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OSHPC “Barki Tojik”
Republic of Tajikistan

Rogun HPP ESIA

Environmental and Social Impact Assessment for Rogun Hydro Power Plant

ОАХК «Барки Точик»
Республика Таджикистан

ОЭСВ РОГУНСКОЙ ГЭС

Оценка экологического и социального воздействия для Рогунской ГЭС

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Picture on front page: View of the construction site of Rogun HPP; picture taken 2013-08-25

Фото на первой странице: Обзор строительной площадки Рогунской ГЭС; фотография сделана 2013-02-19

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LIST OF ACRONYMS AND ABBREVIATIONS

AIDS	Acquired Immunodeficiency Syndrome
CASAREM	Central Asia/South Asia Regional Electricity Market
COE	Committee of Environment
d/s	downstream
DO	Dissolved Oxygen
EH&S	Environment, Health and Safety
EMP	Environmental Management Plan
EPS	Environmental Protection Authority
ESIA	Environmental and Social Impact Assessment
ESMMP	Environmental and Social Management and Monitoring plan
ESMP	Environmental and Social Management Plan
FSL	Full Supply Level
GOT	Government of Tajikistan
GPS	Global Positioning System
HIV	Human Immunodeficiency Virus
HPP	Hydropower Project
HR	Human Resources
IFC	International Finance Corporation
ILO	International Labour Organisation
LFMP	Labour Force Management Plan
m asl	meters above sea level
NH	Natural Hazards
NHP	Natural Hydrometeorological Phenomena
OSC	Open Stock Company
PAP	Project Affected Person
PIU	Project Implementation Unit
POE	Panel of Experts
PPE	Personal Protection Equipment
RAP	Resettlement Action Plan
RU	Resettlement Unit
SADC	Southern African Development Community
SCADA	Supervisory Control and Data Acquisition
SIA	Social Impact Assessment
S-MMP	Sub-Monitoring and Management Plan
STD	Sexually Transmitted Disease
TBC	Tuberculosis
TEAS	Technical and Economic Assessment Study
TSS	Total Suspended Solids

u/s	upstream
WB	World Bank
WHO	World Health Organisation
WWTP	Waste Water Treatment Plant

1 INTRODUCTION

The preliminary Environmental and Social Management Plan (ESMP) for the Rogun Hydro Power Plant is based on the ESIA carried out for this Project (see ESIA Main Report Volume I). Details of the ESIA study are provided in ESIA Report Vol. I and are not repeated here.

The ESIA identified the relevant impacts of the Project and described the necessary mitigation measures. The ESMP takes up the summarised description of impacts and measures from the ESIA Report Vol. I (Chapter 15). The main parts of the ESMP then consist in a detailed description of these measures. Annex 2 provides a number of sample sheets which outline individual sub-plans for managing specific aspects.

1.1 Objectives of Environmental and Social Management Plan

The ESMP will help Rogun HPP to address the adverse environmental impact of the project, enhance project benefits, and introduce standards of good environmental practice. The primary objectives of the plan are to:

a) Define the responsibilities of project proponents, contractors and other role players, and effectively communicate environmental issues among them.

b) Facilitate the implementation of the mitigation measures identified in Vol. I Chapter 16 by providing the instructions on how to handle the issues, and providing an implementation schedule.

c) Define a monitoring mechanism and identify monitoring parameters to ensure that all mitigation measures are completely and effectively implemented.

d) Identify, as far as possible at this stage, the resources required to implement the ESMMP and outline corresponding financing arrangements.

1.2 Construction Site Management and Rehabilitation

As mentioned in Vol. I, Rogun HPP is a special case with respect to the fact that construction activities started a long time (over 20 years) ago, and were resumed after a prolonged interruption about 6 years ago. This means that a very large construction site is already in place. Even if at present, under the agreement of the Republic of Tajikistan with the World Bank, construction activities are restricted to absolutely required maintenance measures aiming at preventing additional damage to structures already built, it is still a large construction site. According to the TOR for the ESIA, a construction site audit had to be carried out (see Vol. I). In the present Vol. III, comments are made and recommendations provided on requirements for construction site management aiming at achieving general good housekeeping and acceptable environment, health and safety (EH&S) conditions on site. In addition, recommendations are made for construction site rehabilitation. These aspects, which are usually not, or at least not in that detail, the subject of an ESIA, are dealt with in Chapters 5 and 6.

1.3 Responsibilities

The ESMP makes a distinction between responsibilities of the Project Owner (Republic of Tajikistan, OSHPC “Barki Tojik”), or its implementing unit (PIU within Rogun OSC) and the Contractor. In many or most cases this responsibility is clearly attributable. So e.g. the Contractor will be directly responsible for all environment, health and safety (EH&S) measures related directly with construction sites and activities; this includes items as diverse as solid waste management, availability of PPE (personal protection equipment) for workers, health care services for the work force, etc.

However, in some cases responsibility is not a priori clear. So e.g. it is primarily the Project Owner who is responsible for implementing mitigation measures which are not related to construction, as e.g. archaeological investigations or planting of trees for slope stabilisation outside the construction site perimeter. Obviously, he can mandate a contractor with this work. This also applies to other basic responsibilities of the Project Owner.

If the Project Owner engages an Owners Engineer, this latter will have the responsibility to supervise the contractors; normally this supervision of the Owners Engineer covers the construction period and construction related issues, e.g. EH&S measures related directly to construction sites and activities. These responsibilities will have to be defined in the contract of the Owner's engineer.

In any case, the Project Owner has the following overall main responsibilities concerning environmental management (in the wider sense of the term):

- To make sure that the required measures are properly implemented, whether by him directly or by a third party.
- To formulate clear conditions (in the tender documents) for all obligations of the contractor(s); it must be very clear that such conditions, e.g. concerning EH&S measures, also apply to subcontractors, and that the contractor has a responsibility for their performance.
- To monitor implementation of these measures (by its own work force and by subcontractors) and to take adequate steps in case of non-compliance.

1.4 ESMP and RAP

The main social impacts and measures, i.e. everything related to impacts on the local population requiring compensation, or in other words all activities related to resettlement, are dealt with on a different level. A competent Resettlement Unit (called "Directorate of the Flooding Zone of Rogun HPP) is in place and has started working a number of years ago.

Within the present ESIA, the following main steps have been carried out in relation with issues concerning the local population and resettlement:

- Description of the socio-economic situation of the local population (Chapter 13 of ESIA Report Vol. I)
- Outline of a resettlement plan for Stage 2 of Rogun HPP development (Chapter 19 of ESIA Report Vol. I).
- Resettlement Policy Framework (RPF): separate document.

- Resettlement Action Plan (RAP) for Stage 1 resettlement: separate document
- Resettlement Audit: separate document.

For the implementation of the project, these documents will have the same importance, and will be equally binding, as the ESMP; for this reason, aspects related to resettlement (in the wider sense of the term, and not limited to physical relocation) are not repeated in the ESMP.

2 SUMMARY OF MAIN IMPACTS AND MITIGATION MEASURES

In the ESIA Report Vol. I, environmental risks and impacts likely to emanate from project parts or project related activities were described. This chapter takes up the synopsis of the impacts, with their importance, and lists the required or proposed mitigation measures, where such measures seem necessary for minimising the impact as far as possible or reducing the risk to an acceptable level.

2.1 Overall Impact Evaluation

The conclusions of the discussion in the previous section are the following:

- Most impacts are rather small and easily mitigated, if mitigation is required at all.
- There are two areas of potentially important impacts, which need to be addressed in detail and where mitigation is required. These two are:
  - the local population directly affected by the project, which will have to be resettled, and
  - potential effects of the project on downstream river discharge, which could negatively affect downstream riparians.
- There is no impact of the category "strong negative, mitigation not possible", which would have to be considered as a no-go for the project.

2.2 Summary of Impacts, Mitigation Measures and Monitoring Activities

Table 1 on the following pages lists the identified impacts as well as a summary overview of the proposed mitigation measures and related monitoring activities. It describes impacts before mitigation, mitigation measures, and remaining impact after mitigation (including, where applicable, the potential for increasing project benefits if appropriate measures would be taken).

For more details on these measures, especially for contractual purposes and implementation, see detailed description of these measures in Annex 2.

Table 1: Synopsis of Impacts and Mitigation Measures

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Physical Environment						
Climate	Reservoir	A surface of water of 170 km^2 will increase evaporation, and it can have a moderating effect on temperature. Since the reservoir will not be large enough there will be no noticeable effect on the local climate. The effects (reduction of the number of frost days, reduction in summer temperatures, increase in humidity) will be limited to the immediate surroundings of the reservoir, and they will be too small to play any decisive role. There will be no GHG emission of any relevance from the reservoir (see Section 8.11.3).	**none**	Not required	**none**	No S-MMP
Air quality	Quarries, construction activities and transportation activities	Air pollution (dust, exhaust gases) mainly by nitrogen oxides (NOx) and Particulate Matter (PM10) • Emission related to construction activities • Emission related to transport of material. • Emission related to borrow areas. Impact restricted to construction site (including quarries and access roads) and construction activities (works, traffic, etc.).	**small negative / negative** → Minor impact, localised to construction site and access roads, and limited to the duration of construction.	Use adequate and well maintained construction and transportation equipment and the contractor has to develop a maintenance program to ensure this. Take good measures for dust suppression: • This includes among others good housekeeping. • Instruct workforce on appropriate measures to minimize air pollutants. • Optimization of storage on-site of materials that are known to be whirled up by wind. • Water sprinkling especially on unpaved roads. • Trucks which transport construction material for longer distances (quarry to construction site) should be covered. • Do not exceed speed limits. • Do not burn waste. Organize the sequences of construction activities in a way that the use of equipment powered by diesel fuel is optimized and duration is minimized (switch off the engine during parking periods).	**small negative** reduction of quantity of exhaust gas, dust; will be within legal limits	Environmental, Health and Safety Management and Monitoring of the contractor Equipment Maintenance Management Plan Traffic Management Plan Waste Management Plan Air Quality Management Plan → *For detailed information: see also Mitigation Measure Data Sheet No. 5, Air pollution (ESIA Main Report Vol. III, Annex A2.1)*

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Noise	Quarries, construction activities and transportation activities	Impact caused by construction activities (works, traffic, machines, etc.), mainly on the workforce.	**small negative / negative** → Minor impact, localised to construction site and access roads, limited to the duration of construction.	Main aim: meeting Tajik and other applicable noise limits. Use adequate and well maintained construction and transportation equipment including state-of-the-art built in systems (muffler) to reduce the noise. The contractor has to develop a maintenance program to ensure to keep noise within legally permitted limits. Instruct the workforce to avoid unnecessary noise. Use adequate and state of the art techniques for blasting, which do not exceed the exposition time to the noise. Workers exposed to excessive noise have to be equipped with PPE (e.g. ear protectors) and the exposition time has to be limited. The quarry must be located in a sufficient distance to any populated area. Separate installation areas, for example mechanical workshops etc. from areas that are used by people for temporary housing and recreation; distance should be at least 10 m. Noise and vibration associated with the use of explosives needs to be monitored. Max 136 db Avoid any noise intensive activities such as metalworking, blasting (in quarries) etc. during night time. Avoid transporting of material (rock, concrete, etc.) during night, if they have to pass villages.	**small negative** → reduced noise level due to maintaining the noise standards set by international organisations such as WHO or Tajik legislation.	Environmental, Health and Safety Management and Monitoring of the contractor Traffic Management Plan Equipment Maintenance Management Plan Explosives Management Plan Health and Safety Management Plan *→ For detailed information: see also Mitigation Measure Data Sheet No. 6, Noise and Vibration (ESIA Main Report Vol. III, Annex A2.1)*
Vibration	Construction activities and quarries	Main sources of impacts: traffic and use of explosives. Mainly on the workforce, possibly on villages in the risk zone if not yet relocated	**small negative**	Use best practice to reduce the dispersion of material and vibrations near any physical structures. Install a monitoring system at sensitive sites and monitor and record vibrations during blasting events. Use state of the art techniques. Restrict access during blasting events. Minimize night traffic through villages. On-demand monitoring of vibration, taking adequate measures if required.	**small negative** → reduced level of vibration due to maintaining the standards set by international organisations such as WHO	Environmental, Health and Safety Management and Monitoring of the contractor Explosives Management Plan Health and Safety Management Plan Traffic Management Plan *→ For detailed information: see also Mitigation Measure Data Sheet No. 6, Noise and Vibration (ESIA Main Report Vol. III, Annex A2.1)*

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Hydrology	Dam, reservoir, turbine operation; reservoir filling	Impact on the downstream area, if river discharge pattern is changed (seasonal and daily distribution of flows). Two main sources of impact: • filling of reservoir; • power plant operation. Main potential impacts: • on Tigrovaya Balka (and to a much lesser extent on other floodplain habitats along he Amu Darya) mainly by reducing summer peak flows: • negative impact on riparian countries (availability of water for irrigation) if summer flows are reduced. • positive impact on downstream area, and mainly on riparian countries, by reducing flood risk (reduction of flood peaks, cascade capable of handling PMF). • potential for making more water available for irrigation in the downstream area in the case of dry summers.	**negative** The direct effect of Rogun will be strongly influenced by Nurek, especially where the short term fluctuations during operation are concerned. However, if no adequate measures are taken, impacts on the entire downstream area are potentially serious during filling and operation. Potential for improving the situation /regulating flows for better flood management and for more water in d/s areas during dry summers)	This is, together with resettlement, i.e. with the direct project impact on the local population, the most relevant potential impact of the project. The most important mitigation measure consisted in finding a way to fill and operate Rogun HPP in a way which allows Tajikistan to remain within the conditions defined by the Nukus declaration and Protocol 566, i.e. by not using more water than allocated to the country, on a yearly basis, by ICWC. The hydraulic model for operation of the Vakhsh cascade, which was prepared by TEAS in close cooperation with the ESIA Consultant, shows that the cascade (i.e. mainly the combination of Rogun and Nurek HPPs, the other dams not having storage capacity of any relevance) can be operated in a way as not to change the runoff pattern, i.e. water availability, in the downstream area. GOT intends to operate the cascade in this way, which will not change the flow pattern (seasonal distribution of water) in Vakhsh river downstream of the cascade. In this way, Rogun HPP can be built and operated in compliance with present rues and practices for water allocation in the Amu Darya basin. It is recommended that the ICWC member states should modify existing agreements and practices to include operation of Rogun HPP The most important components of such modifications would be: • a firm commitment to operate the cascade according to the results of the hydraulic model, i.e. by respecting ICWC water allocation; • a commitment for not retaining any water in Rogun in especially dry years during the filling phase; and • a rule for making available additional water to the downstream areas in exceptionally dry years during the operation phase. For emphasising the credibility of such rules, it is important that an online monitoring system of Vakhsh Cascade operation is set up, and that the results of this be made available in real time in the internet, on a site accessible to all interested parties.	**none** as long as operated according to the identified operation rules. **positive** if potential for improvements is implemented.	Cascade Operation Plan (to be defined) Online hydrological monitoring, made publicly available. Modification of existing agreements and practices recommended.

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Hydrogeology	Reservoir	The groundwater table in the alluvions along the reservoir will be influenced directly by the water level in reservoir, and especially by the yearly drawdown.	**negative** The reservoir could trigger local landslides by mobilising the sediment deposits along the FSL.	Needs to be monitored. Specific measures would have to be taken in the case that settlements would be at risk.	**small negative** reduced risk of accidents due reservoir triggered landslides.	Monitoring of landslide prone areas
Water quality	Construction activities	There is a risk of water contamination mainly during the construction period. Main sources: • Suspended solids from the construction site and related activities (excavations, quarrying, earthworks causing erosion, preparation of aggregates, disposal of material, etc.). Leads to higher silt load in the d/s area. • Water pollution with fuel oil, lubricants and other dangerous substances from leaking containers and from vehicles and machines. • Contamination of water with concrete increases pH to levels potentially harmful for aquatic life (fish, amongst others). • Contamination of water with Nitrite Ions (NO_2^-) as a result of blasting (quarries). Nitrite is highly toxic to the fish fauna even in low concentrations. Waste water: During the most intensive part of the construction phase, the construction camp will be populated by a large work force.	**negative** Risk limited to construction period. Localised, but potentially of serious consequences.	"Good housekeeping" on the construction site. All equipment, machinery, trucks and camp installations have to be located in a distance of more than 250 m to water used for human consumption and at least 150 m to any body of surface water. Water quality monitoring. Measures to be taken during construction, like e.g.: • No deposit, even for uncontaminated gravel from the quarry, near any body of surface water. Sedimentation and neutralisation ponds for reducing sediment load and effect on pH. Drainage water draining from quarry to be lead to sedimentation and neutralisation ponds before releasing it to the river. • Strict measures to prevent oil pollution of the river: Storage of fuel and lubricants away from the river, in tight containers placed on sealed surfaces. Storage areas designed to contain 110 % of the largest container/ vessel stored in the storage area, waterproof; equipment and material for clean-up avaialble. Good maintenance of vehicles and machines to prevent oil losses. No cleaning or maintenance of vehicles or machines in close proximity to the. To be done in specially prepared areas (workshops) equipped with oil skimmers. • Water from the batching plants, concrete mixer washing facilities and the crusher plants needs to be collected and treated (e.g. neutralisation ponds for effect on pH) before releasing to the environment. Waste water from the camp site must be collected in portable latrines or septic tanks and has to be treated before releasing into a river.	**small negative / none** → The water pollution control measures during construction and operation will considerably reduce the discharge of water deteriorating substances and thus improving quality of the surface waters	Environmental, Health and Safety Management and Monitoring of the contractor Equipment Maintenance Management Plan Wastewater Management Plan Waste Management Plan Pollutant Spill Contingency Plan *→ For detailed information: see also Mitigation Measure Data Sheet No. 8, Waste Water Management (ESIA Main Report Vol. III, Annex A2.1)*

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Water quality	Reservoir	Change from river to lake ecosystem.	**small negative** No large amount of biomass will be submerged, therefore no water quality deterioration, absence of large settlements and industries in the catchment area.	Given the situation of the project area no specific major mitigation measures are required in this respect. Proper waste and waste water management in the communities around the reservoir would be desirable; however, this is not in the direct responsibility of Rogun HPP.	**small negative**	Water Quality Management Plan during operation Waste Water Management Plan during operation Waste Management Plan during operation
Geology	Dam and reservoir	No valuable mineral deposits within the area to be submerged → no project impacts	**none**	Not required	**none**	No S-MMP
Seismicity	Dam and reservoir	Dam and reservoir are located in a seismic active area. There is a risk of reservoir triggered seismicity, which could result in an increased frequency of small earthquakes.	**small negative** Reservoir triggered seismicity cannot be of a higher magnitude than a potential spontaneous earthquake would be.	The dam is designed so as to withstand the probable maximum earthquake (see technical studies). The reservoir will be filled over a period of 16 years to mitigate this risk. The installation of a micro-seismic monitoring network is proposed.	**small negative**	Seismic Monitoring of Rogun HPP (*ESIA Main Report Vol. III, chapter 7.2)*
Soils	Reservoir	Soils will be lost in the area covered by the reservoir (up to 170 km^2). Erosion due to the drawdown of the reservoir. Landslides could put some settlements on risk.	**small negative** → Localised effect, limited to the reservoir area; no important concern.	For the loss of soils within the submerged area is no mitigation possible. Watershed-management plan with special concern on the side banks of the future reservoir (e.g. monitoring of sensitive areas).	**small negative**	Watershed Management Plan Re-cultivation Management Plan Erosion Monitoring Plan during operation

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Soils (Topography, geomorphology)	Construction area, quarries, burrows and dumping areas	Main risks: Soil erosion and landslides. • Creation of open and erosion prone surfaces during construction phase. → In the absence of vegetation cover the soil will become more susceptible to erosion. • Sediment deposits along the FSL of the reservoir may be mobilised, leading to local landslides. • Small negative effect (visibility, change in morphology). While a natural process, erosion can locally be accelerated by the project.	**negative** Localised effect, can have negative effects.	Special risks for Rogun HPP construction site since the site already exists since 30 years. Following measures need to be implemented: Reuse as much as possible of the excavated material. Excavate material inside of the future reservoir and deposit unused, uncontaminated material in the future reservoir. Keep additional sites as small as possible. Good engineering practices will help controlling soil erosion both at construction sites and in peripheral areas, particularly in borrow and dumping areas and along access roads. Following measures have been mentioned: • Install sediment traps. • Drainage channels where necessary. • Prevent steep slopes, define optimum height of work evaluating the instability of the rock, soil etc. • Stabilise, compact and strengthen steep slopes. • Adequate selection of road tracks, taking into account the landscape, technical environmental and social aspects. • Construct drainage ditches at roads if there are passing through mountainous area If the slope is more that 16 % they have to be paved. • Install culverts with enough capacity for strong rains, drainage pipes and channels have to be of an adequate size and should be equipped with screens at entrance and exit points to reduce the risk of clogging. • Re-vegetation of surfaces after (temporary) use. • Focus on erosion control measures along roads. Monitoring of erosion prone sites during operation, measures as may be required.	**small negative** → The erosion prevention control measures during construction and operation will considerably reduce the soil erosion and therefore also the suspended solids in the river and thus improving quality of the habitats and water quality. → visibility of remaining scars in landscape and of possible landslides, mud and debris flows will be reduced.	Environmental, Health and Safety Management and Monitoring of the contractor Erosion Management Plan Site Rehabilitation Plan. → *For detailed information: see also Mitigation Measure Data Sheet No. 9, Erosion prevention (ESIA Main Report Vol. III, Annex A2.1)*

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Soils	Construction activities	Contamination of soil	**negative**	The maintenance of machinery and lorries has to be done in workshops, liquids including cleaning water should be collected in tanks. Storage of fuel and lubricants has to be in tight containers placed on sealed surfaces underneath a roof. The storage has to be equiped with all safety measures to prevent oil spilling including fire fighting equipment. The area needs to be marked. Sufficient quantities of oil absorbent have to be stocked and have to be easily accessible in case of an oil spill. The contaminated absorbent has to be disposed of properly. Hazardous waste has to be stored in designated closed tanks or areas. Solid waste generated during construction and at campsites will be properly treated and safely disposed of only in demarcated waste disposal sites. All activities which could contaminate the soil have to be carried out on a sealed surface. If accidental spillage occurs, the contaminated soil has to be excavated and disposed of properly.	**small negative** → reduced risk of soil contamination; unexpected spills and leakages will be treated properly and fast, the contamination of soil will be locally and due to clean-up mechanisms not spread into the surrounding or drained into the water and/or groundwater	Environmental, health and safety management and monitoring of the contractor Equipment Maintenance Management Plan Wastewater Management Plan Waste Management Plan Hazardous Material Management Plan Pollutant Spill Contingency Plan → *For detailed information: see also Mitigation Measure Data Sheet No. 10 Hazardous Material Management, No. 11 Equipment Maintenance Management and No. 12 Pollutant Spill Contingency Plan (ESIA Main Report Vol. III, Annex A2.1)*
Biological Environment						
Vegetation and flora	Construction area, reservoir	The reservoir will submerge an area of up to 170 km². Vegetation on this land will be lost. Loss of two floodplains (natural habitats).	**small negative** Impact of minor importance, since no critical natural habitats, no especially rare vegetation types and no rare or endangered species will be lost.	Measures during construction: • Damage to the natural vegetation to be minimized. • The useful wood to be made available to the local population. • Re-vegetate as far as possible the reservoir banks with native shrubs and trees in an appropriate manner. Offset for submerged floodplains: measures for improvements in Tigrovaya Balka.	**small negative** **positive,** if measures for Tigrovaya Balka implemented	Watershed Management Plan Re-cultivation Management Plan Site Restoration Plan Pre-impoundment survey
Vegetation and flora	Transmission line and new access roads	Occupation of land and loss of vegetation due to the construction of new roads which are necessary to grant access, e.g. to villages remaining around the reservoir. TLs not part of present ESIA, will require their own assessment.	**small negative** only small impact expected. However, road construction in this area can trigger erosion, which can locally become quite massive.	Use existing facilities and roads where possible for access roads and Transmission and Distribution Lines (T&DL). Measures for stabilising the berms and slopes in order to minimise erosion. Do not use any herbicides for vegetation clearing (manual clearing rather than mechanical or herbicides). Re-vegetation of disturbed areas with native species.	**none / small negative**	Erosion Management Plan Site Restoration Plan

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Vegetation and flora	Work force (construction phase and operation)	Destruction of vegetation / flora by work force The vegetation cover within the construction area is already degraded due to the past construction activities, the clearance of the dam site and appurtenant structures like camp sites, access roads, etc. → additional impact is estimated to be negligible / very small	**small negative**	Any illegal logging of the work force must be forbidden. In general: Strengthen the awareness of the workforce for the environment (protected areas, plants and wildlife) to avoid logging, hunting etc. at project site and in the surroundings. Construction site to be fenced off for preventing use of areas outside.	**none / small negative**	Needs to be part of the employees contract and of the HR Policy
Vegetation and flora	Future resettlement areas (Surroundings of the reservoir)	As an indirect impact / result of the resettlement land will be used, which (partly) has not been occupied until now. These areas are rather small compared to the inundation area.	**none / small negative** Resettlement carried out so far was done in areas largely used for agriculture until now, no valuable habitats were affected	Mitigation measures depend on the way how many people will be resettled in the future (i.e. relocated outside of the project area) and how many will stay in the region. → Question of available capacity of the remaining land for the number of resettled people and their livestock (needs to be addressed in the course of preparation of the Stage 2 RAP)	**none / small negative**	Specific plans for resettlement areas.
Vegetation and flora	Reservoir (first filling)	In general: Submerged biomass can produce anaerobic conditions and might cause problems (water quality, GHG) when discharged downstream, containing toxic substances (mainly H_2S). Furthermore submerged biomass leads to water quality deterioration in the deeper layers of the reservoir; effect on people, who depend on drinking water quality.	**none** Small amount of biomass to be submerged, oxygen depletion due to submerged biomass will not be a problem.	Pre-impoundment clearing not required, however, trees should be cut. Use of timber and other useful wood (e.g. fuelwood) as valuable resource growing in the reservoir area.	**small positive** → wood / timber as valuable resource for local people	No special plan required, implementation along with resettlement.

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Terrestrial Fauna	Construction area, roads and all temporary structures	Fauna mainly depends on their habitats, which are neither rare nor valuable in the project area. In addition, the habitats are already strongly influenced by human use and the situation is not new (construction activities are on-going since the 1980ies). The impact on fauna caused by the project is small and of minor importance.	**small negative**	The impact on fauna within the reservoir cannot be mitigated. Since fauna is strongly related to their habitats, damage to the natural habitat should be minimized where possible. It should be forbidden to destroy additional areas due to dumping of construction material. Reconstruction of habitat through reforestation with native species. Offset measure required as compensation for submerged floodplains: Tigrovaya Balka.	**none /** **positive** if measures for Tigrovaya Balka are implemented.	Watershed Management Plan and Re-cultivation (will improve habitats for terrestrial fauna. Plan for measures in Tigrovaya Balka.
Terrestrial Fauna	Work force (construction phase and operation)	Disturbance (e.g. noise) caused by the presence of a high number of people. Risk of illegal hunting.	**small negative**	Hunting by members of the work force must be forbidden. In general: Strengthen the awareness (training) of the workforce for the environment (protected areas, plants and wildlife) to avoid logging, hunting etc. at project site and in the surroundings.	**small negative**	Noise Management Plan. Hunting ban needs to be part of the employees contract and of the HR Policy.
Terrestrial Fauna	Reservoir	Up to 170 km^2 of habitat will be submerged.	**small negative / none** → Impact of minor importance, since no valuable habitats and no rare or endangered species will be lost. The most valuable habitat type affected are two river floodplains which will be submerged.	The affected floodplains are a natural habitat, but not a rare one in Tajikistan. As an offset for this impact, it is proposed to contribute to the management measures for Tigrovaya Balka.	**small negative / none** **positive** if plan for Tigrovaya Banka implemented.	Watershed Management Plan and Re-cultivation Management Plan will improve habitats for terrestrial fauna.
Fish	Dam	Interruption of the river by a dam, which will be an obstacle to fish migration.	**small negative** → All migration already blocked by Nurek. Therefore, not considered as serious impact.	Not required	**small negative**	No S-MMP

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Aquatic Fauna	Reservoir	Part of the river will change from river to lake conditions → change from a lotic ecosystem more to a lentic ecosystem.	**small negative** → Impact of minor importance. Fish fauna is poor, migrations (if there were any) already interrupted by Nurek dam.	No direct mitigation measures required. However, it is recommended to study the potential of the future reservoir for fish stocking and/or aquaculture. → Carry out a study for developing the fisheries potential in the reservoir; consider possibility of floating cage aquaculture. Note that the potential will be determined largely by the mode of operation of the reservoir. A large seasonal drawdown will reduce such a potential considerably.	**small negative / none** **positive** if potential for fisheries can be developed.	Fish Monitoring Management of Natural Populations, Fisheries Development Plan (needs to be developed)
Aquatic Fauna	Reservoir filling phase (Stage 1)	Will have a negligible impact on the downstream area since the reservoir will be full to this level in a short time, retaining a small amount of water.	**none**	The defined minimum discharge will have to be released.	**none**	Operation Plan
Aquatic Fauna	Reservoir filling Phase (Stage 2)	Will have an effect on the d/s area by retaining a large quantity of water.	**small negative**	Reservoir filling to be made according to the proposed rules. Release of the defined minimum discharge.	**none**	Operation Plan
Aquatic Fauna	Construction activities	Risk of water contamination	**negative**	See mitigation measures for water quality	**small negative / none** The water pollution control measures during construction and operation will considerably reduce the discharge of water deteriorating substances and thus improving quality of the surface waters	Environmental, health and safety management and monitoring of the contractor Equipment Maintenance Management Plan Wastewater Management Plan Waste Management Plan Pollutant Spill Contingency Plan *→ For detailed information: see also Mitigation Measure Data Sheet No. 8, Waste Water Management (ESIA Main Report Vol. III, Annex A2.1)*

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Landscape	All visible parts of the project	The visible structures will change aspect of landscape.	**small negative / negative** during operation, the impacts are reduced to the remaining visible structures (dam, reservoir, switchyard, new roads, etc.), considering that all mitigation measures were taken into account.	No mitigation possible for the drawdown area. Mitigation measures • Landscaping and re-vegetation of temporarily used areas so that this areas can return into a natural ecosystem. • Start with the re-vegetation of areas as soon as possible. • Unused material for example from the quarries should be deposited in a way compatible with the landscape and should be re-vegetated. • Ensure the conservation of the landscape where possible. • If possible, dump unused, uncontaminated material in the future reservoir. Keep additional sites as small as possible.	**small negative / none / positive**	Watershed Management Plan Re-cultivation Management Plan Waste Management Plan Site Rehabilitation Plan
Protected Areas	Operation	There is no protected area in the area affected by dam and reservoir. One protected area (Tigrovaya Balka), located d/s of the Vakhsh cascade. It is an important floodplain habitat with a very special and rare vegetation type and associated fauna. It depends on seasonal fluctuations in river discharge.	**none** Tigrovaya Balka was already affected by Nurek HPP. The hydraulic model shows that under the proposed operation scheme for Rogun HPP there will be no change in river flows downstream of Nurek, and therefore no additional impact on Tigrovaya Balka caused by Rogun HPP.	Operation of the cascade according to proposed regime. Additional measures specific for improving the situation in Tigrovaya Balka could be: • Participation of Rogun HPP in the on-going efforts for improving habitat conditions; this would be a valuable offset for the impact of Rogun HPP on vegetation, fauna and natural habitats. • Release of occasional "artificial floods"; this would have to be done in close coordination with all concerned stakeholders, mainly also to prevent damage to inhabited and cultivated areas. This is proposed to be taken as offset measure for the loss of two floodplains (see above).	**positive**, if offset implemented	Plan for measures in Tigrovaya Balka
Human Environment						
Human population	Reservoir (stage 1)	Physical displacement has to take place. 7 villages will have to be resettled.	**strongly negative**	The affected population has to be resettled. Resettlement plan focuses mainly on physical relocation and livelihood restoration. Resettlement has started (so-called Stage 1 resettlement, villages affected by the construction activities). A Resettlement Unit is in place.	**none / small positive** resettled people will be at least not worse off than they were before; conditions should improve.	Resettlement Action Plan Monitoring of the resettled people

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Human population	Reservoir (stage 2)	The reservoir area of 170 km² is rather densely populated. Physical displacement has to take place. A total of 77 villages with approximately 42'000 inhabitants will have to be resettled.	**strongly negative** This is considered as a very substantial negative impact of the project.	A resettlement action plan will have to be prepared for the remaining villages (Stage 2). Resettlement plan focuses mainly on physical relocation and livelihood restoration. Resettlement planning will have to be done and implemented in stages, in accordance with the implementation of the technical project, mainly given the long construction time of up to 15 or more years.	**none / small positive** resettled people will be at least not worse off than they were before; conditions should improve.	Resettlement Action Plan (Stage 2) Monitoring of the resettled people
Local Economy	Work force and construction activities, and operation	The project area offers little prospect for economic activities; subsistence agriculture is important for the livelihood of the local population; unemployment rate is very high. Presently, there are two main means of income generation in the project area: • emigration to Russia in search of work; • Employment in Rogun HPP (construction work).	**positive**	Even if the job opportunities are largely limited to the construction period, this is very important given the duration of these activities of about 15 years → Wherever possible, local inhabitants should get preference in job allocation. Problems caused by recent stand-still of construction activities (relegation of a large number of workers due to the agreement of WB with GOT to limit work to the absolutely required maintenance work) needs to be taken into consideration.	**positive** Potential positive impact on the local community (generation of jobs), although limited to construction period.	Socio-Economic Development Plan Contractor's Human Resources Management Plan

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Health	Construction sites / camps, construction activities	Potential negative effect on health (communicable diseases brought from outside by workers)	**small negative / negative**	All workers should attend a work shop on communicable diseases (TBC, etc.). How to get infected, how to recognise symptoms, what should be done and on prevention measures. Every worker has to have the necessary vaccination (Hepatitis A and B, Tetanus, etc.). Overall good housekeeping contributes to maintain hygienic and safe conditions on the construction site. Local population should be allowed to benefit from health infrastructure in construction camp. Install Project Information Centre and prepare a Community Relation Plan and inform the population about the Project. Control activities affecting waters and landscape used for recreation. Develop training and lectures about environmental conservation for the local population (waste education, agricultural education). Development of activities to enable the strengthening of new sources of revenue for the local population. Improve infrastructure in the area directly affected by the project (maintenance of access roads). Speed limits and a safety driving training should be implemented.	**positive** minimisation of transmission of diseases, health protection for the local population and for the work force	Community Relation Management Plan Health and Safety Management Plan Traffic Management Plan → *For detailed information: see also Mitigation Measure Data Sheet No. 2, Public Health (ESIA Main Report Vol. III, Annex A2.1)*
Land use	Reservoir	Land, used for agriculture and pastures, will be submerged. Impact on forest: rather small only on steep slopes.	**small negative / negative**	A re-cultivation program will be developed. The re-cultivation will be carried out with native species. Remaining forest above FSL should be given better protection (neither tree cutting, nor burning of vegetation above final FSL).	**none / small negative**	Watershed Management Plan Re-cultivation Management Plan Resettlement Action Plan

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Fishing	Reservoir	Fish fauna is low (species, quantity). Fish do not have any economic importance for the local population. Therefore only small impacts / chances are expected in terms of establishing commercial fisheries in Rogun reservoir and/or possibly impacts on existing fisheries.	**none / small negative**	Measure of prevention: Avoid water contamination (see water quality measures)	**none** **positive** if fisheries can be developed	Fish Monitoring Program Fish Management and Fisheries Development Plan. *→ For detailed information: see also Mitigation Measure Data Sheet No. 8, Waste Water Management (ESIA Main Report Vol. III, Annex A2.1)*
Cultural Resources (archaeology, culture)	Reservoir	Submersion of up to 170 km² of land, relocation of local population. The area is archaeologically rather important, since it was inhabited at least since the Neolithic period. A number of archaeological sites were related to the silk road passing through this valley.	**small negative / negative** 14 sites of archaeological interest were identified in the project area; most of them were partly or totally destroyed in the past. One site within the reservoir area remains intact and has not been investigated yet.	Two measures of different nature proposed: 1. Excavation of one site, so far not investigated but affected by reservoir impoundment. Archaeological investigation prior to impoundment. 2. Carrying out of a socio-cultural survey of the affected population prior to relocation, in order to document the local (oral) traditions. Chance find procedure to be developed for project related activities outside the construction site (e.g. construction of new roads).	**none** archaeological site excavated and documented **positive** local culture documented	Special plans to be developed: Cultural Heritage Management Plan Chance find procedure
Emergency preparedness	Lower Vakhsh valley, downstream of Nurek to confluence with Pyanj; Amu Darya valley as far d/s as the Aral Sea.	Flood due to exceptionally high inflows; Risk of flood caused by a dam break	**strong negative**	Main measures: engineering; dam designed according to highest safety standards (TEAS). Develop an Emergency Preparedness Plan.	none risk level reduced to acceptable level (TEAS risk assessment).	Emergency Preparedness Plan Technical measures (as defined by TEAS)

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
General construction related issues						
Waste, hazardous waste and storage of hazardous materials	Construction Phase, Operation Phase	Contamination of soil, water, health risk; due to: • Domestic waste (mainly during construction). • Solid waste (mainly during construction and demolition of old structures of Rogun HPP). • Liquid waste (from maintenance of all lorries and construction machinery). • Hazardous waste (can occur during construction time for the maintenance of the Machinery).	**negative**	Develop a waste management system. Install garbage cans for temporary waste disposal of domestic waste. Those have to be collected and disposed according to the regulation of solid waste management and approved by the local authorities. No waste shall be disposed of or buried on the site. Illegal dumping, either at the construction camp, along the roads or in the surrounding areas, or into the river shall not be allowed. Solid waste generated during construction and at campsites will be properly treated and safely disposed of only in demarcated waste disposal sites. In general waste should be reduced, re-used, recycled and the disposal should be controlled. Hazardous waste (oil, chemicals, etc.) has to be stored in a designated closed tank and/or area. Until will be delivered to companies specialised on the proper disposal or recycling of those hazardous wastes. Containers have to be available at the workshops for the disposal of used filters, gaskets and other spare parts. A full cleanup of the site has to be carried out before main construction starts. A full cleanup of the site has to be carried out after construction. All wastes accumulated during construction and all demolishment wastes from temporary structures have to be disposed properly. A continuous monitoring of the proper waste handling by the contractor and by the Owner is indispensable to ensure that problems are identified and addressed early Instruct workforce on appropriate measures to minimize waste. Spill / emergency preparedness plans in case of major accidents (fuel tanks, etc.).	**small negative / none** Appropriate waste handling measures result in minimisation of contamination of the environment and in improved health protection	Waste Management Plan Hazardous Material Management Plan Consturction Site Emergency Preparedness Plan → *For detailed information: see also Mitigation Measure Data Sheet No. 7 Waste Management and No.10 Hazardous Material Management (ESIA Main Report Vol. III, Annex A2.1)*

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Use, transport and storage of explosives	Construction Phase	Accidental explosions with potential negative effect on work force.	**negative**	Take into account the procedures established by the responsible authorities of Tajikistan and/or any international standards accepted by the country. Do not use explosives in areas not authorized for this purpose. Explosive material should be stored in a state of the art storage (solid structure, fire resisted material, ventilation for heat control, electrically grounded, clean and dry, exclusively for explosives) it has to be labelled with the necessary warnings, and needs to be closed and lockable. The storage needs to have an area open surrounding of 10 m and no other combustible material is allowed to be stored in a distance less than 20 meter. Detonators should be stored in a different storage or at least in a different compartment of the storage. Blasting agents should be stored separately from explosives, safety fuses and detonating cords. Only authorised persons should be allowed to store, handle, use and transport explosive material. The authorisation has to be maintained if required by the Tajik legislation and the certificate should be kept on site. For transport of explosives use designated closed containers with insulation. Use separate containers for the detonators. Do not allow people, workers and animals in a distance of less than 500 m of a blasting point. Implement suitable warning system (banners, mobiles, sirens etc.) Activate an auditable alarm 15 minutes before blasting.	**positive** improvement of safety for work force	Explosives Management Plan → *For detailed information: see also Mitigation Measure Data Sheet No. 3, Explosives Management (ESIA Main Report Vol. III, Annex A2.1)*

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Occupational Health and Safety	Mainly Construction Phase and Operation Phase	Work accidents, occupational diseases (skin irritation, noise, etc.)	**negative**	Develop occupational health and safety procedures like to wear protective equipment, proper handling of hazardous substances, etc. All workers have to use the relevant protective equipment (helmet, gloves, goggles, work boots, masks, ear plugs, etc.). All restricted plant facilities have to be labelled with caution signs, especially those with potential risk for workers. All construction areas shall be marked and fenced to avoid accident from unauthorised people. Fence off all areas like excavation pits, quarries etc. to prevent accidents. First aid kits need to be available at the construction site for fast action if an accident occurs. Accessible consultation sheets for review in case of contingency or emergency situations. These should have phone numbers for police, fire fighters, Red Cross, personal supervisor or project leader. Prepare a scheme of the evacuation routes and where the fire extinguishers are located within the plant and place them at conspicuous places. Maintenance of machinery (preventive and corrective; during construction and operation). Provide sufficient potable water. Assign during construction a special area for the food intake. Separate installation areas, for example mechanical workshops etc. from areas that are used by people for temporary housing and recreation; distance should be at least 10 m. Install portable toilets for the disposal of manure generated by the builders in a distance of at least 15 m to the river. They should be regularly maintained and disinfected. The number of latrines is correlated with the number of employees and there should be one toilet for every ten (10) workers. Workshops and camp site must have acceptable conditions of light, ventilation and safety for workers. Label T&D Line poles indicating danger, high voltage.	**positive** reduction of accidents, health protection, appropriate reaction in case an accident happens	Health and Safety Management Plan Construction Site Emergency Preparedness Plan *→ For detailed information: see also Mitigation Measure Data Sheet No. 1, Occupational Health and Safety (ESIA Main Report Vol. III, Annex A2.1)*

Issue	Project component	Impact and significance before mitigation	Importance	Mitigation measures	Remaining impact after mitigation	Related Sub Monitoring and Management Plans (S-MMP)
Occupational Health and Safety	Working at height on structures	Work accidents	**negative**	Numerous measures required (see ESMP), as e.g.: • PPE • training of work force on accident prevention and first aid • specific safety measures depending on risk of work place (e.g. welding, crushing plants, work in heights, work near water).	**positive / small negative** reduction of risk of accidents, appropriate reaction in case an accident happens	Health and Safety Management Plan
Traffic and roads	On site (construction site), off site (transportation routes)	Additional traffic passing through villages. Medium impact on air, work force and population.	**negative**	Adequate signing, warnings and controls have to be implemented like speed limits, roads in use or under construction. Enforce maximum load restriction. All vehicles have to be well maintained. Implement a maintenance program for access roads carried out before winter (cleaning gutters, improvement of the road if necessary, etc.). Develop procedures for parking and on-site traffic movement. Use if feasible project buses to transport workers to the site.	**small negative** reduce risk of accidents and injuries to persons, reduce air emissions (exhaust gas, dust), reduce lubricant and oil losses.	Traffic Management Plan Equipment Maintenance Plan → *For detailed information: see also Mitigation Measure Data Sheet No. 4, Traffic Management Plan (ESIA Main Report Vol. III, Annex A2.1)*

3 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The Environmental and Social Management Plan (ESMP) provides an overall approach for managing and monitoring environment and social issues and describes the institutional framework and resource allocations required to implement the environmental and social management and monitoring plan (ESMMP) for the project.

This chapter of the ESMP Report presents the framework that will be developed for the project and under which the Contractor will be required to operate.

3.1 Legal Framework

Annex 2 of ESIA Vol. II provides a list of the relevant laws on protection of the environment, occupational health and safety.

As international standards for the Rogun HPP, the IFC EH&S Guidelines have been used. The following Table lists the topics which are covered by the IFC Guidelines and the Management Plans which will have to be implemented by Rogun HPP.

Table 2: IFC EHS Guidelines which have been applied for the ESMP

General EHS Guidelines IFC	Management plans to be implemented
1. Environmental	
1.1 Air Emissions and Ambient Air Quality	Air Quality Management plan
1.2 Energy Conservation	
1.3 Wastewater and Ambient Water Quality	Waste Water Management Plan / Water Quality Management Plan
1.4 Water Conservation	
1.5 Hazardous Materials Management	Hazardous Material Management Plan, Explosives Management Plan
1.6 Waste Management	Waste Management Plan, Hazardous Material Management Plan
1.7 Noise	EH&SMMP of the contractor, Equipment Maintenance Management Plan, Explosives Management Plan,
1.8 Contaminated Land	Pollutant Spill Contingency Plan
2. Occupational Health and Safety	EH&SMMP of the contractor
2.1 General Facility Design and Operation	General Construction Site Operation plan
2.2 Communication and Training	Training Management Plan
2.3 Physical Hazards	Emergency preparedness Plan, Explosives Management Plan, part of EH&SMMP of the contractor
2.4 Chemical Hazards	Hazardous Material Management Plan, part of EH&SMMP of the contractor
2.5 Biological Hazards	Not applicable
2.6 Radiological Hazards	Not applicable
2.7 Personal Protective Equipment (PPE)	Part of EH&SMMP of the contractor
2.8 Special Hazard Environments	
2.9 Monitoring	Health and Safety Management Plan, part of EH&SMMP of the contractor
3. Community Health and Safety	Health and Safety Management Plan
3.1 Water Quality and Availability	Water quality Management Plan, Rogun HPP Operation Plan
3.2 Structural Safety of Project Infrastructure	
3.3 Life and Fire Safety (L&FS)	
3.4 Traffic Safety	Traffic Management Plan

3.5 Transport of Hazardous Materials	Hazardous Material Management Plan, Explosives Management Plan
3.6 Disease Prevention	H&S Management Plan, part of EH&SMMP of the contractor
3.7 Emergency Preparedness and Response	Emergency Preparedness and Response Plan
4. Construction and Decommissioning	
4.1 Environment	Additional Plans to the above mentioned are the: Erosion Management Plan Site decontamination plan Re-cultivation management plan
4.2 Occupational Health & Safety	See above
4.3 Community Health & Safety	See above

3.2 Institutional Requirements

Figure 3-1 shows the institutional setup of Rogun HPP within the state organisation and the management units which are in place or which will have to be created to properly implement the construction and operation of Rogun HPP. The most relevant entities are shortly described here.

