procedures will provide the employees with the necessary information to understand how to operate safely and why safe operations are needed. The training program should include:
  - The list of employees to be trained
  - Specific training objectives
  - Mechanisms to achieve objectives (i.e. hands-on workshops, videos, etc.)
  - Means to determine the effectiveness of the training program
  - Training procedures for new hires and refresher programs

Preventive Measures

The plan should include procedures to implement preventive measures specific to each hazardous material offered for transportation, including:

- Classification and segregation of hazardous materials in warehouses and transport units
- Packaging and packaging testing
- Marking and labeling of packages containing hazardous materials
- Handling and securing packages containing hazardous materials in transport units
- Marking and placarding of transport units
- Documentation (e.g. bills of lading)
- Application of special provisions, as appropriate

Emergency Preparedness and Response

It is important to develop procedures and practices for the handling of hazardous materials that allow for quick and efficient responses to accidents that may result in injury or environmental damage. The sponsor should prepare an Emergency Preparedness and Response Plan that should cover:

- *Planning Coordination:* This should include procedures for:
  - Informing the public and emergency response agencies
  - Documenting first aid and emergency medical treatment
  - Taking emergency response actions
  - Reviewing and updating the emergency response plan to reflect changes and ensuring that the employees are informed of such changes

- *Emergency Equipment:* The plan should include procedures for using, inspecting, testing, and maintaining emergency response equipment.

- *Training:* Employees should be trained in any relevant procedures

3.6 Disease Prevention

Communicable Diseases

Communicable diseases pose a significant public health threat worldwide. Health hazards typically associated with large development projects are those relating to poor sanitation and living conditions, sexual transmission and vector-borne infections. Communicable diseases of most concern during the construction phase due to labor mobility are sexually-transmitted diseases (STDs), such as HIV/AIDS. Recognizing that no single measure is likely to be effective in the long term, successful initiatives typically involve a combination of behavioral and environmental modifications.

Recommended interventions at the project level include[94]:

- Providing surveillance and active screening and treatment of workers
- Preventing illness among workers in local communities by:
  - Undertaking health awareness and education initiatives, for example, by implementing an information strategy to reinforce person-to-person counseling addressing systemic factors that can influence individual behavior as well as promoting individual protection, and protecting others from infection, by encouraging condom use
  - Training health workers in disease treatment
  - Conducting immunization programs for workers in local communities to improve health and guard against infection
  - Providing health services
- Providing treatment through standard case management in on-site or community health care facilities. Ensuring ready access to medical treatment, confidentiality and appropriate care, particularly with respect to migrant workers
- Promoting collaboration with local authorities to enhance access of workers families and the community to public health services and promote immunization

Vector-Borne Diseases

Reducing the impact of vector-borne disease on the long-term health of workers is best accomplished through implementation of diverse interventions aimed at eliminating the factors that lead to disease. Project sponsors, in close collaboration with community health authorities, can implement an integrated control strategy for mosquito and other arthropod-borne diseases that might involve:

- Prevention of larval and adult propagation through sanitary improvements and elimination of breeding habitats close to human settlements
- Elimination of unusable impounded water
- Increase in water velocity in natural and artificial channels
- Considering the application of residual insecticide to dormitory walls
- Implementation of integrated vector control programs
- Promoting use of repellents, clothing, netting, and other barriers to prevent insect bites
- Use of chemoprophylaxis drugs by non-immune workers and collaborating with public health officials to help eradicate disease reservoirs
- Monitoring and treatment of circulating and migrating populations to prevent disease reservoir spread
- Collaboration and exchange of in-kind services with other control programs in the project area to maximize beneficial effects
- Educating project personnel and area residents on risks, prevention, and available treatment
- Monitoring communities during high-risk seasons to detect and treat cases

[94] Additional sources of information on disease prevention include IFC, 2006; UNDP, 2000, 2003; Walley et al., 2000; Kindhauser, 2003; Heymann, 2004.