3.2.1 Resettlement Unit / Directorate of the Flooding Zone in Rogun HPP

The Rogun Resettlement Unit (RU) is also known as the "Directorate of the flooding zone of Rogun HPP". This is a unit which is operating directly under the President's office, and does not belong to a specific ministry; for more details see Stage 1 RAP.

3.2.2 Committee of Environment

The authorized organ for state ecological expertise is the Committee on Environment Protection which has a state ecological expertise department in its structure (see Annex 3 to the Regulation on the Environment Protection Committee adopted by the Resolution of the Government of RT dated April 24, 2008 № 189).

3.2.3 Ministry of Energy

The Ministry of Energy is the public authority responsible for the implementation of unified state policy and regulation of legal ranges in the area of fuel and energy, natural resources, as well as irreplaceable resources of energy. Ministry heads, coordinates and supervises the activity of executive organs, public services of energy control under executive bodies, workshops and institutions of ministerial system. The overall activities of the Ministry, are subordinated to the Constitution of the Republic of Tajikistan, constitutional laws of the RT, laws of the RT, international bills about legal ranges acknowledged by RT, resolutions of Majlisi Milli and Majlisi Namoyandagon of Majlisi Oli of the RT, decrees of the President of the RT and decrees of government of the RT. The activity of Ministry is also connected with other local executive bodies, NGOs and other enterprises.

3.2.4 Barki Tojik

The Open Joint Stock Holding Power Company "BARKI TOJIK" was established by Resolution of the Government of the Republic of Tajikistan dated November 3, 2001 № 492 and reregistered by Resolution of the Government № 537 dated October 31, 2008 and by 01.01.2009.

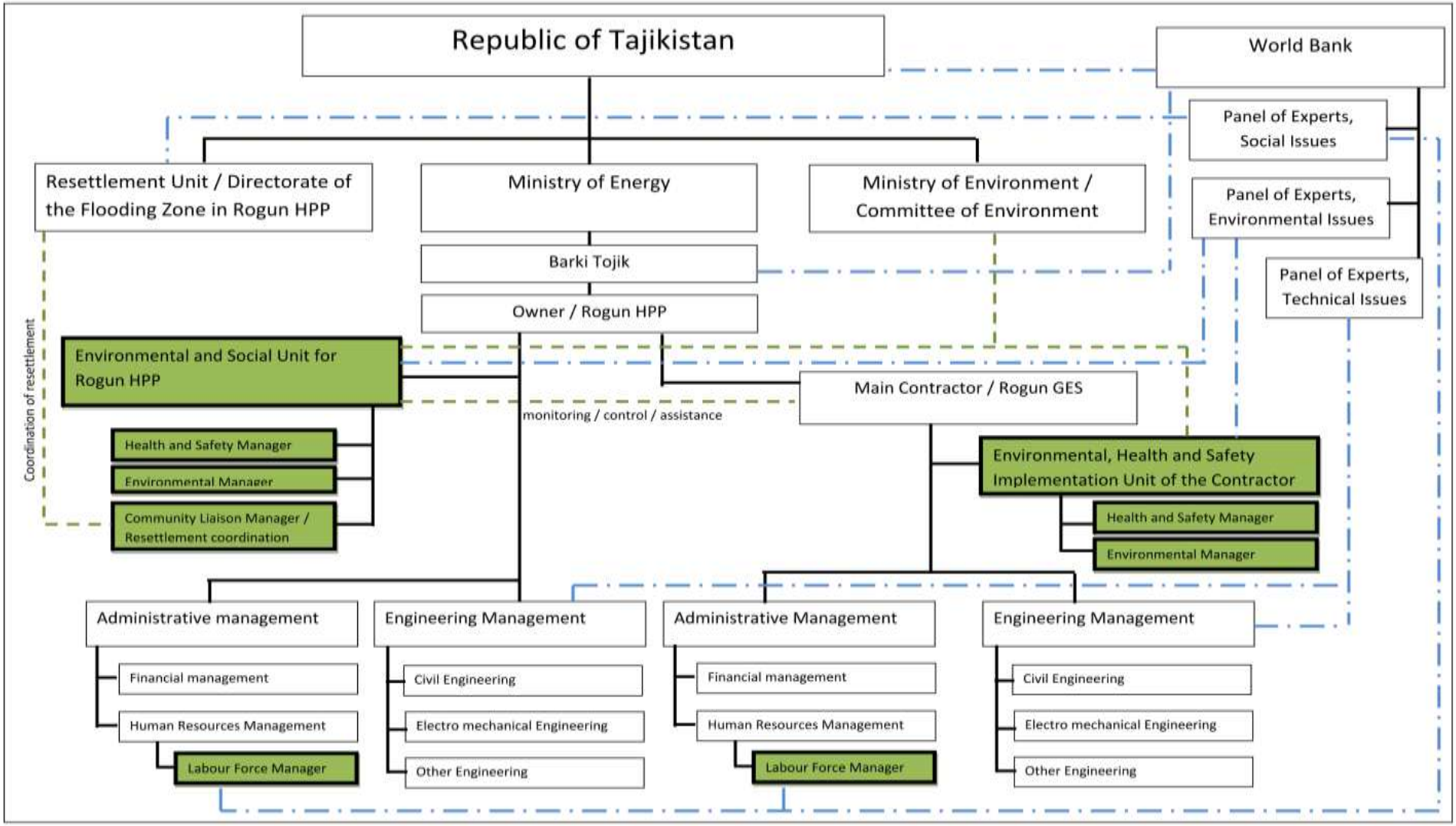

Figure 1: Organigramm of the Institutional requirements of Rogun HPP

3.2.5 Project Owner / Rogun HPP

The Republic of Tajikistan is the Owner and will have the overall responsibility for the project’s compliance with national (Tajikistan) legislation and international lender legislation and guidelines for environmental and social performance,

The Project Owner, i.e. Republic of Tajikistan (Rogun OSC), will have the overall responsibility for the project, for the compliance with national (Tajikistan) legislation, international lenders' standards and guidelines for environmental and social performance, as well as with international treaties which may be applicable (most importantly: Nukus Declaration and Protocol No. 566, which regulate water use in the Amu Darya basin), and for project implementation according to the plans and conditions agreed upon. These conditions, obviously, also contain the requirements for environmental and social management described in this ESMP.

The organisation directly responsible for project implementation on behalf of GOT and BT is the Project Implementation Unit (PU). In order to be able to comply with the requirements as far as environmental management is concerned, the specific capacity and know how must be available. For this purpose PIU will have to put in place an Environmental and Social Unit (ES Unit) containing of a qualified environmental engineer or somebody with a similar background, a qualified health specialist and a public relations manager. Those will be in charge of carrying out the necessary supervisions, control and monitoring work. In addition to those key personnel supporting staff will have to be employed.

The following will be the main duties of this Environmental and Social Unit:

- To review and approve the Contractor's ESMP including the Health and Safety Management Plan and other Sub-ESMPs, as well as labour working conditions concerning compliance with national and international guidelines.
- To check the staff training of the contractors to ensure a continued environmental performance.
- To check regularly the monitoring and progress reports to be provided by the Contractor (and to make sure that these reports are being produced according to schedule).
- To carry out regular inspection visits on the construction site regarding environmental, health and safety.
- To organise and coordinate activities of external monitoring.
- To carry out some direct monitoring works (see owner’s management and monitoring plans, most important: Water quality, erosion activities on the reservoir bank). To this end, the environmental specialist must be provided with a corresponding measuring device.
- The social specialist needs to coordinate construction site issues with the resettlement unit; he will be responsible for any grievance from workers and local population.
- To assist in proposing corrective measures in case non-compliance has been observed with any of the conditions.

- To report immediately to the contractor's as well as to the owner’s management in case a serious non-compliance, which presents considerable risks to the environment and/or to workers' health, has been observed.
- To alert the owner’s and contractor's management immediately in case of an emergency.
- To prepare reports for the attention of the owner’s management and the Lenders (at a frequency to be determined by the Bank; the Environmental Consultant proposes Quarterly Reports).
- To report regularly to the owner’s management on the state of the work and compliance with environmental, social, health and safety rules.

These are full time positions during the entire construction period, and presence on site is required.

3.2.6 Contractor

The contractor will have his own staff for dealing with the requirements of the contract, and specifically for compliance with environmental, health and safety management measures. Therefore the contractor will implement an Environmental, Health and Safety (EH&S) Unit.

The following personnel is required:

- A safety manager: responsible for security (access control to the construction site and for safety on site (availability of all required safety devices, including health protection equipment for workers; marking of restricted areas; control of implementation of these measures, training of the supervision personal, etc.).
- Health specialist: heading the Health Centres, he will be responsible for the coordination of the already existing Health Centres, for the equipment and the responsibilities of the Health Centres. Furthermore, he will be responsible for health and safety statistics (non-compliances with the health and safety manual, near misses, minor accidents without interruption of work, minor accidents with 3 days of leave, accidents with more than 3 days of leave and fatal accidents); for training in first aid and capable of giving instructions to workers, for the proper storage of drugs and for the disposal of medical waste.
- An environmental specialist (environmental engineer or similar). His main duties will be the formulation of detailed environmental management plans as per the Data Sheets, supervision of implementation of all the measures (internal monitoring), participation in implementation of measures, and reporting (preparation of the required monitoring reports).

The contractor will have to include costs for these specialists in his proposal.

Given the size of the construction site, it will be required that these specialists have several assistants (technicians), mainly for carrying out routine supervision and monitoring activities, marking of restricted areas, etc.

3.3 Monitoring

3.3.1 Monitoring Activities

Monitoring of all the environmental protection measures described in the ESMP has to be carried out in the way outlined. The aims of the monitoring are the following:

- To check on compliance with the conditions set forth and standards to be met.
- To inform the relevant authorities (contractor's construction site management, Rogun OSC) on cases of non-compliance observed.
- To propose corrective measures for such cases.
- To check on the success of these measures.

Monitoring, in order to be effective, has to be done at different levels as described shortly below.

3.3.2 Internal Monitoring

3.3.2.1 Contractor's Monitoring

The first level of monitoring has to be carried out by the contractor. This is part of the duty of the personnel described in Section 3.2.6.

3.3.2.2 Equipment

For an efficient monitoring, a number of measuring devices are required, which allow to make fast and precise measures on site at the required places and intervals. The Environmental Consultant proposes to use modern hand-held equipment for this purpose. The following Table provides a list of these devices that seem to be required.

Table 3: Proposed set of monitoring equipment

Recommended Instruments	Unit	Unit cost	USD
IdB Noise Indicator	2	1'000	2'000
Portable Turbidimeter Model 2100P	2	2'000	4'000
Casella Microdust pro Particulate Monitor 176000°	2	1'000	2'000
Dual Channel Handheld Oil in Water Analyser TD 500D, Extended Range & Check POINT solid Calibration Check Standard TD 500D.	2	6'000	12'000
Water Quality Measuring Instruments (for temperature, O_2, pH, conductivity, turbidity).	2	4'000	8'000
Laptop Computer	4	1'500	6'000
Digital camera	4	500	2'000
GPS	4	1'000	4'000
Contingencies		4'000	5'000
Total USD			**45'000**

Note that the prices given here are indicative and depend largely on the type of instrument and optional devices chosen, as e.g. for the Oil in Water Analyser.

3.3.2.3 Monitoring by Rogun HPP

PIU, as the project owner, will need a supervision and monitoring of its own in order to make sure that the contractor keeps to his obligations. This will be one of the main duties of the E&S Unit described shortly under Section 3.2.5.

This monitoring will be done by checking the regular monitoring reports to be provided by the contractor, and by carrying out regular site visits.

3.3.3 External Monitoring

External monitoring is usually required in such projects. This can be done in two - not necessarily mutually exclusive - ways as described below.

3.3.3.1 Institutions

The Committee of Environment will have the following obligations:

- Check the reports received from Rogun HPP; this latter will have to make sure that regular monitoring reports are being delivered to COE.
- Carry out some inspections by its own (as e.g. on the type and condition of vehicles and machines used in the construction; on waste management and waste disposal; and on water quality).

3.3.3.2 External Experts

As a part of its normal procedures, for large Category A project, the World Bank normally uses Panels of Experts for checking on compliance with environmental and social safeguards. Such a POE regularly (usually twice a year) visits and inspects the construction site and reports on its observations.

Such a POE for Rogun HPP is already in place. It will have to be decided whether this will continue its assignment.

Costs for such a POE, obviously, depend very strongly on the person(s) selected for carrying out this assignment, and on the scope of work defined for them. Tentatively, the costs (per site visit, duration including travelling and a short report, for one expert, including international travelling, local transport and per diems) can be estimated at about USD 30’000.00.

3.4 Reporting

Reporting is essential. The following monitoring reports seem required for this project:

- Monthly Progress and Monitoring Report: to be prepared by the Contractor's specialists, providing a (short) statement on all monitoring activities, and on any specific events, as the case may be. Internal reports, to be made available to Rogun HPP (routinely) and Committee of Environment (COE) (at their request).
- Quarterly Reports: to be prepared by the Contractor, summarising all observations of the period. Report for Rogun HPP and COE.

- Quarterly Report by Rogun HPP: based on the contractor's reports and on own activities, for COE and the Lenders.
- Yearly Report: to be prepared by Rogun HPP: based on the contractor's reports and on own activities, for COE and the Lenders.
- Additional reports according to specific conditions. Most importantly: if a POE should be in place, this would have to prepare a short report after every site visit, on behalf of Rogun HPP and the WB.

3.5 Contractual Measures

It has been mentioned that most of the measures, since they are to be implemented during the construction period, will be the obligation of the Contractor. For this it is important that the measures as described here shall be included in the tender documents, and that the potential contractor will have to prepare their proposals taking into account these measures. It will also have to be stated clearly in the tender documents, that non-inclusion of these measures in the proposal will lead to a disqualification of the proponent.

Likewise, the contract with the successful bidder should contain these environmental management measures as firm conditions to be complied with.

WB proposes a series of general contract clauses, which can be included in such contracts. The ones that seem applicable for this Project are provided in Annex 3.1.

3.6 Sub-ESMPs

The Owner will be committed to the creation and implementation of programmes to reduce the probability of occurrence of deleterious environmental incidents. Contingency plans will be developed for dealing with such adverse incidents, if they occur.

The Owner will expect the same level of environmental performance from its contractors, sub-contractors and suppliers and needs to stipulate this in any legally binding agreements it enters with these parties (see Section 3.5).

The Owner should include the following umbrella obligations into the contract of any main and sub-contractors:

"The Contractor shall take all responsible steps to protect the environment (both on and off the site) and to limit damage and nuisance to people and property resulting from pollution, noise and other results of his operation.

The Contractor shall ensure that emissions, surface discharge and effluents from the contractor’s activities shall not exceed the values indicated in the Employer’s requirements, and shall not exceed the values prescribed by applicable laws.

The Contractor shall take all responsible steps to ensure the occupational health and safety of its workforce as well as the security of the public (both on and off the site). The Contractor is obligated to equip its workforce with the required personal protective equipment, to supervise and to train its workforce related to international safety standards (ILO Standards, IFC Performance standards) and to report any incidents to the Client (Rogun OSC). In case of non-compliance it can be considered as breach of contract.

The contractor will have to include these conditions in all the contracts with his subcontractors, and he will be responsible for the compliance of the subcontractors with these conditions.

This Clause shall take precedence over all environmental-related clauses elsewhere in the Contract."

Furthermore, the Contractor will be under contractual obligation to the Owner to implement the aspects of the ESMP that apply to it, and to ensure compliance by its own subcontractors. The Owner and the Contractor will ensure that appropriate corporate resources, personnel and reporting and accountability systems, are in place for the successful implementation of the ESMP. They will, on a continuing basis, review the objectives of the ESMP as well as the company’s success in achieving them. Where objectives are not being achieved, corrective action will be taken. Adjustment may be made to environmental mitigation measures as needed in order to reach compliance with ESMP objectives.

The ESMP is an umbrella plan that is comprised of several components that are to be integrated and implemented by the Owner and the Contractor with regard to the Rogun Hydropower Project. These components are shown in Figure 3-2 below:

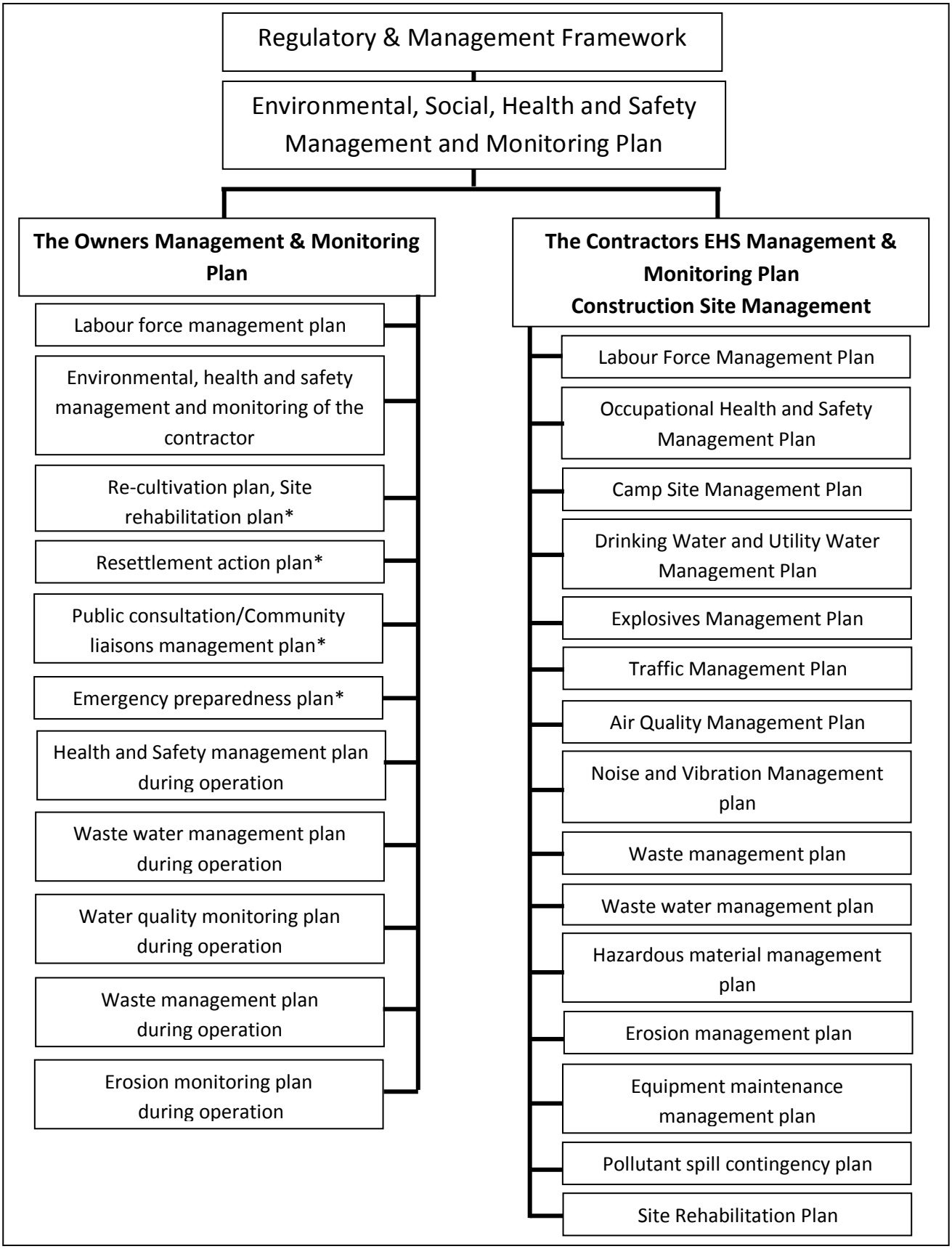

Figure 2: ESMMP and Sub-ESMMPs

* Responsibility that can be allocated to, or shared with, a third party (not necessarily the or one of the construction contractors)

Each Sub-ESMP should include the following:

- The purpose
- Reference and relevant documents (legislation of Tajikistan and other applicable international standards and other documents used)
- Roles and responsibilities
- The management process
    - Emission standards and requirements
    - The project emission sources
    - Prevention and control
- Surveillance
    - Inspections
    - Monitoring (measurements)
    - Reporting
- Actions to be taken in the case of non- compliance
- Awareness and training
- Documentation and communication

An example for Waste Management is given in Annex 3.2.

4 OWNERS MANAGEMENT AND MONITORING PLANS

The owner is committed to monitor the construction site management. Furthermore he has to develop al the management plans related to plant operation and the management plans during construction, which are not in the responsibility of the Contractor.

4.1 Owner's Labour Force Management Plan (OLFMP)

In order to safeguard workers' rights and implement good practice in relation to labour and working conditions, Rogun HPP will implement a Labour Force Management Plan. This will contain the human resource policies and procedures already in place or to be put in place by Rogun HPP in relation to its own staff, and also the commitments it will require of the contractor and its sub-contractors in relation to human resource management and compliance with labour standards during the construction phase.

The Owner's LFMP will contain requirements in relation to policies and procedures on:

- Human resources policy and information provision to workers (on terms and conditions, relevant employment policies and training opportunities) in line with the lender's requirements (IFC Performance Standards 2 and ILO Standards);
- Maintenance of accurate records in relation to each worker's employment covering issues such as payment of wages and social security, and working hours
- Respect for collective agreements and provision of reasonable working conditions and terms of employment;
- Freedom of association and collective bargaining;
- Non-discrimination and equal opportunity;
- Retrenchment;
- Grievance mechanisms;
- Child labour and forced labour - including verification procedures to check employees' age.
- Health and safety;
- Non-employee workers;
- Supply chains; and,
- Labour standards-related ToR for contractor, and subcontractors, including security personnel;
- Local workforce recruitment

The Labour Force Management Plan will also include a Code of Conduct that shall cover main rules of interaction with local communities; rules of conduct in case of conflict situations; emphasizing cultural characteristics of the local communities if migrants from different cultures enter the area. It will also include a grievance mechanism, which will allow the affected communities to express concerns about the conduct of personnel. The grievance mechanism will include a mechanism for assessing the credibility of allegations, investigation of credible allegations of unlawful behaviour, corrective actions and documentation and (where appropriate) reporting of such incidents.

4.2 Environmental Health and Safety Management and Monitoring Plan

In order ensure that the contractor is in compliance with the Environmental, Health and Safety requirements the Owner needs to supervise the activities of the Contractor. The

main responsibilities in relation to supervision of the contractor are already mentioned in Chapter 3.2.5.

4.3 Water Quality Monitoring

It is recommended to choose as a minimum the following three sites for water quality monitoring:

- Upstream of the reservoir; here, it will be sufficient to carry out the monitoring program proposed for being done on a quarterly basis (see below).
- 2 to 5 km upstream of the dam site; it is important that this point is clearly out of reach of any influence of the construction site, since it serves as control. After closing the dam, sampling at approximately the same place should continue to monitor water quality development in the reservoir.
- Downstream of the dam site, below all relevant installations of the construction site; this station will monitor the direct effect of the construction site.

The sampling sites will have to be determined according to the descriptions provided above, but also for ease of access; they must be clearly marked, so that sampling takes place always at the same locations.

The two stations in proximity of the dam will serve as the main control, with two main objectives, namely, (i) detecting whether construction site activities cause any impact on water quality, and (ii) detecting any contamination which might stem from the upstream area and which therefore cannot be blamed on Rogun HPP:

At the two sites near the construction site the following parameters have to be recorded:

- Temperature: in the initial phase, during construction, this will provide information on water temperature in the river under natural conditions. Later on, the changes in temperature due to the presence of the reservoir can be identified and compared with these values.
- DO: dissolved oxygen is one of the most important parameters for water quality, since it provides immediate information on the acceptability of the water as a habitat for fish species, and after the impoundment of the reservoir on the development of water quality in the new lake.
- pH: provides an indication, during the construction phase, on water pollution with concrete. A strong rise in alkalinity due to such pollution can be harmful for fish.
- TSS, total suspended solids: the comparison of up- and downstream values during the construction phase will show the amount of suspended solids caused by construction activities. After reservoir impoundment, and if samples will be taken in its main tributaries, this parameter will allow to see how much of the fine material is being retained in the reservoir.
- HCH (oil and grease): there is a risk of water pollution by hydrocarbons mainly during the construction phase.

During the construction phase, this sampling (two stations) should be carried out at least in weekly intervals; measures can be taken by hand-held equipment, but the best solution would be to have permanent, on-line stations in place for recording a few basic

parameters (t, pH, DO). In addition to the above three sampling sites the contractor needs to monitor the drainage channels leading from the construction site into the river (workshops, batching plant and crushing plant, sewage treatment discharge). This will enable the contractor to localise any contamination to its source and to react fast.

After completion of the filling of the reservoir, it will be sufficient to have a monthly sampling. The monitoring of water quality should be continued into the operation phase for as long as required, i.e. until the water quality in the reservoir has stabilised, and/or until the relevant environmental authority will be satisfied that no additional measures have to be taken.

Other parameters (like Na, K, Ca, Mg, Cl, SO_4, CO_3; BOD, COD, total hardness, conductivity, heavy metals, coliform bacteria etc.), will have to be recorded for having a more complete view of the situation, but are of less direct importance. However, in order to have a good information basis on the pre-project situation, this complete program should be analysed during the construction phase already. These parameters need not be analysed on a weekly or monthly basis, it will be sufficient to have them analysed quarterly, i.e. four times a year. Proposal from qualified laboratories will have to be obtained for the costs of these parameters.

After impoundment, at least one sampling station will have to be inside the reservoir, approximately in the location where the upstream monitoring station was. It will however be required to make sure that this station is a few hundred meters away from the water intake structure. At this station, temperature and DO will have to be measured over the whole water column (in depths of 0, 1, 5, 10 and on the ground) in order to accurately monitor water quality. For the other parameters, it is sufficient to have three samples, one in the epilimnion, a second one just below it (at about 10 m, to be determined) and a third near the ground.

During the whole monitoring period, reports will have to be handed over to the competent authority, quarterly during the construction phase and yearly afterwards. The original data must be kept on file and handed over to the competent authority on request.

4.4 Hydrology Monitoring

Data on hydrology, both during the construction and the operation phase, are important especially for evaluating and monitoring downstream effects. However, since hydrology is an essential part of the hydropower project as such, this type of monitoring will be included in the technical project anyway, and so will be the necessary equipment for monitoring the relevant parameters on a continuous basis (reservoir level, residual flow, amount of water passing through the turbines, flow in Vakhsh river at relevant locations as the main information required). For this reason, this point is not addressed in any more detail here.

4.5 Activities During Operation

Environmental and social impact of the Project during operation will be much reduced as compared to the construction phase. Still, a number of obligations will remain with Rogun HPP, to be continued from the construction phase, to be modified or to be started as new activities:

- HR policy and management, including health provision for staff.

- Good housekeeping: these basic activities, like waste management, waste water treatment, general hygiene, accident prevention etc., need to be continued. Given the small number of employees the plant will have, and the very much reduced activities, this will obviously be on a much smaller scale.
- Good maintenance of all structures.
- Management of oil and lubricants (e.g. transformer oil).
- Hydrological monitoring, including monitoring of the release of the residual flow.
- Water quality monitoring; this was described already.

In case operation should be done by a different entity, PIU will have the obligation to hand over these instructions, and to make sure that all relevant information will be transmitted to the new entity.

The Management plans which will have to be developed for the operation phase are similar to those related to the construction period. A risk assessment should be carried out to identify areas of risk for health and safety as well areas of risk of erosion. Following Management plans will have to be developed:

- Health and Safety Management Plan
- Waste Management Plan
- Waste Water Management Plan
- Erosion Monitoring Plan
- Hydrological Monitoring
- Fish and Fisheries Monitoring.

5 CONSTRUCTION SITE MANAGEMENT

The results of the construction site audit were described in the ESIA Vol. I, Chapter 18. Here, relevant aspects for construction site management are taken up, and measures to be taken for achieving general good housekeeping and a satisfactory standard in EH&S aspects are described.

5.1 Contractor's Labour Force Management Plan (CLFMP)

The contractor will ensure that labour standards (IFC Performance Standards 2 and ILO Standards) are respected during the project, as set out in the contractor's TOR. Under the contractor's LFMP, the contractor will take into account the capacity of sub-contractors to achieve sound labour management in its assessment of potential sub-contractors.

The contractor will ensure a contractual commitment on the part of labour providers to comply with all relevant aspects of Tajik national labour law, including the establishment of formal employment relationships with labourers – ensuring legal protection on form and frequency of pay, working hours.

Under the Contractor's LFMP, the contractor will:

- Commit, where requested, to provide a copy of employment registers and records including details of hours/overtime worked, wages paid and the employment status of workers, both those employed directly and indirectly;
- Assume primary responsibility for day-to-day monitoring of the implementation of labour standards requirements placed by project financiers on the Project Proposer (Rogun HPP) and thereby designate a manager who is responsible for ensuring that labour and health and safety legislation is complied with, both in the direct and indirectly-employed workforce (namely, subcontracted labour);
- Provide or ensure that training is carried out on health and safety issues with regard to all workers, direct and indirectly employed;
- Put in place a mechanism for checking the age of workers (prevention of child labour);
- Carry out risk assessments in relation to all employees who are under the age of 18;
- Put in place a worker grievance mechanism and details of any complaints lodged under the procedure in the last year;
- Undertake to inform Rogun HPP – and thereafter the project financiers – of all serious accidents that take place in relation to the project; and,
- Provide Rogun HPP – and thereafter the project financiers – with sample copies of payslips for direct and sub-contracted workers indicating payment of wages and social security contributions.

5.2 Occupational Health and Safety Management Plan

During the construction phase, the Contractor will be responsible for the prevention of unhealthy or unsafe conditions and practices and for the promotion of healthy and safe working practices at the site. The Contractor will develop an Occupational Health and

Safety Management Plan including emergency response plan and procedure that includes training of workers. The Owner will monitor the compliance of the Contractor with the management plans and Procedures, which have been approved by the Owner.

Important measures were identified during the ESIA and listed in the Measure Data Sheet No. 1 (Annex A2.1). It is strongly recommended to include this sheet in the tender documents, and that the Contractor will have to take these measures into account as firm conditions for his contract. The sheet can be used as a basis for developing the specific Sub-ESMP.

The improvement of safety, health and working conditions depends ultimately upon the people who are working together, whether governments, employers or workers. Safety management involves the functions of planning, identifying problem areas, coordinating, controlling and directing safety activities at the work site, all aimed at the prevention of accidents and ill health. Most people believe wrongly that the word "accident" is synonymous with "injury". This assumes that no accident is of importance unless it results in an injury. Construction managers are obviously concerned with injuries to the workers, but their prime concern should be concerning the dangerous conditions that produced the injury – with the "incident" rather than the "injury". On a construction site there are many more "incidents" than injuries. A dangerous act can be performed hundreds of times before it results in an injury, and it is at eliminating these potential dangers that managers' efforts must be directed. Effective safety management has three main objectives:

- to make the environment safe;
- to make the job safe,
- to make workers safety conscious.

5.2.1 Safety

Safe and healthy working conditions do not happen by chance. Employers need to have a written safety policy for their enterprise setting out the safety and health standards which is their objective to achieve. The policy should name the senior executive who is responsible for seeing that the standards are achieved, and who has authority to allocate responsibilities to management and supervisors at all levels and to see that they are carried out.

A risk assessment will have to be carried out to identify hazards and measures for the prevention of accidents. General principles have to be the conditioning and maintenance of the workplace (good housekeeping); the development of knowledge, experience and training of the work force at all levels, the coordination, organization and management of the work force, duties and responsibilities of supervisors and key workers, that facilities and equipment are appropriate for the work to be performed and that they meet the health and safety standards. Furthermore the policy needs to contain the selection and control of subcontractors and the arrangements for setting up safety committees. Following procedures will have to be developed:

- Training and capability of the workforce
- Investigation of accidents
- Construction and camp site management plan

- Housekeeping at construction site
- Rules for the guards of custody and security of the facilities
- Manual for the use and function of Personal Protection Equipment (PPE)
- Procedures for excavation and excavation support
- Procedures for scaffolding
- Procedures for working in height elevations (prevention of falling down)
- Procedures for welding and cutting torches
- Procedures for working in and near water
- Procedures for working in confined space
- Procedures for the use of hand tools
- Procedures for working with hazardous substances.
- Electrical risks
- Explosives management plan (safety procedures for blasting events)
- Rules and safety procedures for traffic and vehicles at the construction site.

5.2.1.1 Training and Capability of the Workforce

One of the most important measures at a construction site is to implement a continuous training of the workforce to raise the awareness that personal at all levels have a degree of responsibility in relation to environmental, health and safety issues. Therefore it is needed to implement an induction training for each worker and a periodical repetition on general environmental, health and safety issues. In addition to the general EH&S training task specific training modules need to be developed to train the workforce related to their specific activity. Documentation needs to be kept to verify that the workforce has been trained adequate.

5.2.1.2 Investigation of Accidents

All accidents as well as near misses need to be reported and investigated to be able to take corrective actions, to learn and finally to prevent future incidents.

5.2.1.3 Construction and Camp Site Management Plan

Sanitary Facilities

National laws usually prescribe the type, number and standard of sanitary facilities which should be provided, but as a general guide the following should be regarded as a practical minimum:

- a sufficient number of water flush-type lavatories for men when this is practicable, including sufficient urinal accommodation; chemical lavatories may be used otherwise;
- a sufficient number of separate water flush-type lavatories for women when this is practicable; again, chemical lavatories may be an alternative;

- the accommodation should be designed and constructed so as to screen the occupants from view and afford protection against the weather;
- the accommodation should be separate from any mess room or rest-room;
- a smooth and impermeable floor;
- effective natural and/or artificial lighting and ventilation;
- at least 30 m from any well;
- constructed for easy maintenance and cleaned out at least daily.

Lighting

All parts of the site need to be properly lit by natural or artificial means whenever work is going on. Site lighting is always necessary in those areas short of natural light such as shafts and enclosed stairways. Artificial lighting should be placed to avoid deep shadows – these may conceal hazards which would be obvious in good light. Mounting of lights should be as high as practicable to avoid glare, and lights should be placed so that workers do not have to work in their own shadow.

Hot Weather

Workers on construction sites are often exposed to all weathers, radiation from the sun, which increases fatigue from heavy work and causes heat stress which may lead to heat exhaustion and heatstroke, the latter a medical emergency, and to ill health. The effects of heat combined with physical workload tend to accumulate. Therefore it is necessary to provide sufficient resting areas equipped with a roof for shadow and the suitable arrangement of working time is important.

Cold Weather

Cold is not just uncomfortable – it may affect health and judgement. This is a problem especially in winter. workers need to be equipped accordingly, and housing must be adequate.

Child-care Facilities

Working mothers employed at construction sites often need help with the special problems of caring for their children while they are at work.

Children should never be allowed to wander into or play on construction sites. There are excavations to fall into, scaffolding to fall from, hazardous equipment, loose and dangerous building materials, and chemicals lying about.

5.2.1.4 Housekeeping at Construction Site

A badly planned and untidy site is the underlying cause of many accidents resulting from falls of material and collisions between workers and plant or equipment.

A worker can make a major contribution to safe working conditions on site by attention to tidiness. There are many accidents due to tripping, slipping or falling over materials and equipment which have been left lying around, and stepping on nails which have been left projecting from timber.

The objective is to promote an efficient housekeeping management in all work and living places in order to ensure fundamental tidy conditions and the protection of all personnel health.

5.2.1.5 Personal Protective Equipment (PPE)

Standard PPE such as safety helmets, reflectors and appropriate footwear (safety shoes or boots) needs to be used on the whole construction site area, and by all persons on site. The need for other PPE (like goggles, hearing protection, gloves and masks) will depend on the type of work done by the employee. Furthermore, proper work clothes will provide protection for the skin.

It is the contractor's obligation to provide the required PPE, and to enforce its use.

5.2.1.6 Excavation Safety

Most construction work involves excavation for foundations, sewers and underground services. Excavation or trenching work can be highly dangerous and even some of the most experienced workers have been caught by the sudden and unexpected collapse of the unsupported sides of a trench. Buried under a cubic meter of soil a worker is unable to breathe due to pressure on the chest, and quite apart from any physical injury he will quickly suffocate and die, for even this comparatively small amount of soil weighs over 1 ton.

Excavation work involves the removal of soil or a mixture of soil and rock. Water is nearly always present, even if only as moisture in the soil, and heavy rain is a frequent cause of soil slip. The possibility of flooding presents an additional hazard which should always be considered. Cracks are caused by pressure release as soil is removed, or from drying out in hot weather.

Soil varies in its nature (e.g. fine sand which flows easily, and stiff clay which is more cohesive). However, no soil can be relied upon to support its own weight and precautions always need to be taken to prevent the collapse of the sides of an excavation of more than 1.2 m in depth.

5.2.1.7 Scaffolding

Falls of persons from a height, and similarly of materials and objects, represent the most serious safety risk in the construction industry. A high proportion of deaths are caused by falls. Many of the falls are from unsafe working places or from unsafe means of access to working places. This section, and those which follow dealing with ladders and hazardous processes, are aimed at tackling the problem.

Scaffolding can be defined as a temporary structure supporting one or more platforms, which is used either as a workplace or for the storage of materials in the course of any type of construction work, including both maintenance and demolition work.

Where work cannot safely be done from the ground or from the building or structure being worked upon, then there should always be suitable and sufficient scaffolding. This must be properly constructed of sound material which is of adequate strength to provide safe access and a safe place of work.

Scaffolds should be erected, altered or dismantled only by competent persons under supervision. After erection, scaffolds should be inspected at least once a week and a written report on each inspection needs to be kept.

5.2.1.8 Fall Protection (Ladders)

Every year many workers are killed or severely injured while using ladders of all types. Because a ladder is so readily available and inexpensive, its limitations are easily overlooked. So the first question to ask is – can the job be done more safely using other equipment? For example, a proper working platform can often ensure that the job is performed more quickly and efficiently.

5.2.1.9 Welding and Cutting

The welding and cutting of metal, using both the electric arc and oxyacetylene methods, is a process widely used in construction.

Danger from welding is not only to the welder doing the job but also to those working nearby. The risks include eye damage, skin injuries, burns and the inhalation of toxic gases.

Welding in a confined space, the use of some types of welding rod, or welding on certain painted metals may cause an accumulation of toxic gases and fumes. If local ventilation cannot be arranged, the welder should be provided with respiratory protection and a supply of fresh air. Welding carried out on metals covered with alloys of lead, cadmium, mercury or zinc may lead to a build-up of dangerous fumes requiring exhaust ventilation. Fumes may also be produced from paint and plastic on the surface being welded, and they should first be cleaned off.

5.2.1.10 Working Near Water

Procedures for working in and near water will have to be developed, like throwing lines, life buoy, do not work alone near water, training on emergency procedures for the staff, etc.

5.2.1.11 Working Tools and Equipment

Workers must be properly instructed or trained for safely using tools and equipment. These must be well maintained.

5.2.1.12 Hazardous Material Management Plan

A Hazardous Materials Management Programme will be prepared by the Contractor to comply with the relevant IFC Environmental, Health and Safety Guidelines. This will set out the methods for screening the characteristics and threshold quantities of hazardous materials, managing the risks associated with their transportation, storage, use and disposal, keeping safety data sheets at the place where hazardous material is used, stored and disposed of, specific training program for employees concerning H&S, and authorisation for people working with hazardous substances, and for informing the potentially affected community (if relevant). Important categories are the following:

Chemical Substances

Many chemicals are hazardous, with a potential for fire and explosion, or toxic, with an inherent potential to cause poisoning. Toxic substances cause both acute effects, such as dizziness, vomiting and headaches, produced in a short time by exposure to solvents, and chronic effects resulting from exposure over a long period as in lung diseases such as

asbestosis and silicosis. Contact dermatitis may result from the contact between the skin and some chemicals. Acids and alkalis are corrosive and can damage both skin and eyes.

Cement

Cement mixes are a well-known cause of skin disease. Both irritant and allergic contact dermatitis can result from proximity to wet cement. Prolonged exposure to wet cement (for example, by kneeling or standing in it) may cause cement burns or ulceration of the skin.

Asbestos

Breathing in asbestos dust can kill by causing irreversible lung damage and cancer. There is no known cure for asbestos-related diseases. The more asbestos dust breathed in, the greater the risk to health. There are control limits for the various types of asbestos.

5.2.1.13 Explosives Management Plan

The use of explosives shall at all times be in accordance with the relevant regulations. Storage and transport of explosives shall be conducted in accordance with appropriate Tajik and international protocols. Site specific procedures for drilling and blasting, including appropriate safety and adjacent structure stability monitoring protocols should be prepared by the Contractor and approved by the appropriate government. Procedures in relation to security (alarm signals, information of the local population) will have to be implemented.

5.2.1.14 Fire Precautions

Fires on construction sites arise from the misuse of compressed gases and highly flammable liquids, from the ignition of waste material, wood shavings and plastic materials, and from the failure to recognize that adhesives and some floor and wall coatings are highly flammable.

Every individual on site should be aware of the fire risk, and should know the precautions to prevent a fire and the action to be taken if fire does break out. Fire fighting material must be available on all sites.

5.2.1.15 Traffic Management Plan

The underlying cause of most site traffic accidents is the failure to plan a safe system of work and to train workers how to follow it. However, the common immediate causes are one or a combination of the following factors:

- bad driving techniques which include reversing blind;
- poor maintenance of vehicles;
- carelessness or ignorance of special hazards, e.g. overhead power lines or excavations;
- carrying unauthorized passengers;
- overloading or bad loading;
- site congestion,

- poor traffic layout;
- lack of proper roadways combined with uneven ground and debris.

The Contractor will produce a Traffic Management Plan (TMP) which needs to contain appropriate strategies for moving materials and persons to, from and within the construction areas, including abnormal loads. It will also contain provisions for management of connection points between site access roads and the main public roads, and for any upgrading work to be carried out. Specific traffic management measures will include, but not be limited to the following procedures:

- parking and on-site traffic movement, when possible switch off engines when not in use.
- include safety driving procedures (training, enforce use of safety belts, backwards driving signals, etc.)
- training and testing of heavy equipment operators and drivers, including vision tests, with records kept of all trainings;
- the use of any kind of drugs needs to be forbidden and sanctioning needs to be included
- use of buses to transport workers to reduce traffic;
- all vehicles need to be lit front and back and to be properly maintained; maintenance inspection should be carried out periodically;
- enforcement of maximum load restrictions;
- posting and enforcement of speed limits;
- compliance with all relevant applicable laws;
- vehicle safety classes in the affected villages for villagers, in particular pedestrians and bicyclists.

The Traffic Management Plan will also specify the procedures for the monitoring and reporting of the construction-generated traffic movements, and associated environmental problems. As basis for developing the specific Sub-ESMP it is strongly recommended that the Contractor includes the Measure Data Sheet No. 4 (Annex A2.1) as well.

5.2.2 Health

It is recommended that each worker participates in a first aid course and all workers should attend a workshop on communicable diseases (TBC, HIV/AIDS and STDs), covering topics like recognising infection risks, how to recognise symptoms, what should be done in case of an infection, and on the prevention measures.

- Procedures on medical check, first aid, etc.
- Procedures on health service & evacuation in case of an accident
- Procedures on hearing protection, respiratory protection and eye protection are normally already covered by the procedures for PPEs.

5.2.2.1 Procedures on Medical Check and First Aid

Medical Check

Each worker should conduct a general medical check.

Workers who carry out safety-critical tasks need a detailed medical check. Safety critical tasks are for example vehicles and equipment operating on and around construction sites, which can include specialised lifting gear, cranes, lift trucks, heavy goods vehicles, dumpers, specialised vehicles or plant. Activities like scaffolding, tunnelling, working in confined space, steel erection, working at heights, etc.

The focus on health conditions should involve:

- sudden loss of consciousness (e.g. epilepsy, some heart conditions, diabetes (particularly insulin-dependent diabetes));
- impaired awareness or concentration;
- sudden incapacity;
- impaired balance or coordination;
- restricted mobility; and
- impaired vision or hearing.

Detailed medical assessments are confidential to the worker and the occupational health practitioner or general practitioner. However, an employer can reasonably expect the occupational health practitioner to provide a general report about individual fitness.

First Aid

The purpose of this procedure will be to describe the measures to be implemented and facilities to be installed throughout all HEPP sites to ensure efficient first aid assistance at workplaces, as first step for an effective emergency response.

First-aid and rescue equipment should always be available. What is needed will depend on the size of the site and the numbers employed, but there should be at least a stocked first-aid box and a stretcher and blanket – the stretcher should be of a type which can be raised and lowered to and from upper floors. On large sites, and always where more than 200 people are employed, there should be a properly equipped first-aid room or hut.

On any construction site of size, at least one person on every shift should have been trained in first aid to a nationally recognized standard.

5.2.2.2 Health Service and Evacuation

Health services (clinics) must be provided on site, and they need to be appropriately staffed and equipped. This is the responsibility of the main contractor.

It is strongly recommended to include the Measure Data Sheet No. 2 (Annex A2.1), concerning Communicable Diseases, in the tender documents of the Contractor, who will have to take these measures into account as firm conditions for his contract.

An emergency preparedness plan will need to be developed, e.g. for cases of serious accidents or illnesses; this plan will clearly identify the responsible persons including telephone numbers, the next first aid centre and the referral hospital(s) as well as the

evacuation procedures. An agreement will have to be made with referral hospitals. given the size of the site and the number of workers, a minimum of two fully equipped ambulances will have to be on site permanently.

5.3 Environmental Management Plans

General principles are to involve the relevant stakeholders in environmental education and awareness, to verify the compliance with national and international environmental regulations and standards, to strengthen the environmental awareness of the workforce through training, to reduce possible negative impacts by applying proper environmental procedures and practices. Responsible supervisors are in charge of the proper conduct of their workers, equipment and facilities. A positive attitude shall be developed concerning environmental procedures.

The following set of Procedures/Sub-management Plans is proposed (for more details see the Measure Data Sheets provided in Annex A2.1):

- Solid Waste Management and Monitoring Plan (Data Sheet No. 7)
- Waste Water Management Plan and Protection of Natural Streams (Data Sheet No. 8)
- Air Quality Management and Monitoring Plan (Data Sheet No. 5)
- Noise and Vibration Management and Monitoring Plan (Data Sheet No. 6)
- Hazardous Material Management and Monitoring Plan (Data Sheet No. 10)
- Erosion Protection Management and Monitoring Plan (Data Sheet No. 9)
- Equipment Maintenance Management Plan (Data Sheet No. 11)
- Pollutant Spill Contingency Plan (Data Sheet No. 12)

5.3.1 Solid Waste Management Systems

Proper waste management has short and long term benefits to community health, quality of life and environmental protection. It also enables anticipation of associated problems and their mitigation. It is therefore essential to develop efficient management practices because of risks such as the following:

- Uncontrolled burning of waste pollutes the atmosphere, produces poisonous gases and can cause injuries if e.g. pressurized empty cans explode.
- Uncontrolled burying of waste can pollute the ground and surface water.
- Uncollected piles of waste attract animals and insects which are harmful and can spread diseases. Sharp objects like needles, broken glass and blades, and other dangerous (hazardous) waste might be present in waste piles and may harm human scavengers, in particular children, and animals. Piles of waste are unsightly, they emit odour and make people nearby feel uncomfortable generally reducing the aesthetic value of the environment. It also blocks drains, leading to flooding and blocked access routes.