- Distributing appropriate education materials
- Following safety guidelines for the storage, transport, and distribution of pesticides to minimize the potential for misuse, spills, and accidental human exposure

3.7 Emergency Preparedness and Response

An emergency is an unplanned event when a project operation loses control, or could lose control, of a situation that may result in risks to human health, property, or the environment, either within the facility or in the local community. Emergencies do not normally include safe work practices for frequent upsets or events that are covered by occupational health and safety.

All projects should have an Emergency Preparedness and Response Plan that is commensurate with the risks of the facility and that includes the following basic elements:

- Administration (policy, purpose, distribution, definitions, etc)
- Organization of emergency areas (command centers, medical stations, etc)
- Roles and responsibilities
- Communication systems
- Emergency response procedures
- Emergency resources
- Training and updating
- Checklists (role and action list and equipment checklist)
- Business Continuity and Contingency

Additional information is provided for key components of the emergency plan, as follows below.

Communication Systems

Worker notification and communication

Alarm bells, visual alarms, or other forms of communication should be used to reliably alert workers to an emergency. Related measures include:

- Testing warning systems at least annually (fire alarms monthly), and more frequently if required by local regulations, equipment, or other considerations
- Installing a back-up system for communications on-site with off-site resources, such as fire departments, in the event that normal communication methods may be inoperable during an emergency

Community Notification

If a local community may be at risk from a potential emergency arising at the facility, the company should implement communication measures to alert the community, such as:

- Audible alarms, such as fire bells or sirens
- Fan out telephone call lists
- Vehicle mounted speakers
- Communicating details of the nature of the emergency
- Communicating protection options (evacuation, quarantine)
- Providing advise on selecting an appropriate protection option

Media and Agency Relations

Emergency information should be communicated to the media through:

- A trained, local spokesperson able to interact with relevant stakeholders, and offer guidance to the company for speaking to the media, government, and other agencies
- Written press releases with accurate information, appropriate level of detail for the emergency, and for which accuracy can be guaranteed

Emergency Resources

Finance and Emergency Funds

- A mechanism should be provided for funding emergency activities.

Fire Services

- The company should consider the level of local fire fighting capacity and whether equipment is available for use at the facility in the event of a major emergency or natural disaster. If insufficient capacity is available, fire fighting capacity should be acquired that may include pumps, water supplies, trucks, and training for personnel.

Medical Services

- The company should provide first aid attendants for the facility as well as medical equipment suitable for the personnel, type of operation, and the degree of treatment likely to be required prior to transportation to hospital.

Availability of Resources

Appropriate measures for managing the availability of resources in case of an emergency include:

- Maintaining a list of external equipment, personnel, facilities, funding, expert knowledge, and materials that may be required to respond to emergencies. The list should include personnel with specialized expertise for spill clean-up, flood control, engineering, water treatment, environmental science, etc., or any of the functions required to adequately respond to the identified emergency
- Providing personnel who can readily call up resources, as required
- Tracking and managing the costs associated with emergency resources
- Considering the quantity, response time, capability, limitations, and cost of these resources, for both site-specific emergencies, and community or regional emergencies
- Considering if external resources are unable to provide sufficient capacity during a regional emergency and whether additional resources may need to be maintained on-site

Mutual Aid

Mutual aid agreements decrease administrative confusion and provide a clear basis for response by mutual aid providers.

- Where appropriate, mutual aid agreements should be maintained with other organizations to allow for sharing of personnel and specialized equipment.

Contact List

- The company should develop a list of contact information for all internal and external resources and personnel. The list should include the name, description, location, and contact details (telephone, email) for each of the resources, and be maintained annually.

Training and Updating

The emergency preparedness facilities and emergency response plans require maintenance, review, and updating to account for changes in equipment, personnel, and facilities. Training programs and practice exercises provide for testing systems to ensure an adequate level of emergency preparedness. Programs should:

- Identify training needs based on the roles and responsibilities, capabilities and requirements of personnel in an emergency
- Develop a training plan to address needs, particularly for fire fighting, spill response, and evacuation

- Conduct annual training, at least, and perhaps more frequent training when the response includes specialized equipment, procedures, or hazards, or when otherwise mandated
- Provide training exercises to allow personnel the opportunity to test emergency preparedness, including:
  - Desk top exercises with only a few personnel, where the contact lists are tested and the facilities and communication assessed
  - Response exercises, typically involving drills that allow for testing of equipment and logistics
- Debrief upon completion of a training exercise to assess what worked well and what aspects require improvement
- Update the plan, as required, after each exercise. Elements of the plan subject to significant change (such as contact lists) should be replaced
- Record training activities and the outcomes of the training

Business Continuity and Contingency

Measures to address business continuity and contingency include:

- Identifying replacement supplies or facilities to allow business continuity following an emergency. For example, alternate sources of water, electricity, and fuel are commonly sought.
- Using redundant or duplicate supply systems as part of facility operations to increase the likelihood of business continuity.
- Maintaining back-ups of critical information in a secure location to expedite the return to normal operations following an emergency.

4.0 Construction and Decommissioning

Applicability and Approach

This section provides additional, specific guidance on prevention and control of community health and safety impacts that may occur during new project development, at the end of the project life-cycle, or due to expansion or modification of existing project facilities. Cross referencing is made to various other sections of the General EHS Guidelines.

4.1 Environment{ TC "4.1 Environment" \f C \l "2" }

Noise and Vibration

During construction and decommissioning activities, noise and vibration may be caused by the operation of pile drivers, earth moving and excavation equipment, concrete mixers, cranes and the transportation of equipment, materials and people. Some recommended noise reduction and control strategies to consider in areas close to community areas include:

- Planning activities in consultation with local communities so that activities with the greatest potential to generate noise are planned during periods of the day that will result in least disturbance
- Using noise control devices, such as temporary noise barriers and deflectors for impact and blasting activities, and exhaust muffling devices for combustion engines.
- Avoiding or minimizing project transportation through community areas

Soil Erosion

Soil erosion may be caused by exposure of soil surfaces to rain and wind during site clearing, earth moving, and excavation activities. The mobilization and transport of soil particles may, in turn, result in sedimentation of surface drainage networks, which may result in impacts to the quality of natural water systems and ultimately the biological systems that use these waters. Recommended soil erosion and water system management approaches include:

Sediment mobilization and transport

- Reducing or preventing erosion by:
  - Scheduling to avoid heavy rainfall periods (i.e., during the dry season) to the extent practical
  - Contouring and minimizing length and steepness of slopes
  - Mulching to stabilize exposed areas
  - Re-vegetating areas promptly
  - Designing channels and ditches for post-construction flows
  - Lining steep channel and slopes (e.g. use jute matting)
- Reducing or preventing off-site sediment transport through use of settlement ponds, silt fences, and water treatment, and modifying or suspending activities during extreme rainfall and high winds to the extent practical.

Clean runoff management

- Segregating or diverting clean water runoff to prevent it mixing with water containing a high solids content, to minimize the volume of water to be treated prior to release

Road design

- Limiting access road gradients to reduce runoff-induced erosion
- Providing adequate road drainage based on road width, surface material, compaction, and maintenance

Disturbance to water bodies

- Depending on the potential for adverse impacts, installing free-spanning structures (e.g., single span bridges) for road watercourse crossings
- Restricting the duration and timing of in-stream activities to lower low periods, and avoiding periods critical to biological cycles of valued flora and fauna (e.g., migration, spawning, etc.)
- For in-stream works, using isolation techniques such as berming or diversion during construction to limit the exposure of disturbed sediments to moving water
- Consider using trenchless technology for pipeline crossings (e.g., suspended crossings) or installation by directional drilling

Structural (slope) stability

- Providing effective short term measures for slope stabilization, sediment control and subsidence control until long term measures for the operational phase can be implemented
- Providing adequate drainage systems to minimize and control infiltration