Therefore, good practice in waste management is very important in order to avoid these risks to our health and the environment community lives in.

The objectives of a waste management system are to ensure a safe and clean living environment, protecting loss of life and property and ultimately mitigating adverse impacts on the natural environment. This is achieved through systematic planning, implementation and monitoring of minimizing, storing, collecting, recycling and disposal of refuse.

Solid waste can broadly be categorized into two groups namely hazardous waste and non-hazardous waste. On the other side, liquid waste can be categorized into two groups as domestic wastewater and industrial wastewater.

Hazardous waste which can be generated by industries, hospitals/medical centres and other sources should be handled and disposed of by specialists who are specifically trained for that purpose. Normal waste collectors should however be trained to at least differentiate and/or identify hazardous waste and take steps to report them with urgency. Figure 4-1 below illustrates classes of hazardous waste and non-hazardous waste.

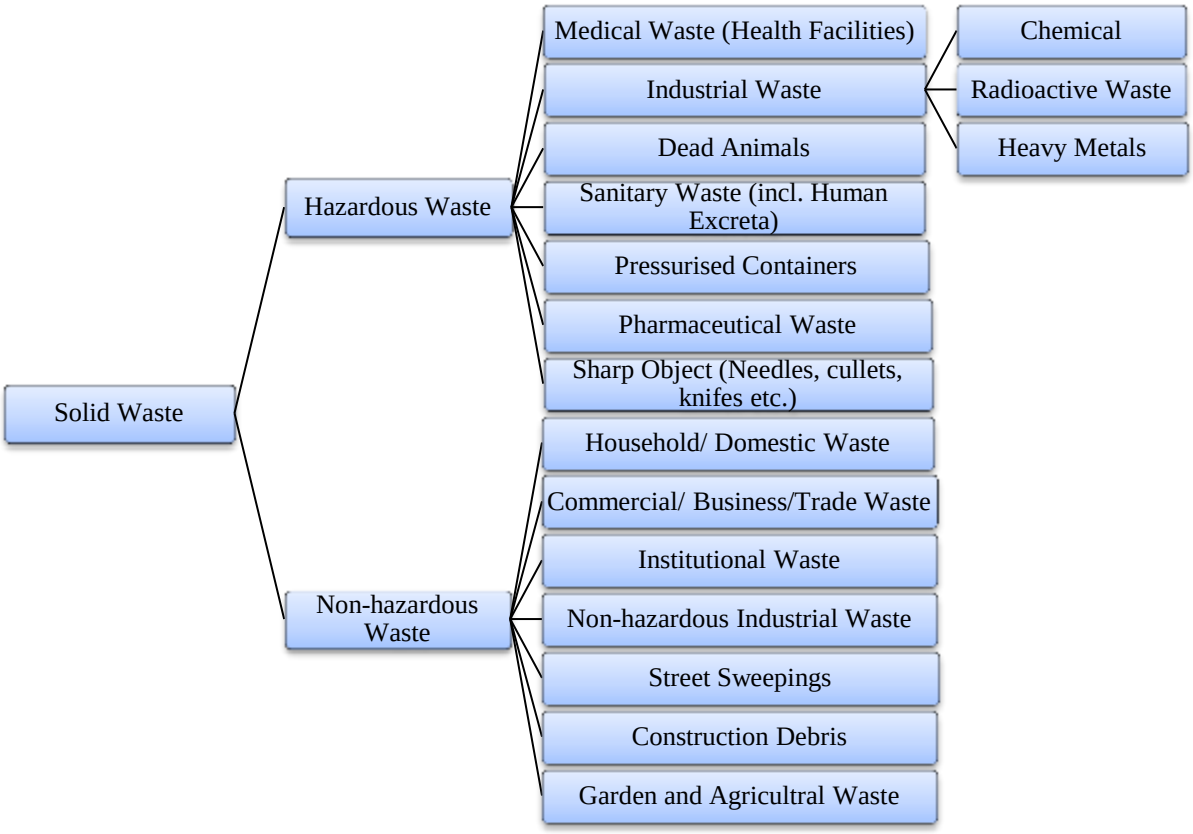

Figure 3: Solid waste types

Source ILO

In order to prepare a solid waste management system (e.g. collecting, reuse, recycling, and disposal) in Rogun HPP construction site some general statistical information on domestic solid waste generation is needed. Furthermore, hazardous waste stream data should be recorded in Rogun HPP construction site via designated personnel. For planning purposes and depending on the location, household it can be assumed that waste is generated at a rate of 0.25 kg/person-day in low income areas to 1.0 kg/person-

day in high income areas. The volume generated can vary from 0.4 litres/person-day in very poor rural communities to 10 litres/person-day in very affluent communities. Table 4-1 gives indicative waste generation rates for various conditions. It should be noted that the data given below are not particular for Tajikistan:

Table 4: Typical waste generation rates

Land use	Generation rates kg/person-day		
	Low-income country	Middle-income country	High-income country
Mixed urban waste – large city	0.50 to 0.75	0.55 to 1.1	0.75 to 2.2
Mixed urban waste – small to medium city	0.35 to 0.65	0.45 to 0.75	0.65 to 1.5
Residential waste only	0.25 to 0.45	0.35 to 0.65	0.55 to 1.0

Source: Word Bank

5.3.2 Wastewater Management System

Wastewater means waste principally consisting of water, and includes wash down water, cooling water, effluent, irrigation runoff and contaminated stormwater;

Wastewater management system means a system designed and operated for the purpose of collecting and managing wastewater so as to minimise any adverse impacts of the wastewater on the environment. Wastewater can be classified into two categories namely:

- Domestic wastewater means wastewater from residential settlements and services which originates predominantly from the human metabolism and from household activities;
- Industrial wastewater means any waste water which is discharged from premises used for carrying on any trade or industry, other than domestic waste water and run-off rain water;

Any type of wastewater should be subject to a treatment process before it is discharged to the environment. The treatment process is identified according to the content of wastewater. In Rogun HPP construction site three main types of wastewater are generated. These are domestic wastewater, wastewater generated from concrete batching works and wastewater generated by aggregate washing.

Key elements of wastewater treatment:

- Pre-treatment is the removal of sand and fat using mechanical processes such as screening, sedimentation or flotation
- Primary treatment is the removal of suspended solids by passing wastewater through a settlement process in flotation tanks
- Secondary treatment is a biological treatment.
- Tertiary (more advanced treatment) involves removal of phosphorus and nitrogen.

5.3.3 Drinking and Utility Water Quality Management

Clean and permanent water supply is extremely substantial in the construction site. The clean water is needed mainly for following household needs:

- Drinking water
- Showering
- Washing dirty cutleries, tableware
- Laundry
- Cleaning/washing surfaces
- Flushing toilets etc.

The water is also used for other purposes, such as irrigation and dust suppression. The water quality for these usages does not have to be as high as for the household water quality.

Water demand per capita is not been identified for Tajikistan. The Table 4-2 below is a summary of unit rates developed in South Africa.

Table 5: Water demand per capita in South Africa

Description	Unit	Typical Consumption	Range
Standpipe (200 m walking distance)	l/cap*d	25	10 - 50
Yard connection	l/cap*d	55	50 - 100
With dry sanitation			30 - 60
With Low Flow on site Sanitation Systems (LOFLOS)			45 - 75
With full-flush sanitation			60 - 100
House Connection (Developed Areas)	l/cap*d		60 - 475
Development Level: Moderate		80	48 - 98
Moderate to high		130	80 - 145
High		250	130 - 280
Very high		450	260 - 480

Source: CSIR

National Standards for Drinking Water Quality

Drinking water standard in line with the national regulation is provided in Table 4-3. The limits are extracted from GOST 2874 – 82 State Drinking Water Standards.

Table 6: Drinking Water Quality Standards

Parameters	**Unit**	**Limits**
Turbidity	mg/l	up to1.5
Colour	NA	NA
Odour and taste	NA	NA
pH		6.5 – 8.5
Hardness	mg-equivalent/l	7
Fluorine	mg/l	0.7 – 1.5
Ferrous	mg/l	up to 0.3
Nitrates	mg/l	up to 10
Total Bacteria Count (TBC)	CFU/ml*	100
Coli – index	NA	up to 3
Coli – titre	NA	max 100

Source: GOST 2874 – 82

5.3.4 Air Quality Management Plan

The Contractor will produce an Air Quality Management Plan. Air quality and equipment maintenance are strongly related; good equipment maintenance will prevent high emissions (see Equipment Maintenance Management Plan). Furthermore procedures like road sprinkling, energy efficient driving training, good housekeeping, etc. need to be implemented. Daily inspections and instrumental monitoring outside the construction site (e.g. Rogun town) will have to be carried out.

Confined spaces (tunnels, workshops, caverns etc.) will need special attention and mechanism will be implemented to guarantee good ventilation. In this respect, present conditions, especially for underground work on Rogun site, are not satisfactory.

5.3.5 Noise and Vibration

Excessive exposure to loud noise can cause permanent damage to hearing. Hearing protection will be required for work in especially noisy places, e.g. crushing plants. Machines, including vehicles, will have to be maintained in a way as to stay within legal noise limits. This will have to be monitored.

5.3.6 Erosion Management Plan

The Contractor will develop procedures to minimize erosion caused by construction activities. Sensitive areas need to be identified, and avoided if possible. If work has to be carried out in such sensitive places, state of the art techniques have to be used to reduce erosion were possible (implement drainage channels, slope properly, compact, if necessary stabilize, start re-cultivation as soon as possible). Areas sensible to erosion should be monitored.

5.3.7 Pollutant Spill Contingency Plan

The Contractor's Pollutant Spill Contingency Plan, will outline the procedures for proper handling of potential pollutants and procedures to be carried out in the event of a

pollutant spill. It will also specify equipment procurement and training of construction personnel. The most important pollution mitigation measures are shown below:

- Prohibition of dumping of any contaminating material product into the environment (including oil, waste oils).
- Storage and routine handling of fuels, lubricants, and other contaminating substances in workshops with sealed floor and equipped with a drainage system with oil skimmer.
- Storage areas shall be designed such that they will contain 110% of the largest container/vessel stored in the storage area; suitable clean-up equipment and material needs to be on site.
- All wastes recovered during cleanup operations to be collected and stored for subsequent disposal.
- Supply agreement will include responsibility for supplier to take waste oil,
- The Contractor will verify each supply/disposal subcontractor(s) has adequate arrangements or facilities for proper disposal, treatment or recycling of these waste.
- Personnel will be educated on proper use and disposal of hazardous materials.

5.4 Equipment Maintenance Management Plan

The Contractor will produce an Equipment Maintenance Management Plan which needs to contain the processes for the maintenance of the different construction equipment used on-site and off-site, maintenance protocols should be developed for the different equipment, machine and vehicle types, the periodicity in which the maintenance inspections needs to be carried out for the different equipment, machines and vehicles types needs to be determined. Furthermore the Contractor will set up procedures to take worn out or unsafe equipment out of operation until it has been repaired and is in compliance with the safety standards.

All maintenance protocols needs to be kept on the construction site.

5.4.1 Site Rehabilitation Plan

All areas used temporarily and/or interfered with by construction activities will have to be rehabilitated to a natural appearance by landscaping, top soil spreading, grassing and planting of trees, as appropriate.

The Contractor’s (including Sub-contractor’s) temporary facilities, including batching and crushing plants, crane foundations, workshops, offices and other buildings will be removed from site as far as they are not submerged by the reservoir. All contaminated areas within the future reservoir area will have to be cleaned. The contaminated soil has to be excavated and disposed of properly.

Given the size of the construction site for Rogun HPP, the fact that work has been under way for a number of years already, and the generally high erosion risk within this area, site rehabilitation is being dealt with in the following chapter.

6 SITE REHABILITATION PLAN

6.1 Approach

A number of plans were prepared related to site management and rehabilitation. They are provided in Annex 6.1 (Figures 17-23).

To prepare the site rehabilitation plan, in a first step, the prevailing situation was mapped during a site visit. This present situation at the construction site (Figure 17), including e.g. all access roads and quarries/gravel pits, was described to:

- get an overview over all the ongoing construction activities on the basis of a topographical map;
- get an idea on the dimensions the site rehabilitation has to cope with.

In addition, for the dam site and its immediate surroundings, on the basis of a satellite picture a map was prepared (Figure 18), in order to:

- differentiate between areas that will be submerged or stay outside the future reservoir (stages 1 and 2). Site rehabilitation will have to concentrate on areas not submerged, clean-up on submerged as well as on not submerged areas.
- understand the functions of the future dam and power plant.

For this purpose, the data gathered by GPS and a few maps prepared by Hydropower Moscow were used.

With the focus on erosion control, an analysis of the current situation (Figure 19) was carried out in order to:

- limit and clarify the area for possible measures for erosion control
- get some figures on the area for possible measures.

In order to coordinate site repair works with necessary clean-up, a map with suspected contaminations (Figure 20) was prepared. Independently from the site preparation, further investigations on these possibly polluted sites will have to be carried out, and site clean-up will have to be done in the future reservoir as well as in the not submerged areas.

After the mapping of the prevailing situation, in a second step the area was analysed in relation to:

- future infrastructure (e.g. roads, buildings, above ground components of the power plant, entrances to different subterranean parts of the plant, transformers)
- possible future uses of the affected areas.

Finally a series of maps were prepared to indicate, what measures on what place and in what stage are recommended to accomplish. The following maps are part of the site rehabilitation planning:

- Measures for erosion control (Figure 21)
- Cleanup of contamination (Figure 22)
- Site rehabilitation (Figure 23).

It should be noted that the title of this Chapter, Site Rehabilitation, should not lead to the misconception that in this respect nothing will have to be done until the end of the construction period. It is very important, especially concerning erosion control and waste management (including prevention of soil contamination), that such types of work as described here should be carried out on a continuous basis: as soon as a site will no longer be used, it should immediately be rehabilitated in order to reduce or prevent erosion. All structures no longer needed should immediately be dismantled, the material recycled or disposed of according to standards, and the site, if required, cleaned and rehabilitated.

6.2 Prevailing situation

The prevailing situation in and around Rogun can be described from the point of view of scenic landscapes, arable land and livelihood of the local people as follows.

6.2.1 Construction Site

The construction site together with all necessary installations to build the power plant (e.g. concrete plants, workshops) and its different parts is rather large and covers an area of about 20 km^2. Some roads, built to connect the site with the main road M41 and the village of Obi Garm measure up to 15 km. These elements dominate the complete surrounding of Rogun already for a number of years, probably since construction works started in the 1980ies.

Along with the technical installations the handling of the filling material (open pits, quarries, storage of gravel/rock) as well as the long stretch of hauling roads are responsible for the consumption of the vast area. The handling of the filling material stretches out up to 7 km upstream from the future dam. Remarkable is the fact, that technical installations like concrete plants and workshops are spread all over the site. A broken down conveyor belt of about 7.8 km long is leading from the open pits and gravel storage areas to the future dam. Parts of the belt lead through tunnels. At present, the conveyor belt is out of operation due to landslides. To handle the large amount of filling, this conveyor will have to be refurbished.

The site of the dam itself is defined by the Vakhsh River gorge and its steep rock walls. A system of tunnels, bridges and subsurface structures allows to access the gorge and the site of the future dam. Downstream of the dam site, the gorge opens again to accommodate more gravel pits and a quarry.

There are some settlements within or close to the construction site, surrounded by hauling roads, stockpiles and other construction site structures. Mostly, access to these villages takes place across the site, forcing pedestrians to interfere with the heavy traffic on the roads.

On a ridge opposite to Rogun an existing but out of operation sewage treatment plant is being refurbished. The plant is placed in an old quarry, using the platform that originated on the bottom of the quarry. A future bridge, carrying sewer tubes, will lead from the village across an arm of the reservoir to the plant.

In a distance of 2-3 km to Rogun a group of abandoned workshops and a substation are placed on the back of the next hill (one building is in use by the army). These structures plus the access road and a road to the future sewage treatment plant influence the

appearance of the landscape in a negative way, since every visitor of Rogun has to come past these remains.

Taking all installations together, a large amount of land is occupied.

6.2.2 Erosion problems

Here, only erosion which occurs on the surface will be discussed. Not part of this section are the more dangerous and larger scale landslides (Section 6.2.3) that occur under specific sub-surface conditions. Erosion generally is a natural process - although often triggered or exacerbated by human activities - due to gravity and in the Rogun region normally caused by water flow in different forms. Other forms of erosion like wind-erosion play a minor role in this case.

Although the region of Rogun dam is subject to strong natural erosion, the actual amount of naked slopes and traces of erosion is enormous. In the drawing (Figure 19) all major patches of erosion are shown and split into three categories, depending on their origin. From this drawing, the following numbers give an idea about the erosion problems the project has to cope with. The largest category of about 3.2 km^2 is formed by naturally occurring erosion, mainly along Vakhsh river and creeks. The second category of about 2.2 km^2 is formed by erosion that is induced by human activities like road construction and landfill. The third category of about 0.8 km^2 is formed by a composition of these two other categories, including natural as well as human induced factors.

6.2.2.1 Natural Erosion Caused by Rivers and Creeks:

The Vakhsh River and its tributaries are basically steep watercourses in a mountain region and as such responsible for the movement of till (rock, gravel and sand). Due to this general geological situation, erosion is predominant above sedimentation. Sedimentation can be locally observed but will vanish on the long run as a temporary phenomenon. The mechanism works as follows: in a first step, the watercourse is deepening its river bed. The foot of the adjacent bank is brought down also and due to this, the slope is getting to steep and instable. Once the lower part starts moving downward, sooner or later the whole slope will follow until the entire riverbank has regained a stable angle. The adjustment of the angle starts on the foot and moves upward to the top. The stable angle is given by the characteristics of the soil.

6.2.2.2 Erosion Caused by Human Activities:

The most heavy erosion can be observed under conditions where from a flank of a hill a large amount of runoff water can accumulate before arriving on a man-made slope. Strong erosion can also take place on slopes missing a vegetation cover. On artificially formed slopes often the natural soil structure is disturbed or absent and plant roots that would otherwise hold the soil in place are removed.

In Rogun, mostly roads are responsible for increased rates of erosion because, in addition to removing the ground cover, the roads change drainage patterns and the slopes are too steep. Some retaining walls made of prefab concrete parts do exist. On most road cuttings and embankments, the drainage work is not done in a proper way, successful planting and seeding cannot be observed. Runoff water is forming gullies.

Since the road alignment was not selected according to topography, on several places such roads were interrupted. This can be:

- dropping of roadway (concrete slabs slipped downward),
- collapse of walls (prefab concrete elements broken down, mud is covering road and concrete elements),
- covering of road due to man-made landslide (fast process),
- constant covering of road by erosion and sedimentation on roadway and drainage system (slow process).

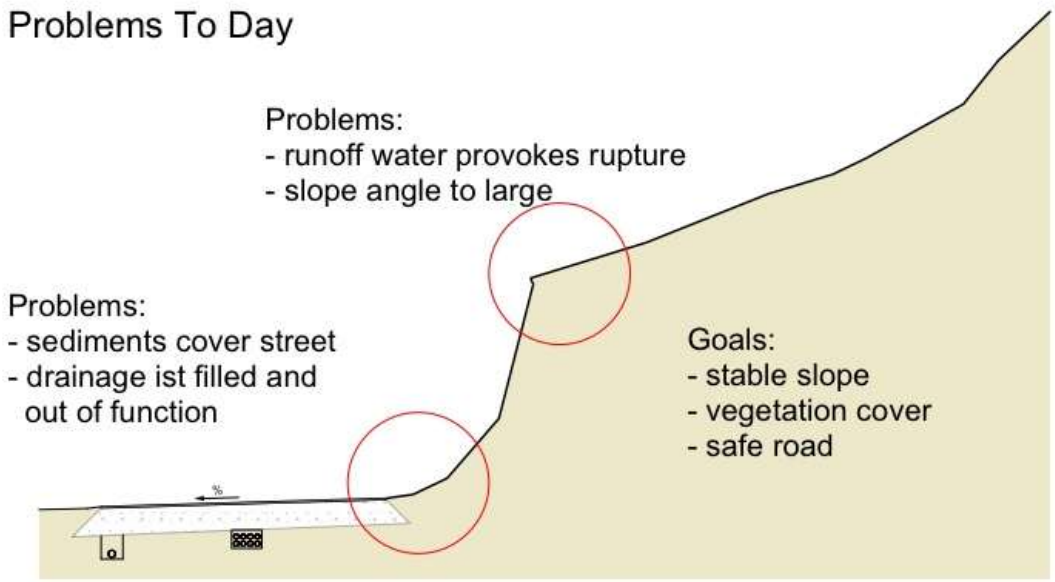

Figure 4: Typical situation along existing roads

6.2.2.3 Natural Erosion Accelerated by Human Activities:

Two ways of negative influence by human activities could be observed:

1. In the first place the intensive and continuous overgrazing of all meadows and pastures has a strong negative effect by accelerating erosion. This is a major problem for the whole watershed of the Vakhsh River.

   The land is heavily used because the land resources in the area of Rogun are limited and because the owners of the animals underestimate the consequences of the wrong usage of land. The Consultant could not observe any form of fertilizing or usage of manure on the pastures. Possibly, the dung is used as a fuel source out of lack of fuel wood. The overgrazing leads to a degradation of the soil, this process is accelerated by water erosion on the sparsely covered slopes. In addition, the growth of the vegetation is limited by cold winters and long dry summers.

2. The exploitation of boulders and gravel in rivers and creeks is accelerating the deepening of these river beds. The deepening on the spot where the gravel and

stones are removed has an effect in the upstream direction (regressive erosion) as well as downstream. Natural erosion, as described before, is intensified.

6.2.3 Landslides

Landslides in the areas located between Chorsada and Nurobod, and near the confluence of Surkhob and Obihingou rivers (both on the right bank of the river) present a risk for the settlements which are located nearby. This will have to be studied in more detail during future stages of project development. Therefore, it is recommended to install a monitoring system in these two areas. The costs for such a system are included in the TEAS study, and details will be studied in the detailed design phase.

6.2.4 Contamination

Within the borders of the whole site a variety of visible, suspected or possible contaminations do exist. A map (Figure 20) differentiates three groups of contamination:

- Possibly contaminated sites like dumpsites, installations and building sites
- Visible waste, landfills, dump sites
- Installations and technical equipment causing possible contamination.

Table 7: Types of contaminated or possibly contaminated sites

Category	Notes	Kind of contamination
Possibly contaminated sites	Widespread over different parts of the site Partly hidden (covered with clean material or vegetation) Partly from long ago (1970-2000) No documentation existing and available Piping, wiring, lines across different parts of the site (welding, coating)	No separation of waste A wide range is possible (from inconvenient sludge to hazardous waste) Oil, heavy metals, PAH (polycyclic aromatic hydrocarbons) Anti-rust protection (polychlorinated biphenyls PCB, heavy metals; note; no former use of PCBs was confirmed)
Visible waste, landfills, dump sites	Discharge of waste water from workshops, concrete factories etc. Heaps of rubble widespread over different parts of the site	Rubble (stones, concrete, mud) Waste materials (tyres, waste wood, synthetic material, urban waste, broken tubes, abandoned machines) Slag from smelter Calcium carbonate from cement
Installations and technical equipment		
• Electrical transformers and substations	high tension lines and pylons temporarily placed transformers close to every installation transformers	anti-rust protection (PCB, heavy metals) Insulating oil
• Concrete plants, cement silos	Rinsing of plants and equipment takes place without collection of waste water	Calcium carbonate from cement Additives for concrete, shotcrete etc. Packaging Lubricants

• Processing gravel (breakers)	Heavy crushers and sieves, not state of the art, sometimes in poor condition Widespread over different parts of the site	Lubricants
• Metal smelter	Running during summertime, when Nurek power plant can deliver electricity Possibly no filters for exhaust To small capacity for all scrap metal in Rogun Possibly no control of metal regarding radioactive contamination	Heavy metals Slag of unknown quality Used filters and/or dust (dioxin) Elevated radioactivity
• Housing of staff	Accommodation, Restaurants/Café, Ambulance, Offices etc.	Waste water Urban waste
• Filling stations	Paved or partly paved Discharge not controlled, no cover against rainfall No recovering of vapour	Diesel, gasoline, oil and lubricants
• Workshops	Maintenance of all equipment (from simple oil change to backfitting) Production of iron parts for the power station	Waste water, sewage sludge Fuel, oil and lubricants Used tyres, scrap iron, empty barrels Packaging

The map does not provide any information about scrap metal and abandoned machines, because these are spread all over the construction site. There is also no information about facilities for the treatment of waste and wastewater because no such facilities where shown or found during the visit.

6.2.5 Future Dam

The map (Figure 18) shows that a lesser part of the site will be submerged in Stage 1 and an important part of the site at Stage 2. Still, some important areas will remain outside the future reservoir. The most important part is situated close to Rogun around the Settlement Pasim Ukhrakha (Пасимухраха). Another important area is placed downstream of the dam on the left bank (Settlement Розе Мурое).

6.3 Impacts

The impacts which can be expected are already known, due to the long lasting of the construction site. Generally, the observed and above described impacts in terms of erosion problems and site contamination will increase/intensify or dislocate and concentrate on the parts that will remain outside of the future reservoir.

6.3.1 Impact of construction

6.3.1.1 Waste

For the construction of both stages of the dam as well as for the underground power station, a high number of additional workers will be needed (number unknown). In

spring 2011, the construction of a group of buildings for the housing of staff members was under way. The pressure on available land will increase, while solutions for as example sewage water problems are not in view. It is to fear, that for different types of waste, no sustainable disposal procedures do exist till then. Main categories of waste, waiting for solutions:

- Waste water from processing gravel.
- Waste water and waste from handling of concrete.
- Scrap from workshops and housing (used tyres, used oil, packaging, urban waste; medical waste from health centres on site).

6.3.1.2 Erosion Caused by Human Activities

Due to the construction of more workshops for machinery and equipment, more access roads to the dam site etc. the erosion caused by humans will probably increase. This has not necessarily to be so, if the constructing activities are managed in an environmentally sound way. For that reason, implementation of the environmental management plan should start before the intensive construction phase starts.

While constructing the following **roads**, new erosion problems should be avoided:

- temporary access road from construction site to dam site, above level of reservoir Stage 1, right river bank (1 km)
- road from dam crest level to foot of dam d/s, on right bank (1.5 km)
- road from dam crest to left bank, connecting all settlements on left bank, above reservoir Stage 2 (ca. 65 km)
- road from dam crest to foot of dam on left bank (2.5 km).

All new roads (and landfills) should be fitted into the pre-existing topography more carefully. If these new roads are built in the same way the existing roads were built, the impacts on the landscape, agricultural land and the riverbeds / reservoir could be severe. The maintenance of slopes, culverts, bridges, roadways and drainage systems will be very costly and a never ending task.

It is not known if and where new **quarries** and open **pits** might be opened or whether existing ones will continue to be exploited. Although there is no information about it, it will be necessary to start **landfills** outside of the future reservoir to handle waste coming from the construction or dump sites. Anyway, every new activity around quarries, pits, dumps and landfills has to be done in a way to avoid new problems with erosion, landslide and contaminations.

6.3.1.3 Natural Erosion Accelerated by Human Activities:

Together with the construction of roads, a lot of creeks will be touched by the building of bridges / abutments. Here again, the aim should be to avoid accelerated erosion due to incorrect handling of the river bed or banks.

6.3.2 Impact of Phase 1

6.3.2.1 Construction Site

Stage 1 reservoir will cover approximately an area of 13 km^2, much less than the existing constriction site of 20 km^2.

It is recommended that prior to the start of the impoundment the area of the future reservoir will undergo a strict decontamination as a preparation for submersion. Failure to do so could result in pollution of the reservoir and Vakhsh river with soluble substances. Required measures are described here shortly.

The existing dump site along the river Vakhsh (right bank) between the tributaries Obi Garm river and Obiuuchokh will be submerged. The responsible site managers have to identify new dumping sites outside of the future reservoir (Stages 1 and 2). These dumps should be able to collect the following materials:

- Waste and contaminated material from old dumps. An inventory of all scrap and hazardous waste has to include quantities, categories, disposal pathways and recyclability.
- New waste coming from the ongoing construction activities.

A number of internal construction site roads will be submerged at this early stage. Where replacement is required, efforts should be made to avoid or minimise erosion.

6.3.2.2 Contamination

While the existing - and partially rather old - dump site creates a problem because of its dimensions, the unknown history and the unknown contents of the metal smelter presents a particular challenge because of its potential hazard. The smelter has to be dismantled before impoundment. There is a risk of problems due to heavy metals (like Cu, Pb, Zn, Cd, As, Ni, Sn, Sb, Al) and possibly also cyanide (CN) for the following reasons:

- The surroundings of the smelter are probably contaminated by air / exhaust gases.
- The way the slug is treated or deposited is not known.
- The smelter is a partly open structure and is/was certainly not equipped with a filter system. Still, if this had been the case there would be the question of what happened with the filter dust or filters.
- Casting moulds or remains of these moulds (e.g. sand), depending on the kind of casting. If simple forming of blocks: less problems (only heavy metal); if casting of work pieces or metallurgical treatment: more contamination (binding agents, detergents etc.)

Especially the ground water and the reservoir / river Vakhsh are in peril by dissolved forms of these metals.

The smelter runs only in summertime, when Nurek HPP produces enough electricity and/or the available electricity is not used to heat houses and light settlements. Because of the reduced running time and the small capacity of the smelter, a lot of scrap metal is laying around within the construction site and will probably not be processed before the

filling of reservoir Stage 1. A solution has to be found for the smelter as well as for the scrap metal. This should include

- avoidance of new contamination caused by the running of the smelter
- better information about and treatment of existing contamination
- definition of an efficient pathway for the handling of existing and oncoming scrap metal.

6.3.3 Impacts of Phase 2

6.3.3.1 Construction Site

The Stage 2 reservoir will cover approximately an area of 170 km^2. About 17 km^2 of the existing construction site will be submerged. The size of the remaining construction area outside of the reservoir is roughly 5 km^2; however, this part is of great importance for future land use. The scale of the area that has to be rehabilitated will be known as soon as the planning of all dumps and landfills is ready.

Main topics for the filling of Stage 2 reservoir are:

- Decontamination of the construction area within future reservoir.
- Site preparation outside the future reservoir. Re-cultivate and re-vegetate temporary used areas.

For both stages, the future reservoir area will have to undergo a strict decontamination and will have to be prepared for impounding according to relevant standards.

The site preparation and re-cultivation outside of the reservoir is a complex and long lasting work that will interfere with resettlement issues. Because of the increasing pressure on the remaining land, the planning and the preparations should start in an early stage. The management should have a close look on a fair participation of the local people and on the safeguarding of valuable top soil for future land use.

6.3.3.2 Contamination

Within the limits of the whole construction area a variety of installations have to be treated in order to avoid contamination of the future reservoir:

- Electrical transformers and substations
- Concrete plants /cement silos
- Breakers
- Filling stations
- Workshops
- Housing for staff

It is important to learn from the decontaminating works for the filling of Stage 1 with the purpose to reduce the amount of material that has to be treated and to reduce the surface of landfills outside of the reservoir.

6.4 Measures

The main aim of this section consists in identifying mitigation measures; some measures were mentioned before, while discussing the prevailing situation and the impacts.

As a general rule, measures should be taken according to the following priorities:

1. avoidance,
2. minimisation,
3. compensation.

Covering all three priorities, the problem of overgrazing has to be discussed.

The following Table gives an overview over the main measures that will be required to reduce the impact to an acceptable level.

Table 8: Main measures for site restoration

Phase	Measures		
	Area Stage 1	**Area Stage 2**	**Area outside future reservoir**
Construction Dam Stage 1	Establish waste management system Treatment of contaminations (relocate outside reservoir), rehabilitation sites	Establish waste management	Avoid new contamination Avoid creation of new erosion problems (roads, landfill, dumps) Establish program for erosion control Controlled landfill Establish sustainable land management
Filling Reservoir Stage 1	Moving out of equipment Eliminate dangerous potential landslides and too steep slopes Clearing of vegetation		First measures against erosion
Construction Dam Stage 2	Control potential landslides	Continue waste management Treatment of contaminations (relocate outside reservoir), rehabilitation sites Stock top soil for later use	Avoid new contamination Avoid creation of new erosion problems Continue measures against erosion Enhance sustainable land management
Filling Reservoir Stage 2		Moving out equipment Eliminate dangerous potential landslides and too steep slopes Clearing of vegetation below future FSL Dismantle relocated villages	Treatment of contaminations, rehabilitation of sites Site preparation for future farmland or other use Adapt housing of staff for permanent settlement Continue measures against erosion
Operation	Control potential landslides	Control potential landslides	Continue measures against erosion Enhance sustainable land management

6.4.1 Avoidance and Minimisation

6.4.1.1 Establish Waste Management System

A waste management system is a prerequisite for optimised landfills and dump-sites outside the future reservoir. It allows the reuse of as much materials as possible and an accurate planning of the necessary top soil (stripping, stocking, covering landfill).

6.4.1.2 Avoid New Contamination

While cleaning up the surface that will be submerged, the problems with hazardous wastes should not just be moved to another area, but solved for good. In contrast to the existing / inherited contaminations, the construction of the dam has to avoid the creation of new contaminations from the beginning. This avoidance policy has to be the main part of the waste management system.

From the point of view of site rehabilitation, the main goal of the waste management system is to limit the land use outside of the future reservoir.

6.4.1.3 Avoid Creation of New Erosion Problems

There is a risk of new creating new erosion-prone sites wherever new roads, landfills or dumping sites are installed.

As mentioned before, about 65 km of new access road on the left bank (and 33 to 99 km on the right bank, depending on alternative chosen) will be constructed, partly in steep, difficult terrain. To handle steep slopes, a few possible solutions to reach a stable situation do exist. Construction work will be more expensive, however, maintenance will be much easier and less costly, and use will be safer. The recommended solutions are well known in most mountainous regions and field tested.

More precisely, all new roads have to take the following considerations into account:

- the alignment should take the topography or contour lines into consideration, especially under steep conditions
- allow narrow turns, following the contour lines (at the same time reducing the velocity and lowering danger coming from traffic)
- reduce width of roads to the minimum required, under steep conditions allow stretches of one-way road with passing places (not every road has to count with heavy loads and much traffic)
- minimize slopes and cuttings
- take into account geological conditions, from almost vertical walls in solid rock (10:1) to gently inclined slopes in argilliferous hillsides (1:3)
- do not deposit the excavated material beneath the road in the form of uncontrolled landfills
- landfills should be filled and compacted layer by layer, receive no runoff water and get a vegetation cover as soon as possible.

Annex 6-2 describes a bundle of bioengineering measures which can be realised with comparatively few technical equipment and local work force. A number of measures are exemplified in the following Figures.

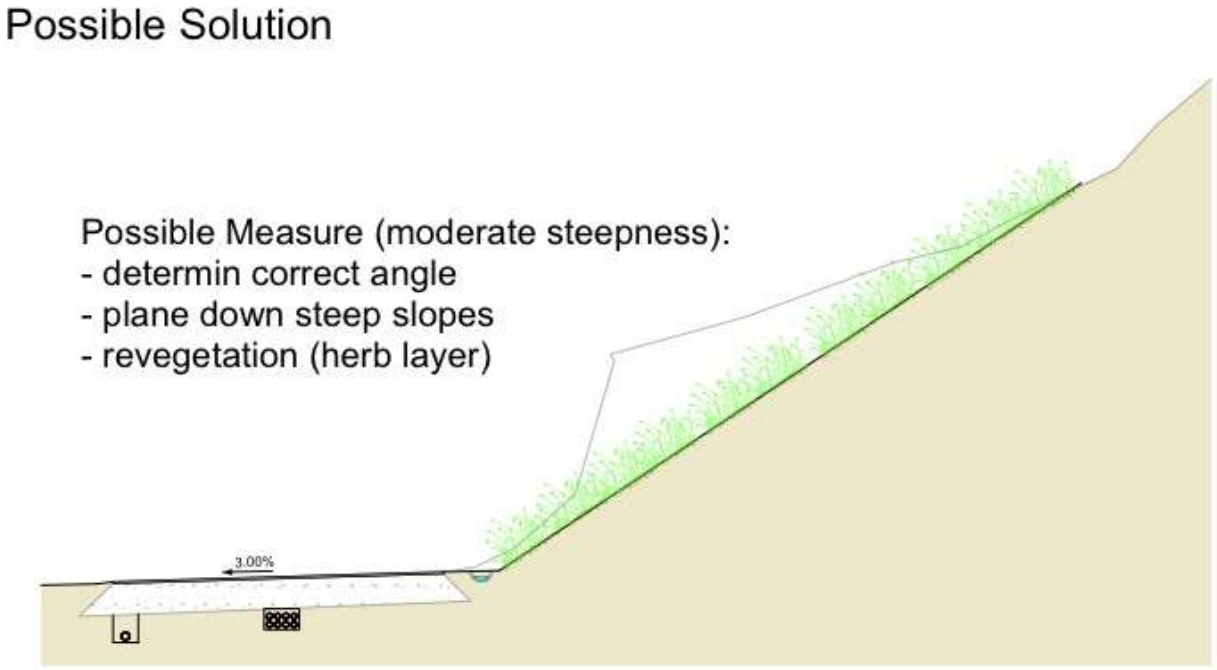

Figure 5: Simple way to get a stable slope with a layer of top soil and vegetation.

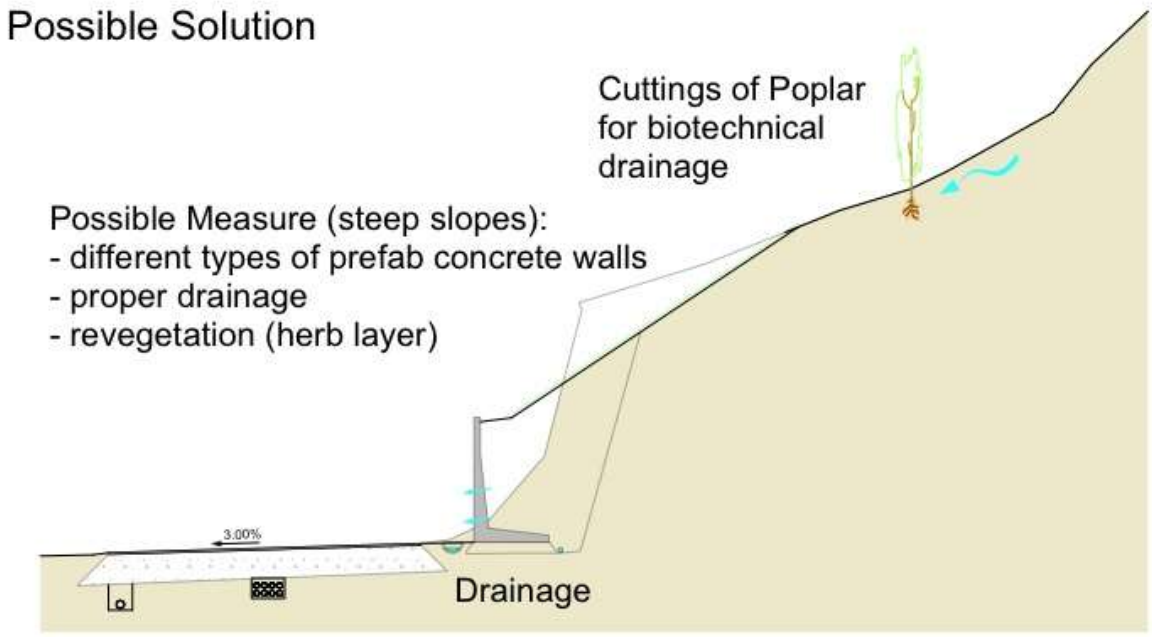

Figure 6: Solution in Rogun: Retaining wall with prefab concrete system,

Additional planting of trees to slow down the runoff water.

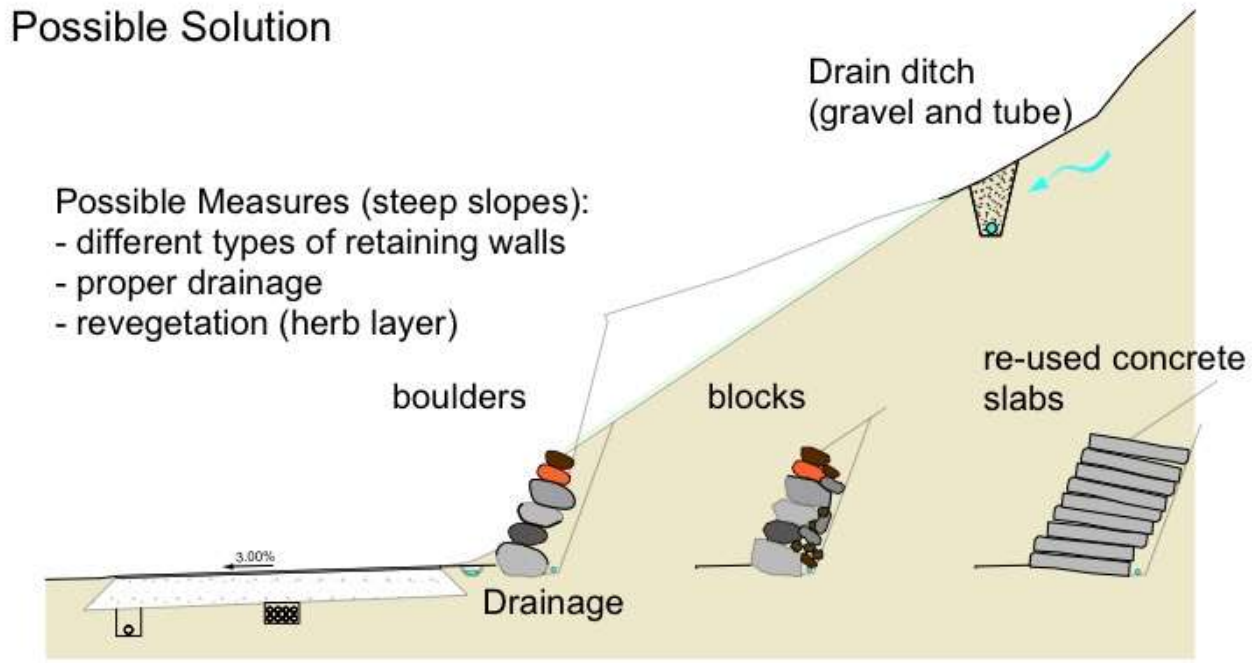

Figure 7: Types of retaining walls plus additional drain to intercept the runoff water

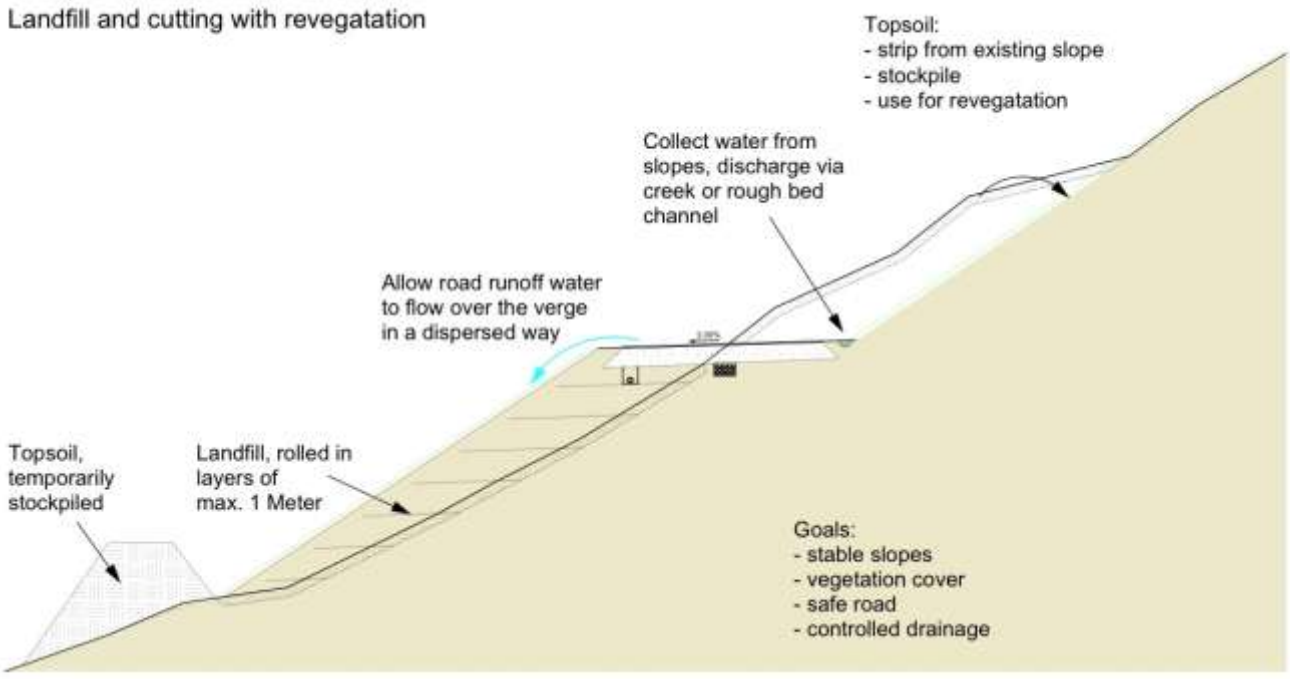

Figure 8: Built landfills and cuttings in a stable angle, cover with top soil and revegatate.

6.4.1.4 Discharge of Water into Steep Slopes or Creeks

Whenever runoff water accumulates (e.g. on street surfaces or in drainage systems), if released into steep slopes this water causes erosion. For this reason, either creeks with natural river beds or artificial channels with a rock bed have to catch the run-off.