Air Quality

Construction and decommissioning activities may generate emission of fugitive dust caused by a combination of on-site excavation and movement of earth materials, contact of construction machinery with bare soil, and exposure of bare soil and soil piles to wind. A secondary source of emissions may include exhaust from diesel engines of earth moving equipment, as well as from open burning of solid waste on-site. Techniques to consider for the reduction and control of air emissions from construction and decommissioning sites include:

- Minimizing dust from material handling sources, such as conveyors and bins, by using covers and/or control equipment (water suppression, bag house, or cyclone)
- Minimizing dust from open area sources, including storage piles, by using control measures such as installing enclosures and covers, and increasing the moisture content
- Dust suppression techniques should be implemented, such as applying water or non-toxic chemicals to minimize dust from vehicle movements
- Selectively removing potential hazardous air pollutants, such as asbestos, from existing infrastructure prior to demolition
- Managing emissions from mobile sources according to Section 1.1
- Avoiding open burning of solid (refer to solid waste management guidance in Section 1.6)

Solid Waste

Non-hazardous solid waste generated at construction and decommissioning sites includes excess fill materials from grading and excavation activities, scrap wood and metals, and small concrete spills. Other non-hazardous solid wastes include office, kitchen, and dormitory wastes when these types of operations are part of construction project activities. *Hazardous solid waste* includes contaminated soils, which could potentially be encountered on-site due to previous land use activities, or small

amounts of machinery maintenance materials, such as oily rags, used oil filters, and used oil, as well as spill cleanup materials from oil and fuel spills. Techniques for preventing and controlling non-hazardous and hazardous construction site solid waste include those already discussed in Section 1.6.

Hazardous Materials

Construction and decommissioning activities may pose the potential for release of petroleum based products, such as lubricants, hydraulic fluids, or fuels during their storage, transfer, or use in equipment. These materials may also be encountered during decommissioning activities in building components or industrial process equipment. Techniques for prevention, minimization, and control of these impacts include:

- Providing adequate secondary containment for fuel storage tanks and for the temporary storage of other fluids such as lubricating oils and hydraulic fluids,
- Using impervious surfaces for refueling areas and other fluid transfer areas
- Training workers on the correct transfer and handling of fuels and chemicals and the response to spills
- Providing portable spill containment and cleanup equipment on site and training in the equipment deployment
- Assessing the contents of hazardous materials and petroleum-based products in building systems (e.g. PCB containing electrical equipment, asbestos-containing building materials) and process equipment and removing them prior to initiation of decommissioning activities, and managing their treatment and disposal according to Sections 1.5 and 1.6 on Hazardous Materials and Hazardous Waste Management, respectively
- Assessing the presence of hazardous substances in or on building materials (e.g., polychlorinated biphenyls, asbestos-containing flooring or insulation) and decontaminating or properly managing contaminated building materials

Wastewater Discharges

Construction and decommissioning activities may include the generation of sanitary wastewater discharges in varying quantities depending on the number of workers involved. Adequate portable or permanent sanitation facilities serving all workers should be provided at all construction sites. Sanitary wastewater in construction and other sites should be managed as described in Section 1.3.

Contaminated Land

Land contamination may be encountered in sites under construction or decommissioning due to known or unknown historical releases of hazardous materials or oil, or due to the presence of abandoned infrastructure formerly used to store or handle these materials, including underground storage tanks. Actions necessary to manage the risk from contaminated land will depend on factors such as the level and location of contamination, the type and risks of the contaminated media, and the intended land use. However, a basic management strategy should include:

- Managing contaminated media with the objective of protecting the safety and health of occupants of the site, the surrounding community, and the environment post construction or post decommissioning
- Understanding the historical use of the land with regard to the potential presence of hazardous materials or oil prior to initiation of construction or decommissioning activities
- Preparing plans and procedures to respond to the discovery of contaminated media to minimize or reduce the risk to health, safety, and the environment consistent with the approach for Contaminated Land in Section 1.6
- Preparation of a management plan to manage obsolete, abandoned, hazardous materials or oil consistent with the approach to hazardous waste management described in Section 1.6.

Successful implementation of any management strategy may require identification and cooperation with whoever is responsible and liable for the contamination.

4.2 Occupational Health and Safety{ TC "4.2 Occupational Health and Safety" \f C \l "2" }

Over-exertion

Over-exertion, and ergonomic injuries and illnesses, such as repetitive motion, over-exertion, and manual handling, are among the most common causes of injuries in construction and decommissioning sites. Recommendations for their prevention and control include:

- Training of workers in lifting and materials handling techniques in construction and decommissioning projects, including the placement of weight limits above which mechanical assists or two-person lifts are necessary
- Planning work site layout to minimize the need for manual transfer of heavy loads
- Selecting tools and designing work stations that reduce force requirements and holding times, and which promote improved postures, including, where applicable, user adjustable work stations
- Implementing administrative controls into work processes, such as job rotations and rest or stretch breaks

Slips and Falls

Slips and falls on the same elevation associated with poor housekeeping, such as excessive waste debris, loose construction materials, liquid spills, and uncontrolled use of electrical cords and ropes on the ground, are also among the most frequent cause of lost time accidents at construction and decommissioning sites. Recommended methods for the prevention of slips and falls from, or on, the same elevation include:

- Implementing good house-keeping practices, such as the sorting and placing loose construction materials or demolition debris in established areas away from foot paths
- Cleaning up excessive waste debris and liquid spills regularly
- Locating electrical cords and ropes in common areas and marked corridors
- Use of slip retardant footwear

Work in Heights

Falls from elevation associated with working with ladders, scaffolding, and partially built or demolished structures are among the most common cause of fatal or permanent disabling injury at construction or decommissioning sites. If fall hazards exist, a fall protection plan should be in place which includes one or more of the following aspects, depending on the nature of the fall hazard[95]:

- Training and use of temporary fall prevention devices, such as rails or other barriers able to support a weight of 200 pounds, when working at heights equal or greater than two meters or at any height if the risk includes falling into operating machinery, into water or other liquid, into hazardous substances, or through an opening in a work surface
- Training and use of personal fall arrest systems, such as full body harnesses and energy absorbing lanyards able to support 5000 pounds (also described in this section in Working at Heights above), as well as fall rescue procedures to deal with workers whose fall has been successfully arrested. The tie in point of the fall arresting system should also be able to support 5000 pounds
- Use of control zones and safety monitoring systems to warn workers of their proximity to fall hazard zones, as well as

[95] Additional information on identification of fall hazards and design of protection systems can be found in the United States Occupational Health and Safety Administration's (US OSHA) web site: http://www.osha.gov/SLTC/fallprotection/index.html

securing, marking, and labeling covers for openings in floors, roofs, or walking surfaces

Struck By Objects

Construction and demolition activities may pose significant hazards related to the potential fall of materials or tools, as well as ejection of solid particles from abrasive or other types of power tools which can result in injury to the head, eyes, and extremities. Techniques for the prevention and control of these hazards include:

- Using a designated and restricted waste drop or discharge zones, and/or a chute for safe movement of wastes from upper to lower levels
- Conducting sawing, cutting, grinding, sanding, chipping or chiseling with proper guards and anchoring as applicable
- Maintaining clear traffic ways to avoid driving of heavy equipment over loose scrap
- Use of temporary fall protection measures in scaffolds and out edges of elevated work surfaces, such as hand rails and toe boards to prevent materials from being dislodged
- Evacuating work areas during blasting operations, and using blast mats or other means of deflection to minimize fly rock or ejection of demolition debris if work is conducted in proximity to people or structures
- Wearing appropriate PPE, such as safety glasses with side shields, face shields, hard hats, and safety shoes

Moving Machinery

Vehicle traffic and use of lifting equipment in the movement of machinery and materials on a construction site may pose temporary hazards, such as physical contact, spills, dust, emissions, and noise. Heavy equipment operators have limited fields of view close to their equipment and may not see pedestrians close to the vehicle. Center-articulated vehicles create a significant impact or crush hazard zone on the outboard side of a turn while moving. Techniques for the prevention and control of these impacts include:

- Planning and segregating the location of vehicle traffic, machine operation, and walking areas, and controlling vehicle traffic through the use of one-way traffic routes, establishment of speed limits, and on-site trained flag-people wearing high-visibility vests or outer clothing covering to direct traffic
- Ensuring the visibility of personnel through their use of high visibility vests when working in or walking through heavy equipment operating areas, and training of workers to verify eye contact with equipment operators before approaching the operating vehicle
- Ensuring moving equipment is outfitted with audible back-up alarms
- Using inspected and well-maintained lifting devices that are appropriate for the load, such as cranes, and securing loads when lifting them to higher job-site elevations.