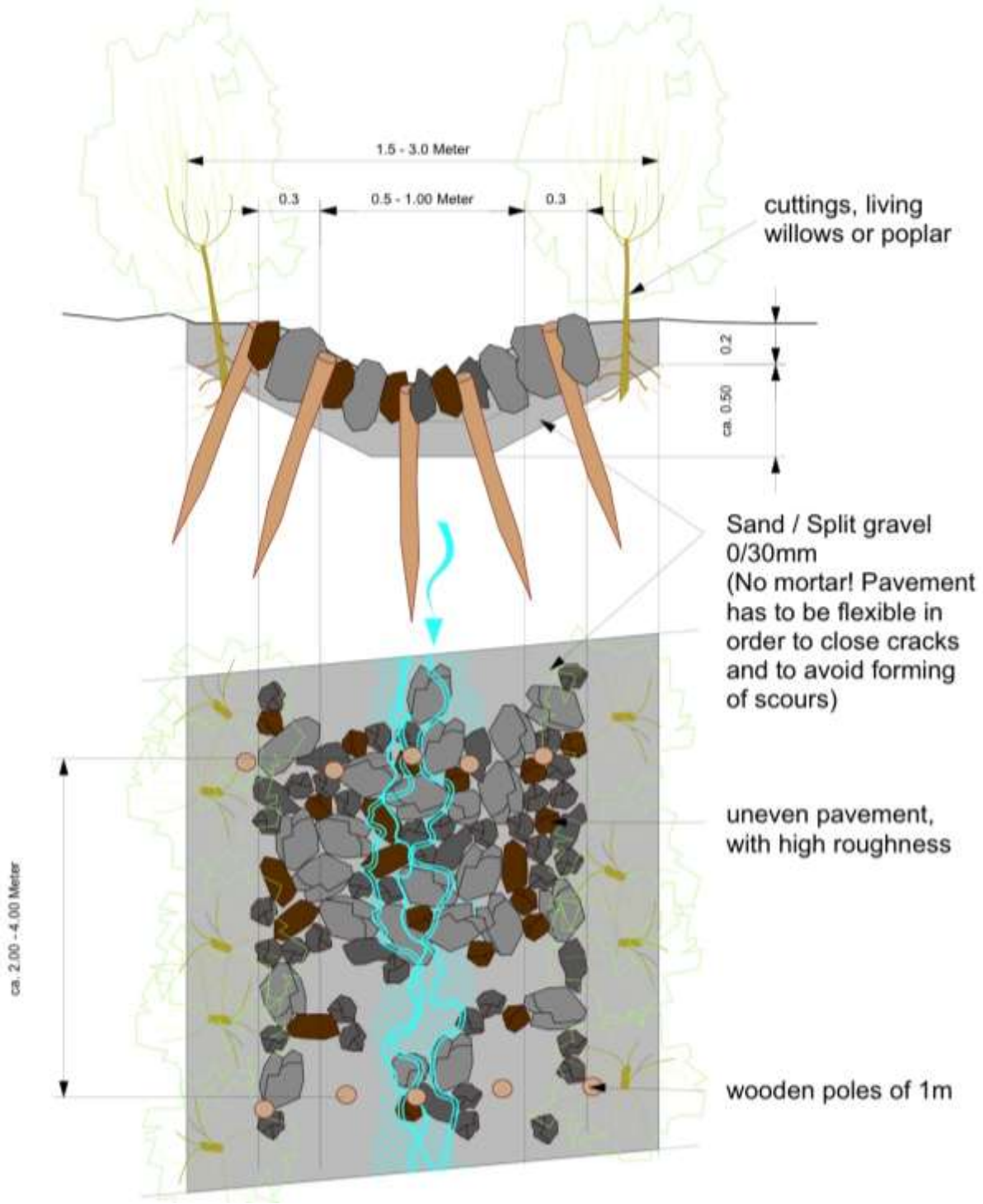

Figure 9: Rough bed channel or rock ditch;
suggested dimensions and usage of plants, cross section and top view.

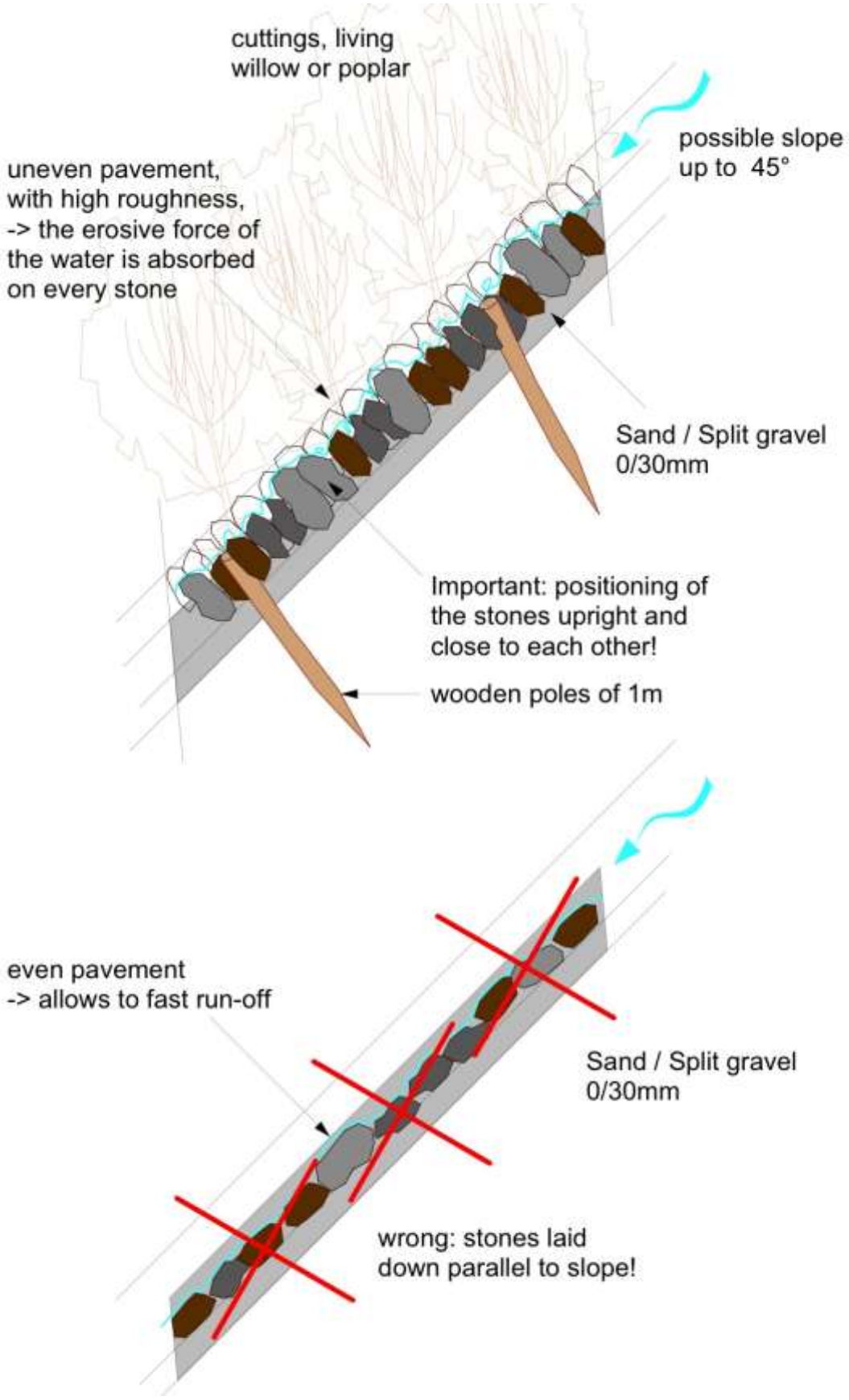

Figure 10: Rough bed channel or rock ditch, cross sections. Second type with wrong layout!

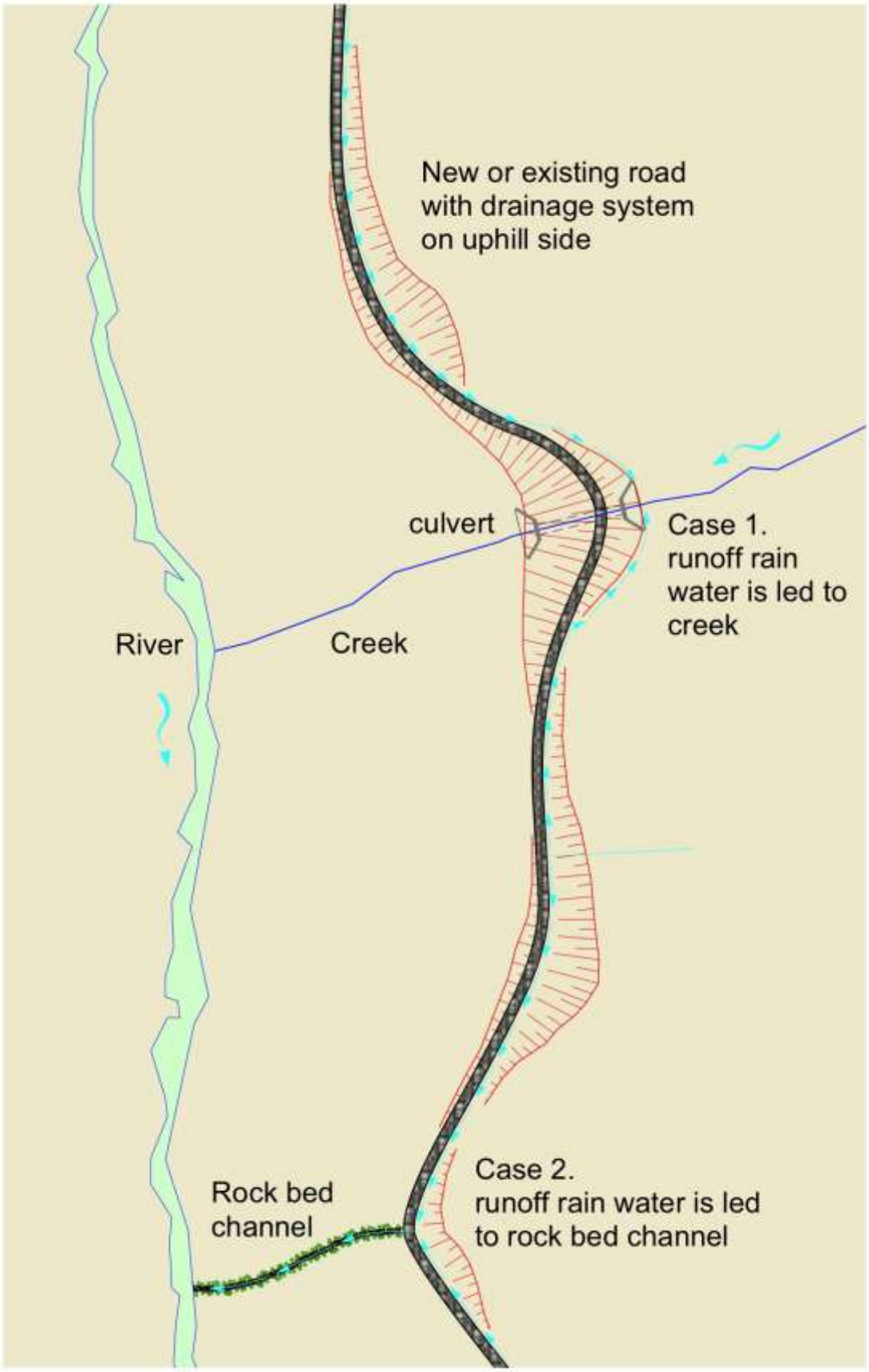

Figure 11: Two possibilities for discharging collected run-off water.

For the realisation of an unknown number of landfills and dumps, the following considerations have to be taken into account:

- landfills should be built up and compacted layer by layer (layers of 1 m maximum)
- receive no concentrated runoff water coming from paved areas / streets
- surface water should be collected and led in a controlled way into creeks, rivers or rock bed channels
- artificial water courses with fixed beds have to be built (-> rock bed channel)
- get a vegetation cover as soon as possible
- use shrubbery and trees to secure slopes and water bodies or places where water is welling up.

6.4.2 Compensation

6.4.2.1 Site Preparation for Use as Farmland

When all the works for the construction of the dam will be finished, as much land as possible should be prepared for future agricultural use. This will lower the pressure on the remaining farmland in the surroundings of Rogun and thus help diminish erosion problems. The farmland can be divided into garden plots or orchards of high value and into pasture land with a lesser value. Areas close to villages and farms should be appointed as gardens and orchards, especially even yards and areas where irrigation is possible.

While forming landfills and dumps, the future usage as farmland has to be taken into account. For garden plots, the rehabilitated soil has to consist of two layers:

- A-Horizon, topsoil, 20-30 cm
- B-Horizon, subsoil, 50 - 80 cm

Underneath follows the C-Horizon, containing parent material and weathered rocks or the material of the landfill (or dump with covering). The A-Horizon bears some local seeds and is home for all the biological activity that will help to revegetate the area. The B-Horizon is able to hold back a certain amount of water and make it available for the vegetation cover during the dry season (more crop!).

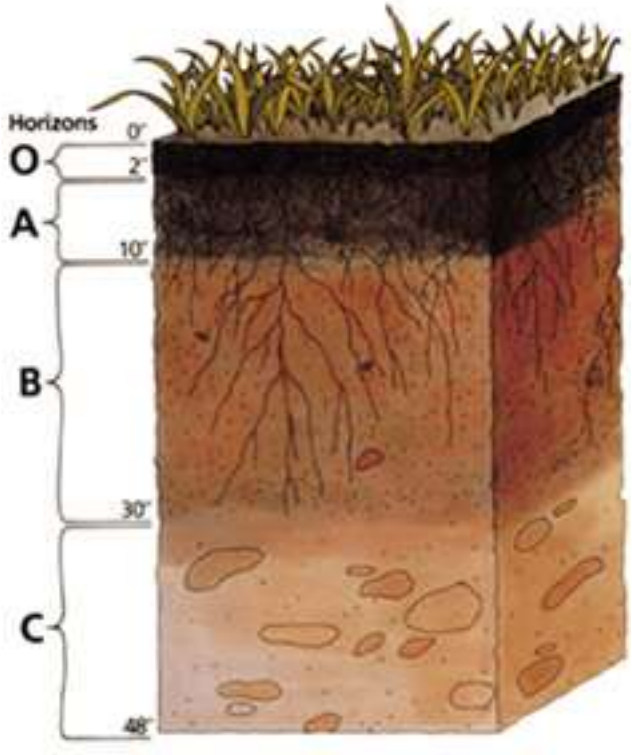

Figure 12: Soil layers for rehabilitation farm land

For pastures or under steep conditions it might be enough to apply only one layer of topsoil.

Inside the boundaries of the future reservoir, large areas of farming land will be submerged. The topsoil of these areas forms a very valuable resource, which the project of Rogun cannot afford to forget. By way of example, one km² of site rehabilitation (1'000'000 m^2) would need 300'000 m³ of topsoil and 700'000 m^3 of subsoil. The handling of material on such a large scale has to be planned on beforehand.

6.4.2.2 Site Rehabilitation

One of the most important goals of site rehabilitation and erosion control is to create a covering layer of vegetation, being first of all grasses and herbs plus shrubs or trees. For Rogun it is not possible to get commercially available seeds or forest plants of autochthonous origin. However, it is not recommended to bring in seeds or plants from other regions of Tajikistan or even from abroad, because the resulting plants would not be adapted to the local climate conditions and because alien species could harm the local biodiversity. Therefore a botanist should be mandated for identifying plants and seeds that will be used, in particular also for branches that will be used for soil bioengineering (e.g. "living pole drain").

Seeding has to be carried out according the following steps:

- A botanist has to identify the base material (stock plants, vegetation units) for multiplication

- The botanist has to evaluate the conditions of the location (slopes, future gardens, pastures etc.) that has to be revegetated. He decides, if the rehabilitation site is ready to be seeded.
- The botanist chooses the appropriate seeds.
- Before bringing out the seeds, the plots have to be fenced off.
- Plots with base material have to be fenced in early spring or even in wintertime, to guarantee a good growth and rich harvest.
- The harvesting of seeds (hay, infructescence) has to be done at the right moment, before the seeds drop. If the seeds cannot be brought out immediately, the hay or seeds should be preserved in a dry and cool place.
- Seeds and hay are brought out according to the methods "hayseed sowing", "sowing of threshed hay", "seeding of hay mulch", "planting of infrutescence" (see Annex 26-8).
- The botanist coordinates these works and keeps a list of plots for harvesting, seeds on stock, he keeps track of revegetated plots etc.
- After the first or second vegetation period, maintenance of the herb layer should start. The botanist decides, if use as pasture for sheep or goats is possible or if the vegetation should be mowed (see Annex 26-8).
- After the first maintenance, stones should be removed if necessary (see Annex 26-8).
- The botanist checks the results in the following years.
- The botanist decides when the rehabilitated areas can be transferred to the system of sustainable land use that is being developed in the region.

Planting of trees and reforestation has to be carried out according the following steps:

- A botanist has to appoint the base material (stock plants, fruit trees etc.) for multiplication
- In a nursery, the trees and shrubs will be propagated by seeding, cuttings, grafting etc.
- The botanist decides, whether the plots are ready to plant or not.
- The plants should be protected against livestock and game.
- The botanist checks the results in the following years.
- For fruit trees he organizes the maintenance for the following 5 years at least.

All these measures should be done in close cooperation with local inhabitants who will be in charge (or owners) of areas planted in this way once the rehabilitation phase ends.

6.4.3 Overgrazing

6.4.3.1 Establish Sustainable Land Management

A lot of measures are related to recultivation and revegetation in order to:

- stop erosion
- gain new land or regain temporarily used land for future land use.

The success of all these measures is based on a well working sustainable land management. In the short run, all newly sowed and planted areas have to be fenced off. In the long run, pressure from grazing has to be limited in order to maintain stable slopes and drainage systems.

The local farmers have developed a few types of fencing around their orchards and gardens, that are based on available material like cuttings of poplar and wooden poles as well as barbed wire. Due to the particular form of the high growing and slender poplars, these fences do not grow out to wide and thick hedges European style. The grown wood can be used periodically.

The Consultant recommends to use the local style of fencing in the whole area of site rehabilitation, although until now fences are only known in and around the villages / orchards. The fences have a permanent character. In the first years, the revegetated surfaces need a strict fencing. In the following years, the fences help to establish a sustainable land use, e.g. no grazing during winter time.

6.5 Costs

The budget prepared for the original project contains an item identified as "sanitary preparation of reservoir area", with a proposed amount of USD 29.3 million for FSL 1290 (see Report on Infrastructure Replacement and Resettlement Costs for Dam Alternatives). These costs were already included in the evaluation of total project costs.

7 INSTRUMENTATION AND MONITORING PLAN

The technical project as prepared by TEAS contains technical instrumentation of the dam (monitoring of dam stability etc.), and this is not covered here. The present Chapter discusses the need for some additional specific monitoring which is not directly related to dam safety.

7.1 Hydrology: Online Monitoring

7.1.1 Purpose

In order to demonstrate compliance with accepted rules for operating the Vakhsh Cascade it is strongly recommended to install an online monitoring system which will make the relevant parameters accessible in real time on an internet site.

Some examples of large energy infrastructure releasing real-time environmental data on the web:

- Three Gorges dam, China, world's largest hydropower scheme: http://www.ctg.com.cn/inc/sqsk.php
- Grande Dixence dam, Switzerland, world's tallest concrete dam: http://www.grande-dixence.ch/energie/hydraulique/valais/multimedia.html
- Zaporojie Nuclear Power Plant, Ukraine, world's second largest nuclear power plant: http://www.npp.zp.ua/ascro

In the case of the Vakhsh cascade, the relevant parameters would be mainly water inflow into the system and water release from the cascade, i.e. from Nurek as well as the quantity of water stored in the two reservoirs.

7.1.2 Costs

The costs cannot be accurately defined here; however, some indications can be given.

First of all, much depends on (i) finding cost-effective solution to monitor the Vakhsh itself which is a very powerful river, and (ii) the number of hydrological stations that will need to be rebuilt in the lower Vakhsh cascade (to monitor actual flow and consumption), because they might require significant civil works. There is also a plan to build a new hydrological station on the Amu Darya near the place where it crosses the border into Uzbekistan. For obvious reasons, it would be very good to include data from this station into the website.

As a comparison, the lake Sarez remote sensing system (with real time data transmission to Dushanbe via satellite) had a cost of 1'600'000 USD around 10 years ago, with an annual operation budget of around 14'000 USD (data provided by Barki Tojik). A good description of this system is available on:

http://planung.fela.ch/en/projects/projects-2003-2007/project-lake-sarez-tajikistan/">http://planung.fela.ch/en/projects/projects-2003-2007/project-lake-sarez-tajikistan/

A recent discussion with Grande Dixence S.A., a large Swiss hydropower station which has such a system, provided the following results: the data shown online are data from measuring stations which were already installed, and which are part of the monitoring system which is required for the operation of the power plant in any case. These data

arrive on line in the despatch centre. All that was required to do was then to decide which data to put on the website, and to design this website. There was no additional hardware required, meaning that the costs for making data available in the internet were actually very low.

Finally, according to information received from TEAS, with the construction of Rogun, an automated and coordinated management of the whole Vakhsh cascade will be required. The technical project includes a SCADA (supervisory control and data acquisition system), which basically includes all automated real time measurements of flows and their transmission to a control centre in Dushanbe. This SCADA shall include the measurement of flows in the lower Vakhsh in order to calculate the consumption of water (to be confirmed by TEAS). This also means that the costs for the monitoring stations as well as for the SCADA are comprised in the technical project, since this an integrating part of it.

The following recommendations are made:

- An detailed audit of the presently available hydraulic monitoring system should be carried out with the aim of defining exactly the requirements for the new system. The auditors could be asked to define the most appropriate monitoring system which should e.g. not exceed a cost of up to 5 million USD, with an annual operation budget of 50'000 US$. The costs for such an audit are estimated at USD 400'000.
- Operation costs for the system should then not exceed USD 50'000 per year. It should be noted that these are costs for operating the entire hydrological monitoring system, and not just the operation of the website. These cost might actually already be included in the technical project.

Putting the relevant data on the web will then be just a question of web site design and database development.

7.2 Seismic Monitoring of Rogun HPP

7.2.1 Introduction

The Rogun Hydropower Project in the in Tajikistan is located in a mountainous area of high seismicity where strong earthquakes may occur frequently. Moreover, active or potentially active faults are crossing the dam foundation. Thus the dam has to be able to withstand the strongest ground shaking and largest fault movements to be expected at the dam site.

Another important phenomenon, which is likely to occur at Rogun, is reservoir-triggered seismicity similar to that observed at Nurek and some 100 other large dam projects all over the world. Although reservoir-triggered seismicity is not a safety problem for a dam designed against earthquakes according to the current state of practice, the ground motion of reservoir-triggered events may be strong enough to cause damage to buildings and infrastructure located in the project region and to create psychological concerns among the population in the dam region on the safety of the dam etc.

Therefore, the following two types of seismic monitoring systems are recommended for the Rogun HPP:

(i) Microseismic network for the detection and recording of reservoir-triggered seismicity; and

(ii) Strong motion instrumentation of the dam body to record the behaviour of the dam during strong earthquakes occurring in the project region.

The data obtained from the strong motion instruments is used for the safety assessment of the dam after a strong earthquake and for updating the seismic hazard at the dam site.

7.2.2 Microseismic Network for Rogun HPP

7.2.2.1 Scope

For the Rogun HPP a microseismic monitoring network shall be provided consisting of maximum 7 stations including a central recording station. The system shall be used to monitor the seismicity of the dam and reservoir region (i) prior to impounding of the reservoir in order to record the natural seismicity in the project region, which is used as a reference for the assessment of reservoir-triggered seismicity (the natural seismicity should be observed for a period of about 5 years prior to impounding of the reservoir), (ii) during impounding of the reservoir, and (iii) during the first years of operation of the reservoir.

Depending on the nature of the seismicity observed the system may be in operation for up to 20 years.

The purpose of the system is to ensure the optimal detection and recording of local earthquakes, with a minimum magnitude of 0.5 ML and an accuracy of hypocentres of less than 2 km, as well as the determination of earthquake parameters (epicentre coordinates, magnitude, intensity, focal depth, focal mechanism etc.).

For earthquakes with magnitudes of say M>3.5 an event report shall be prepared, which includes acceleration time histories and focal mechanisms etc.

As Rogun and Nurek reservoirs form a cascade, and since the operation of Nurek will change once Rogun is completed, therefore it is also recommended to have an operational microseismic network in the dam and reservoir region of Nurek. Any concerns about an effect of the Rogun project on the seismicity at Nurek can be assessed by such a comprehensive network covering both projects.

7.2.2.2 Summary of Specifications for Microseismic Network

The cost estimate for the microseismic network shall comprise the following supplies:

- Seven autonomous microseismic stations; one of them shall serve as control centre, where the seismic signals from all the stations are collected electronically and analysed. All stations must have a GPS receiver for timer synchronization.
- The microseismic stations must be capable to record and locate events with magnitudes larger than or equal to 0.5. The location of the microseismic stations will have to be selected and agreed upon with the dam owner.
- Software and hardware for the automatic analysis and storage of microseismic activity and seismic events, i.e. evaluation of time, epicentre, hypocentre, focal depth, magnitude, focal mechanism, plotting of epicentres in map etc.

- Data transmission from microseismic stations to main control station by radio, telephone or internet.
- Supply, construction and installation of seismic stations with autonomous power supply and communication. Check if mobile connection is available at proposed stations.
- Annual maintenance costs of whole system.
- Training of operating staff.
- Insurance, and transportation to sites.
- Guarantee period of supplies: 5 years.

7.2.2.3 Information on Technical Specification of Seismic Sensors

Sensors

The seismograph’s equipment must include a triaxial sensor of the acceleration or velocity and time, and a seismic trigger.

The tracker of the time flow of acceleration or velocity shall contain the following properties:

1. Minimum five-second pre-event memory;
2. Minimum five-second post-event memory;
3. Minimum 24-bit analogue-digital converter;
4. Sampling of a minimum of 200 samples per second;
5. Sampling of a minimum of 3 channels;
6. Simultaneous sampling of all channels;
7. Storage in a permanent memory medium;
8. Multitasking: capturing of events during transfer, and a review of events stored;
9. Automatic checking of operation;
10. Possibility of remote calibration (own oscillation period and muffling of sensor);
11. Possibility of modem access for the adjustment of parameters and data transfer;
12. Autonomous solar power supply where connection to the grid is not possible;
13. Minimum 24-hour autonomous operation without solar power supply or power supply from the grid;
14. Synchronisation with an international standard of accurate time (GPS receiver is desired) and accuracy to at least 1 millisecond.

Sensor Specification

The sensor must contain the following elements or properties:

1. Dynamic range > 120 dB at 1 Hz;
2. Frequency range from 1 to 30 Hz;
3. Muffling at between 55 and 70 per cent of critical muffling;
4. Maximum measuring range up to 1 g.
5. Resistance to high humidity, temperatures from -40°C to 70°C, watertightness of equipment; corrosion resistant casing.
6. The resolution of the system shall be 24 bit.

Seismic Trigger

The seismic trigger must have the following properties:

1. 1. It must be adjustable for each channel separately.
2. 2. It must trigger by comparing the current value with the average value of the seismic signal.

Data Transfer and Acquisition

Data transfer and acquisition according to the following:

1. WiFi, GPRS, GSM communication setup;
2. Real-time data recording to a central seismic server;
3. Software for data acquisition and analysis.

Assembly

During the assembly of seismological instruments, the following must be ensured in particular:

- Protection of seismological instruments against possible mechanical defects;
- Faultless and continuous operation of seismological instruments;
- All seismological instruments at the same facility must have equally positioned directions on the spatial axis;
- The appropriate anchoring of seismological instruments;
- Tight contact of the sensors with the basement.

7.2.2.4 Tender

The quotation shall include all items listed under Section 7.2.2.3.

The supplier shall list what services and supplies are not included in the tender.

The validity of the tender shall be 12 months, without any cost escalation.

7.2.3 Strong Motion Instrumentation of Rogun HPP

7.2.3.1 Introduction

The installation of strong motion instrumentation in very large dams, located in areas of high seismicity, is highly recommended by the Committee on Seismic Aspects of Dam Design of the International Commission on Large Dams (ICOLD).

For Rogun 6 strong motion accelerometers are recommended for the dam body and at least three in the foundation rock to record the spatial varying ground motion in the rock. The instruments will be located on the dam crest, at midheight at the downstream face of the dam and in foundation galleries.

In view of the fact that Rogun and Nurek form a cascade it is also recommended to have a similar strong motion instrumentation system in Nurek as well.

7.2.3.2 Information on technical specification of strong motion instruments

For the strong motion instrumentation, accelerometers shall be used. The specification of these instruments is given above, as for both the strong motion instrumentation and the microseismic network, accelerometers can be used. However, for the microseismic network seismometers (velocity recorders) are often used.

The accelerometers shall be able to record events with a peak acceleration of 5 g.

The instruments shall be installed when the dam has been completed.

7.2.4 Conclusions

A microseismic monitoring of the dam and reservoir region and the strong motion instrumentation of the dam body are recommended for Rogun HPP. This is in line with current recommendations by ICOLD's Committee on Seismic Aspects of Dam Design.

As Rogun and Nurek HPPs form a cascade and as events triggered by Rogun may also affect Nurek, it is recommended to have similar seismic monitoring systems at both dams.

At Nurek seismic monitoring systems had been installed at the time of construction, however, some of these instruments may no longer be functioning or are technically obsolete, therefore, these systems have probably to be updated as well.

Cost Estimate

For reaching exact costs, offers based on precise specifications will have to be obtained and evaluated. At this point in time, based on experience with similar projects, the following rough cost estimates can be made:

- Microseismic network with 7 stations, including training, communication, autonomous energy supply, 5 years warranty, 5 years maintenance and data analysis: USD 500'000.00.
- Strong motion instrumentation for the dam, with 10 devices, including training, and warranty, maintenance and data analysis for 5 years: USD 300'000.00.
- If as recommended the same systems will be installed in Nurek as well, this would bring total instrumentation cost to 1.6 million USD.
- Engineering services and support to the Client for systems design, tendering, tenders evaluation and commissioning: USD 150'000.00.

7.3 Emergency Preparedness Plan

Emergency preparedness has to consider the following main risks:

- Flood due to exceptionally high inflows;
- Risk of flood caused by a dam break.

These risks have to be seen not only for Rogun HPP, but should be considered for the cascade, i.e. for the combination of Nurek and Rogun dams.

Two areas have to be considered, namely:

- Lower Vakhsh valley, downstream of Nurek to the confluence with Pyanj river; and
- Amu Darya valley as far d/s as the Aral Sea.

For the second part, i.e. the Amu Darya valley, preparation of an emergency preparedness plan, and the organisation dealing with it, should be coordinated with such plans already prepared or still to be prepared for other similar risks, like Lake Sarez.

The following structures and plans are in place:

- Flood risk monitoring and forecasting system in the Vakhsh river basin: the Communication Centre of the State Hydrometeorological Institute receives operating hydrometeorological data from more than 50 weather stations, 25 hydrological stations and 28 agro-meteorological stations. Data on natural hazards (NH) and natural hydrometeorological phenomena (NHP) is received from all the stations. If there is a risk of such an event, the data are sent to the Committee on Emergency Situations and Civil Defence under the Government of Tajikistan, the Office of the President of Tajikistan, the Committee on Environment Protection and other government agencies as well as relevant local authorities. The Committee on Emergency Situations and Civil Defence has procedures for preparing and sending out warnings in the case of NH and NHP to administrations, security, defence and law enforcement agencies, as well as relevant ministries at the national level. Furthermore, there are bilateral agreements on cooperation for storm data exchange between Uzbek Hydromet and Tajik Hydromet and other neighbouring countries.
- Nurek HPP emergency plan (Plan of action for Nurek HPP staff in case of damage to structures, 2006). This plan defines who (local authorities, army, civil organisations) have to be informed in case of a threat of a flood, and also defines modes of action in cases of damage to the different structures of the power house and the dam. However, it does not mention the risk (or case) of a dam break, and does not include an alarm system for the population in the lower Vakhsh valley or the Amu Darya valley. It also does not identify the areas which would be at risk in the case of a major emergency.
- Lake Sarez: It was feared that the dam might be unsafe and could cause a major damage in case of a rupture, which would immediately threaten the villages located in Bartang valley downstream of Lake Sarez. For this reason, about 10 years ago a monitoring system was installed and an emergency plan was developed. This is a very detailed plant which lists all structures at risk, and mainly an early warning system and evacuation procedures for the local population. However, it is limited to the settlements in the region and does not take into consideration the areas further downstream.

However, there is no comprehensive emergency plan for the entire downstream area. Such a plan should include, based on the risk assessment of Nurek and Rogun dams:

- An identification of risk areas, i.e. zones which would be threatened by flooding under the conditions of an extreme emergency (dam break).
- Estimate of time for the different parts of the downstream area till the water would reach there.
- Identification of entities to be informed in the case of such an event, including also those in riparian countries (Afghanistan, Turkmenistan and Uzbekistan).
- Alarm system and evacuation plans for the population at risk.

It is strongly recommended to develop such a plan; obviously, this would have to be done based on the technical data (risk analysis) of Rogun and Nurek dams, and in close cooperation with the riparian countries.

7.4 Watershed Management Plan

In the framework of an ESIA for a dam project it is usually not possible (and was also not foreseen in the TOR) to prepare a Watershed Management Plan.

Such a plan would have to analyse the prevailing situation in the catchment (watershed) area of the reservoir and then propose appropriate measures, if required. Usually, in the case of a dam project such measures concentrate on two main subjects, namely:

- Water quality: checking for sources of water pollution and, if necessary, propose measures to reduce or prevent water pollution in order to maintain or reach good water quality in the reservoir and downstream of it. Such sources of pollution can be mainly the following:
    - Large settlements which produce a considerable amount of domestic waste water, with a risk of water contamination (mainly bacterial and NO_3 and PO_4, the two latter being main nutrients which can lead to eutrophication in the reservoir.
    - Industrial activities, including mining, from where contamination could arise (chemicals, hydrocarbons, heavy metals etc.).
    - Large and intensively used agricultural areas (contaminating water with agrochemicals as pesticides and fertilisers, and here again NO_3 and PO_4).
- Erosion control: erosion in the catchment area of a reservoir can lead to sedimentation in the reservoir, in this way reducing the storage volume and ultimately the life span of the project.

In the case of Rogun HPP, water quality is not a major concern, given the fact that none of the major sources of water contamination is present (or thought to be developed in the near future) in the catchment area of the dam.

However, erosion is a major issue. Vakhsh river and its tributaries carry large amounts of sediments (in the form of bedload, i.e. coarse material, as well as in the form of suspended solids, i.e. fine material). Inflow and retention of sediments already start to cause problems in Nurek reservoir. With Rogun dam in place, all these sediments will be retained in Rogun reservoir.

A watershed management plan for Rogun HPP therefore would have to focus on possibilities for reduction of erosion. Without trying here to give a complete set of measures, based on the information gathered for this ESIA it is nevertheless possible to point out a number of possible measures as follows:

- Reforestation: as mentioned (Vol. I), all forests in the project area (and probably in all or most of the watershed) have been influenced and damaged by human use (mostly logging and grazing by livestock), and can no longer be termed as "real" forests. Some areas might be suitable for reforestation measures.
- Livestock management: this would mainly include the proper management of pasture land with the aim of preventing overgrazing, and at the same time producing more forage for livestock. According to information received, such management schemes existed formerly, but were no longer observed after the independence of Tajikistan.
- Livestock exclusion: in some cases it might be sufficient to exclude the access of livestock for enabling the natural vegetation to recover; this could be mainly areas where relics of the original forests still exist (in the form of small forest patches, stunted or single trees), and where the natural vegetation therefore could recover rather easily in the absence of livestock.
- Specific erosion control: various methods could be used depending on the specific situation, like e.g. training of small and medium sized mountain streams in order to reduce their eroding power.

All these measures would obviously have to be analysed, planned and implemented carefully.

Given the size, importance and costs of Rogun HPP, it would certainly be worthwhile to develop such a Watershed Management Plan, which could help increasing the life span of the project. Since part of the watershed of Rogun HPP is located in Kyrgyzstan, a cooperation with this neighbouring country in this respect would be a plus.

8 SCHEDULE

The activities related to environmental management and monitoring have to be integrated in the overall construction schedule. Total construction time is estimated at 15 years from the moment of river diversion (for FSL 1290; possibly now thought to be somewhat longer, up to 17 years, and shorter for the alternatives including lower dams, i.e. FSL 1255 and 1220).

The following indications can be given:

- All measures which can be summarised as "good housekeeping" (which includes solid waste and waste water management, EH&S measures, health services for work force, etc.): throughout the entire construction period and to be continued after commissioning, to the extent required, as long as any work is still ongoing.
- Site rehabilitation measures (including decontamination of contaminated sites): to be done according to requirements as follows:
    - Immediate rehabilitation of a site if it is no longer used; this will include decontamination (if required), landscaping, covering with topsoil, revegetation etc., according to planned use in the future.
    - Sites to be submerged at Stage 1: before Stage 1 impoundment, which is planned to happen 3 years after start of construction.
    - Other sites to be submerged: in line with increase in water level of the reservoir. As for Stage 1, it is essential that all such preparation (removal of structures, decontamination if required; removal of vegetation, mainly trees, to make use of the wood, if any relevant quantities are present) takes place and is finalised before the area is submerged. Obviously, landscaping measures are not required on areas which will be submerged. However, it has to be pointed out that work here is not restricted to the construction site, but has to cover all areas which will be submerged (dismantling of villages and all structures in the future reservoir area, removal of trees).
    - Sites used during construction, but not to be submerged: to be rehabilitated for future use as mentioned above. Some of this work will be done during the construction period (for sites which are no longer used), some however can only be done after all construction related activities are finalised.
    - In the end, there should be an overall "as built" map (for the construction site) which shows (i) for which purpose a specific area was used, (ii) what rehabilitation measures were applied, and (iii) what the final stage at the end of the construction phase was.
- Monitoring: depends very much on the type of monitoring:
    - The "normal" monitoring of construction related activities has to take place as long as such activities are going on.
    - After finalising construction, a final monitoring report should be prepared (which will include the "as built" map mentioned above), which

will come to the conclusion whether all was done in a satisfactory way, or whether some measures will still have to be taken.

- Some specific monitoring measures will have to continue well into the operation phase (and it will have to be decided on a case to case basis for how long this will be required):
  - Water quality: to be monitored as described throughout the construction and impoundment phase and into operation at least until such a time when the relevant authority will come to the conclusion that a satisfactory new equilibrium has been reached. It will have to include the monitoring of at least two parameters (temperature and oxygen content) over the entire water column of the reservoir (or, given the fact that it will be a very deep reservoir, at least to a depth which will be sufficient for covering thermal stratification and related phenomena.
  - Fish: what exactly to do will depend not in the least from the final decision on how the reservoir will be operated. However, fish population should be monitored continuously during the filling phase of the reservoir and at least for a number of years after full impoundment.
- Monitoring of issues related to operation, obviously, will have to be carried out throughout the life span of the project; this concerns mainly hydrology (including the real time web platform for public access) and the microseismic network.

9 COSTS OF ESMP IMPLEMENTATION

9.1 Contractor's EH&S Management

The obligations of the contractor(s) for implementing the part of the ESMP for which they are responsible will have to be, as mentioned, in their proposals and cannot be specified here. It will be important that the Tender Documents will clearly specify this. Some of the main elements to be considered in cost estimates will be the following:

- Preparation of detailed Sub-management Plans for each relevant item; costs for this might not be negligible especially if a contractor required external consulting for this.
- Staffing of the EH&S unit on site.
- Required equipment of the EH&S Unit to enable it to carry out its tasks (including office space and equipment, clerical support, computers, monitoring devices for air, noise, water etc., laboratory costs, transportation, etc.).
- Specific equipment to be installed on site (drinking water treatment and distribution, waste water treatment plants, waste storage and handling facilities and material, oil spill fighting material, etc.).

Obviously, costs to be included in the contractor's proposal will also depend on what the Project Owner decides to include in the tender (e.g.: pre-impoundment clearing).

9.2 Project Owner's ESMP Implementation

The budget prepared for the original project included a sum of 29.3 million USD for "sanitary preparation of reservoir area", and this amount (reduced for lower dam and reservoir level alternatives) was included in the overall project costs (see Report on Infrastructure Replacement and Resettlement Costs for Dam Alternatives). This amount should be largely enough for covering environmental protection measures to be taken by the project owner, i.e. all such activities which cannot be related to construction work and which therefore are not under the obligation of the contractor(s).

ANNEXES

For easy reference, there is one Annex for each main Chapter.

Where there is no entry in annex to a specific Chapter, this is noted with the observation “**no entry on this page**”, however, the Annex as such is maintained.

На основную Главу приходится одно Приложение.

Дополнительные приложения предусмотрены специально для фотографии и прилагается список литературы.

Там, где нет записи в приложении к конкретной главе, это отмечается отметкой **"нет записи на этой странице",** однако, приложения как таковое содержится.

ANNEX 1 INTRODUCTION

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ANNEX 2 MAIN IMPACTS AND MITIGATION MEASURES

A2.1 Mitigation Measures Data Sheets

For some of the important measures identified and listed in Chapter 2, a Mitigation Measure Data Sheet was prepared. These Data Sheets are provided on the following pages. They contain, to somewhat more detail than is possible in the summary Tables given in Chapter 2, information on

- Type of impact, including indications of importance of this effect.
- Specific measures to be taken.
- Expected effects of the measures.
- Responsibilities for detailed planning and implementing of measures, and monitoring of effects; to this point also see general observations in Chapter 2.
- Cost estimate: note that in many cases, measures are either parts of general good practice (and therefore do not cause additional costs), are dependent on the final design of the project (and therefore part of overall project costs), or are to be defined by the contractor and included in his cost estimate. Therefore, for many of these measures, it is not possible to provide specific costs.

It is strongly recommended that these Mitigation Measures Data Sheets will be included in the tender documents, and that the Contractor will have to take these measures into account as firm conditions for his contract. They can be used as a basis for developing the specific Sub-ESMPs which are described, to some extent, in Chapter 3.

Measure	**Occupational Health and Safety**	**No.**	**1**
Impact	Work accidents, occupational diseases (skin irritation, noise, etc.)		
Phase	Mainly Construction Phase and Operation Phase		
Project component	Construction of the Rogun HPP		
Affected part of environment	Workers		
Place	On site (construction site), off site (roads, quarries and dumping sites for excavation material)		
Description of impact	Accidents can occur for instance due to careless driving, bad maintenance of machinery, careless handling of hazardous material on the construction site, etc.		
Characteristics	Transient and permanent; high probability; high importance		
Measures	• Carrie out a risk assessment to identify activities and areas of high risk. • Develop a Health and Safety Manual, including all necessary procedures (e.g. working at height, near water, scaffolding, etc.) • Ensure a safety and emergency training for all employees. • Ensure a qualified person responsible for all health issues and equipment for first aid. First aid kits need to be available at the construction site for fast action if an accident occurs. • Accessible consultation sheets for review in case of contingency or emergency situations. These should have phone numbers for police, fire-fighters, hospital, personal supervisor or project leader. • All workers have to use the relevant PPE (helmet, gloves, goggles, work boots, masks, ear plugs, etc.) • Workers handling hazardous material have to be trained and material safety data sheet should be provided. • All restricted plant facilities have to be labelled with caution signs, especially those with potential risk for workers. • All construction areas shall be marked and fenced to avoid accident from unauthorised people. • Fence off all areas like excavation pits, quarries etc. to prevent accidents • Machinery has to be equipped with warning alarms while reversing. • Machinery has to be maintained in good working order. • Driver has to follow road safety rules. Driving has to be done only in designated areas. • All workers, working near the water have to know how to swim. • Lifesaving vests have to be available. Lifesaving rings have to be installed at the work site near the water. • Evacuation plan for emergency cases (identification of and arrangement with referral hospital; organisation of alarming system; ensuring availability of ambulance). • Prepare a scheme of the evacuation routes and where the fire extinguishers are located within the plant and place them at on conspicuous places. • Provide sufficient portable water. • Assign during construction special areas for the food intake. The minimum distance of such areas, as well as (temporary) housing and recreation areas, from work areas (mechanical workshops etc.) should be 10 m. • Toilets for workers, in the vicinity of working areas and at a rate of one toilet for every 10 workers, should be installed, whereby a distance of at least 15 m to the river has to be kept. The toilets need to be maintained and disinfected regularly, waste water must be collected and treated before being resituated to the river • Workshops and camp site must have acceptable conditions of light, ventilation and safety for workers. • Label T&D Line poles indicating danger, high voltage		

Effects	• Reduction of accidents. • Health protection. • Appropriate reaction in case an accident happens.
Responsibilities	Rogun HPP to include the clauses in the tender document; Contractor to comply with the clauses in his tender.
Detailed plan	Detailed action plan on how to adhere to the clauses in the tender document and how to guarantee the compliance with best practice has to be provided by the Contractor. This action plan has to be approved by the EMP implementation unit.
Implementation	Starting when construction starts, ending by completion of construction and re-vegetation works
Monitoring	Responsible person for health and safety has to monitor during whole construction period. Health and Statistics have to be kept on site and reported to Rogun HPP on a monthly basis. Statistics on non-compliance with PPE carried out. Any major accident has to be reported immediately to Rogun HPP.
Cost estimate	Has to be included in the cost proposals of contractors.
Observations	
Reporting	• General measures taken, normal procedures: to be integrated in pre-defined periodic (monthly, quarterly, annual) report; this also includes the cases of minor accidents and "normal” diseases. • Major accidents (especially fatal ones, accidents with severe injuries and/or involving several persons and/or severe damage to the environment) as well as cases of dangerous or highly contagious diseases (e.g. cholera) have to be reported immediately. An accident protocol has to be established for each such accident.

Measure	**Public Health**	**No.**	**2**
Impact	Communicable Diseases		
Phase	Before and during construction phase and operation phase		
Project component	Project site and vicinity		
Affected part of environment	Permanent and temporary work force, local population		
Place	Construction site and vicinity		
Description of impact	Transmission of communicable diseases		
Characteristics	Transient, high probability, high importance		
Measures	• During the first week of employment all workers should attend a work shop on communicable diseases (TBC, HIV/AIDS and STDs). How to get infected, how to recognise symptoms, what should be done and on the prevention measures. • HIV/AIDS and STD: Dissemination of information. Voluntary counselling and testing. Provision of condoms at work site. • Every worker has to have the necessary vaccinations (Hepatitis A and B; Yellow Fever; Typhus; Tetanus etc.). • Overall good housekeeping: contributes to maintaining hygienic and safe conditions on the construction site. • Do not create additional breeding places at the construction site for arthropods e.g. unnecessary ponds, tires etc. • A campaign on hygiene and sanitation must be maintained regularly to promote healthy behaviours. Similarly, it is important to develop devices for household waste collection, disposal and wastewater treatment and latrines maintenance • Install Project Information Centre and prepare a Community Relation Plan and inform the population about the Project. • Speed limits and a safety driving training should be implemented • Improve infrastructure in the area directly affected by the project (maintenance of access roads) • Control activities affecting waters and landscape.		
Effects	• Minimisation of transmission of diseases • Health protection for the local population and for the work force.		
Responsibilities	Rogun HPP to include the clauses in the tender document; Contractor to comply with the clauses in his tender.		
Detailed plan	Detailed Plan related housekeeping, workers health, reduction of breeding places in the construction area, etc. has to be provided by the Contractor		
Implementation	Before work commences and during construction		
Monitoring	Responsible person for health and safety should monitor during whole construction period.		
Cost estimate	Has to be included in the cost proposals of contractors		
Observations	Provision for Public Health as accompanying duty should be included in the ToR for construction and maintenance works.		
Reporting	• Normal (monthly, quarterly, annual) reports • Keep medical records on all cases, treatments, work days lost, etc.		

Measure	**Explosives Management**	**No.**	**3**
Impact	Work force		
Phase	Construction Phase		
Project component	Construction of Rogun HPP		
Affected part of environment	Work force		
Place	On site (construction site), off site (roads, quarries)		
Description of impact	Accidental explosion would harm the work force		
Characteristics	transient; low probability; high importance		
Measures	The Explosion Management Plan will outline the procedures for proper handling, transport and storage of potential explosives. It will also specify equipment procurement and training of construction personnel. The most important measures are shown below: • Take into account the procedures established by the responsible authorities of Tajikistan and/or any international standards accepted by Tajikistan • Do not use explosives in areas not authorized for this purpose. • Use adequate and state of the art techniques for blasting, which do not exceed the exposition time to the noise. Noise and vibration associated with the use of explosives needs to be monitored. Max 136db • Explosive material should be stored in a state of the art storage (solid structure, fire resistant material, ventilation for heat control, electrically grounded, clean and dry, exclusively for explosives) it has to be labelled with the necessary warnings, and needs to be closed and lockable. • The storage needs to have an area open surrounding of at least 10 m and no other combustible material is allowed to be stored in a distance less than 20 meter. • Detonators should be stored in a different storage or at least in a different compartment of the storage. • Blasting agents should be stored separate from explosives, safety fuses and detonating cords. • Only persons authorised should be allowed to store, handle, use and transport explosive material. The authorisation has to follow relevant legislation and the certificate to be kept on site. • For transport of explosives use designated roads/tracks, designated closed containers with insulation. Use separate containers for the detonators • Do not allow people, workers and animals in a distance of less than 500 m. • Inform local Population on blasting events. • Implement suitable warning system (banners, mobiles, sirens etc.) Activate an auditable alarm 15 minutes before blasting		
Effects	Safety		
Responsibilities	Rogun HPP to include the clauses in the tender document; Contractor to comply with the clauses in his tender.		
Detailed plan	Detailed action plan on how to adhere to the clauses in the tender document and how to guarantee the compliance with best practice has to be provided by the Contractor. This action plan has to be approved by the EMP implementation unit.		
Implementation	Before any blasting activities		
Monitoring	Noise and Vibration Monitoring during blasting events.		
Cost estimate	Has to be included in the cost proposals of contractors.		
Observations			

Measure	**Traffic Management Plan**	**No.**	**4**
Impact	Air, work force, population		
Phase	Construction Phase		
Project component	Construction of Rogun HPP		
Affected part of environment	Air, population, safety		
Place	On site (construction site), off site (roads)		
Description of impact	Air emissions, risk of accidents		
Characteristics			
Measures	A Traffic Management plan will have to be developed, which has to be compulsory for all contractors and subcontractors on roads within the project area as well as on all public roads. • Regular maintenance of the vehicles (brakes, wheels, lights, brakes and power lines, etc.) • The driver has to adapt his driving style to type of charge and the weight of the charge (braking distance increases with the weight), special caution has to be taken in front of schools where children suddenly cross the street. • In the villages animals and pedestrians have the right of way. • Procedures if an accident occurs (whom to call, which is the next hospital, etc.) including reporting procedures. • It is forbidden to create new pathways apart from the designated roads/tracks • Actions to be taken if the driver does not comply with the set guidelines. • Adequate signing, warnings and controls have to be implemented like speed limits. • Enforce maximum load restriction • Implement a maintenance program for access roads carried out before rainy season (cleaning gutters, improvement of the road if necessary, etc.) • Develop procedures for parking and on-site traffic movement • No drugs during working time • Use if feasible project buses to transport workers to the site.		
Effects	• reduce the risk of accidents and injuries to persons • reduce air emissions (exhaust gas, dust) • reduce lubricant and oil losses.		
Responsibilities	Rogun HPP to include the clauses in the tender document; Contractor to comply with the clauses in his tender.		
Detailed plan	Detailed action plan on how to adhere to the clauses in the tender document and how to guarantee the compliance with best practice has to be provided by the Contractor. This action plan has to be approved by the EMP implementation unit.		
Implementation	Starting when construction starts, ending by completion of construction and re-vegetation works		
Monitoring	Periodic check of vehicles and machines. Immediate removal of lorries and other vehicles visibly emitting "black clouds".		
Cost estimate	Has to be included in the cost proposals of contractors.		
Observations			
Reporting	• Normal (monthly, quarterly, annual) reports • Immediate reporting of accidents (see measure No. 1).		

Measure	**Air pollution**	**No.**	**5**
Impact	Air pollution		
Phase	Construction Phase		
Project component	Construction of Rogun HPP		
Affected part of environment	Air quality		
Place	On site (construction site), off site (roads and surroundings due to traffic)		
Description of impact	Air pollution (mainly emission of nitrogen oxides (NOx) and particulate matter) will result from all construction activities related to the project. The three main sources are (i) emissions related to the construction activities, (ii) emissions resulting from transport of material and personnel from/to the construction sites, and (vi) emissions of burrow areas, quarries and dumping sites.		
Characteristics	Main air pollution will result from construction machinery and delivering of construction material. transient; high probability; low importance.		
Measures	The following air pollution control measures have to be included as clauses in the tendering documents for all construction, demolition and construction works: • Use only adequate and well maintained construction and transportation equipment including diesel fuel of good quality. The reduction of particulate (soot) emitted by diesel engines is by far the most efficient measure for keeping the air pollution low. • Organize the sequence of construction activities in a way that the use of construction equipment powered by diesel fuel is optimized and the duration of use is minimized. • Take appropriate measures for dust suppression; this includes among other good housekeeping and water sprinkling especially on unpaved access roads. • Optimise storage on-site of materials that are known to be whirled up by wind. • Truck which transport construction material for longer distances (quarry to construction site) should be covered. • Do not exceed speed limits • Do not burn waste • Avoid burning of inopportune or hazardous combustible material. • Instruct the workforce on the appropriate measures to minimize air pollutants and dust.		
Effects	• Up to 50% less dust produced compared to construction site without specific precautions for dust suppression • About 30% less emission of NOx and up to 95% less emission of soot compared to heavy duty traffic and civil construction works. without enforcing of proper maintenance		
Responsibilities	Rogun HPP to include the clauses in the tender document; Contractor to comply with the clauses in his tender.		
Detailed plan	Detailed action plan on how to adhere to the clauses in the tender document and how to guarantee the compliance with the standards has to be provided by the Contractor. This action plan has to be approved by the EMP implementation unit.		
Implementation	Starting when transport for construction material starts, ending by completion of construction and re-vegetation works		
Monitoring	All organisational measures for dust minimizing and proper maintenance of the construction machinery and the lorries should be monitored continuously by the EMP unit and audited every trimester by POE		
Cost estimate	Has to be included in the cost proposals of contractors. Based on experience of similar construction sites, the financial proposals for construction and demolition works including the mentioned measures for minimizing air pollution are about 1 to 2% higher than without a commitment to meet these measures.		
Observations	Provisions for air pollution control should be included in the tender documents for all construction, demolition and maintenance works.		

Measure	**Noise and Vibration**	**No.**	**6**
Impact	Noise		
Phase	Construction Phase		
Project component	Construction site and transport		
Affected part of environment	Noise		
Place	On site (construction site), off site (roads and surrounding due to traffic)		
Description of impact	The significant impact of the project on the noise environment will be limited in time to the construction and transportation activities. The three main sources are (i) noise related to the construction activities for the HPP (vehicles, machines), (ii) heavy duty traffic noise along roads crossing inhabited areas, generated by transport of material from/to the construction sites, and (iii) blasting.		
Characteristics	(i): no major negative impact on noise sensitive areas is expected because of the distance between construction site and noise sensitive areas (about 500 m to the next villages, once the resettlement of villages in the risk zone will have been finalised). (ii): currently there is not enough information on daily transports to the construction area, it is known from previous projects, noise generated by road transport for construction activities of that scale and type remain well within the acceptable limits. (iii): potentially harmful effects on workers exposed to high noise levels in their work place (crushing plant, generators,…).		
Measures	The following noise control measures have to be included as clauses in the tendering documents for all construction works: • Use only well maintained construction and transportation equipment including state-of-the-art built in systems to reduce the noise. • Workers exposed to excessive noise have to wear PPE (ear protectors). • Separate installation areas, for example mechanical workshops etc., from areas that are used by people for temporary housing and recreation. • The quarry must be located in a sufficient distance to any populated area. • Avoid any noise-intensive works such as piling, demolition, metalworking and blasting (in quarries) etc. during night time. • Avoid transporting of material (rock, concrete, steel, machinery) during night time. • Use adequate and state of the art techniques for blasting, which do not exceed the exposition time to the noise. Noise and vibration associated with the use of explosives needs to be monitored. Max 136db • Restrict access during blasting events. • Instruct the workforce to avoid unnecessary noise.		
Effects	Maintaining the noise standards set by international organisations such as WHO.		
Responsibilities	Rogun HPP to include the clauses in the tender document; Contractor to comply with the clauses in his tender.		
Detailed plan	Detailed action plan on how to adhere to the clauses in the tender document and how to guarantee the compliance with the standards has to be provided by the Contractor. This action plan has to be approved by the EMP implementation unit.		
Implementation	Starting when transport for construction material starts, ending by completion of construction and clean-up/re-vegetation works		
Monitoring	All organisational measures for noise preventing and proper maintenance of the construction machinery and the lorries should be monitored continuously by the EMP unit and audited by POE.		
Cost estimate	Has to be included in the cost proposals of contractors. Based on experience of similar construction sites, the financial proposals for construction and demolition works including the mentioned measures for noise protection are less than1% higher than without a commitment to meet these measures		
Observations	Provisions for noise control should be included in the tender document for all construction and maintenance works.		

Measure	**Waste Management**	**No.**	**7**
Impact	Waste		
Phase	Construction Phase and Operation Phase		
Project component	Construction, operation and maintenance of Rogun HPP.		
Affected part of environment	Environment		
Place	On site (construction site)		
Description of impact	Domestic waste Solid waste Liquid waste Hazardous waste		
Characteristics	Domestic waste will occur mainly during construction. Solid waste occurs mainly during construction and demolition of old structures of Rogun HPP. There will be liquid waste from the maintenance of all lorries and construction machinery. Hazardous wastes can occur during construction time for the maintenance of the Machinery Transient and permanent; high probability; high importance		
Measures	The following mandatory waste handling procedures have to be included as clauses in the tendering documents for all construction and operation works for the HPP: • Install garbage cans for temporary waste disposal of domestic waste. Those have to be collected and disposed according to the regulation of solid waste management and approved by the local authorities. • No waste shall be disposed of or buried on the site. Illegal dumping, either at the construction camp, along the roads or in the surrounding areas, or into the river shall not be allowed. • The different types of solid waste have to be separated and disposed of separately according to the environmental guidelines and best practise. • Solid waste generated during construction and at campsites will be properly treated and safely disposed of only in demarcated waste disposal sites. In general waste should be reduced, re-used, recycled and the disposal should be controlled. • Hazardous waste (oil, chemicals, etc.) has to be stored in a designated closed tank and/or area. Until it will be delivered to companies specialised on the proper disposal or recycling of those hazardous wastes. • Containers have to be available at the workshops for the disposal of used filters, gaskets and other spare parts. • The maintenance of machinery and lorries have to be done in workshops, liquids and including the cleaning water to be collected in tanks and transported to the waste water treatment plant. • Oil contaminated water to be treated with an oil skimmer. • A full clean-up of the site has to be carried out after construction. All wastes accumulated during construction and all demolishment wastes from temporary structures have to be disposed properly. • A continuous monitoring of the proper waste handling by the contractor and by the Owner is indispensable to ensure that problems are identified and addressed early • Instruct workforce on appropriate measures to minimize waste and raise the awareness of the workforce. • Implement a waste management for the population upstream of the dam so that the mixture of plastic and tree branches will not block the racks of the HPP		
Effects	Appropriate waste handling measures result in minimisation of contamination of the environment and in improved health protection		

Responsibilities	Rogun HPP to include the clauses in the tender document; Contractor to comply with the clauses in his tender.
Detailed plan	Detailed plan on how to adhere to the clauses in the tender document and how to implement the different waste handling procedures on site has to be provided by the Contractor. This plan has to be approved by the EMP implementation unit.
Implementation	Starting with preparation of construction sites, lasting for construction and operation phase
Monitoring	A continuous monitoring of proper waste handling by the EMP implementation unit is indispensable to ensure that problems are identified and addressed early, thus minimising the risk of unnecessary waste producing and uncontrolled waste disposal. Periodic independent auditing by POE during construction as well of operation of the HPP required
Cost estimate	Has to be included in the cost proposals of contractors. Based on experience of construction sites of similar size, the mentioned waste handling procedures mainly consist of good working practice and therefore do not require additional costs. Exemplary waste handling practices on construction sites normally have the opposite effect: they reduce the amount of waste and save on costs.
Observations	Stringent Provision for waste management should be included in the tender documents for all for construction works. Most of the measures are part of normal good housekeeping procedures for a construction site.

Measure	**Waste Water Management**	**No.**	**8**
Impact	Pollution of surface waters		
Phase	Construction Phase, Operation Phase, Maintenance works		
Project component	Rogun HPP construction site		
Affected part of environment	Water Quality		
Place	Vicinity of construction site		
Description of impact	The potential environmental implications of construction activities on surface water quality include: • Effects on general water quality through construction activities such as painting, grouting, concreting, drilling, use of lubricants and grease etc.; and • Effects on general water quality though instream activities such as placement of rock, piling, dredging and reclamation. During operation the main sources to have an adverse effect on surface water quality are: • The release of waste into the waters near the construction area. Concrete contaminated waters, washing waters of equipment, used lubricants, sewage waste, litter and waste materials; • Discharge of poorly treated waste water from fuel pumping and storage activities.		
Characteristics	With the exception of bacterial contamination stemming mainly from human waste the water quality of the Vahksh river is actually rated 'good' according to international standards. Construction of the HPP will temporarily and locally deteriorate the water quality as a part of the works will have to take place in the water environment. If the mitigation measures to prevent/minimize the input of sediment load, concrete runoff, oily and otherwise harmful liquids into the surface water are enforced, the construction will only have a minor adverse impact**.**		

Measures	The following mandatory water pollution control measures have to be included as clauses in the tendering documents for all construction, demolition and construction works:
	• All necessary steps have to be taken to ensure that oil is not released into the river or allowed to seep into the ground.
	  ◦ Storage of fuel and lubricants away from the river, in designated areas, tight containers placed on sealed surfaces.
	  ◦ Storage areas shall be designed such that they will contain 110 % of the largest container/ vessel stored in the storage area and waterproof, to isolate them from near-by drains; have available on site equipment and materials to execute clean-up (sufficient absorbent).
	  ◦ Good maintenance of vehicles and machines to prevent oil losses.
	  ◦ No cleaning or maintenance of vehicles or machines in close proximity to the river. This must be done on specially prepared places (workshops) equipped with oil skimmers.
	  ◦ the use of biodegradable oils
	  ◦ the provision of waste oil reception facilities (or oil banks).
	• Unnecessary dangerous chemicals and/or toxic substances are forbidden to use.
	• Where water quality endangering liquids are handled for any purpose, the methods employed have to meet accepted standards for health, safety and the environment. Adequate training for appropriate site personnel is imperative, both during construction and operation.
	• For in-stream works, using isolation techniques such as berming or diversion during construction to limit the exposure of disturbed sediments to moving water.
	• Restricting the duration and timing of in-stream activities to dry season, and avoiding periods critical to biological cycles of valued flora and fauna (e.g., migration, spawning, etc.).		

	• Do not install a deposit even for uncontaminated gravel from the quarry near any body of surface water • All the water draining down from the quarry needs to be lead to sedimentation and neutralisation ponds and has to be treated before releasing it to the river. • All the waters from the batching plants, the concrete mixer washing facilities and the crusher plants needs to be collected and treated before releasing to the environment. • Blasting material has to be disposed in an adequate distance to the river. The contaminated water should be collected and treated before release into the river. Nitrite ions (NO_2^-) as a result of blasting are highly toxic to fish fauna even in rather low concentration. • Sewage effluent is not allowed to be discharged into surface waters without treatment, again due to the effects on the natural and human environment, meaning that suitable facilities have to be provided for the reception of all sewage waste resulting from the construction site. In addition, disposal of strong cleaning agents, cooking oils and general litter/waste to proper reception facilities has to be implemented • Waste water from the camp site must be collected in portable latrines or septic tanks and has to be treated before releasing into a river.
Effects	The water pollution control measures during construction and operation will considerably reduce the discharge of water deteriorating substances and thus improving quality of the surface waters
Responsibilities	Rogun HPP to include the clauses in the tender document; Contractor to comply with the clauses in his tender.
Detailed plan	Detailed plan on how to adhere to the clauses in the tender document and how to implement the different water pollution control measures on site has to be provided by the Contractor. This plan has to be approved by the EMP implementation unit.
Implementation	Starting with preparation of construction sites, lasting for construction and operation phase
Monitoring	Water quality needs to be monitored at each location where used water (treated water) enters into natural surface water e.g. after sedimentation and neutralisation ponds before entering into the river. An online monitoring or a daily sampling is recommended with a reduced set of parameters (pH, TSS, temperature, conductivity, dissolved oxygen) to be able to detect any spills or leakages fast and to react adequately. A continuous regimen of maintenance and technical monitoring of processes by the EMP unit is indispensable to ensure that problems are identified early on, thus minimising the risk of oil accidentally entering the surface waters or ground. Periodic independent auditing by POE during construction as well of operation of the HPP required
Cost estimate	Costs for waste water collection and treatment (inclusive of suitable container held WWTPs) have to be included in the Contractor's proposal.
Observations	none

Measure	**Erosion prevention**	**No.**	**9**
Impact	Soil erosion		
Phase	Construction Phase		
Project component	Rogun HPP construction site		
Affected part of environment	soil		
Place	On site (construction site), off site (roads, quarries and dumping sites for excavation material)		
Description of impact	Soil erosion will result from all construction activities related to the project especially there where the vegetation cover is removed.		
Characteristics	Main soil erosion will result from transport, burrow areas, dumping sites and the construction site itself. transient; high probability; low importance		

Measures	Good engineering practices will help controlling soil erosion both at construction sites and in peripheral areas, particularly in borrow and dumping areas and along access roads. The following erosion control measures have to be included as clauses in the tendering documents for all construction works:
	• The Contractor needs to identify sensitive areas, so that these can be avoided if possible,
	• if not possible state of the art techniques needs to be used to reduce erosion were possible:
	  • Install sediment traps
	  • Drainage channels where necessary
	  • Prevent steep slopes, define optimum height of work evaluating the instability of the rock, soil etc.
	  • Slope properly, stabilise, compact and strengthen steep slopes
	  • Adequate selection of road tracks, taking into account the landscape, technical environmental and social aspects
	  • Construct drainage ditches at roads if there are passing through mountainous area If the slope is more that 16 % they have to be paved
	  • install culverts with enough capacity for strong rains, drainage pipes and channels have to be of an adequate size and should be equipped with screens at entrance and exit points to reduce the risk of clogging
	  • Re-vegetation as soon as possible
	  • Areas sensible to erosion should be monitored		

Effects	The erosion prevention control measures during construction and operation will considerably reduce the soil erosion and therefore also the suspended solids in the river and thus improving quality of the habitats and water quality		
Responsibilities	Rogun HPP to include the clauses in the tender document; Contractor to comply with the clauses in his tender.		
Detailed plan	Detailed action plan on how to adhere to the clauses in the tender document and how to guarantee the compliance with best practice has to be provided by the Contractor. This action plan has to be approved by the EMP implementation unit.		
Implementation	Starting when construction starts, ending by completion of construction and re-vegetation works		
Monitoring	Steep slopes, excavation material disposal areas and especially the parts of the river banks where the vegetation has been cleared have to be monitored periodically.		
Cost estimate	Has to be included in the cost proposals of contractors.		
Observations	Re-vegetation has to start as soon as possible with native species.		

Measure	**Hazardous Material Management**	**No.**	**10**
Impact	Soil contamination, water contamination		
Phase	Construction Phase		
Project component	Construction and operation of Rogun HPP		
Affected part of environment	Soil, water, work force		
Place	On site (construction site), off site (roads, quarries and dumping sites for excavation material)		
Description of impact	contaminate the soil and water, risk for occupational health		
Characteristics	Spillages and/or leakages can occur during the construction and operation due to improper maintenance of equipment, storage tanks of oil or any other toxic substances. • Toxic or flammable gases • Flammable liquids • Flammable solids • Oxidizing substances • Toxic and infectious substances • Corrosive substances • Miscellaneous dangerous materials. transient; high probability; low importance		
Measures	• Hazardous materials (oil, chemicals, etc.) have to be stored in a designated closed tank, storage and/or area. • Prohibition of dumping of any contaminating material product into the environment is prohibited (including oil, waste oils). • Storage and routine handling of fuels, lubricants, and other contaminating substances in workshops with sealed floor and equipped with a drainage system with oil skimmer. • Storage areas shall be designed such that they will contain 110% of the largest container/vessel stored in the storage area; suitable clean-up equipment and material needs to be on site. • Supply agreement will include responsibility for supplier to take waste oil. • The Contractor will verify each supply/disposal subcontractor(s) has adequate arrangements or facilities for proper disposal, treatment or recycling of these wastes. • Each storage container should be marked visible with the necessary precaution signs and the Material Safety Data Sheet needs to be readily accessible to the workers. • Hazardous wastes have to be stored in a designated closed tank, storage and/or area (do not mix anything). Until it will be delivered to companies specialized on the proper disposal or recycling of those hazardous wastes. • All employees working with Hazmats should be provided with suitable personal protection equipment (footwear, masks, protective clothing and goggles in appropriate areas), emergency eyewash and shower stations, ventilation systems, sanitary facilities, pre-employment and scheduled periodic medical examinations. • All employees working with Hazmats should be trained in hazard identification, safe operating procedures, appropriate materials handling procedures, safe work practices, basic emergency procedures, and (if applicable) special hazards unique to their jobs. • A continuous monitoring of the proper hazardous material handling by the contractor and by the Owner is indispensable to ensure that problems are identified and addressed early. • Transportation procedures should be prepared to be consistent with internationally accepted standards and should cover, at a minimum the following: (i) ensuring that the nature, integrity and protection provided by packaging and containers used for transport are appropriate for the kind and quantity of hazardous material involved; (ii)		

	ensuring adequate transport vehicle specifications; (iii) routes used; (iv) loading and unloading procedures; (v) informing employees involved in the transportation and training them as appropriate to handle normal operations and emergencies; (vi) using labelling and placarding (external signs in transport vehicles) as required; and (vii) providing the necessary means for emergency response; and (viii) compliance audit procedures.
Responsibilities	Rogun HPP to include the clauses in the tender document; Contractor to comply with the clauses in his tender.
Detailed plan	Detailed action plan on how to adhere to the clauses in the tender document and how to guarantee the compliance with best practice has to be provided by the Contractor. This action plan has to be approved by the EMP implementation unit.
Implementation	Starting when construction starts, ending by completion of construction and re-vegetation works
Monitoring	Monitoring records must be made available to employees handling Hazmats and Rogun HPP; records should be kept for Lenders review and reports on Hazmat management.
Cost estimate	Has to be included in the cost proposals of contractors.
Observations	

Measure	**Equipment Maintenance Management**	**No.**	**11**
Impact	Soil contamination, water contamination, occupational health and public health		
Phase	Construction Phase		
Project component	Construction of Rogun HPP		
Affected part of environment	Soil, water, population		
Place	On site (construction site), off site (roads, quarries and dumping sites for excavation material)		
Characteristics	Improper maintenance of equipment leads to spillages, unnecessary high air emissions, and unsafe working conditions. transient; high probability; high importance		
Measures	The Equipment Maintenance Management Plan needs to contain: • the processes for the maintenance of the different construction equipment, with respect to the manual of each equipment or vehicle, used on-site and off-site, • maintenance protocols should be developed for the different equipment, machine and vehicle types, • the periodicity in which the maintenance inspections needs to be carried out for the different equipment, machines and vehicles types needs to be determined. • procedures will have to be set up to take not maintained equipment and or unsafe equipment out of operation until it has been repaired and is in compliance with the safety standards. All maintenance protocols needs to be kept on the construction site and a copy should be carried within the vehicle and need to be shown if they are inspected.		
Effects	Safe construction work and transportation reduction of air emissions, noise, contamination of soil and water		
Responsibilities	Rogun HPP to include the clauses in the tender document; Contractor to comply with the clauses in his tender.		
Detailed plan	Detailed action plan on how to adhere to the clauses in the tender document and how to guarantee the compliance with best practice has to be provided by the Contractor. This action plan has to be approved by the EMP implementation unit.		
Implementation	Starting when construction starts, ending by completion of construction and re-vegetation works		
Monitoring	Periodical monitoring time frequency depends on the construction machinery itself, should be in the manual of each equipment		
Cost estimate	Has to be included in the cost proposals of contractors.		

Measure	**Pollutant Spill Contingency Plan**	**No.**	**12**
Impact	Soil contamination, water contamination		
Phase	Construction Phase		
Project component	Construction of Rogun HPP		
Affected part of environment	Soil, water		
Place	On site (construction site), off site (roads, quarries and dumping sites for excavation material)		
Description of impact	Accidental spillages or leakages will contaminate the soil, ground and surface water		
Characteristics	Spillages and/or leakages can occur during the construction and operation due to improper maintenance of equipment, storage tanks of oil or any other toxic substances. transient; high probability; low importance		
Measures	The Contractor’s Pollutant Spill Contingency Plan will outline the procedures for proper handling of potential pollutants and procedures to be carried out in the event of a pollutant spill. It will also specify equipment procurement and training of construction personnel. The most important pollution mitigation measures are shown below: • The Contractor needs to identify sensitive areas, so that these can be avoided if possible. • Prohibition of dumping of any contaminating material product into the environment is prohibited (including oil, waste oils). • Storage and routine handling of fuels, lubricants, and other contaminating substances in workshops with sealed floor and equipped with a drainage system with oil skimmer. • Storage areas shall be designed such that they will contain 110% of the largest container/vessel stored in the storage area. • Suitable clean-up equipment and material needs to be on site, • All wastes recovered during clean-up operations to be collected and stored for subsequent disposal. • Supply agreement will include responsibility for supplier to take waste oil. • The Contractor will verify each supply/disposal subcontractor(s) has adequate arrangements or facilities for proper disposal, treatment or recycling of these wastes. • Personnel will be educated on proper use and disposal of hazardous materials.		
Effects	Unexpected spills and leakages will be treated properly and fast, the contamination of soil will be locally and due to clean-up mechanisms not spread into the surrounding or drained into the water and/or groundwater.		
Responsibilities	Rogun HPP to include the clauses in the tender document; Contractor to comply with the clauses in his tender.		
Detailed plan	Detailed action plan on how to adhere to the clauses in the tender document and how to guarantee the compliance with best practice has to be provided by the Contractor. This action plan has to be approved by the EMP implementation unit.		
Implementation	Starting when construction starts, ending by completion of construction		
Monitoring	• Regular visual control of fuel containers etc. • Water quality monitoring including detection of oil.		
Cost estimate	Has to be included in the cost proposals of contractors.		
Reporting	• Normal (monthly, quarterly, annual) reports • Exceptional events (e.g. major oil spills) have to be reported immediately (event, measures taken, impacts, follow-up).		

ANNEX 3 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

A3.1 Sample Environmental Contract Clauses

The following clauses are formulas proposed by the World Bank. If they are applied, they might have to be adapted to the specific conditions presented by the Project in question.

The following text was taken over from a World Bank document (WB 2008). Only slight modifications to the original were made in order to adapt it to the present Project. Note that all relevant measures addressed here are also addressed in the Mitigation Measure Data Sheets provided in Annex 2.

DRAFT ENVIRONMENTAL CONTRACT CLAUSES

Environmental Management, Safety and Security

1. Before the order to commence civil works, the contractor is required to implement the Environmental Management Plan (EMP) as specified in the Environmental Impact Assessment (EIA) prepared for the particular works. The Plan spells out how the contractor should achieve environmental targets and objectives specified in the EMP and agreed upon by the Parties. The plan shall include all steps to be taken by the Contractor to protect the environment in accordance with the relevant national legislation for environmental protection. Where the EMP does not exist, the clauses contained herein shall form the basis of a rehabilitation plan.

2. Notwithstanding the contractors' obligation under the above clause, the Contractor shall implement all measures necessary to keep all sites at acceptable standards and abide by environmental performance indicators specified under the EMP to measure progress towards achieving objectives during execution or upon completion of civil works. These measures shall include, but are not limited to the following:

a. Minimize the effect of dust on the surrounding environment resulting from quarries, earth mixing sites, asphalt and concrete mixing sites, vibrating equipment, temporary or permanent access roads, along transport routes, etc. to ensure safety, health and the protection of workers and communities living downwind of dust producing activities.
b. Ensure that noise levels emanating from machinery, vehicles and noisy construction activities are kept at a minimum for the safety, health and protection of workers within the vicinity of high noise levels and communities near rock - blasting areas.
c. Ensure that existing water flow regimes in rivers, streams and other natural or irrigation channels - if any - are maintained and/or re-established where they are disrupted due to civil works being carried out.
d. Prevent bitumen, oils, lubricants and waste water used / produced during the execution of works from entering into coastal or other natural water bodies.
e. Ensure that stagnant water in uncovered borrow pits is treated in the best way to avoid creating possible breeding grounds for mosquitoes.
f. Prevent and minimize the impacts of quarrying, earth borrowing, piling and building of temporary construction camps and access roads on the bio-physical environment including protected areas and arable lands; local communities and their settlements. In as much as possible restore/rehabilitate all sites to acceptable standards.

g. Discourage construction workers from engaging in the exploitation of natural resources, mainly fishing, or any other activity that might have a negative impact on the social and economic welfare of the local communities. Especially prevent the use of explosives for fishing activities.
h. Ensure that garbage, sanitation and drinking water facilities are provided in construction workers camps.
i. Ensure that in as much as possible, local materials are utilized to avoid importation of foreign material and long distance transportation.
j. Ensure public safety and meet traffic safety requirements for the operation of work to avoid accidents.

3. The contractor shall indicate the period within which he shall maintain status on site after completion of civil works to ensure significant perturbations arising from such works have been taken into account.

4. The contractor shall adhere to the proposed activity implementation schedule and the monitoring plan / strategy to ensure effective feedback of monitoring information to both project management (PIU) and the environmental protection authority (EPA), so that impact management can be implemented properly, and if necessary, adapt to changing and unforeseen conditions.

5 The environmental specialists of the contractor, together with the environmental specialist of PIU and with EPA, and the PoE, as the case may be, shall inspect significant sites where civil works have been carried out and proposed mitigation measures implemented and shall give certification regarding the adequacy or inadequacy of rehabilitation measures carried out on the bio-physical environment resulting from implementation of civil works.

6. If the Contractor fails to implement the approved EMP and fails to do so in spite of notification by PIU, this latter shall seek legal redress through EPA and appropriate penalties shall be instituted in accordance with the provisions of the relevant environmental legislation.

Worksite/Camp Site Waste Management

- All vessels (drums, containers, bags, etc.) containing oil/fuel/surfacing materials and other hazardous chemicals must be bunded in order to contain spillage. All waste containers, litter and any other waste generated during the construction shall be collected and disposed of at designated disposal sites in line with municipal regulations.
- All drainage and effluent from storage areas, workshops and camp sites shall be captured and treated before being discharged into the drainage system.
- Used oil from maintenance shall be collected and disposed of appropriately at designated sites or be re-used or sold for re-use locally.
- Entry of runoff to the site shall be restricted by constructing diversion channels or holding structures such as banks, drains, dams, etc. to reduce the potential of soil erosion and water pollution.
- Construction waste shall not be left in stockpiles along the road. Waste and other excess material shall be used for rehabilitating borrow areas and landscaping around the road.
- If other spoil disposal sites are necessary, they shall be located in areas of low land use value and where they will not result in material being easily washed into drainage channels. Whenever possible, spoiled materials should be placed in low-lying areas and should be compacted and planted with species indigenous to the locality.

A3.2 Sample Waste Management Plan

On the following pages, a sample waste management plan is provided as an example on how such a plan (which is one of a number of Sub-ESMPs to be developed) could be structured.

When reading this plan it has to be considered that it was originally not developed specifically for Rogun HPP, but for a different project. Some adaptations were made (e.g. the mentioning of Rogun HPP, or reference to Tajik legislation). Still, while much of it could be taken over, obviously some project specific adaptations will still have to be made in any case.

SAMPLE WASTE MANAGEMENT PLAN FOR XXX PROJECT

1. DEFINITIONS AND ABBREVIATIONS

The principal terms and abbreviations used in the present document are reported below:

EI	Environmental Inspector
EMMP	Environmental Mitigation Monitoring Plan
EO	Environmental Officer
HPP	Hydro Power Project
HSE	Health Safety and Environmental
PSCS	Pollutant Spill Contingency Plan
WMP	Waste Management Plan

2. PURPOSE AND SCOPE

2.1 PURPOSE

The Waste Management Plan (WMP) describes how waste associated with site works in the framework of the Rogun HPP will be managed by the Contractor. The purpose of the WMP is to:

- Identify the different types of waste in accordance with Tajik regulations;
- Define waste segregation criteria;
- Provide the baseline document to obtain any waste permits;
- Establish the general criteria to avoid or to effectively minimize, manage, monitor any possible form of environmental damage or pollution during works;
- Define recording, monitoring and waste tracking procedures;
- Define responsibility for waste management handling including safe disposal.
- Facilitate compliance with applicable requirements (Tajik legislation, applicable international standards, and other requirements).

The Contractor will promote and enforce waste minimization activities. Waste minimisation can be accomplished through a hierarchical application of practices, including:

- Pre-planning
- Reduction
- Reuse
- Recycling
- Recovery
- Treatment
- Responsible disposal.

During the construction period, The Contractor will be responsible for collection, storage, treatment, transport and disposal of all types of waste generated by its activities.
For the purposes of this plan, waste has to be defined to be included into different waste typologies.
The Contractor will provide all necessary planning, materials, equipments, tools and training required to ensure appropriate project waste management related to Rogun HPP activities. The Contractors employees and subcontractors personnel will be properly trained.
The waste associated with pollutant spill response activities (e.g. contaminated soil, absorbents etc.) will be managed as hazardous waste in accordance with the WMP. The "Hazardous Material Management Plan" and the "Pollutant Spill Response Plan" will provide procedures and guidance for

managing hazardous substances (e.g., gasoline, diesel, oil, grease, chemicals) to prevent releases to the environment.

2.2 SCOPE

This WMP is applicable across the Contractor’s entire direct and indirect activities (i.e. subcontractors) at Rogun HPP main site and accommodation camp construction sites.

3. REFERENCES AND OTHER RELEVANT DOCUMENTS

Include references used e.g.

- The Tajik Legislation Concerning Waste
- IFC General EHS Guidelines: Environmental, Wastewater and Ambient Water Quality, April, 2007
- IFC General EHS Guidelines: Environmental, Waste Management, April, 2007
- ESIA Report, ESMP Report.

4. RESPONSIBILITIES

The Project Environmental Manager (PEM), is ultimately responsible for the implementation of this WMP.
While the PEM shall have overall responsibility for the implementation of this plan, all supervisors, including subcontractor supervisors, will be made aware of, and sensitized to this plan. Formal reporting mechanisms between supervisors shall include reporting on the implementation of the requirements enumerated in this plan.

5. LEGAL AND OTHER REQUIREMENTS

The reference sources which need to been used to identify the legal and other associated requirements relating to the waste management at the Contractors site are the Tajik legislation e.g. Law “On Production and Consumption Waste” and relevant international standards (e.g. IFC). (A full list of applicable regulations Tajik and IFC requirements should be included here).

6. WASTE MANAGEMENT PROCEDURE

6.1 WASTE MANAGEMENT APPROACH

Due to the sensitivity of terrestrial and fluvial areas affected by Rogun HPP activities, site works will be carried out with the utmost care to environmental issues by means of suitable arrangements to ensure that any potential sources of pollution have been identified, evaluated and monitored accordingly.
Waste management incorporates handling, storage, collection and disposal of waste in designated sites.
Waste handling, storage, transportation and disposal procedures should prevent the occurrence of the following hazards as the minimum safety level:

- Contamination of surface water and groundwater
- Emission of airborne pollutants
- Nuisance created by noise, dust and odour
- Health hazards created by breeding vector
- Injuries to workers and public health & safety and

- Hazards to fish and wildlife.

The Contractor will obtain as soon as possible any waste approvals or contractual agreements required to meet applicable requirements in compliance with this WMP.
Procedures for proper management of hazardous substances and fuel products (e.g., gasoline, diesel, oil, grease) to prevent releases to the environment are addressed in the “Hazardous Material Management Plan” and in the “Pollutant Spill Response Plan”.

6.2 WASTE MINIMISATION

The Contractor will promote and enforce waste minimization activities. Waste minimisation approach aims at:

- Identifying opportunities to prevent and minimise waste generation from construction activities;
- Identifying and eliminating hazards to human health and the environment;
- Minimising exposure to potential liabilities at acceptable cost.
- Waste minimisation is generally accomplished through the "4Rs" - reduce, reuse, recycle and recover. Optimisation efforts will be supported through:
- Promoting low waste-generating processes and operating, maintenance and housekeeping practices
- Purchasing of materials in returnable containers or in bulk
- Selecting of hazardous chemicals based on ecological information in order to prevent pollution.

6.3 PROJECT WASTE IDENTIFICATION AND CLASSIFICATION

As it is stated in the Contractor’s Social and Environmental Management Plan, national laws and regulations are at the top of the hierarchy of HSE requirements. Therefore, waste classification will be mainly based on Tajik legislation e.g. Law “On Production and Consumption Waste” and relevant international standards (e.g. IFC) apply.

6.3.1 HAZARDOUS WASTE

Hazardous wastes are classified as those wastes which by virtue of their concentration of constituents and characteristics pose a hazard to human health and/or the environment if improperly managed. In addition, any waste having the characteristics (such as oxidizing, flammable, corrosive, toxic, etc.) must be considered as “hazardous”.
The most common hazardous wastes during the Contractors project activities are:

- Paints (Paint/thinners/coatings);
- Batteries wet & dry (Spent cells used in machineries);
- Chemicals (Process, utilities chemicals - expired, used, unused);
- Waste oils, lubricants (Process and maintenance spent oils from machinery & equipment);
- Medical waste (Dressings, hand gloves, sharps and syringes generated from sick bay, blood).

6.3.2 NON-HAZARDOUS WASTE

Non-hazardous waste will include mainly food waste and metal scraps. In general, non-hazardous waste can be classified as follows:

- Domestic Waste

- Kitchen/canteen (Food/vegetable scraps);
- Cooking oil (Kitchen oil);
- Office trash (Paper, containers, plastic, food, scraps, cartons/cardboard, aluminium cans, etc.) excluding toners.
- Industrial Waste: non-hazardous solid waste generated by manufacturing or industrial processes. They can include but are not limited to: uncontaminated metal scrap, uncontaminated empty metal and plastic drums, electric cable and copper (off-cuts from constructions activities), electrical/electronic components, wood, sludge resulting from processes or treatment operations, tank deposit, ash from incineration, etc.
- Inert Waste: inert waste is neither bio-degradable nor chemically active in the natural environment, such as construction and demolition waste, excavation material, top soil (surface valuable topsoil to be salvaged for reuse).

6.4 HANDLING PROCEDURES

Wastes will be managed in order to reduce their potential to pose a hazard to human and environmental health, and to reduce operating costs and potential future liabilities.
At site, the following issues will be addressed:

- Pollution prevention – elimination, change or reduction of operating practices which result in wastes;
- Source reduction – generation of less waste through more efficient processes;
- Re-use – the use of materials or products that are reusable in their original form;
- Recycling/recovery – the conversion of waste into usable materials, or the extraction of energy or materials from wastes;
- Treatment – the destruction, detoxification and/or neutralization of residues.
- Disposal in an environmental suitable manner

The amount of waste generated will be minimised and the application of reuse and recycling will be maximised whenever reasonably practicable, using appropriate technology, designs and waste management approaches.

6.4.1 WASTE SEGREGATION

All waste will be segregated into clearly marked containers. Each container/skip shall bear prominent labelling, which clearly indicates the container/skip use. An example is shown in the table below.

Table 1 Waste Segregation

Waste skip	Waste classification	Skip contents
A	Hazardous waste - generic	All oil/chemicals/paints contaminated materials including paint tins, oily rags, empty chemical containers, oil spill granules, etc.
B	Hazardous waste - medical	Medical
C	Non-hazardous – Plastic	Non-biodegradable - Municipal and industrial
D	Non-hazardous – Metal	Non-biodegradable - Municipal and industrial
E	Non-hazardous - Organic waste	Biodegradable - Waste food, paper, etc.

Waste streams segregation will be addressed based on waste hazard classification, biodegradability, potential for re-use or recycling and final disposal. In any case, hazardous wastes must always be segregated from non-hazardous wastes.
Chemical waste materials will be classified according to the product type and as indicated in the material safety data sheet (MSDS). Wastes from different sources will not be placed in the same container unless written confirmation is available to determine chemical compatibility. Mixing between hazardous and not hazardous waste will be prohibited.
Personnel will be deployed to ensure segregation of waste in accordance with criteria above mentioned. Segregation criteria relevant to each class of waste are described hereunder.

6.4.1.1 Hazardous Waste

Hazardous waste will be segregated in separate skips/containers appropriately labelled. The EIs will constantly check that different chemical wastes are not mixed in order to avoid uncontrolled chemical reactions.
Medical waste including dressings, hand gloves, sharps and syringes generated from clinical facilities are classified as hazardous waste. This waste will be segregated, stored in a dedicated, clearly labelled skip or sealable container.
In particular, medical refuse, given its potential risk for blood born pathogenesis transmission (the most contagious of which being HIV virus and Hepatitis B and C) will be obligatorily disposed of under the surveillance of the Site Physician and in compliance with the following rules:

- Refuse that cannot cut or puncture (such as: disposable gloves, surgical masks, etc.) will be collected in specially labelled bags.
- Refuse that can cut or puncture (such as: needles, blades, etc.) will be put in special containers immediately after their use. The containers will be made in such a way as to exclude the possibility of injury to personnel during their storage and disposal
- All medical refuse, whether in bags or in containers, in any case, will be handled using, at least, protective gloves.

6.4.1.2 Non-hazardous municipal waste

Food waste will be collected in closed skips to prevent odours and water contact, stored in the dedicated container/designated storage. Plastic and metal will be processed stored in dedicated containers. Other waste (non-hazardous waste such as non-plastic drums and containers, wood, etc.) will be collected, stored at site for subsequent disposal.

6.4.1.3 Non-hazardous industrial waste

All the industrial waste generated during construction activities will be segregated as appropriate, collected in dedicated labelled skips and stored in a designated storage area.

6.4.1.4 Non-hazardous inert waste

The topsoil and overburden material resulting from excavation activities shall be separately stored and integrally returned in neat uniform layers to borrow areas before completion of works.

6.4.2 WASTE STORAGE

Waste storage areas will be designated, labelled, contained and maintained in accordance with requirements described in the following sections. Before storage takes place at site, the Contractor shall apply for a specific licence.

6.4.2.1 Non-Hazardous Storage Requirements

Non-hazardous storage areas will be selected and designated to prevent any accumulation of refuse and outbreak of health and fire hazards. The following guidelines will apply:

- Storage areas will be readily accessible to collection vehicles;
- Storage areas will be designed to prevent the spread of fire, emission of airborne pollutants, odour and vectors throughout the area;
- Storage areas will be of adequate size and capacity to accommodate required number of containers consistent with waste generation routine and collection schedules;
- Containers will be marked and selected for the specific intended service;
- Containers and storage area will be cleaned on a regular basis;
- Waste material will be removed to the disposal site at the earliest opportunity and as the waste is generated.

6.4.2.2 Hazardous Storage Requirements

The following guidelines will be applied for the storage of hazardous wastes, whenever possible:

- Hazardous waste storage areas will be designed to have spill containment systems;
- Containers and storage tanks will be comprised of suitable/compatible material to permanently contain the hazardous waste and have an identification label (see below);
- Storage facilities will be inspected regularly for leakage and any accumulation will be removed to preclude eventual overflow and seepage into the ground;
- Store in closed containers away from direct sunlight, wind and rain;
- Emergency Response Kit will be available in the storage area for any accidental spillage (also refer to the “Pollutant Spill Contingency Plan”.
- Incompatible materials will not be stored or placed in either common
- containment areas or containers;
- Storage areas will be paved, fenced, marked and illuminated
- Storage areas with hazardous wastes will be secured to minimize the access
- Storage areas waste oil will be equipped with a sealed surface a drainage channel which needs to be equipped with an oil skimmer.
- Containers with liquid waste need to be stored on sealed surface surrounded by an bund with the capacity of 110% of the largest container in the storage area..

Labelling shall be in easily legible characters, written in English and/or the language(s) used on site, and at a minimum, it will contain the following information:

- The identity of the hazardous waste;
- The name and address of the generator of the waste;
- The net contents;
- The normal storage stability and methods for safe storage;
- The name and percentage by weight of active ingredients and names and percentages by weight of other ingredients;
- Warning or caution statements which may include all or some of the following as appropriate

- The words “Warning” or “Caution”, “Danger! Keep away from unauthorised persons”, as appropriate;
- The word “Poison” (marked indelibly in red on a contrasting background) and a pictogram of a skull and crossbones; or the appropriate MSDS hazard code which should be placed on all containers containing hazardous waste;
- A statement of first-aid measures, including the antidote when inhaled or ingested, and a direction that a physician must be contacted immediately;
- Adequate directions, in an accompanying leaflet, for the handling of the waste, including safety precautions in transporting, storage and disposal of the waste and measures for cleaning any equipment used;
- Directions for the disposal of the container and the waste in accordance with the Act and these Regulations; and
- Any other information that the authority may deem necessary.