Dust

- Dust suppression techniques should be implemented, such as applying water or non-toxic chemicals to minimize dust from vehicle movements
- PPE, such as dusk masks, should be used where dust levels are excessive

Confined Spaces and Excavations

Examples of confined spaces that may be present in construction or demolition sites include: silos, vats, hoppers, utility vaults, tanks, sewers, pipes, and access shafts. Ditches and trenches may also be considered a confined space when access or egress is limited. In addition to the guidance provided in Section 2.8 the occupational hazards associated with confined spaces and excavations in construction and decommissioning sites should be prevented according to the following recommendations:

- Controlling site-specific factors which may contribute to excavation slope instability including, for example, the use of excavation dewatering, side-walls support, and slope gradient adjustments that eliminate or minimize the risk of collapse, entrapment, or drowning
- Providing safe means of access and egress from excavations, such as graded slopes, graded access route, or stairs and ladders
- Avoiding the operation of combustion equipment for prolonged periods inside excavations areas where other workers are required to enter unless the area is actively ventilated

Other Site Hazards

Construction and decommissioning sites may pose a risk of exposure to dust, chemicals, hazardous or flammable materials, and wastes in a combination of liquid, solid, or gaseous forms, which should be prevented through the implementation of project-specific plans and other applicable management practices, including:

- Use of specially trained personnel to identify and remove waste materials from tanks, vessels, processing equipment or contaminated land as a first step in decommissioning activities to allow for safe excavation, construction, dismantling or demolition
- Use of specially trained personnel to identify and selectively remove potentially hazardous materials in building elements prior to dismantling or demolition including, for example, insulation or structural elements containing asbestos and Polychlorinated Biphenyls (PCBs), electrical components containing mercury[96]
- Use of waste-specific PPE based on the results of an occupational health and safety assessment, including respirators, clothing/protective suits, gloves and eye protection

4.3 Community Health and Safety{ TC "4.3 Community Health and Safety" \f C \l "2" }

General Site Hazards

Projects should implement risk management strategies to protect the community from physical, chemical, or other hazards associated with sites under construction and decommissioning. Risks may arise from inadvertent or intentional trespassing, including potential contact with hazardous materials, contaminated soils and other environmental media, buildings that are vacant or under construction, or excavations and structures which may pose falling and entrapment hazards. Risk management strategies may include:

- Restricting access to the site, through a combination of institutional and administrative controls, with a focus on high risk structures or areas depending on site-specific situations, including fencing, signage, and communication of risks to the local community
- Removing hazardous conditions on construction sites that cannot be controlled affectively with site access restrictions, such as covering openings to small confined spaces, ensuring means of escape for larger openings such as trenches or excavations, or locked storage of hazardous materials

Disease Prevention

Increased incidence of communicable and vector-borne diseases attributable to construction activities represents a potentially serious health threat to project personnel and residents of local communities. Recommendations for the prevention and control of communicable and vector-borne diseases also applicable to

[96] Additional information on the management and removal of asbestos containing building materials can be found in ASTM Standard E2356 and E1368

construction phase activities are provided in Section 3.6 (Disease Prevention).

Traffic Safety

Construction activities may result in a significant increase in movement of heavy vehicles for the transport of construction materials and equipment increasing the risk of traffic-related accidents and injuries to workers and local communities. The incidence of road accidents involving project vehicles during construction should be minimized through a combination of education and awareness-raising, and the adoption of procedures described in Section 3.4 (Traffic Safety).

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