6.4.4 WASTE TRANSPORTATION

All waste shall be shifted only by the Contractor or an authorized waste handling subcontractor, which will be responsible for waste transportation from the offloading point to the final authorized receiving facility (disposal/recovery sites). In case the transportation is performed by the Contractors, relevant authorizations shall be obtained.
Waste carrier (Contractor or subcontractor) will:

- Be licensed in accordance with Tajikistan Regulations(If necessary),
- Have suitable equipment for the required transportation,
- Ensure transportation is performed in vehicles properly covered so as to avoid spillages along the way,
- Have appropriate emergency response procedures,
- Be equipped with appropriate fire and personnel protection equipment,
- Ensure compliance with applicable Tajikistan legislation.

All hazardous waste containers designated for off-site shipment should be secured and labelled 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) describing the load and its associated hazards.
Transportation will take place during the day and in acceptable weather/road conditions.
The Contractor’s responsibility for the waste ends once the waste has been delivered to an approved site of final treatment/reuse/recycle or disposal.

6.4.5 WASTE DISPOSAL

Waste can be treated, reused, recycled, incinerated or disposed of. The Contractor will promote reuse and recycling, as reasonably practicable. If possible, specific agreements with companies involved in reuse or recycling will be made.
When applicable, waste will be treated to reduce or eliminate any potential environmental hazard prior to final disposal. In no case potentially contaminant waste will be discharged or disposed in any state into the environment unless it has been treated in a treatment facility and in a manner approved by Tajikistan legislation.

6.4.5.1 Hazardous Waste

Dumping of any contaminating material product, including waste oils, into the environment/onto the ground is strictly forbidden. Whenever possible, supply agreements will include responsibility for the suppliers to take waste oil, empty containers, etc.
All hazardous waste, including wastes recovered during cleanup operations, shall be collected and stored for subsequent disposal. The Contractor is investigating the presence of in-country facilities for proper treatment and disposal of hazardous wastes.

6.4.5.2 Non Hazardous Waste

Municipal waste, metal and plastic will be transported to XXXXX disposal site in XXX (to be defined). Plastic and metal waste shall be sorted at the dumping site and sent to recycling plants. Biodegradable waste will be composted at a landfill site designated by the relevant authority. Therefore, as previously stated (see Section 6.4.1), proper segregation of biodegradable from non-biodegradable waste is necessary.
Wood, tires and cable reels may be sold for a nominal fee to local persons or given for free on written request by interested parties. If this is to be done, specific guidelines shall be developed by the Contractor aiming at a correct handling of the process.
In case non-hazardous waste generated at the site cannot be disposed of at licensed disposal location, material will be handled using one of the following options:

- burial,
- incineration,
- distribution to local users, or
- returning to the supplier.

Any burial and burning operations are to adhere to acceptable international standards for these activities and will be used as a last resort. Burning will not occur within the way leave, but at the hydropower station under controlled combustion. Only dry, clean-burning material (wood, cardboard, paper, dry vegetal material) will be allowed to be burned. Burning shall be performed in accordance with the provisions of the “Fire Control” Procedure.

7. WASTE TRACKING (RECORD KEEPING) AND REPORTING

Waste management from will be tracked and recorded according to the Contractor monitoring, recording and tracking system in compliance with any applicable Tajik laws.
The Contractor will keep records of all types of wastes movements.
The waste tracking system will include the following minimum information:

- Waste Classification and description
- Quantity
- Hazardous Properties
- No. & type of containers
- Hazard Class
- Safety Handling Procedures.

The above records shall be made available to the Tajikistan authorities and the Owner upon request. In addition, relevant records will be submitted to the authority every three months.

8. TRAINING

As soon as possible, all involved personnel will be adequately informed about the contents of the WMP by means of awareness meetings.
The Project management team will be briefed by the PEM regarding applicable Tajikistan regulation and international requirements addressing the waste management.
Specific training will be organized by the Contractor for all personnel involved in the Rogun HPP.
Training will cover at least the following information:

- Rules regarding minimization of waste generation
- Waste classification
- Waste handling (storage, loading/unloading, transportation)
- Labelling of waste storage containers
- Waste monitoring, recording and tracking procedures.

Usefulness of segregation explaining different ways of treatments and promoting recycling and reuse.
Suitable notices on waste management matters will be displayed at site in order to provide a continuous reminder and improve individual awareness on waste management procedures during the whole project. Periodical retraining, if required, will be provided for all personnel.

9. MONITORING

The PEM will develop a site-specific waste monitoring program to demonstrate compliance with this plan and with applicable Project, Tajikistan and International requirements.
Environmental Audits will be carried out by the PEM on WMP performance in order to ensure that all activities performed are in compliance with the present plan, including regulations and permits.
The EOs/EIs will regularly monitor waste storage areas also to ensure a high standard of housekeeping at site.

ANNEX 4 OWNER'S MANAGEMENT AND MONITORING PLAN

No entry on this page

Нет записи на этой странице

ANNEX 5 CONSTRUCTION SITE MANAGEMENT

A5.1 Documents related to existing EHS policy / Документы относящиеся к существующей политики охраны окружающей среды, здоровья и безопасности

On the following pages, a number of documents related to EHS policy, obtained from Barki Tojik during the site visit carried out by the Consultant’s landscape architect, are included.

На следующей странице представлено несколько документов относящихся к политике охраны окружающей среды, здоровья и безопасности, полученные от Барки Тоджик во время поездки в объект, осуществляемой ландшафтным архитектором Консультанта.

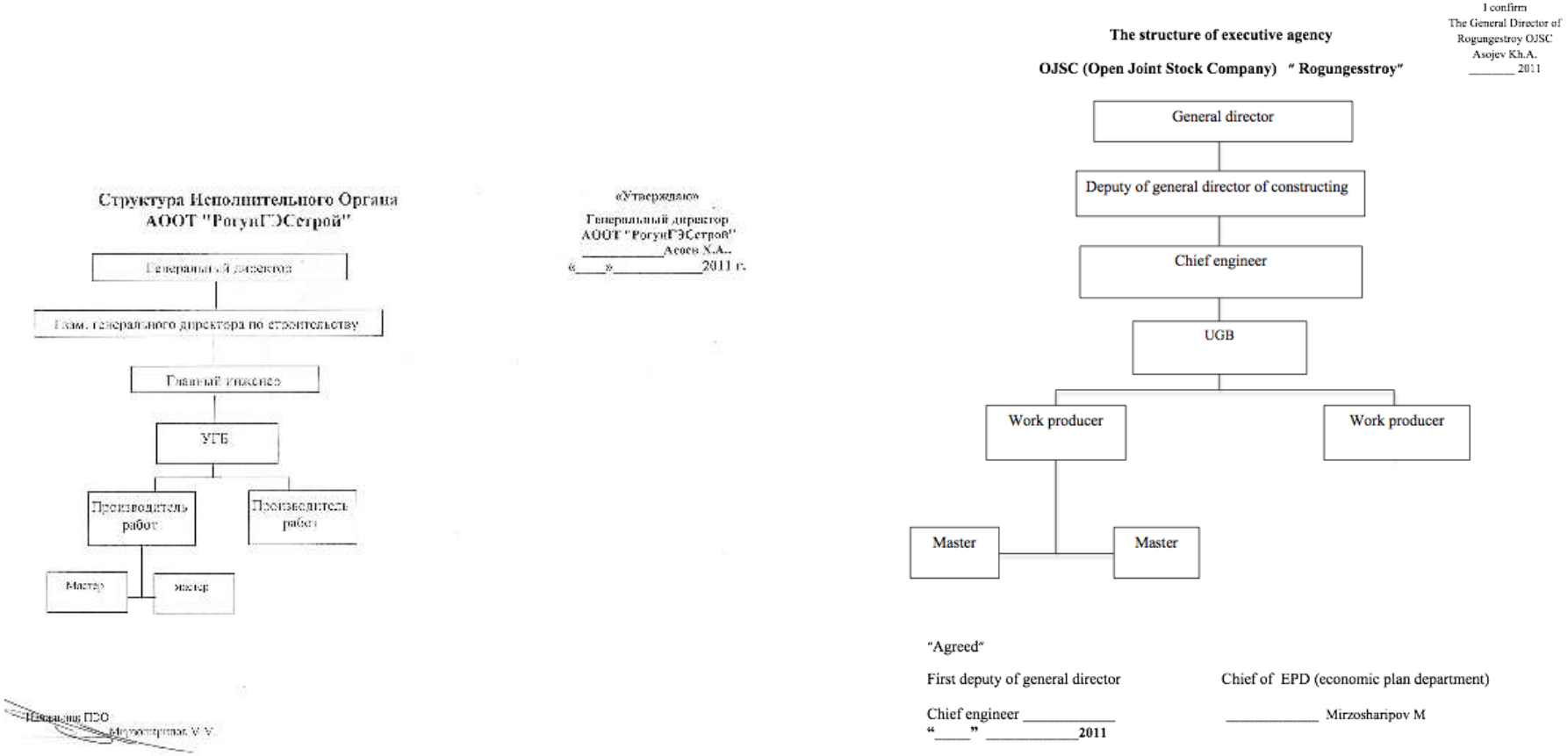
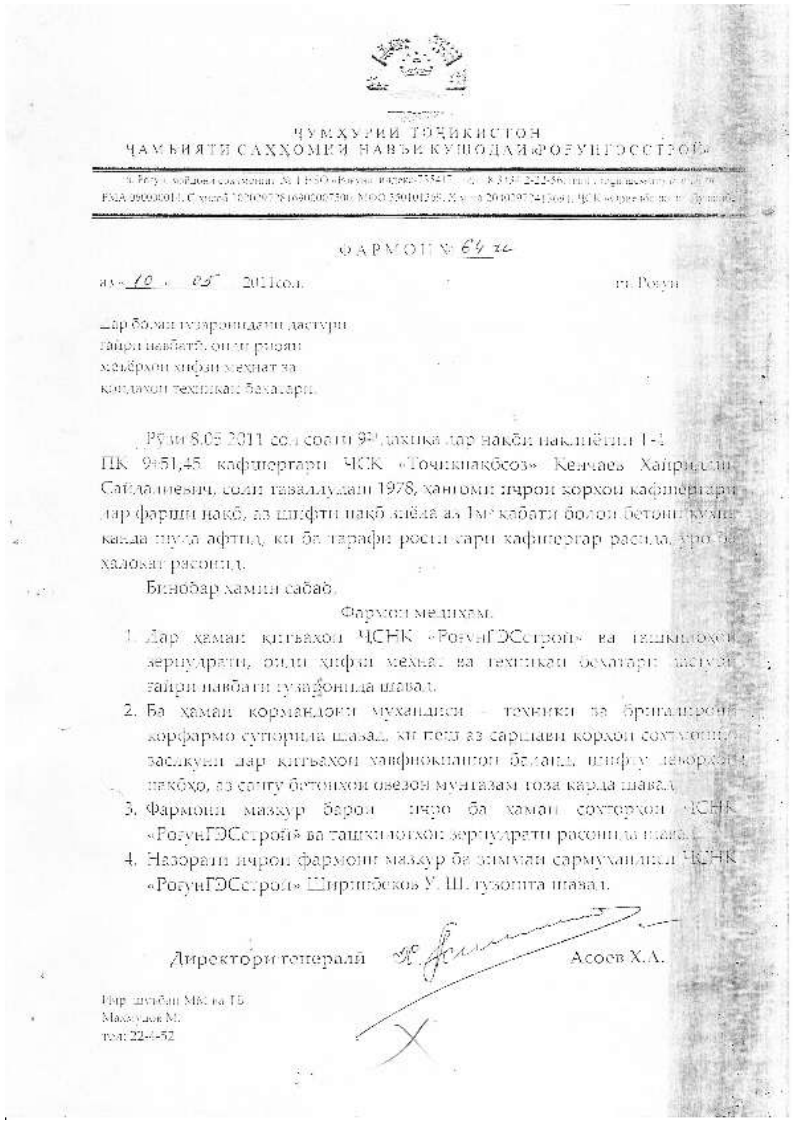


Figure 13: Organisation chart of Rogun HPP / Организационная структура Рогунской ГЭС



ҶУМҲУРИИ ТОҶИКИСТОН
ҶАМЪИЯТИ САҲҲОМИИ НАВБИ КУШОДАИ «РОГУНГЭССТРОЙ»

ФАРМОЙИШ № 64 аз

«10» 05 2011 сол ш. Рогун

Дар бораи гузаронидани дастури
гайри навбатӣ оиди риояи
меъёрҳои ҳифзи меҳнат ва
қоидаҳои техникаи бехатарӣ.

Рӯи 8.05.2011 сол соати 9²⁰ дақиқа дар нақби наклиётии 1-ум ПК 9+51,45 кафшергари ЧСК «Точикнақбосоз» Кенчаев Хайриддин Сайдалиевич, соли таваллудаш 1978, ҳангоми иҷрои корҳои кафшергарӣ дар фарши нақб, аз шифти нақб афтида аз 1м³ кабати болои бетонӣ кушида шуда афтид, ки ба тарафи рости сари кафшергар расида, уро ба халокат расонид.

Бинобар ҳамин сабаб.

Фармоиш медиҳам.

1. Дар ҳаман кисмҳои ЧСНК «РогунГЭСстрой» ва ташкилотҳои зершудрати, оиди ҳифзи меҳнат ва техникаи бехатарӣ дастури гайри навбатӣ гузаронида шавад.
2. Ба ҳаман кормандони муҳандисӣ – техникӣ ва бригадирони корфармо супорида шавад, ки пеш аз сарғози корҳои сохтмонӣ дар кисмҳои ҳавфноктарин баланд, шифту деворҳои нақбҳо, аз сангу бетонҳои овезон мунтазам тоза карда шавад.
3. Фармоиши мазкур барои иҷро ба ҳаман сохторҳои ЧСНК «РогунГЭСстрой» ва ташкилотҳои зершудрати расонида шавад.
4. Назорати иҷрои фармоиши мазкур ба зиммаи сармуҳандиси ЧСНК «РогунГЭСстрой» Ширинбеков У. Ш. гузошта шавад.

Директори генерал Асоев Х.А.

Иҷрошавандаи МБ ва ТБ
Маҳмудов М.
тел: 22-4-52

The Republic of Tajikistan

Open Joint Stock Company “ROGUNGESSTROY”

Order No. 64

From 10.05.2011 Rogun city

About conducting the next statement
concerning following the criterion
of protection of labor and the
technical security rules.

The 8.05.2011 at 9.20 in tunnel T-4 PK 9+51,45 the welder of OJSC Tojiknaqboz Kenjaev, Khayriddin Saydalievich, born in 1978, during welding on the ceiling of the tunnel, a concrete block of about 1m³ broke down and fell to the right side head of the welder and he died.

Because of that

I am ordering

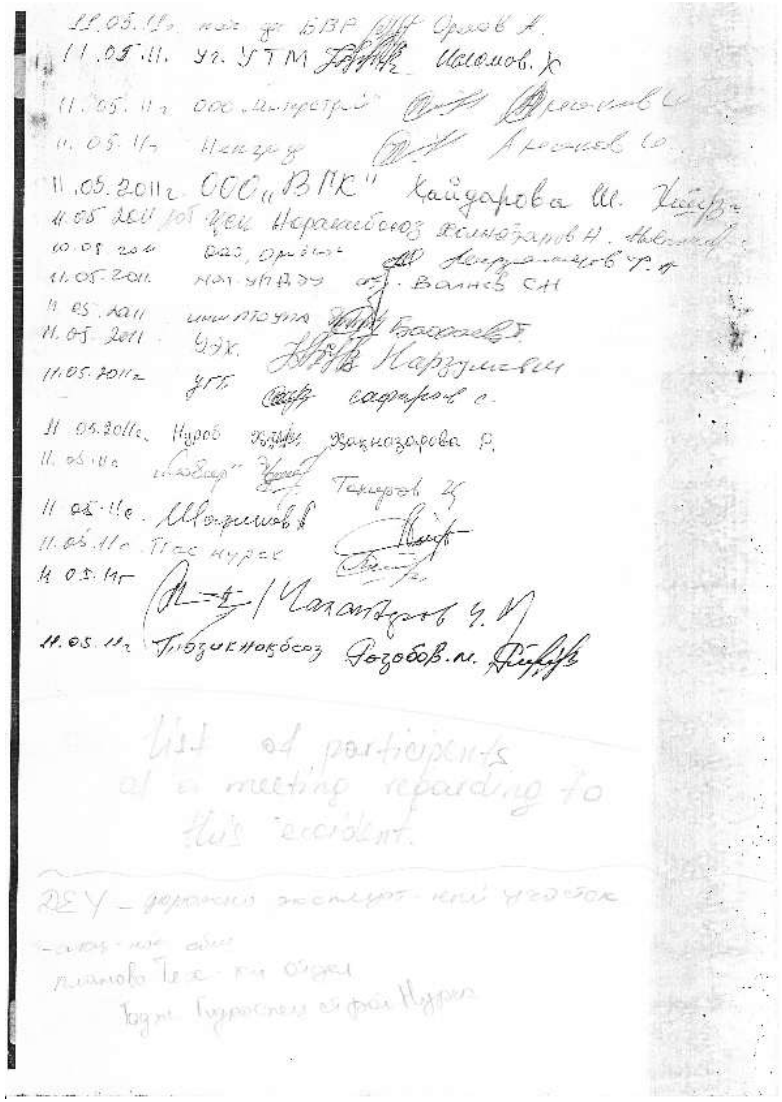
1 In all OJSC Rogungesstroy (= Rogun hydro power plant building) to conduct the statement concerning following the criterion of protection of labor and the technical security rules.

2. All workers on engineering and technique before beginning of the building work and welding in the high places the walls and top of the tunnel should be cleaned from stones and concrete blocks.

3. All the workers of the OJSC Rogungesstroy should be aware about the order.

4. The responsible person for checking the order is followed, is the main engineer of the OJSC Rogungesstroy, Shirinbekov U.SH

The general director Asoev KH.A



List of participants of a meeting regarding to this accident

11.05.11

	Department, Company etc.	Name of participants
1.	The chief of BVR	Orlov A
2.	UTM	Ismoilov KH
3.	Company with limited responsibility "Interstroy"	Amonov I
4.	Nepzod	Amonov I
5.	Company with limited responsibility "VGK"	Haydarova Sh
6.	Open Joint Stock Company "Norakibosoz"	Kholnazarov N
7.	Company with limited responsibility "Oriyono"	Mirzalimov F.A
8.	Chief of road exploitation site	Voliev S.N
9.	Planning and Technical Department	Baroev T
10.	UEH The administration energy department	Narzulloev M
11.	UGB	Safarov S
12.		Nurob Haqnazarova R
13.	"Sobir"	Tohirov J
14.		Sharishov A
15.	TGES "Nurek"	
16.		Chamanbekov Ch
17.	"Tojiknaqbsoz"	Rajabov M

Figure 14: Protocol of follow-up on an accident / Протокол принятия мер в случае несчастного случая

АКТ
горной комиссии

18 апреля 2011 г. г. Рогун

Комиссия в составе:
Председатель:
Ширинбеков У.Ш. – гл. инженер АООТ «РогунГЭСстрой»
Члены комиссии:
Садуллоев М. – начальник ТО АООТ «РогунГЭСстрой»
Кулов С. – ведущий инженер ОАО «Рогунская ГЭС»
Борискова Л.Н.- руководитель группы КИЭ-3
Дерягин А.Л. – начальник УГБ АООТ «РогунГЭСстрой»

Составили настоящий акт осмотра склона над выходным порталом Т-3Е
Комиссией отмечено:
Непосредственно над порталом на отм.1070 визуально зафиксирован висячий блок горных пород, с которого регулярно по данным наблюдения происходит вывал мелких обломков. Кроме того отмечены трещины отрыва по всему склону, различного направления с шириной раскрытия до 20 см.

Для обеспечения мер безопасности на данном объекте необходимо провести следующие мероприятия:
-выставить пост сигнальщиков.
-провести оборку висячего блока с применением БВР малыми зарядами до 5 кг.
-выставить маячки по трещинам с целью прослеживания динамики блока.

Комиссия:

Ширинбеков У.Ш
Садуллоев М.И.
Кулов С.
Борискова Л.Н.
Дерягин А.Л.

P.S. Назначить ответственную службу за ведением выставленных маячков с [illegible] движения массива

Statement\ Act of the mountain commission

18th of April 2011 City of Rogun

Committee members

Chairman:

Shirinbekov U. Sh- chief engineer of «RogunGesstroy»

Committee members:

Sadulloev M- Head of OJSC «RogunGesstroy»

Kulov S- leading engineer of OJSC «RogunGesstroy»

Boriskova L.N manager of the KIE-Z group

Deryagin A.L. head of UGB OJSC «RogunGesstroy»

Prepared the act for observation of exit portal T-3

Noted by the commission

Directly above the portal, at the level of 1070 m, a hanging block of stone was visually recorded, from which regularly - according to the observations - small pieces are falling down. Also there was a crack noted, showing different directions and having a width up to 20cm.

For providing safety in this object it is necessary to organize the following actions

- To put a guard post of signalmen
- To blow up the hanging block, using explosives (BVR) with low a charge till 5kg
- To put a warning light (or position light) on the crack in order to trace the dynamics of the block
-

Commission

Shirinbekov U. Sh
Sadulloev M I
Kulov S
Boriskova L N
Deryagin A L

Figure 15: Protocol on rockfall prevention measures / Протокол профилактических мер в случае обвала

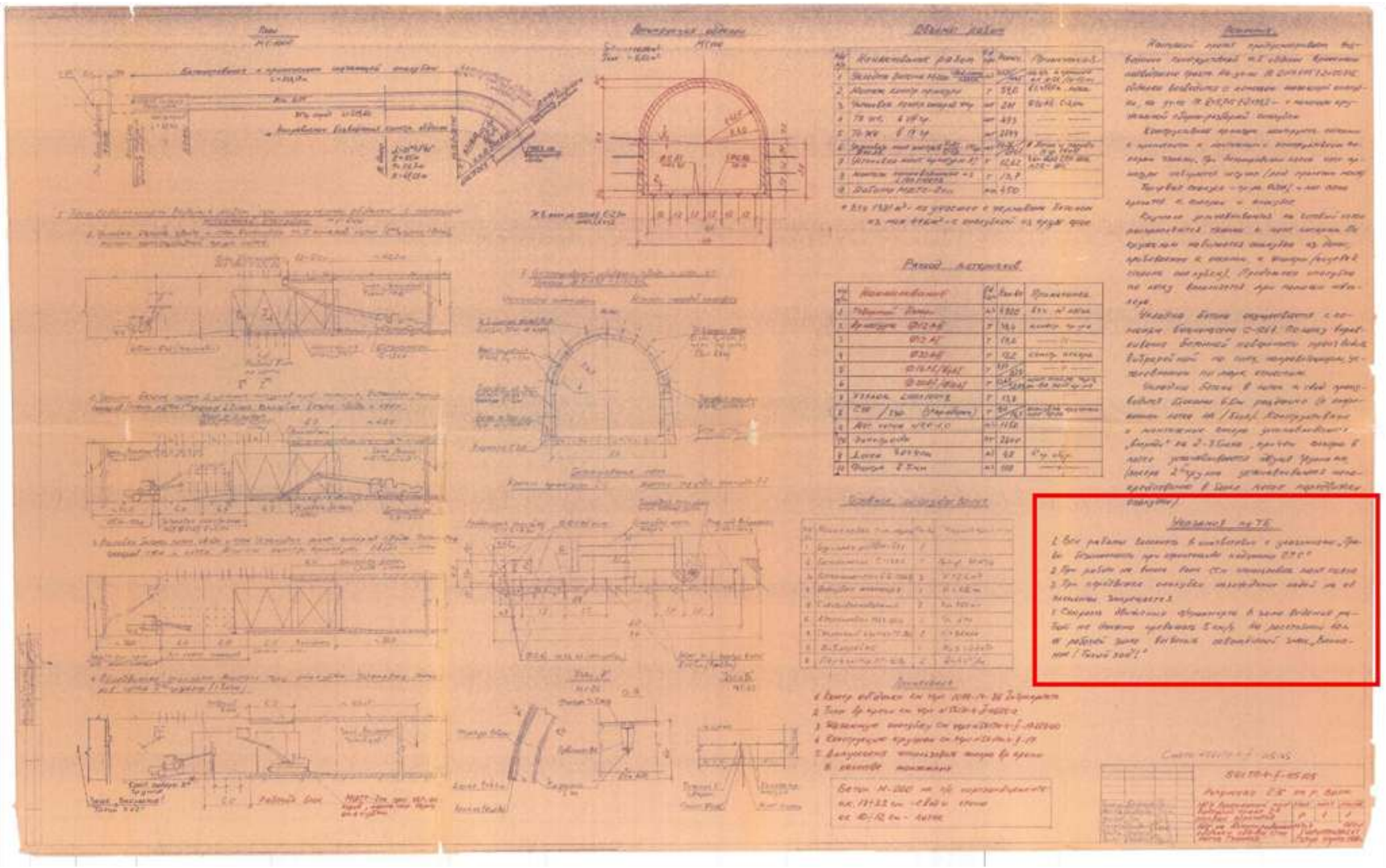


Figure 16: Safety note on a plan / Заметка о безопасности, как часть плана

A5.2 Photos Construction Site Management

Photo 1: Access road between M41 and Rogun / Подъездная дорога между M41 и Рогуном

Reconstruction works. Bare slopes on both sides.

Работы по реконструкции. Голые склоны с обеих сторон.

2011-05-21

Photo 2: Rogun village / кишлак Рогун

Boys playing Volleyball in an abandoned building.

Мальчики играют волейбол в заброшенном здании.

2011-05-19

Photo 3: Construction site d/s / Строительная площадка d/s

One of the many concrete factories

Один из многих бетонных заводов

2011-05-18

Photo 4: Rogun HPP construction site, gorge / Рогунская ГЭС строительная площадка, ущелье

Two members of the mountaineers, doing preventive work against rock fall, position at 50 m above the river.

Два альпиниста, выполняют профилактические работы против камнепадов, положение на высоте 50 м над рекой.

2011-05-18

Photo 5: Gravel pits and storage / Гравийные карьеры и бассейны

Opposite of the village Sichurak, left bank.

Напротив села Сичарог, левый берег.

2011-05-19

Photo 6: Abandoned sewage water treatment plant / Заброшенные очистные сооружения сточных вод

Reconstruction work is ongoing, 13 ponds in a row

Восстановительные работы продолжаются, 13 прудов подряд

2011-05-20

Photo 7: Creek Say Pasmuraho / Устье реки Сэй Пасмурахо

View toward ford, Creek with big capacity to erode.

Вид в направлении брода, устье имеет огромный потенциал уменьшения.

2011-05-18

Photo 8: Road M41 in direction to Nurobod / Дорога М41 в направлении Нуробода

Herders with their livestock on the way to summer pastures.

Пастухи со скотом на пути к летним пастбищам.

2011-05-16

Photo 9: Road to former quarry / new sewer / Дорога к бывшему карьеру / новой канализации

Big landslide formed a gap of about 100 m in the paved road

Большой оползень сформировал зазор около 100 м асфальтированной дороги

2011-05-20

Photo 10: Road to former quarry / new sewer / Дорога к бывшему карьеру / новой канализации

Retaining wall and drainage ditch. The ditch may provoke new erosion because of forming a steep slope without a reason.

Подпорная стенка и дренажные канавы. Ров может спровоцировать новый эрозии из-за формирования крутого склона без причины.

2011-05-20

Photo 11: Access road between M41 and Rogun / Подъездная дорога между M41 и Рогуном

Slope along the street with plantation of trees but no seeding of grass and herbs.

Склон вдоль улицы с плантациями деревьев, но без посева травы и растений.

2011-05-21

Photo 12: Steep wall under the village of Rogun / Крутые стены под кишлаком Рогунской ГЭС

An important amount of water is discharged into the gravel. Once the road close by might collapse.

Важное количество воды сбрасываются в гравий. Если будет дорога рядом, то может обвалиться.

2011-05-20

ANNEX 6 SITE REHABILITATION PLAN

A6.1 Maps

On the following pages, a number of maps related to construction site management and site rehabilitation are provided, namely:

- Figure 17: Overview of construction site
- Figure 18: Overview of dam site
- Figure 19: Erosion on the construction site
- Figure 20: Contaminated sites
- Figure 21: Erosion control
- Figure 22: Waste cleanup
- Figure 23: Proposed site rehabilitation plan

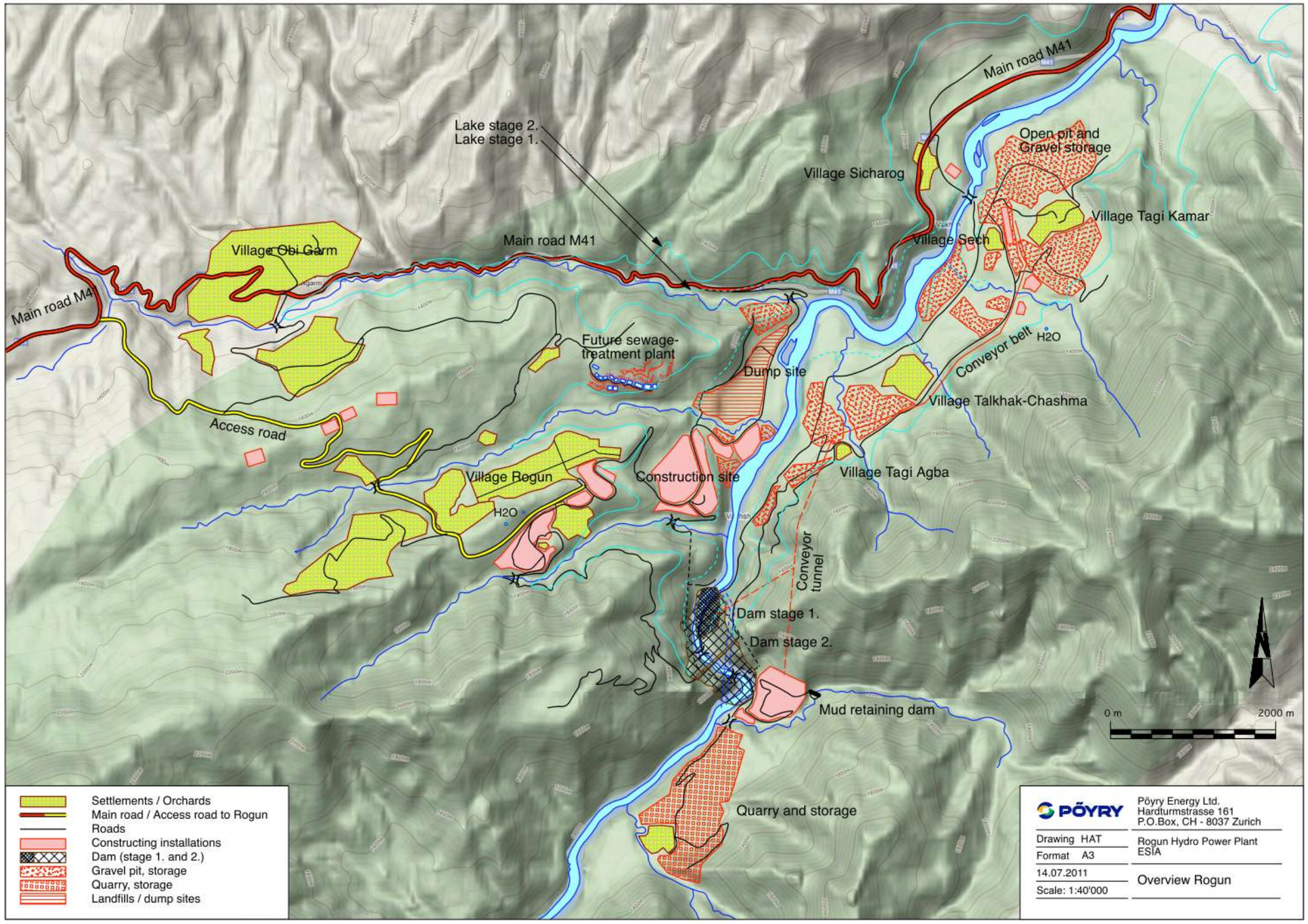


Figure 17: Rogn HPP: overview of construction site

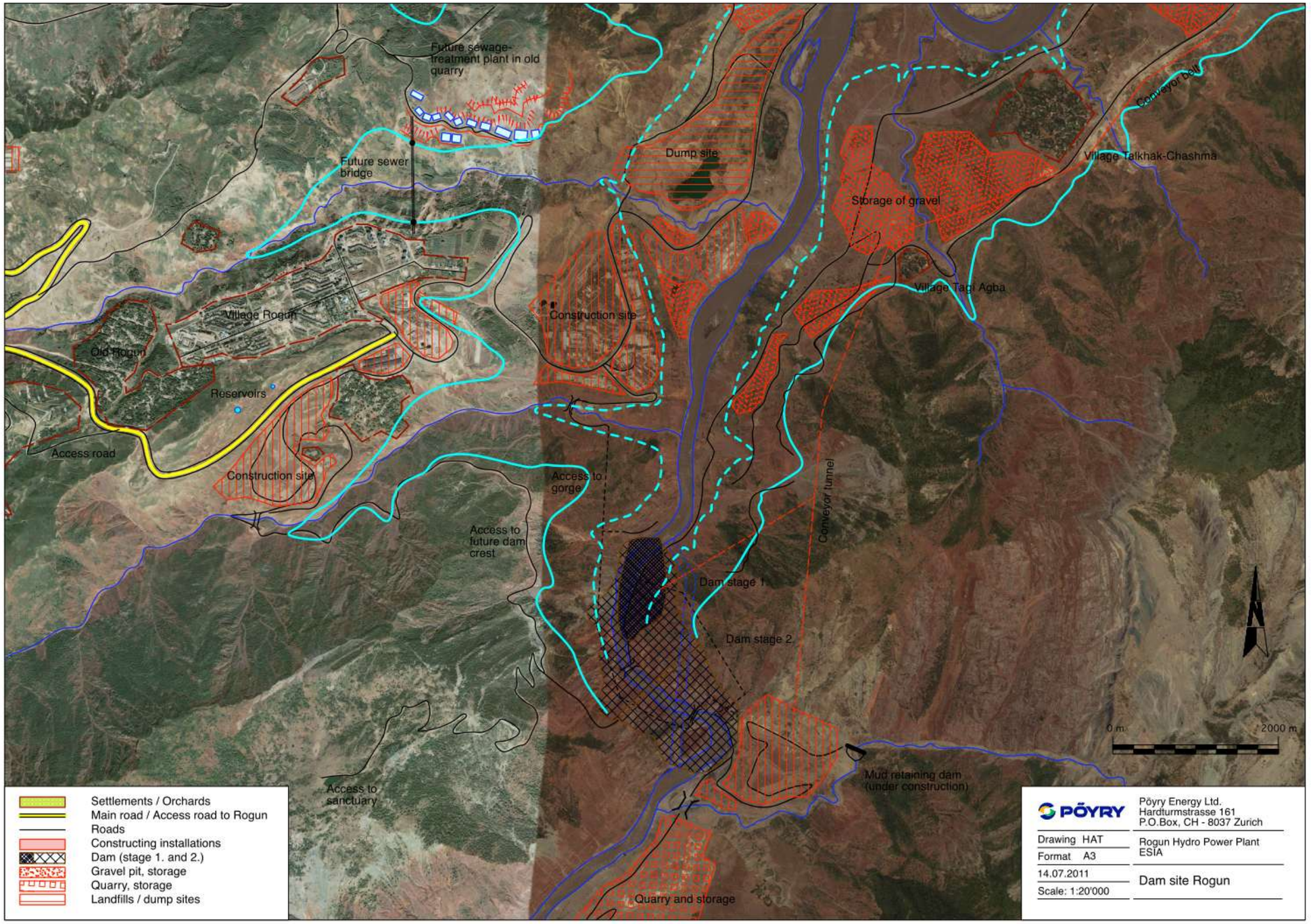


Figure 18: Rogun HPP: dam site

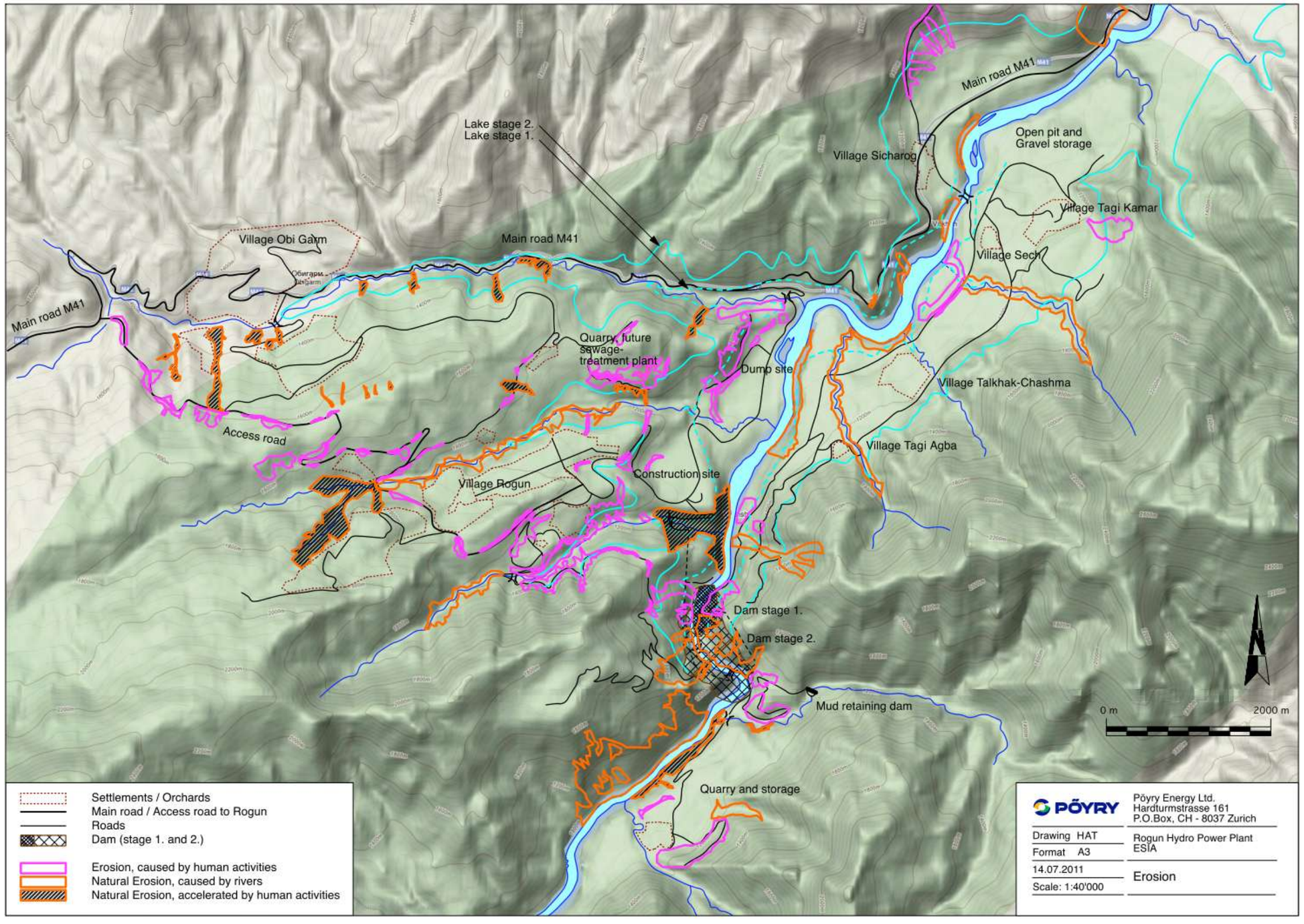


Figure 19: Rogun HPP: erosion on construction site

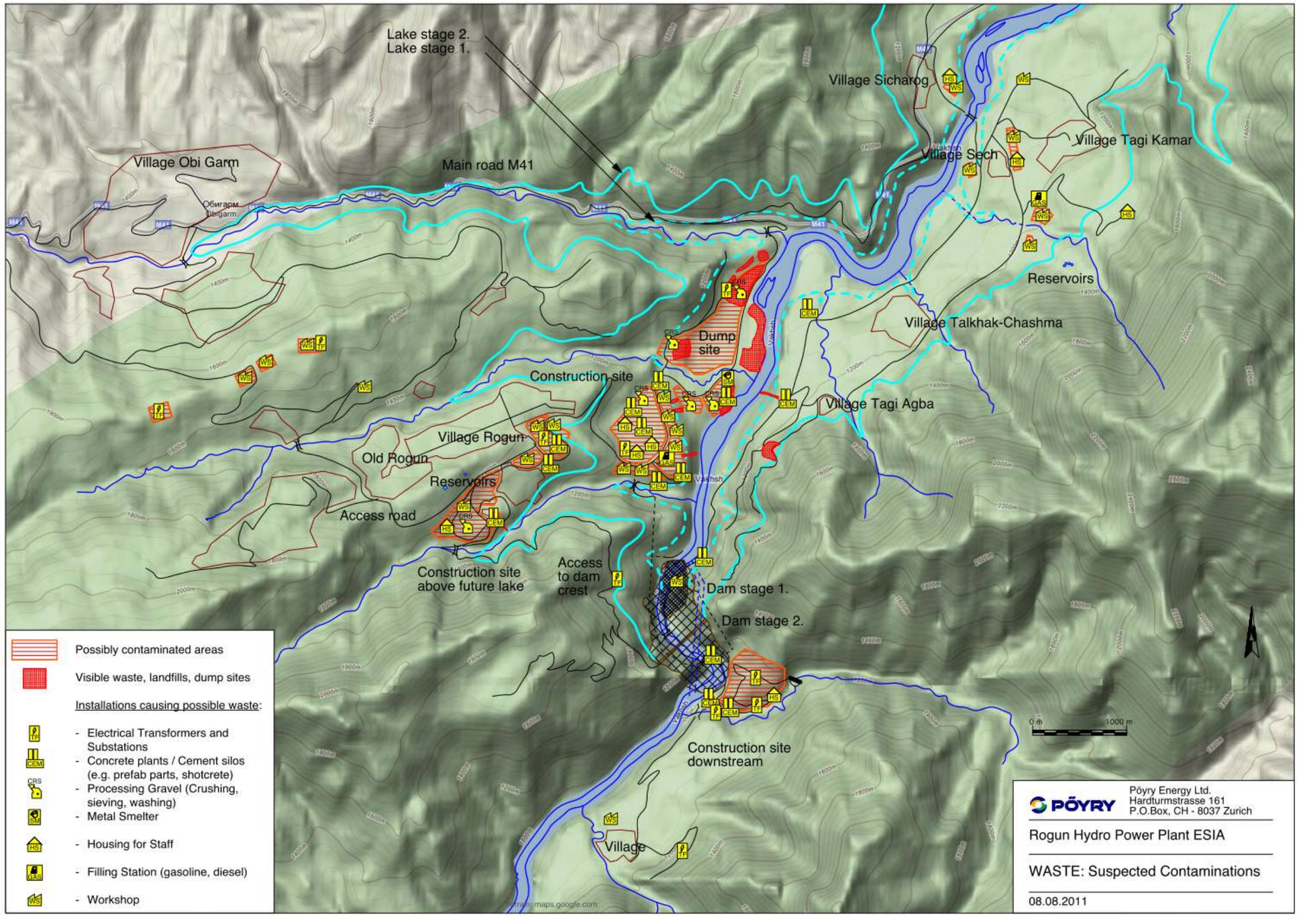


Figure 20: Rogun HPP: contaminated sites within construction site

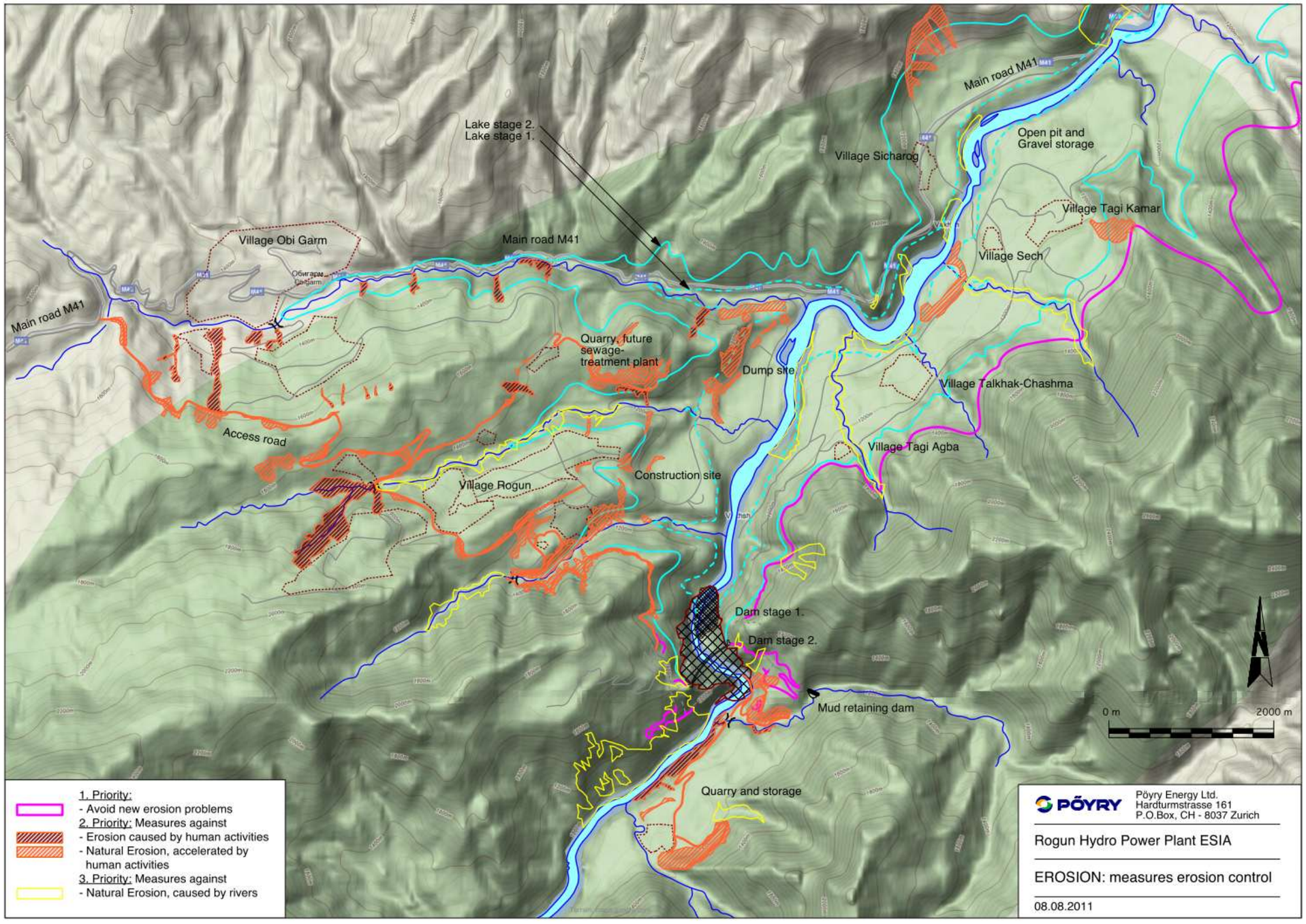


Figure 21: Rogun HPP: Measures for erosion control

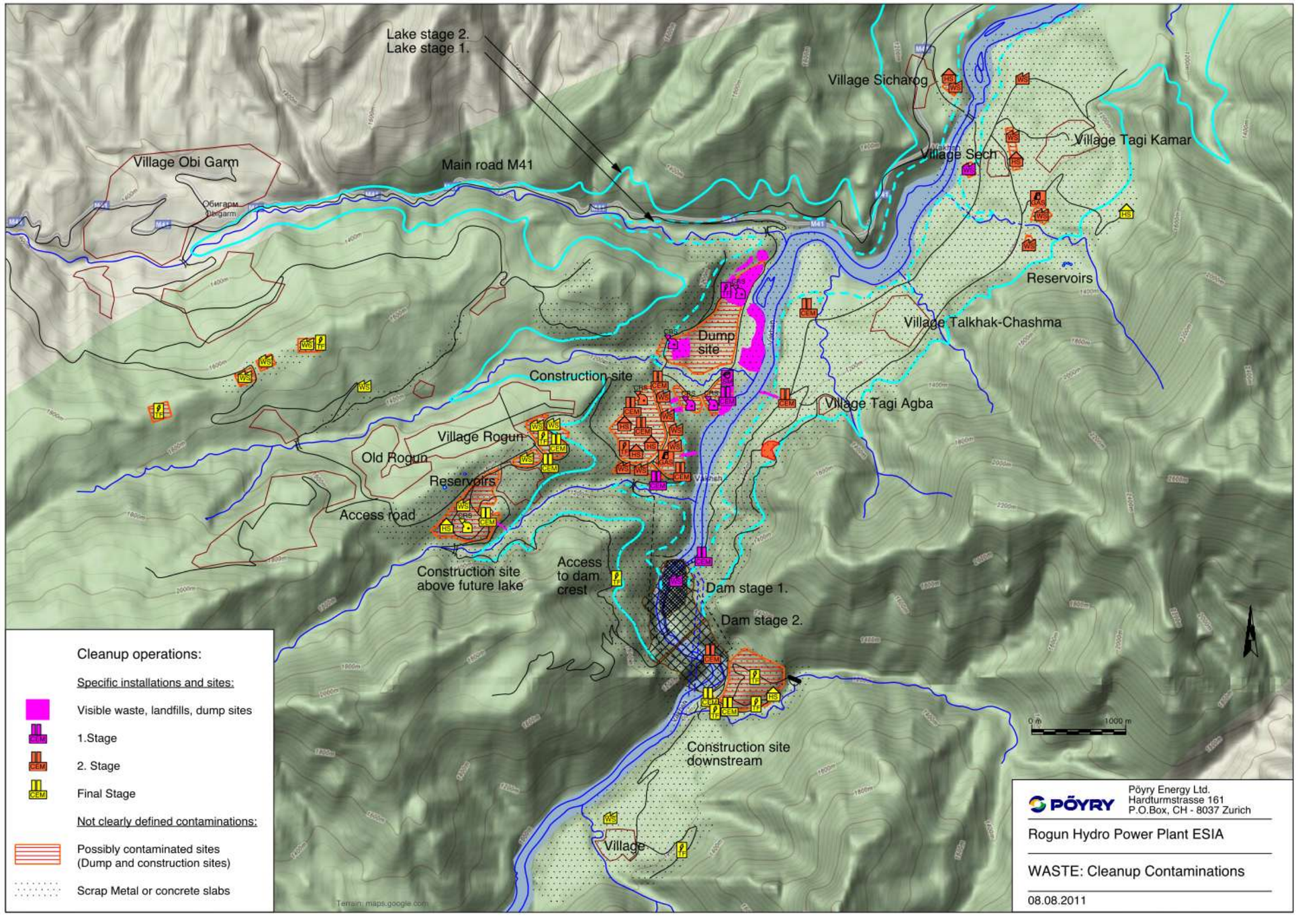


Figure 22: Rogun HPP: cleaning of contaminated sites

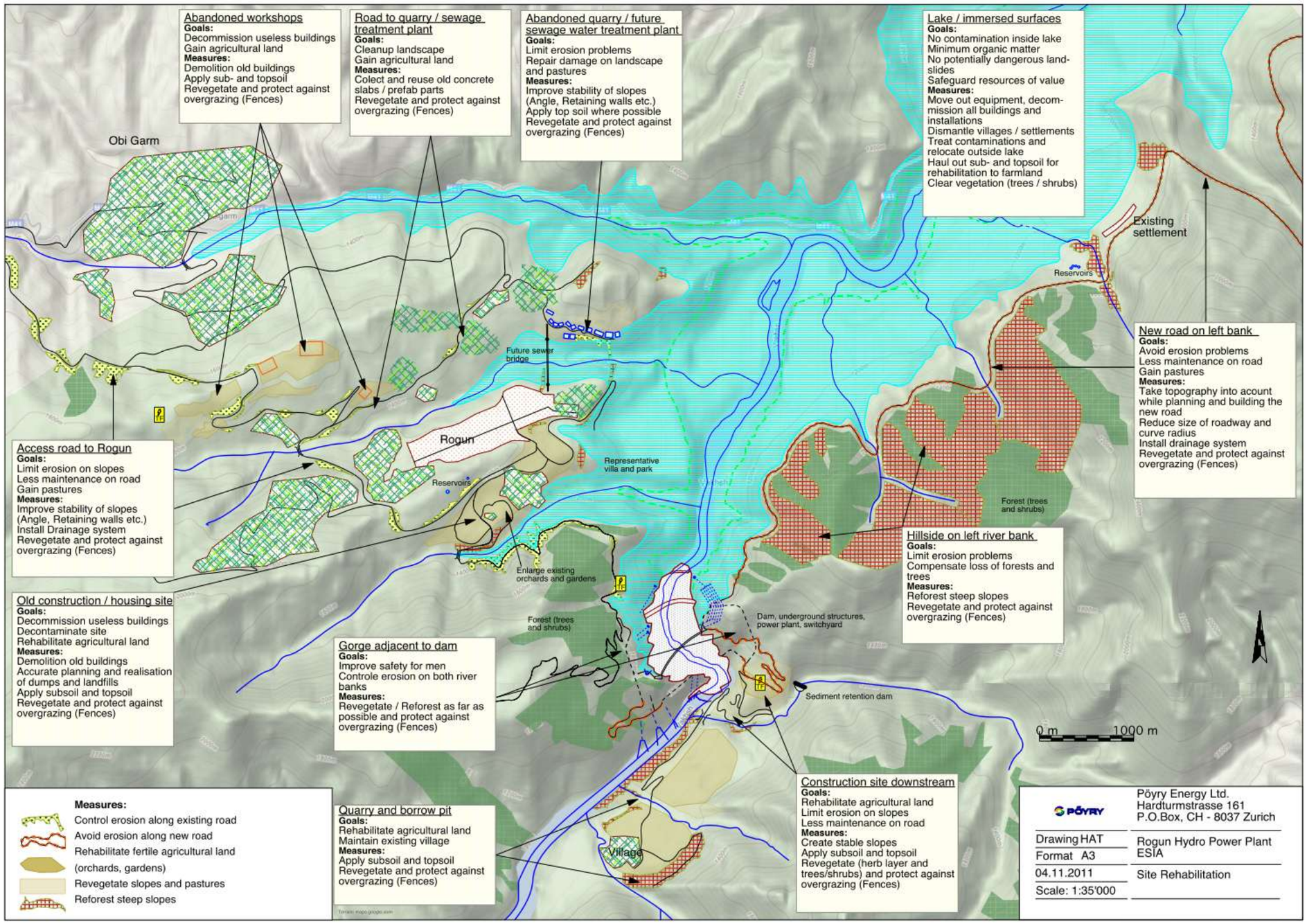


Figure 23: Rogun HPP: proposed site rehbilitation plan

A6.2 Bioengineering

On the following pages, methods mentioned in Chapter 6 are illustrated and explained in more detail.

Source: Zeh, H., 2007: Soil Bioengineering, Construction Type Manual. European Federation for Soil Bioengineering; vdf, Zürich, 450 pp.

Preface by H. M. Schiechtl

Definition of Bioengineering

Bioengineering is a part-discipline of civil engineering. It pursues technological, ecological economic as well as design goals and seeks to achieve these primarily by making use of living materials, i.e. seeds, plants, parts of plants and plant communities, and employing them in near-natural constructions while exploiting the manifold abilities inherent in plants.

Bioengineering may sometimes be a substitute for classical engineering works. However, in most cases it is a meaningful and necessary method of complementing the latter.

Its application suggests itself in all fields of soil and hydraulic engineering, especially for slope and embankment stabilization and erosion control.

Fields of Application and Plants for Bioengineering Control Works

Bioengineering methods can be applied wherever the plants which are used as living building materials are able to grow well and develop.

This is the case in tropical, subtropical and temperate zones whereas there are obvious limits in dry and cold regions, i.e. where arid, semi-arid and frost zones prevail.

In exceptional cases, lack of water may be compensated for by watering or irrigation.

In Europe, dry conditions limiting application exist in the Mediterranean as well as in some inner alpine and eastern European snowy regions. However, limits are most frequently imposed in alpine and arctic regions. These can usually be clearly noticed by the limited growth of woody plants (forest, tree and shrub lines) and the upper limits of closed turf cover. The more impoverished a region is in species, the less suited it is for the application of bioengineering methods.

Functions and Effects of Bioengineering Structures

The objective of bioengineering construction work is that it fulfill important functions. Among these, priority has always been given to

Technical functions:

- protection of soil surface from erosion by wind, precipitation, frost and flowing water
- protection from rock fall
- elimination or binding of destructive mechanical forces
- reduction of flow velocity along banks
- surface and/or deep soil cohesion and stabilization
- drainage
- protection from wind
- aiding the deposition of snow, drift sand and sediments
- increasing soil roughness and thus preventing avalanche release

Apart from these, ecological functions are gaining more and more in importance, particularly as these can be fulfilled to a very limited extent only by classical engineering constructions.

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ОПРЕДЕЛЕНИЕ ИНЖЕНЕРНОЙ БИОЛОГИИ

Инженерная биология – это раздел строительного дела, который ставит перед собой технические, экологические и экономические цели, выполнение которых возможно, благодаря использованию живых стройматериалов, семян, растений, частей растений и сообщества растений.
Этих целей можно достичь при помощи использования разных возможностей растений и типа строительства, благоприятного для природы.

Под инженерной биологией следует также понимать замену инженерного строительства или рациональное и необходимое дополнение к нему.

ОБЛАСТЬ ПРИМЕНЕНИЯ ИНЖЕНЕРНО-БИОЛОГИЧЕСКИХ СООРУЖЕНИЙ

Инженерно-биологические сооружения можно применять везде, где имеются благоприятные места для использования живого строительного материала.
Например, в тропиках, субтропиках и в зонах с умеренным климатом. Особые районы представляют сухие и холодные области, а также пустынные и полупустынные зоны.
Дефицит воды можно выровнять в исключительных случаях орошением. В Европе имеются особые зоны в бассейне Средиземного моря, а также в пределах средне-альпийских и восточно-европейских снежных зонах. Часто встречаются альпийские и арктические холодные районы. В большинстве случаев они отчетливо распознаются по границе леса (деревья и кустарники) и по верхней границе лугов. Чем беднее территория видами растений, тем больше ограничений представляется для применения инженерно-биологических методов.

ФУНКЦИИ И ДЕЙСТВИЕ ИНЖЕНЕРНО-БИОЛОГИЧЕСКИХ СООРУЖЕНИЙ

Целью инженерно-биологических строительных мероприятий является выполнение особых функций.
Наиболее важными являются:

Технические функции:

- Защита наземной поверхности от ветра, осадков, заморозков и водной эрозии
- Защита от камнепада
- Защита от вредных механических воздействий
- Уменьшение скорости потока вдоль берегов
- Укрепление поверхностных и глубинных слоев почвы
- Осушение
- Защита от ветра
- Снегозадержание, защита от песчаных заносов и зыбучих песков
- Предотвращение схода снежных лавин.

Все большее значение приобретают экологические функции, которые достигаются при даже незначительном применении классических инженерно-биологических методов.

Ecological functions:

- improvement of water regime by improved soil interception and storage capability as well as water consumption by plants
- soil drainage
- protection from wind
- protection from ambient air pollution
- mechanical soil amelioration by the roots of plants
- balancing of temperature conditions in near-ground layers of air and in the soil
- shading
- improvement of nutrient content in the soil and thus of soil fertility on previously raw soils
- balancing of snow deposits
- noise protection
- yield increase on neighbouring cropland

Landscaping functions:

- healing of scars inflicted on the landscape by disasters and humans activities (exploitation of mineral resources, construction work, deposition of overburden, tunnel excavation material, industrial and domestic waste)
- integration of structures into the landscape
- concealment of offending structures
- enrichment of the landscape by creating new features and structures, shapes and colours of vegetation

Economic effects:

Bioengineering control works are not always necessarily cheaper in construction when compared to classical engineering structures. However, when taking into account their lifetime, including their service and maintenance, they will normally turn out to be more economical. Their special advantages are:

- lower construction costs compared to “hard” constructions
- lower maintenance and rehabilitation costs
- creation of useful green areas and woody plant populations on previously derelict land

The result of bioengineering protection works are living systems which develop further and maintain their balance by natural succession, i.e. by dynamic self-control, without artificial input of energy. If the right living but also non-living building materials and the appropriate types of construction are chosen, exceptionally high sustainability requiring little maintenance effort can be achieved.

Planning of Bioengineering Construction Works

The early involvement of a bioengineer in the overall project is crucial for its success, at least in the case of large projects.
This will not only result in considerably lower total costs but also in a better integration of the technical construction into the landscape.
In the past, bioengineering solutions were, unfortunately, sought only after classical engineering methods had failed.

The project should be planned in harmony with and close to nature, i.e. adjusted to the landscape and satisfying ecological needs.
First of all, this requires first stocktaking of the existing natural resources, assessment of the ecological conditions (site conditions) as well as identifying the causes for the absence of vegetation and for erosion.

Экологические функции:

- Улучшение водного баланса за счет повышения испарения, используя способность растений регулировать содержание влаги в почве.
- Дренаж почвы
- Защита от ветра
- Защита от разноса вредных веществ
- Механическое укрепление почвы корнями растений
- Снижение разницы экстремальных отношений температуры почвы и воздуха
- Притенение
- Повышение содержания питательных веществ в почве и повышение плодородия почвы
- Равномерное распределение снежных наносов
- Защита от шума
- Повышение продуктивности сопутствующих пород.

Эстетические функции:

- Устранение последствий, наносимых ландшафту чрезвычайными ситуациями и катастрофами или вредным антропогенным воздействием (добыча полезных ископаемых, строительные работы, складирование мусора и т.д.)
- Повышение эстетического вида строительного сооружения,
- Создание ландшафтного пейзажа, используя новые структуры, акценты, форму и цвет растений.

Экономические влияния:

Инженерно-биологические сооружения не всегда бывают дешевле в изготовлении, чем классические инженерные сооружения. Однако, если принимать во внимание долгосрочность сооружений, а также уход за ними и их содержание, все это, как правило, экономически эффективно. Можно отметить следующие преимущества:

- Экономия при строительстве
- экономия на содержании и уходах
- создание полезных площадей с зелеными насаждениями на прежней пустоши.

Результатом инженерно-биологических сооружений является живые системы, которые самостоятельно развиваются по пути естественной сукцессии и саморегулируются без искусственного энерго-притока, самостоятельно поддерживая природное равновесие. При правильном выборе живых и неживых строительных материалов, а также строительных методов, проявляется высокая устойчивость при мизерных затратах на обслуживание.

ПЛАНИРОВАНИЕ ИНЖЕНЕРНО-БИОЛОГИЧЕСКИХ МЕРОПРИЯТИЙ

Решающим значением является включение инженерной биологии на раннем этапе проектирования, поскольку это приведет к существенному снижению общих расходов и лучшему приспособлению технических строительных элементов к ландшафту.
К сожалению, в прошлом при создании классических инженерных сооружений лишь при неудачах прибегали к инженерно-биологическим мероприятиям.

При проектировании необходимо учитывать природные условия, состояние ландшафта и его экологию. Прежде всего, оценивают экологические факторы, а также причины эрозии.

Living building materials

Another equally important issue is the choice of the living materials to be used.
Autochthonous living materials, i.e. plants, seeds, parts of plants and plant communities from the construction site itself and from close around, are always suited best because they have already adapted to the site. This is why a first survey of the future constructions site must always include an inventory of the living building materials available on site. One needs to examine whether parts of the natural vegetation have to be removed in the course of construction and whether these can be reused later on.
Preferred candidates are pieces of closed vegetation, which are lifted off as transplants together with topsoil and roots, stored temporarily, if necessary, and then replaced.
Further material that suggests itself are shoot-forming parts of woody plants, which can be reused as cuttings, branches or twigs, as well as vegetatively propagating herbs and grass species as rhizome cuttings or divided stolons.
One crucial question is always where the living, shoot-forming material to be used for stable constructions comes from. Normally, it is required in larger quantities. Natural poplar and willow stands are best suited because they not only provide all eligible species, but also all age stages and branch diameters as well as the entire genetic potential.
Plants which are valuable, rare or worth protecting and preserving for other reasons can be dug out as individual plants together with their root balls and reset as transplants.
Purchased living building materials will have to be resorted to where they cannot be obtained from natural vegetation at the construction site.
In large areas of southern and central Europe, for example, natural willow and poplar populations no longer exist. It is therefore necessary to use older bioengineering works as secondary stock or to purchase the material from nurseries (willow plantations).
When purchasing living building material, every attempt should be made to make sure that it originates from areas that are largely identical to the site of application. Moreover, compliance with national laws and regulations regarding quality and health has to be ensured.
To warrant sustainability of the living structure to be built, as many different "anabolic" species as possible should be chosen. The ecologically most efficient anabolic plants are those living in symbiosis with bacteria and fungi. Mycorrhizae or nodule-forming bacteria live on the roots of plants and produce nitrogen, thus creating the effect of automatic permanent fertilization, which quickly leads to soil improvement.

For our purpose, alder and legumes are the most important species in Europe possessing these qualities. It should therefore always be considered, when making the choice, whether one of the three indigenous alder species is eligible and which of the commercially available legumes are suitable for the composition of the seed mixture.
Regarding the choice of species to be used, there is ample literature which may be consulted (SCHIECHTL 1994, 2001, SCHIECHTL/STERN 1994, 2001 DIN 18 918).

Choice of the best-suited bioengineering construction method

The intended goal can usually be achieved by a variety of different construction methods. Therefore the choice should be made in favor of those that promise to be most efficient under the given conditions of the site employing those materials that can be obtained at the lowest possible costs. They are, at the same time, the most sustainable ones, require the least maintenance efforts and are therefore, last but not least, the most economical ones.

Timetable

A timetable for the procurement of the plant material as well as for the execution of the individual working steps is of utmost importance because neither of these activities can be carried out with sufficient success in every season. Furthermore, all operations have to be coordinated in time with groundwork and classical engineering work.

ПЛАНИРОВАНИЕ ИНЖЕНЕРНО-БИОЛОГИЧЕСКИХ МЕРОПРИЯТИЙ

Данные об использовании живых строительных материалов являются важным достижением инженерной биологии. Автохтонный живой строительный материал, например, растения, семена, части растений лучше всего подходят к местным сооружениям, так как они произрастают в этих самых местах. Поэтому, прежде всего надо придавать значение тем растением, которые уже имеются на месте. Необходимо проверить, стоит ли в процессе сооружения конструкции удалять части растительности и впоследствии ее вновь использовать. В первую очередь можно использовать пласты растений, которые как трансплантанты покрывают всю поверхность и быстро восстанавливают свою корневую систему и поврежденный участок.
Также можно использовать части растений, способные к образованию адвентивных корней: ветви, черенки, корни или хлысты, а также вегетативно размножающееся разнотравье.
Обычно всегда встает вопрос, откуда брать живой материал, способный к укоренению. Произрастающие на месте растения, например тополь и многие виды ивы лучше всего подходят для живых сооружений, поскольку их ветви обладают мощным генетическим потенциалом. Редкие или ценные породы можно также использовать в отдельных случаях, которые выкапываются вместе с комом земли и аккуратно пересаживаются, как трансплантанты. Покупной материал применяют в тех случаях, если на месте нет естественной растительности.
Например, в Южной и Средней части Европы нет естественных видов ивы и тополя. Поэтому в инженерно-биологических сооружениях используют либо вторичные популяции, либо саженцы из питомников. При покупке живого материала следует обращать внимание на его происхождение и качество.

Чтобы добиться устойчивого функционирования инженерно-биологического сооружения, следует применять различные виды растений. Экологические виды растений наиболее действенны, если они живут в симбиозе с бактериями и грибами. Микориза и прочие бактерии живут на корнях растений и производят азот, который способствует быстрому улучшению почвы. Таким образом, создается эффект долговременного естественного удобрения почвы.

Выбор подходящих инженерно-биологических сооружений

Поставленная цель достигается самыми разнообразными инженерно-биологическими методами. Для этого необходимо выбрать такой метод, который лучше всего подходит к местопроизрастанию, благоприятному для используемых живых растений, поскольку в этом случае растения наиболее устойчивы и, требуют незначительных затрат на обслуживание и являются самыми экономичными.

Календарный план

Важным этапом является составление календарного плана, как для подбора растений, их доставки, так и для исполнения отдельных работ. Поскольку всё не может происходить в любое время года, то все работы нужно согласовывать во времени с земляными работами и классической инженерной работой.

Общее и детальное планирование

При инженерно-биологических строительных работах оказалось нерациональным детальное планирование от начала до конца, поскольку встречаются непредсказуемые изменения во время земляных работ. Поэтому лучше всего сначала составлять только общий план и предпринимать более детальное планирование во время дальнейших строительных работ.

General and detailed planning

It has turned out not to be practical in bioengineering construction works to plan everything in detail in advance as frequently unexpected changes occur during groundwork. It is therefore advisable to start out with a general plan and to plan smaller details as the work progresses if the general plan is not sufficiently detailed.

Tending and Maintenance of Bioengineering Structures

It is a specific feature of bioengineering structures that their protective potential is initially low and that they develop their full effect as the plants develop. To encourage this development and to shorten the period until full effectiveness is achieved, tending and maintenance operations are usually required. The more extreme the conditions are for the survival of the pants the more intensive these will have to be.

In-process tending

This includes all measures which are required for a structure to reach a state at which it is ready for acceptance. Works which have been assigned to special subcontractors for execution should be included as well. This not only clearly settles the matter of responsibility for remedial measures in case of poor workmanship but also for any necessary improvements until acceptance, such as reseeding, replanting, fertilization and pruning as well as mowing, mulching and watering, if necessary.

Sustained tending

This term includes all measures which have to be taken to preserve the vegetation that has developed and to maintain its technical and ecological functions. Sustained tending is the responsibility of the client or it is put up for a separate tender.

Provided the right bioengineering methods as well as the right species of plants have been chosen, in most cases no further tending is likely to be required after two years.
However, on extreme sites, such as very narrow brooks or locations that are exposed to permanent high stress, (e.g. ski slopes), annual tending measure may be needed.
Under normal circumstances, tending measures to preserve bioengineering works and their functions are required at mid-term (3 – 10 years) or long-term (more than 10 years) intervals or after extraordinary events, such as natural disasters, fire or damage by third parties.
Such tending and maintenance measures may include:

- prevention of damage by game animals
- mowing including the removal of the mown herbage material
- pastoral use, usually for a short time, by certain animal species, e.g. sheep
- mulching of woody plants, especially in dry zones
- watering or irrigation
- dewatering or drainage
- soil amelioration by fertilization, aeration and loosening
- wood pruning by removing dead and diseased or damaged shoots for rejuvenation, thinning and encouragement of preferred woody species

Tending and maintenance schedule

For larger bioengineering structures, a tending and maintenance schedule should always be prepared, specifying mandatory measures for an extended period of time (at least 30 years) and containing information in which month the respective measures are to be carried out.

УХОД И ОБСЛУЖИВАНИЕ ИНЖЕНЕРНО-БИОЛОГИЧЕСКИХ СООРУЖЕНИЙ

Особенностью инженерно-строительных методов является то, что свою защитную функцию они выполняют только после устойчивого развития растений. Чтобы содействовать этому развитию и вместе с тем сократить время до наступления полной устойчивости сооружения требуются мероприятия по уходу. Они должны быть интенсивнее там, где наиболее экстремальны условия для существования растений.

Уход за готовым сооружением

Под этим следует понимать все те работы, которые необходимы для достижения устойчивого состояния сооружения. Это и устранение недостатков при выполнении вспомогательных работ, например, дополнительный посев или дополнение древесной растительности, внесение удобрений, при необходимости сенокос, мульчирование и орошение.

Обслуживание

Под этим понятием подразумевают те работы, которые требуются для ухода за сооружением и сохранением его технических и экологических функций. Обслуживание выполняется заказчиком по специальному предписанию.

Если выбраны правильные инженерно-биологические методы, а также производился правильный подбор видов растений, то в большинстве случаев со второго года больше не требуется никакого текущего ухода.
Однако в экстремальных местонахождениях, например на лыжных трассах или возле мелких участках ручьев и рек, может потребоваться ежегодный уход.
Как правило, работы по уходу требуются для сохранения инженерно-биологических сооружений и их функций в среднем через каждые 3 – 10 лет или после чрезвычайных ситуаций, например, после стихийных бедствий, пожара и т.д.
Такого рода уход может содержать следующие работы:

- предотвращение повреждений от диких животных
- сенокос, включая транспортировку
- мульчирование, особенно на засушливых площадях
- орошение
- обезвоживание и создание дренажных систем
- улучшение почвы удобрением и рыхлением
- удаление погибших древесных растений и омоложение древесных пород.

План по уходу

При строительстве больших инженерно-биологических сооружений должен разрабатываться план по уходу, который регулирует долгосрочные работы по обслуживанию (минимум на 30 лет), а также содержит указания, в каком месяце нужно выполнять те или иные работы.

Service Life

Modern bioengineering structures are relatively young. The oldest ones, which are well documented in publications by SCHIECHTL and which still exist, were designed by HASSENTEUFEL, KRAEBEL and PRUECKNER and date back to the 1930's.
Numerous projects implemented by Schiechtl himself are fifty years old and still fully operative.
Although most of them were little cared for and no major maintenance efforts were made due to the lack of money, they still fulfil their function today.
This is clearly the result of a correct assessment of the ecological conditions during planning as well as of the right choice of plants, construction method and workmanship.

Stable permanent states can be safely achieved, as is the case with other plant communities such as forests and grassland.

Profound knowledge and consideration of the dynamics of artificial plant communities thus created (i.e. natural succession) will help to avoid unpleasant surprises and reduce maintenance costs.
Normally, pioneer vegetation develops via several phases of maturity up to a so-called state of climax, which is determined by local ecological conditions. A climax community is a kind of permanent state, which changes only if conditions on site – especially climate – change.

If an intermediate stage of plant development is required for functional reasons, mid-term and, if necessary, even annual maintenance intervention may be required.

The long-tem nature of such developments and the longevity of climax stages justify the assumption that living, bioengineering structures are superior to classical engineering works as regards their service life.

However, every living system depends on its own vitality. This is why bioengineering structures will achieve their highest efficiency and longest service life where optimal growth conditions prevail.

ПРОЧНОСТЬ СООРУЖЕНИЯ

Сооружения современной инженерной биологии относительно молоды. Самые старинные, известные нам из публикаций ШИХТЕЛЯ (SCHIECHTEL), применяемые ХАССЕНТОЙЛЕМ, КРЭБЕЛЬ И ПРЮКНЕРОМ (HASSENTEUFEL, KRAEBEL, PRUECKNER) были построены в тридцатые годы 20 столетия.
Самим Шихтелем были сохранены многочисленные сооружения, которым, например, уже полсотни лет и они прекрасно функционируют. Большинство из них из-за отсутствия денег оставались без ухода, однако до сих пор они выполняют свою функцию.

Это является, без сомнения, правильным экологическим подходом при планировании, а также правильным выбором видов растений и инженерно-строительных методов при исполнении.

Знание и учет развития таких искусственно созданных сообществ растений предотвращает неприятности и уменьшает расходы на содержание.
Если необходима поддержка промежуточной стадии развития растительности, то проводят среднесрочные и возможно даже ежегодные мероприятия по уходу.
Каждая живая система всегда зависит от своей устойчивости и поэтому инженерно-биологические сооружения достигают там своего наивысшего развития и наибольшей прочности, где преобладают лучшие условия роста.

1.1 **Ausrunden von Bruch- und Anschnitträndern**
Modelação da crista do talude em deslizamentos e taludes de escavação
Округление бровки
Rounding off of failure and cutting edges
Reperfilado de la coronación del talud en deslizamientos y en taludes de excavación

Anwendung und Baubeschreibung: Überhängende Bäume, überhängende Ränder von Brüchen und Anschnitten sollen abgetragen und mit einem Radius von mindestens 5 m ausgerundet werden. Die darunter liegende Böschung wird dadurch stabiler und kann sich begrünen oder ingenieurbiologisch verbaut werden.
Baumaterial: Maschinen, wenn Zufahrt möglich, sonst mit Handwerkzeug
Einbauzeit: jederzeit
Arbeitszeit: 5 Min./m, variabel nach Geländesituation

Procedimento construtivo e aplicação: Extrai-se o material que sobressai na crista do talude, incluindo árvores e vedações, arrendondando-se numa curvatura com pelo menos 5 metros de raio. Isto irá determinar a estabilização do corpo do talude, que se pode deixar ao cuidado da vegetação espontânea ou sistematizá-lo com técnicas de engenharia natural.
Materiais: Descoroamento mecânico sempre que seja possível o uso de máquinas, caso contrário, manual.
Período de execução: Qualquer período.
Duração do trabalho: 5 min./m aproximadamente, dependendo da topografia mais ou menos acidentada.

Применение и строительное описание: Выступающую бровку пахотных земель и земельных участков необходимо снести по радиусу 5 м. Только после этого следует начинать озеленять откос или создавать инженерно-биологические сооружения.
Строительный материал: Механизировано в том случае, если позволяют подъездные пути, иначе делать вручную.
Время строительства: в любое время.
Рабочее время: 5 мин/м², в зависимости от состояния земли

Construction procedure and application: Overhanging trees, overhanging edges of failures and cuts should be removed and rounded off with a radius of at least 5 m. This improves the stability of the slope underneath and prepares it for revegetation or bioengineering measures.
Material: machines, if access is possible, otherwise hand tools
Time of construction: any time
Time required: 5 min./m, depending on terrain features

Descripción y aplicación: Se extrae la parte que sobresale de la coronación del deslizamiento, se redondea el perfil con un radio de por lo menos 5 metros. Se acondiciona de esta manera para estabilizar el talud que se encuentra por debajo, y que por lo tanto se podrá bien dejar a la revegetación espontánea o bien se acondicionará con las técnicas de bioingeniería.
Materiales: Reperfilado mecánico siempre que sea accesible a la maquinaria, en caso contrario reperfilado manual
Periodo de ejecución: Cualquier periodo
Duración del trabajo: 5 min./m aproximadamente, dependiendo de la topografía más o menos accidentada

Kosten, custo, Расходы, cost, coste: 10 – 15 €/m

Drainage systems

5.10 Lebender Stangendrän
Canaletas de drenagem com ramagem viva
Дренаж из живых черенков
Living pole drain
Haz de estacas vivas de drenaje

Anwendung und Baubeschreibung: Zur tiefreichenden Entwässerung werden unten tote und oben lebende Stangen in 50 – 60 cm breite und tiefe Gräben eingelegt , evtl. mit Bindedraht gebunden. Sie werden an Rutschhängen mit seitlichen Pfählen gesichert und im sumpfigen Terrain wegen des Auftriebs mit Querstangen niedergehalten.
Baumaterial: Stangen ausschlagfähiger Gehölzarten und andere mit 5 – 10 cm Durchmesser und mindestens 3 m Länge, lebende oder tote Pflöcke, 1 – 1,5 m lang, oder Stahlstäbe, Querhölzer, Bindedraht
Einbauzeit: während der Winterruhe
Arbeitszeit: 30 Min./m

Procedimento construtivo e aplicação: Utilizam-se quando se pretende obter uma drenagem em profundidade. Escavam-se sulcos com uma profundidade entre 50 a 60 cm. Na parte inferior do sulco colocam-se os ramos mortos e sobre estes são colocadas os ramos vivos. Se necessário os ramos podem ser atados com arame. Em taludes com risco de deslizamento, as faxinas são fixadas lateralmente por estacas mortas, de modo a que a mesma fique retida na vala.
Materiais: Ramos de espécies lenhosas com capacidade de propagação vegetativa, com diâmetro entre 5 a 10 cm e um comprimento de pelo menos 3 metros. Ramos mortos ou vivos com um comprimento de 1 a 1,5 m, ou barras de aço e arame.
Período de execução: Durante o período de repouso vegetativo.
Duração do trabalho: 30 min./m².

Применение и строительное описание: Для осушения нижних слоев почвы в борозды, шириной и глубиной 50 – 60 см укладывают мертвые и живые побеги, по возможности связывая их проволокой. По бокам их укрепляют кольями, а на болотистой местности дополнительно закрепляют поперечно.
Строительный материал: Ветви древесных видов, способные укореняться, диаметром 5 – 10 см, длиной минимум 3 м; живые или мертвые колья 1 – 1,5 м длиной или стальные стержни; брусья; проволока.
Время строительства: В период зимнего покоя.
Рабочее время: 30 мин/м.

Construction procedure and application: For deep-reaching drainage, dead poles are placed at the bottom and living poles at the top of ditches of 50 – 60 cm in depth and width and tied together with binding wire, if necessary. On slopes prone to failure, they are secured on the sides by piles. On marshy terrain, they are held down with cross beams to prevent uplift.
Material: poles of shoot-forming woody plants and others of 5 – 10 cm in diameter and of at least 3 m in length, living or dead stakes of 1 – 1,5 m in length or steel rods, cross beams, binding wire
Time of construction: during winter dormancy
Time required: 30 min./m

Descripción y aplicación: Este sistema se utiliza cuando sea necesario un drenaje profundo. Se abren zanjas de una profundidad y anchura de 50 a 60 cm, se colocan estacas muertas en la parte inferior y vivas en la parte superior. Si es necesario, se atan con alambre. En pendientes con deslizamiento, se aseguran con piquetas laterales. En zonas pantanosas o encharcadas, se pueden sujetar los haces de estacas con barras perpendiculares, para evitar el efecto de la fuerza ascendente.
Materiales: Varas de especies leñosas con capacidad de enraizamiento y otras de un diámetro de 5 a 10 cm y una longitud de al menos 3 m, estacas vivas o muertas de 1 a 1,5 m de longitud o barras de acero, traviesas, alambre.
Periodo de ejecución: Durante el reposo vegetativo
Duración del trabajo: 30 min./m

Kosten, custo, Расходы, cost, coste: 20 – 50 €/m

1.8 **Sickergraben**, Sickerschlitz
Canais e fossas de drenagem
Дренажные канавы
Seepage ditch, rubble drain
Fosos de drenaje, canaletas de drenaje

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Anwendung und Baubeschreibung: Zur Oberflächenentwässerung oder bei Staunässe werden je nach anfallenden Wassermengen in regelmässigen Abständen Gräben gezogen und mit wasserdurchlässigem Material gefüllt. Sie münden in andere Entwässerungssysteme.
Baumaterial: Reisig, tote Äste, Rundholzstangen, Steine, Filtergabionen, Kokoswalzen, Kunststoffe
Einbauzeit: jederzeit
Arbeitszeit: maschinell 30 Min./m

Procedimento construtivo e aplicação: Para facilitar a drenagem superficial ou no caso de acumulação de água, constroem-se fossas a uma distância regular, cheias com material que permita a percolação da água. As fossas de drenagem confluem a jusante com outros sistemas de drenagem.
Materiais: Ramagem, ramos mortos, troncos, pedra, gabiões filtrantes, rolo de coco e materiais sintéticos.
Período de execução: Qualquer período.
Duração do trabalho: 30 min./m.

Применение и строительное описание: Для осушения поверхности или луж, по площади на одинаковом расстоянии выкапывают канавы и заполняют их водопроницаемым материалом. Затем они соединяются с другими системами осушения.
Строительный материал: хворост, сучья, деревянные шесты, камни, кокосовые валики, искусственный фильтрующий материал.
Время строительства: в любое время.
Рабочее время: механически 30 мин/м.

Construction procedure and application: For surface drainage or in case of waterlogging, ditches are drawn at regular distances and depending on the water quantities to be drained and filled with material that is pervious to water. They discharge into other drainage systems.
Material: brushwood, dead branches, round timber poles, rocks, filter gabions, coconut fiber rolls, synthetic material
Time of construction: any time
Time required: using mechanical equipment: 30 min./m

Descripción y aplicación: Para facilitar el drenaje superficial o en el caso de un estancamiento del agua, se realizan fosos a distancia regular que se rellenan con material que permita la precolación del agua. Los fosos de drenaje confluyen a valle con otros sistemas de drenaje.
Materiales: Ramaje, ramas muertas, troncos, piedras, gaviones filtrantes, rollos de coco, materiales sintéticos
Periodo de ejecución: Cualquier periodo
Duración del trabajo: 30 min./m

Kosten, custo, Расходы, cost, coste: 50 – 100 €/m

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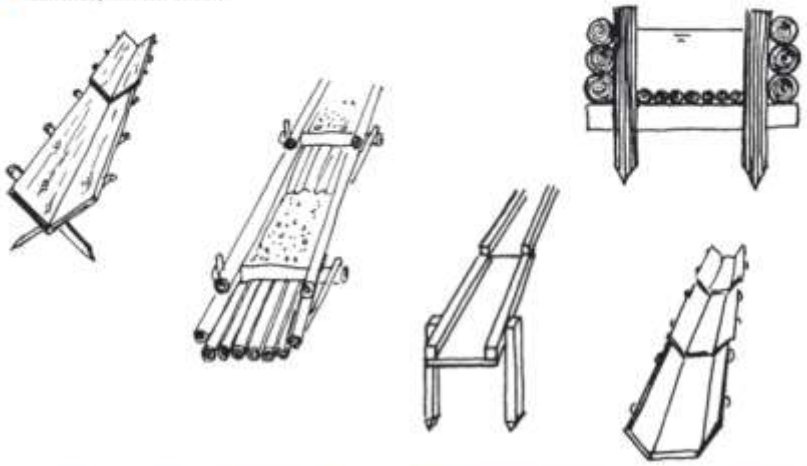
1.6 Offene Rinne
Canais e canaletas abertas
Открытые желоба
Open channel
Canales, canaletas abiertas



Anwendung und Baubeschreibung: Oberflächlich über den Hang abfliessendes Wasser, welches von der Vegetation nicht alleine aufgenommen wird und nicht versickern soll, kann in offenen Rinnen aus jeglichem zur Verfügung stehendem Material abgeleitet werden.
Baumaterial: vorgefertigte oder vor Ort zusammengebaute Elemente aus Holz, Stein, Beton, Blech, Kunststoff, Befestigungsmaterial
Einbauzeit: jederzeit
Arbeitszeit: 30 Min. – 5 h/m

Procedimento construtivo e aplicação: A água que escoa laminarmente sobre o talude, que não é interceptada pela vegetação e que não se infiltra no terreno, pode ser captada, através de canais abertos realizados com qualquer material disponível.
Materiais: Elementos em madeira, pedra, cimento, laminado metálico, plástico pré-fabricado ou feito em obra, material de fixação.
Período de execução: Qualquer período.
Duração do trabalho: 30 min. – 5 h./m.

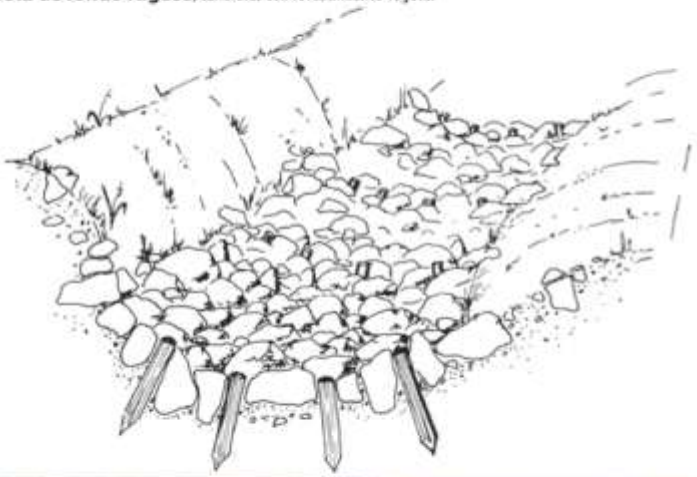
Применение и строительное описание: Текущую по поверхности склона воду, которую не усваивает растительность, можно отвести открытыми желобами из любого, имеющегося в распоряжении, материала.
Строительный материал: изготовленные заранее или собранные на месте элементы из дерева, камня, бетона, жести, искусственного материала (пластмассы), крепежный материал.
Время строительства: в любое время.
Рабочее время: 30 мин – 5 ч/м.

Construction procedure and application: Water that runs off the surface of a slope and cannot be taken up by vegetation alone and should not be allowed to seep into the ground either, can be discharged in open channels of any material available.
Material: elements of wood, rock, concrete, sheet metal, plastic either prefabricated or assembled on site, fastening material
Time of construction: any time
Time required: 30 min. – 5 h/m

Descripción y aplicación: El agua que fluye laminarmente sobre la ladera, que no es interceptada por la vegetación y que no se infiltra en el terreno, puede captarse mediante canaletas abiertas realizadas con cualquier material disponible.
Materiales: Elementos en madera, piedra, hormigón, laminado metálico, plástico ya prefabricados o construidos en obra, elementos de anclaje
Periodo de ejecución: Cualquier periodo
Duración del trabajo: 30 min. – 5 h/m

Kosten, custo, Расходы, cost, coste: 30 – 300 €/m

1.7 Raubettrinne, Raupflaster, Raupackung
Canais e canaletas de fundo rugoso ou com revestimento vegetal
Жесткий желоб (лоток) из булыжника
Rock channel, rough rock paving, riprap
Canaleta de fondo rugoso, canaletas con revestimiento vegetal



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Anwendung und Baubeschreibung: Um Hangwasser oberflächlich abzuleiten und zu versickern, werden in der Falllinie raue Steine möglichst senkrecht in Form von flachen Mulden gepackt und mit Pfählen gesichert. Bei stärkerer Belastung gründet man die Raubettrinne auf Drahtsteinmatten oder Beton.
Baumaterial: bruchraue Steine, Kantenlänge ca. 15 – 30 cm, Pfähle, Filterkies, evtl. Drahtsteinmatten, Beton
Einbauzeit: jederzeit
Arbeitszeit: 120 Min./m²

Procedimento construtivo e aplicação: De forma a facilitar a drenagem superficial ou a impedir acumulações de água, são realizados a distâncias regulares, canais largos e pouco profundos, que são posteriormente preenchidos com pedra ou outro material que consinta a percolação de água. Estes canais são depois interligados a um sistema de drenagem.
Materiais: Pedras de 15 a 30 cm, estacas de madeira, cascalho grosseiro, mantas de gabiões e cimento.
Período de execução: Qualquer período.
Duração do trabalho: 120 min./m².

Применение и строительное описание: Чтобы отвести с поверхности склона воду и обеспечить ее одновременное просачивание, по линии протекания в канавку укладывают неровные камни, по возможности вертикально, и изредка укрепляют их колышками. При сильной нагрузке желоб из булыжника (камней) укрепляют металлической сеткой или бетоном.
Строительный материал: шероховатые неровные камни длиной около 15 – 30 см, колышки, гравий, щиты из камней и проволоки, бетон.
Время строительства: в любое время.
Рабочее время: 120 мин/м².

Construction procedure and application: To discharge slope water on the surface and to enable it to seep into the ground, rough rocks are packed in the fall-line in a vertical direction in the shape of a shallow trough and secured with pegs. In case of higher loading, the rock channel is laid on gabion mats or on concrete.
Material: quarry-faced rocks, edge length approx. 15 – 30 cm, pegs, filter gravel; gabion mats, concrete, if necessary
Time of construction: any time
Time required: 120 min./m²

Descripción y aplicación: Para captar las aguas torrenciales y permitir al mismo tiempo la precolación, se colocan al fondo de valles amplios y poco profundos grandes piedras rugosas orientadas a lo largo de la línea de máxima pendiente, posicionándolas verticalmente siempre que sea posible y si fuera necesario, ancladas con piquetas. En caso de una fuerte carga hidráulica, el canal se cementa.
Materiales: Trozos de piedras de tamaño 15 – 30 cm, piquetas de madera, grava gruesa
Período de ejecución: Cualquier período
Duración del trabajo: 120 min./m²

Kosten, custo, Расходы, cost, coste: 200 – 300 €/m²

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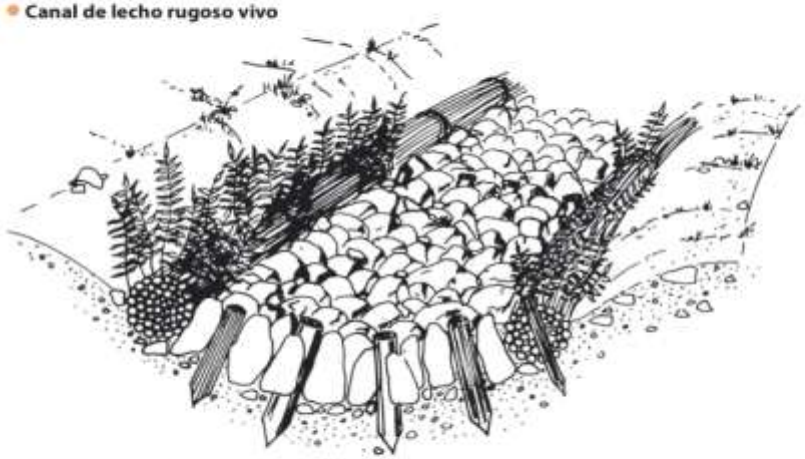
7.17 **Begrünte Rauhbettrinne**
Canal enrocado de leito rugoso vivo
Озеленение рытвин (канав) с шероховатым дном
Vegetated rough bed channel
Canal de lecho rugoso vivo



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Anwendung und Baubeschreibung: In nicht ständig Wasser führenden Runsen oder steilen Entwässerungsrinnen. In flache Mulden werden nach Bedarf Pfähle eingeschlagen, um dahinter Steine zu packen, oder die Steine werden lose geschüttet. Am Rand werden die Mulden mit Faschinen bepflanzt, die Zwischenräume der Steine werden mit Saatgut begrünt. In diesen Rinnen vesickert überschüssiges Wasser oder wird abgeleitet.
Baumaterial: Pfähle, längliche Natursteine oder kantige Schüttsteine, Faschinen
Einbauzeit: jederzeit, Faschinen während der Vegetationsruhe
Arbeitszeit: 60 Min./m²

Procedimento construtivo e aplicação: Em canais com caudal intermitente ou em canais de drenagem declivosos. Os canais planos são recuperados com a ajuda de estacas, atrás dos quais são colocadas pedras. Também se podem colocar as pedras sem ancoragem com estacas. Ao longo das margens colocam-se faxinas. Nestes canais infiltra-se a água em excesso, ou então é escoada com velocidades de escoamento amortecidas pela rugosidade do leito rochoso.
Materiais: Estacas, pedras naturais oblongas ou material de enchimento com extremidades afiadas e faxinas.
Período de execução: Em qualquer estação, as faxinas durante o período de dormência.
Duração do trabalho: 60 min./m².

Применение и строительное описание: Используют для осушения крупных канав или крутых оврагов. В плоскую часть оврага (рытвины), вбивают необходимое количество кольев, и забрасывают камнями. Края впадины озеленяют фашинами. В таких понижениях (впадинах) излишняя влага впитывается в почву или стекает.
Строительный материал: Колья; продолговатые природные камни или острые камешки (щебень); фашины.
Время строительства: в любое время; фашины в период вегетационного покоя.
Рабочее время: 60 мин/м².

Construction procedure and application: In temporarily water-carrying gullies or steep drainage ditches. Piles are driven into shallow troughs and packed or loosely filled with stones behind. The troughs are vegetated with fascines along their edges. In these ditches, excess water seeps into the ground or is discharged.
Material: piles, oblong natural stones or sharp-edged fill material, fascines
Time of construction: any time, fascines during the dormant period
Time required: 60 min./m²

Descripción y aplicación: En regatos intermitentes o en zanjas de drenaje de fuerte pendiente. En hondonadas suaves, se clavan las piquetas que sean necesarias para colocar piedras tras ellas. También se pueden echar las piedras sueltas. En los laterales de la hondonada se colocan fajinas. En estos fosos, el agua excedente se infiltra o puede ser desviada.
Materiales: Piquetas, piedras naturales alargadas o piedras canteadas, fajinas
Periodo de ejecución: En cualquier momento, fajinas en parada vegetativa
Duración del trabajo: 60 min./m²

Kosten, custo, Расходы, cost, coste: 200 – 300 €/m²

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Seeding

2.1 Heublumensaat
Sementeira de feno
Посев высохшими соцветиями
Hayseed sowing
Siembra de heno

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Anwendung und Baubeschreibung: Offene Flächen werden wieder hergestellt, vor allem in alpinen Regionen und Naturschutzgebieten. Von autochtonem Wiesenheu werden die samenreichen Reste samt den Halmen einige Zentimeter stark ausgestreut, gegegenenfalls mit Wasser besprüht.
Baumaterial: samenreiche Reste von Heu, 0,5 – 1 kg/m², das Heu kann auch gedroschen werden.
Einbauzeit: zu Beginn und während der Vegetationszeit
Arbeitszeit: 1 – 3 Min./m²

Procedimento construtivo e aplicação: Para reinstalar vegetação em superfícies nuas, especialmente em regiões montanhosas e em áreas protegidas. Espalha-se uma mistura de feno e restolho rica em sementes de espécies autóctones, até se criar uma camada com alguns centímetros e se necessário rega-se.
Materiais: Mistura de feno rico em sementes, de 0,5 a 1 kg/m². Pode-se utilizar feno triturado.
Período de execução: Início e durante o período vegetativo.
Duração do trabalho: 1 – 3 min./m².

Применение и строительное описание: Участки без растительности восстанавливаются, прежде всего, в альпийской зоне и заповедниках. С оставшейся на лугах автохтонной высохшей растительности заготавливают растения с соцветиями, имеющими большое количество семян. Их укладывают на участки и при необходимости немного увлажняют.
Строительный материал: Богатые семенами остатки высохших растений, 0,5 – 1 кг/м², сено можно также обмолотить.
Время строительства: До начала и во время вегетационного периода.
Рабочее время: 1 – 3 мин/м².

Construction procedure and application: This method is applied for the revegetation of bare areas, especially in alpine regions and conservation areas. The seed-containing residues and stalks of indigenous meadow hay are spread in a thickness of several centimeters and sprinkled with water, if necessary.
Material: hay residues that are rich in seeds, 0,5 – 1 kg/m²; threshed hay may be used as well
Time of construction: at the beginning of and during the vegetation period
Time required: 1 – 3 min./m²

Descripción y aplicación: Para la revegetación de superficies extensas, especialmente en regiones montañosas y en áreas protegidas. Se esparce un residuo de heno rico en semillas de especies autóctonas junto con tallos, con un espesor de diversos centímetros, ocasionalmente se riega.
Materiales: Residuo de heno rico de semillas, de 0,5 a 1 Kg/m², el heno puede ser trillado
Periodo de ejecución: Época de realización: Al inicio y durante la época vegetativa
Duración del trabajo: 1 – 3 min./m²

Kosten, custo, Расходы, cost, coste: 3 – 10 €/m²

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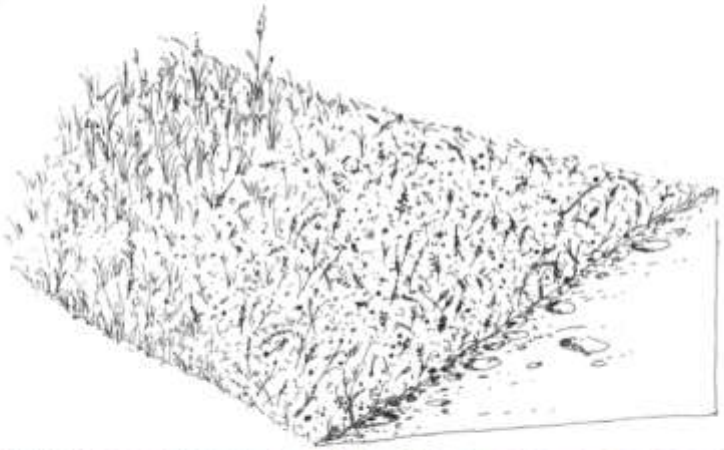
2.2 **Heudruschsaat**, Andecken von Heudrusch
Sementeira de feno obtido a partir de ceifa local
Посев сенного обмолота
Sowing of threshed hay, application of threshed hay
Siembra, semillas de heno procedente del trillado



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Anwendung und Baubeschreibung: Standorttypische Vegetation wird erhalten. Autochtones Mähgut wird gedroschen und auf ökologisch ähnlichen Standorten ausgebracht, gewalzt, beregnet oder mit trockenem Kleber bestreut.
Baumaterial: gedroschenes Mähgut von naturräumlich definierten Ökotypen
Einbauzeit: nach dem Mähen, während der Vegetationszeit
Arbeitszeit: ½ Min./m²

Procedimento construtivo e aplicação: O resultado é a vegetação típica do local. O feno triturado, resultante de cortes de prados naturais, é distribuído por zonas ecologicamente similares, onde é aplicado e fixo ao solo, utilizando-se um cilindro, regando, ou misturando um agregante.
Materiais: Feno triturado, rico em sementes provenientes do corte de ecotipos naturais definidos.
Período de execução: Após o corte, durante o período vegetativo.
Duração do trabalho: ½ min./m².

Применение и строительное описание: Подбираются растения, соответствующие своему месту произрастания. Урожай автохтонной растительности обмолочен, очищен и прикатан в соответствующих местах, полит; возможно, применение сухого клея.
Строительный материал: Обмолот сена из типичных экологических видов.
Время строительства: После покоса, во время вегетационного периода.
Рабочее время: 60 мин/100 м².

Construction procedure and application: Vegetation which is typical of the site is preserved. Indigenous mown herbage is threshed and applied onto ecologically similar sites, rolled, irrigated or sprinkled with dry glue.
Material: threshed mowed matter defined as natural ecotypes
Time of construction: after mowing, during the vegetation period
Time required: ½ min./m²

Descripción y aplicación: Se obtiene una vegetación de temporada. El producto de la siega de prados naturales se esparce en zonas ecológicamente similares, se pasa por el rodillo, se riega, o bien se esparce en seco con un colante.
Materiales: Semillas procedentes de la trilla de la siega de eco topos naturales definidos
Periodo de ejecución: Después de la siega, durante el periodo vegetativo
Duración del trabajo: ½ min./m²

Kosten, custo, Расходы, cost, coste: 0,5 – 3 €/m²

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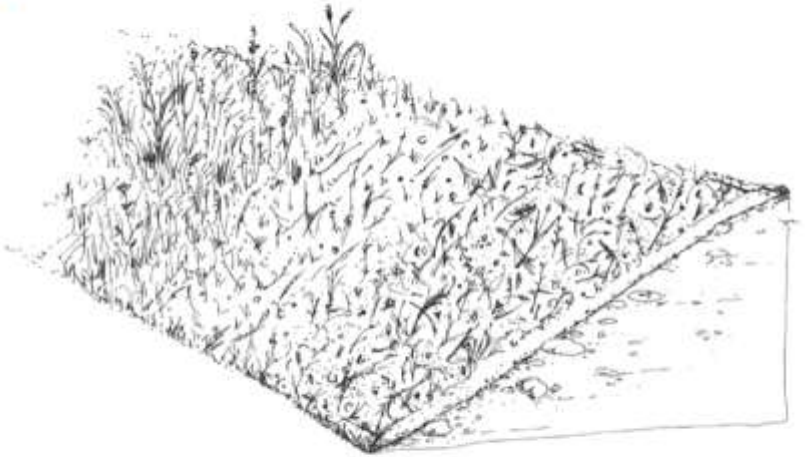
2.3 Heumulchsaat, Heudecksaat
Sementeira de feno sob palha
Посев с мульчированием сеном
Seeding of hay mulch
Siembra, acolchado de heno



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Anwendung und Baubeschreibung: Einheimische Flora, vor allem in Naturschutzgebieten, wird erhalten. Samenreiches Heu von jahreszeitlich gestaffelten Schnitten wird ausgebracht, angewalzt, beregnet oder mit trockenem Kleber bestreut.
Baumaterial: Heu mit Samen von 2 – 3 Schnitten, 300 – 500 g/m²
Einbauzeit: nach dem Schnitt, während der Vegetationszeit
Arbeitszeit: ½ Min./m²

Procedimento construtivo e aplicação: Utilizada sobretudo em áreas protegidas, o resultado é o restabelecimento da flora autóctone. Espalha-se o feno rico em sementes provenientes de cortes anuais consecutivos, passa-se com um cilindro, rega-se ou mistura-se um agregante.
Materiais: Feno proveniente de 2 ou 3 cortes, 300 – 500 g/m².
Período de execução: Após o corte, durante o período vegetativo.
Duração do trabalho: ½ min./m².

Применение и строительное описание: Для восстановления местной флоры, прежде всего в заповедниках, обогащенное семенами сено раскладывают, прикатывают, искусственно орошают или по возможности применяют сухой клей.
Строительный материал: Высокие растения с семенами (из 2 – 3-х укосов), 300 – 500 г/м².
Время строительства: После покоса, во время вегетативного периода.
Рабочее время: 60 мин/100 м².

Construction procedure and application: Autochthonous flora is preserved, especially in conservation areas. Hay which is rich in seeds and has been harvested at different times of the year is applied, rolled down, irrigated or sprinkled with dry glue.
Material: seed-containing hay from 2 – 3 harvests; 300 – 500 g/m²
Time of construction: after the harvest, during the vegetation period
Time required: ½ min./m²

Descripción y aplicación: Se obtiene heno de flora autóctona, sobre todo en áreas protegidas: Se distribuye el heno rico en semillas procedentes de siegas consecutivas, se pasa por el rodillo, se riega o bien se esparce en seco con un colante.
Materiales: Heno procedente de 2 o 3 siegas, 300 – 500 g/m²
Período de ejecución: Después de la siega, durante el período vegetativo
Duración del trabajo: ½ min./m²

Kosten, custo, Расходы, cost, coste: 0,5 – 5 €/m²

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2.4 Auslegen von Fruchtständen, Grasmulchsaat
Revestimento com inflorescências e infrutescências
Расстил соцветий, раскладывание сенной мульчи
Planting of infructescences, application of grass mulch
Revestimiento con frutos

Anwendung und Baubeschreibung: Um einen Standort mit autochthonen Arten zu besiedeln bzw. Lücken zu schliessen, werden reife Fruchtstände kleinflächig ausgebreitet und eventuell mit Klebern oder Matten befestigt.
Baumaterial: samenreiche Fruchtstände von Gräsern, Kräutern, Zwergsträuchern und Gehölzen, Kleber, Matten
Einbauzeit: sammeln und ausbringen kurz bevor die Samen ausfallen, je nach Art von Juni bis September
Arbeitszeit: 1 Min./m²

Procedimento construtivo e aplicação: Para colonizar uma determinada área com espécies autóctones, como por exemplo, o revestimento de falhas ou zonas onde a sementeira falhou, espalham-se em pequenas superfícies inflorescências maduras ou infrutescências que podem ser fixas com um agregante ou com mantas orgânicas.
Materiais: Inflorescências maduras ou frutos ricos em sementes de gramíneas e outras herbáceas, de espécies subfruticosas e plantas lenhosas, agregante e mantas orgânicas.
Período de execução: Recolher e utilizar um pouco antes das sementes serem libertadas, dependendo das espécies de Junho até Setembro.
Duração do trabalho: 1 min./m².

Применение и строительное описание: Чтобы восстановить участок автохтонными видами и закрыть ямки, неровности, на нем раскладывают созревшие соцветия, которые по возможности закрепляют клеящим веществом или щитами (циновками).
Строительный материал: Обогащенные соплодия, соцветия разных трав, например соцветия вереска, древесных растений, клей, щиты (циновки).
Время строительства: Собирают и раскладывают незадолго до опадения семян, в зависимости от разновидности с июня по сентябрь.
Рабочее время: 10 мин/м².

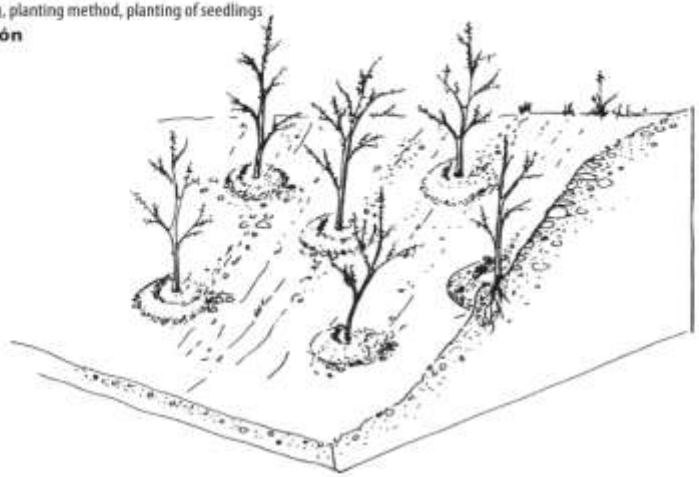
Construction procedure and application: To populate a site with autochthonous species or to fill gaps, ripe infructescences are planted in small patches and secured with glue or mats.
Material: seed-containing infructescences from different kinds of grass, herbs, dwarf shrubs and woody plants, glue, mats
Time of construction: collection and application just before the plants shed their seeds; from June to September, depending on the species
Time required: 1 min./m²

Descripción y aplicación: Para colonizar una determinada área con especies autóctonas, como por ejemplo cerrar algunos huecos, se esparcen en pequeñas superficies frutos maduros que se pueden fijar ocasionalmente con un colante o mantas orgánicas.
Materiales: Inflorescencias maduras o frutos ricos en semillas de gramíneas y otras herbáceas, de especies su fruticosas y de plantas leñosas, agente fijador, colante y manta orgánicas
Período de ejecución: Recolectar y utilizar poco antes de que suelten la semilla, dependiendo de las especies de junio hasta septiembre
Duración del trabajo: 1 min./m²

Kosten, custo, Расходы, cost, coste: 3 – 10 €/m²

Planting

3.1 ● **Pflanzung**, Pflanzverfahren, Bepflanzung, Jungpflanzung
● **Plantação**
● **Посадка**, способы посадок
● **Planting**, planting method, planting of seedlings
● **Plantación**



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Anwendung und Baubeschreibung: Mit verschiedenen Pflanzverfahren werden Flächen mit jungen Gehölzen bepflanzt. Dadurch werden vegetationslose Flächen schneller als durch Sukzession in Wald bzw. Hecken überführt.
Baumaterial: möglichst junge Gehölze von standortgeeigneten Arten, mit Angabe der Herkunft
Einbauzeit: während der Vegetationsruhe
Arbeitszeit: je nach Pflanzart und Schwierigkeit des Geländes 2 – 10 Min./Stück

Procedimento construtivo e aplicação: Utilizando diversas técnicas plantam-se superfícies com plantas jovens. Deste modo, superfícies sem vegetação alcançam as etapas arbustivas e de bosque mais rapidamente do que por sucessão natural.
Materiais: Plantas jovens de espécies autóctones, se possível com certificado de origem.
Período de execução: Durante o repouso vegetativo.
Duração do trabalho: Dependendo do tipo de plantação e das dificuldades encontradas no local 2 – 10 min./planta.

Применение и строительное описание: Саженцы высаживают разными способами. Это необходимо для того, чтобы на площадях, где отсутствует растительность, она появилась быстрее, чем за счет сукцессии в лесу или лесополосах.
Строительный материал: По возможности молодые саженцы видов, соответствующих условиям места произрастания и известного происхождения.
Время строительства: В период вегетационного покоя.
Рабочее время: В зависимости от вида растений и состояния территории 2 – 10 мин/шт.

Construction procedure and application: Using different planting methods, areas are stocked with young woody plants. This enables barren areas to develop forests or hedges sooner than would occur under natural succession.
Material: young woody plants of species suited to the site – with specification of their origin
Time of construction: during the dormant period
Time required: depending on species and difficulty of terrain, 2 – 10 min./piece

Descripción y aplicación: Con diversas técnicas de plantación se establecen superficies con planta joven. De esta manera, superficies sin vegetación alcanzan el clímax del bosque o de la etapa arbustiva antes que con la sucesión natural.
Materiales: Planta joven de especies autóctonas, posiblemente con certificado de origen y procedencia
Período de ejecución: Durante el reposo vegetativo
Duración del trabajo: Dependiendo del tipo de plantación y de las dificultades estacionales 2 – 10 min./planta

Kosten, custo, Расходы, cost, coste: 2 – 20 €/Stück

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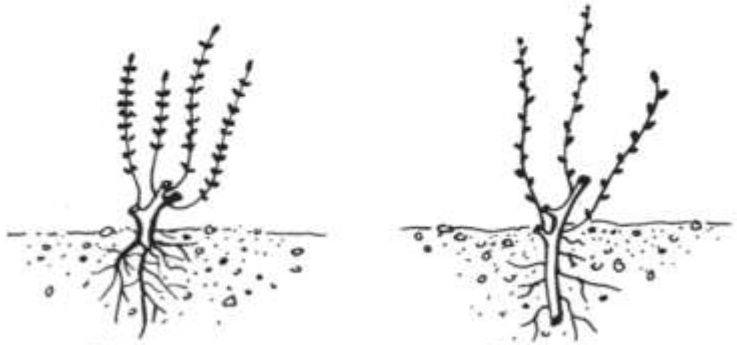
3.2 Pflanzung von geteilten Gehölzen
Plantação de ramos enraizados
Посадка корневых отпрысков
Planting of divided woody species
Plantación de fragmentos de plantas, división de mata



Alnus incana

Corylus avellana

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Anwendung und Baubeschreibung: Zur Bereicherung autochthoner Gehölzarten, die im Handel nicht beschaffbar sind, vermehrt man Sträucher und Bäume von Laubgehölzen durch Zerteilen ihrer Wurzelstöcke und Wurzelausläufer. Evtl. Oberboden oder Kompost beigeben und bewässern.
Baumaterial: Im Baustellenbereich gewonnene basale Trieb- oder Wurzel-Steckhölzer von geteilten Wurzelstöcken oder Ausläuferwurzeln, ca. 20 – 40 cm lange Stücke, 3 Stück/m²; geeignete Arten: Alnus, Cornus, Corylus, Laburnum, Ligustrum, Lonicera, Lycium, Rosa, Viburnum
Einbauzeit: während der Vegetationsruhe, zu Beginn der Vegetationszeit
Arbeitszeit: 2 Min./Stück

Procedimento construtivo e aplicação: Para enriquecimento com espécies lenhosas autóctones que não estão disponíveis no comércio, multiplicam-se determinados arbustos e folhosas pela divisão de cepos, estolhos ou rizomas. Se necessário, adicionar terra vegetal ou composto e regar.
Materiais: Raízes, estolhos, rizomas recolhidos na obra e cortados em partes de aprox. 20 – 40 cm de comprimento, 3 ramos/m² dos géneros seguintes: Alnus, Cornus, Corylus, Laburnum, Ligustrum, Lonicera, Lycium, Rosa, Viburnum.
Período de execução: Durante o repouso vegetativo ou no início do período vegetativo.
Duração do trabalho: 2 min./ramo.

Применение и строительное описание: Для размножения автохтонных видов древесных растений, которых нет в продаже, кустарники и деревья лиственных пород размножают делением куста, отводками и корневыми отпрысками. Растения присыпают почвой, компостом и поливают.
Строительный материал: На строительных площадях используют саженцы, полученные делением куста, отводки, отпрыски, около 20 – 40 см высотой, 3 штуки на 1 м²; подходящие виды: Alnus, Cornus, Corylus, Laburnum, Ligustrum, Lonicera, Lycium, Rosa, Viburnum.
Время строительства: В период вегетационного покоя; в начале вегетационного периода.
Рабочее время: 2 мин/штука.

Construction procedure and application: To enrich autochthonous woody plant species which cannot be obtained from nurseries, deciduous shrubs and trees are propagated by dividing their root stocks and runners. If necessary, add topsoil or compost and irrigate.
Material: basal shoot or root cuttings from divided root stocks or runners obtained from the construction site, pieces of approx. 20 – 40 cm in length, three pieces/m²; suited species: Alnus, Cornus, Corylus, Laburnum, Ligustrum, Lonicera, Lycium, Rosa, Viburnum
Time of construction: during the dormant period, at the beginning of the vegetation period
Time required: 2 min./piece

Descripción y aplicación: Para enriquecer con especies leñosas autóctonas que no están disponibles en el comercio, se multiplican determinados arbustos y árboles caducos por división de mata, de estolones o de rizomas Ocasionalmente se añade tierra vegetal o compost y se riega.
Materiales: Raíces, estolones, rizomas obtenidos en la obra y cortados en trozos de aprox. 20 – 40 cm. de longitud, 3 trozos/m². De los géneros siguientes. Alnu, Cornus, Corylus, Laburnum, Ligustrum, Lonicera, Lycium, Rosa, Viburnum
Periodo de ejecución: Durante el reposo vegetativo o al inicio de la vegetación
Duración del trabajo: 2 min./fragmento

Kosten, custo, Расходы, cost, coste: 3 – 5 €/Stück

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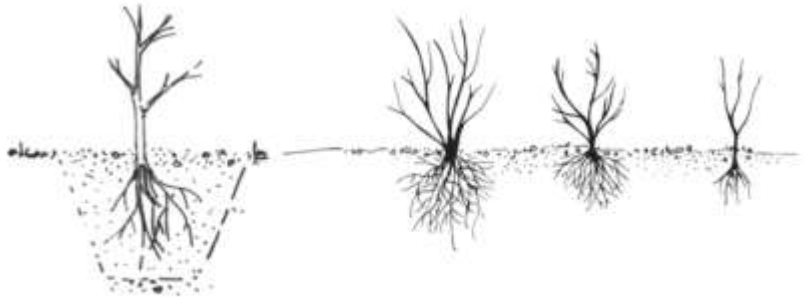
3.3 Pflanzung wurzelnackter Gehölzpflanzen, Nacktpflanzung, Einzelpflanzung, Heckenpflanzung
Plantação em raíz nua
Посадка растений с открытой корневой системой, отдельные посадки, посадка лесных полос
Bare root planting, individual planting, hedgerow planting, planting of woody species with bare roots
Plantación de plantas a raíz desnuda



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Anwendung und Baubeschreibung: Zur Wiederansiedlung von Hecken, Gebüschen oder Wald. In Baumschulen werden vorkultivierte Gehölze ausgegraben und die Erde von ihren Wuzeln geschüttelt, sodass die Wurzeln nackt sind. An frostfreien Tagen werden sie in vorgegrabene Löcher sorgfältig eingepflanzt. Die Pflanzabstände richten sich nach den örtlichen Gegebenheiten (ca. 1 – 3 m).
Baumaterial: Sämlinge oder mehrmals verschulte Sträucher oder Bäume standorttypischer Arten, meist Forstware, 60 – 100 cm gross; an Ufern und Standorten mit vielen Hochstauden 100 – 150 cm gross
Einbauzeit: während der Vegetationsruhe
Arbeitszeit: 3 Min./Stück

Procedimento construtivo e aplicação: Para a instalação de matos, moitas ou bosques, recorre-se a plantas de viveiro as quais são extraídas do solo e desprovidas do torrão ficando assim em raiz nua. São plantadas em covachos em dias sem risco de ocorrência de gelo. A distância entre as plantas depende das características locais e das espécies.
Materiais: Plantas com um ano ou plantas transplantadas, ½ de espécies autóctones de árvores ou arbustos de 60 – 100 cm de altura. Nas margens de linhas de água ou em zonas com vegetação de crescimento rápido, utilizam-se exemplares com 150 cm de altura.
Período de execução: Durante o período de repouso vegetativo.
Duração do trabalho: 3 min./planta.

Применение и строительное описание: Для восстановления лесных полос или лесов. В лесных школах выкапывают выращиваемые древесные растения и отряхивают землю с их корней. В безморозные дни их высаживают в предварительно выкопанные ямки. Расстояние между растениями устанавливают в зависимости от особенности местности (около 1 – 3 м).
Строительный материал: Саженцы кустарников или деревьев местных видов, лучше морозоустойчивые 60 – 100 см высотой; на берегах лучше использовать крупнопарные саженцы 100 – 150 см высотой.
Время строительства: В период вегетационного покоя.
Рабочее время: 3 мин/штука

Construction procedure and application: To initiate re-growth of hedgerows, shrubs and forests. Woody plants that have been pre-cultivated in nurseries are dug out and freed from earth, so that they are bare rooted. They are planted carefully into prepared holes on frost-free days. The distance between plants depends on the local conditions (approx. 1 – 3 m).
Material: seedlings or repeatedly transplanted shrubs or trees of species suited to the site, usually forest plants of 60 – 100 cm in height; along embankments and sites with a large tall-shrub community, 100 – 150 cm in height
Time of construction: during the dormant period
Time required: 3 min./piece

Descripción y aplicación: Para el establecimiento de bosquetes, setos o bosques se obtienen plantas con raíz desnuda sin tierra, procedentes de vivero. En días sin riesgo de helada, se plantan en el terreno. Las plantas se instalan dependiendo de las características estacionales y de las especies.
Materiales: Plantas de un año o plantas transplantadas, ½ de especies autóctonas de árboles o arbustos de 60 – 100 cm de altura, en las orillas o en las zonas con vegetación de rápido crecimiento, se emplean de altura de 150 cm.
Periodo de ejecución: Durante el periodo de reposo vegetativo
Duración del trabajo: 3 min./planta

Kosten, custo, Расходы, cost, coste: 2 – 10 €/Stück

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3.4 Ballenpflanzung von Gehölzen, Containerpflanzung, Topfpflanzung, Root-Trainer
Plantação em torrão, em contentor, em vaso, "Root trainer" (Fitocélulas múltiplas)
Посадка древесных пород с комом земли, саженцы в контейнерах, цветочных горшках, ящиках
Ball planting of woody species, container planting, pot planting, root trainer
Plantación de plantas con cepellón, en contenedor, en vaso, root trainer

Anwendung und Baubeschreibung: Empfindliche Gehölze werden als Ballen ausgestochen und mit einem Gewebe, meist Jute, für den Transport umhüllt. Für die ganzjährige Pflanzmöglichkeit werden Gehölze in Containern kultiviert. Alpine Junggehölze werden in Töpfen oder „Root-Trainern" vorkultiviert. Die Gehölze werden mit den verschiedenen Pflanzverfahren gepflanzt, nachdem sie von ihrer Hülle befreit wurden.
Baumaterial: Jute- oder Kokosnetz, Containertöpfe, Töpfe aus Ton, Plastik, Papier, Torf, Kunststoff-Root-Trainer, jeweils mit Gehölzen, die bei Nacktpflanzung unter dem Verpflanzungsschock leiden würden
Einbauzeit: jederzeit, besser während der Vegetationsruhe, ausser bei Frost
Arbeitszeit: je nach Grösse 6 Min./Stück

Procedimento construtivo e aplicação: As plantas mais sensíveis extraem-se com o torrão e protegem-se com um tecido durante o transporte, normalmente juta. Para se poder plantar em qualquer período do ano, as plantas são reproduzidas em contentores. As plantas jovens reproduzem-se em vasos ou "Root trainers".
Materiais: Mantas de juta ou coco, vasos de plástico, de barro, de papel, de turfa e "Root trainers".
Período de execução: Em qualquer período do ano, mas especialmente durante o repouso vegetativo, sem risco de ocorrência de geadas.
Duração do trabalho: Dependendo das dimensões 6 min./planta.

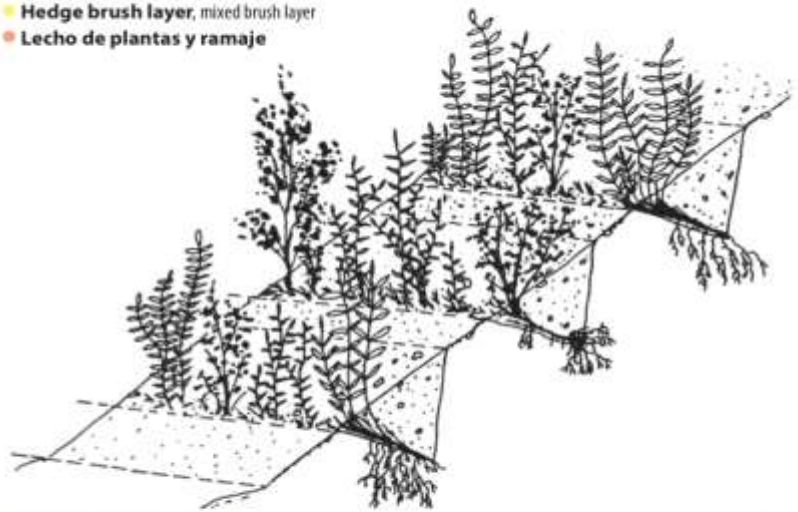
Применение и строительное описание: Плохо приживающиеся древесные растения выкапывают вместе с комом земли, упаковывают в ткань, перетягивают жгутом для транспортировки. При использовании растений в течение всего года их выращивают в контейнерах. Альпийские саженцы предварительно высаживают в цветочные горшки или ящики. Высаживают древесные растения различными способами.
Строительный материал: Сетка из жгута или кокоса; контейнеры для растений; цветочные горшки из глины, пластика, картона, торфа, искусственных материалов.
Время строительства: В любое время, лучше в период вегетационного покоя, но не в морозный период.
Рабочее время: В зависимости от размера 6 мин/штука.

Construction procedure and application: Sensitive woody plants are dug out together with their balls and protected with fabric, usually jute, for transport. For planting all year round, woody plants are cultivated in containers. Young Alpine woody species are pre-cultivated in pots or root trainers. After removal of their protective cover, the plants are set out using different planting methods.
Material: nets of jute or coconut, container pots, pots of clay, plastic, paper, peat, plastic root trainers for woody plants which, if planted with naked roots, would suffer from transplanting shock
Time of construction: any time, however, preferably during the dormant period, but not during frost
Time required: depending on size, 6 min./piece

Descripción y aplicación: Las plantas más delicadas se extraen con un cepellón de tierra y se protegen con un tejido durante el transporte, normalmente yute. Para poder plantar en cualquier periodo del año, las plantas se producen en contenedor. Las plantas jóvenes se cultivan en bandejas alveolares forestales, o root trainer.
Materiales: Bandejas alveolares forestales, yute o manta de coco, vasos, macetas de barro, de plástico, de papel, de turba, de material sintético, root trainer.
Periodo de ejecución: En cualquier periodo, pero especialmente durante la parada vegetativa, sin riesgo de heladas.
Duración del trabajo: Según la dimensión 6 min./planta

Kosten, custo, Расходы, cost, coste: 10 – 100 €/Stück

5.14 Heckenbuschlage, (Lagenbau), Gemischte Buschlage
Faixas de vegetação combinadas
Укладка крупных черенков, способных к укоренению, смешанная укладка ветвей и саженцев
Hedge brush layer, mixed brush layer
Lecho de plantas y ramaje



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Anwendung und Baubeschreibung: Auf Böschungen mit genügend Feinbodenanteil schafft die Kombination aus Buschlagen und Heckenlagen eine Pioniergehölzvegetation zugleich mit der nachfolgenden Laubholzgesellschaft in einem einzigen Arbeitsgang. Zu den lebenden Ästen der Buschlage werden bewurzelte Laubgehölzpflanzen eingelegt und das Ganze auf 10 cm zurückgeschnitten.
Baumaterial: Äste ausschlagfähiger Holzarten, 70 – 300 cm lang, 5 – 10 Äste/m und Sämlinge oder Heister von Laubgehölzen 60 – 150 cm lang, 1 Stück/m
Einbauzeit: während der Vegetationsruhe
Arbeitszeit: 30 Min./m

Procedimento construtivo e aplicação: Em solos de textura média onde tal se prove necessário a combinação de ramos vivos e plantas em torrão assegura a instalação numa única intervenção da vegetação pioneira e das etapas posteriores da sucessão vegetal. Em socalcos separados verticalmente 60 cm são alternadas plantas em torrão com ramos vivos que não devem sobressair da superfície final da encosta mais de 10 cm.
Materiais: Ramos vivos de espécies com capacidade de propagação vegetativa com comprimento entre 70 a 300 cm, 5 estacas por metro linear; plantas em torrão com comprimento entre 60 a 100 cm, uma espécie por metro linear.
Período de execução: Durante o período de repouso vegetativo.
Duração do trabalho: 30 min./m.

Применение и строительное описание: На склонах с достаточно хорошей почвой создают комбинацию из живых ветвей и укоренившихся саженцев древесных пород; за один рабочий приём производят облесение площади с одновременным последующим формированием сообщества лиственных деревьев. К уложенным живым ветвям добавляют укорененные лиственные древесные растения, присыпают их почвой и обрезают надземную часть растений до 10 см.
Строительный материал: Ветви древесных пород, способные к образованию побегов; 70 – 300 см длиной; 5 – 10 веток/метр; саженцы или укоренившиеся черенки лиственных пород 60 – 100 см длиной, 1 штука/метр.
Время строительства: В период вегетационного покоя.
Рабочее время: 30 мин/м.

Construction procedure and application: On slopes with sufficient fine soil, the combination of brush layers and hedge layers promotes the establishment of pioneer tree vegetation with the subsequent deciduous shrub community in one single operation. Rooted deciduous shrubs are inserted together with the living branches of the brush layer. The whole construction is then cut back to a height of 10 cm.
Material: ramified branches of shoot-forming woody plants, 70 – 300 cm in length, 5 – 10 branches/m, and seedlings or saplings of deciduous shrubs of 60 – 150 cm in length, 1 piece/m
Time of construction: during the dormant period
Time required: 30 min./m

Descripción y aplicación: En taludes con suficiente suelo, la combinación de lechos de ramaje y lecho de plantas enraizadas crea en una sola operación una vegetación pionera y la siguiente comunidad arbórea. Junto con las ramas vivas se meten pies leñosas enraizados, cortándolo todo después a 10 cm. Sobre pequeñas bermas, separadas 60 cm, se colocan ramas de sauce y pies leñosos con raíces y se cubren con tierra de la berma siguiente. Revegetación en pendientes deslizantes.
Materiales: 5 a 10 ramas de leñosos (70 – 300 cm) y 1 arbolillo (60 – 100 cm) por metro
Período de ejecución: Durante el reposo vegetativo
Duración del trabajo: 30 min./m

Kosten, custo, Расходы, cost, coste: 10 – 30 €/m

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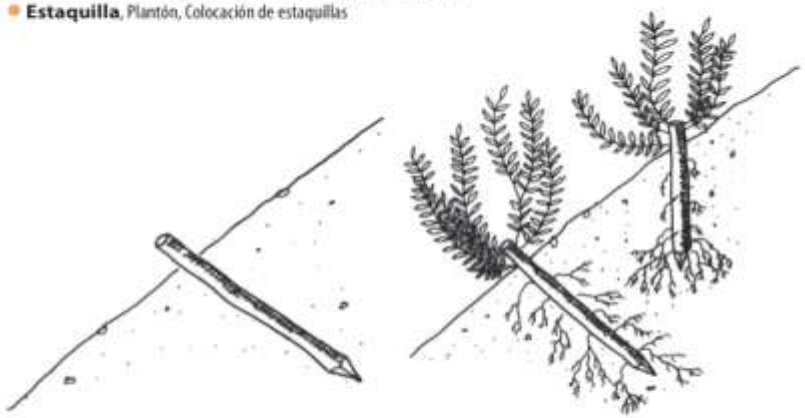
5.1 **Steckholz**, Versetzen von Steckholz, Setzholz, Setzling
Estacas de espécies lenhosas
Одревесневшие черенки, посадка черенков, вегетативных органов
Dormant cutting, planting of cuttings, pole, slip, transplant
Estaquilla, Plantón, Colocación de estaquillas



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Anwendung und Baubeschreibung: Zur Stabilisierung und Entwässerung sowie für Befestigungszwecke bei verschiedenen anderen Bauwerken. Man schlägt Steckhölzer so tief in den Boden ein, dass sie nur mehr einige Zentimeter herausragen. Eventuell schneidet man zu weit herausragende Stumpen ab. In kompakten Böden schlägt oder bohrt man Löcher vor.
Baumaterial: mehrjährige Steckhölzer ausschlagfähiger Holzarten, meist Weiden, 30 – 60 (100) cm lang, 1 – 5 cm dick, unten schräg geschnitten oder zugespitzt
Einbauzeit: während der Winterruhe, aber nicht bei Frost
Arbeitszeit: 5 Min./Stück

Procedimento construtivo e aplicação: Para a estabilização, drenagem e fixação de diferentes estruturas. Introduzem-se as estacas no solo, de modo a que sobressaiam apenas alguns centímetros. Se necessário, cortam-se as estacas demasiado longas. Em solos compactos, os buracos são feitos previamente.
Materiais: Estacas plurianuais, de espécies lenhosas com capacidade de propagação vegetativa, afiados ou cortados em bisel na parte inferior. Geralmente, utilizam-se estacas de salgueiros (Salix sp.), comprimento de 30 a 60 – (100) cm, diâmetro 1 – 5 cm.
Período de execução: Período de repouso vegetativo, excepto em períodos de temperaturas negativas.
Duração do trabalho: 5 min./unidade.

Применение и строительное описание: Для стабилизации и осушения участков, а также с целью укрепления различных сооружений. Колья глубоко вбивают в землю, чтобы над землей осталось только несколько сантиметров. Слишком длинно торчащие пеньки, по возможности обрезают, в плотных почвах предварительно пробуривают отверстия.
Строительный материал: Одревесневшие черенки древесных видов растений, способных к образованию корней и побегов; лучше ивы 30 – 60 (100) см длиной, 1 – 5 см толщиной, срезы под углом.
Время строительства: В период зимнего покоя, но не в морозный период.
Рабочее время: 5 мин/штука.

Construction procedure and application: For stabilization and drainage as well as for fixation of various structures. Cuttings are driven into the ground allowing only a few centimeters to emerge above surface. Stumps protruding too far are cut off. In case of compact soil, holes are pre-dug or pre-drilled;
Material: perennial cuttings of shoot-forming woody plants, mostly willows, 30 – 60 (100) cm in length, 1 – 5 cm in diameter, battered or pointed at their lower ends
Time of construction: during winter dormancy, but not during frost
Time required: 5 min./piece

Descripción y aplicación: Para la estabilización, drenaje y fijación de diferentes obras. Se introducen las estaquillas en el suelo, de tal manera que sólo sobresalgan pocos centímetros. Si fuera preciso, se cortan las estaquillas que hayan quedado demasiado largas. En suelos compactos, se cavan los hoyos con anterioridad.
Materiales: Estaquillas de varios años de especias leñosas con capacidad de echar brotes, afiladas o cortadas oblicuamente por su parte inferior. Generalmente, se utilizan estaquillas de sauce, longitud de 30 a 60 (100) cm, grosor 1 – 5 cm
Período de ejecución: Durante la parada vegetativa invernal, excepto en caso de heladas
Duración del trabajo: 5 min./unidad

Kosten, custo, Расходы, cost, coste: 3 – 5 €/Stück

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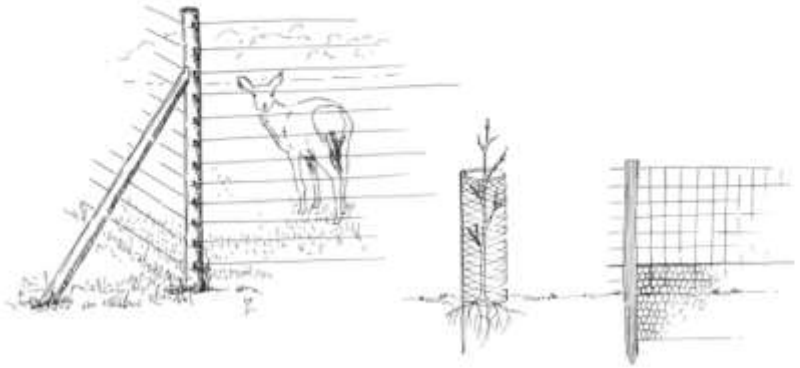
Maintenance

8.24 **Zäunen**, Erhalten von Zäunen
Cercas e vedações e sua manutenção
Ограждение, защитное ограждение
Fencing, maintaining of fences
Vallar



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Massnahme: Bau und Erhaltung von Einzäunungen ingenieurbiologischer Bauwerke oder Zwischendeponien. Ein temporärer Schutz gegen Weidevieh ist durch einfache Elektrozäune möglich. Gegen Kaninchen und Schafe werden Drahtgitter mit engen Maschenweiten mindestens 30 cm tief eingegraben; gegen Rotwild werden mindestens 2 m hohe Drahtzäune errichtet. Für Einzelpflanzen gibt es Einzelschutz vor Verbiss in Form von Draht- oder Kunststoffhosen.
Zeitpunkt: nach dem Pflanzen, jederzeit, laufend kontrollieren, bis die Pflanzen nicht mehr verbissen werden können
Ziel: Schutz ingenieurbiologischer Bauwerke gegen Beweidung, gegen Wildschäden, unbefugtes Betreten und Befahren.

Medida: Construção e manutenção de áreas vedadas para obras de engenharia natural ou escombreiras temporárias. Uma protecção temporária do gado é possível com a simples utilização de vedações eléctricas. Contra coelhos e ovelhas enterra-se a pelo menos 30 cm. no solo uma rede metálica de malha estreita. Contra veados, coloca-se uma vedação metálica com uma altura mínima de 2 metros. Para plantas individuais existem também protecções individuais de forma metálica ou em plástico.
Período de execução: Depois da plantação, em qualquer momento, com controlo contínuo até confirmação de que as plantas já não correm risco de danos de origem animal.
Objectivo: Protecção das obras de engenharia natural contra o pastoreio, contra danos causados por animais selvagens e contra a passagem não autorizada.

Мероприятие: Для сохранения инженерно-биологических объектов и ограждения свалок может быть сооружена электроизгородь как временная защита от выпаса крупного рогатого скота. Проволочная сетка с мелкими ячейками, вкопанная на глубину 30 см защищает от кроликов и овец; для защиты от оленей, сооружают 2-х метровую проволочную изгородь. Отдельно растущие деревья ограждаются от повреждения животными защитными чехлами из проволоки или искусственного материала.
Время проведения: После посадки, в любое время; ограждение постоянно контролируют до тех пор, пока не исчезнет угроза для растений.
Цель: Защита инженерно-биологических сооружений от дичи, нежелательного проезда и прохода.

Measure: Construction and maintenance of enclosures or intermediate depots using bioengineering techniques. Temporary protection against grazing livestock is provided by simple electric fences. To fend off rabbits and sheep, narrow-meshed wire nettings are buried at least 30 cm in the ground. Wire fences of at least 2 m in height are required against red deer. Individual plants are protected against browsing with jackets of wire mesh or plastic.
Time: after planting, any time; to be checked regularly until the plants are no longer endangered by browsing
Objective: Protection of bioengineering structures against grazing, browsing and trespassing.

Medida: Construcción y mantenimiento de vallados para obras de bioingeniería o escombreras temporales. Una protección temporal de la vegetación frente al ganado es posible mediante sencillas vallas eléctricas. Contra conejos y ovejas se entierran, al menos 30 cm. en el suelo, rejillas de alambre de malla estrecha. Contra venados, se colocan vallas metálicas de una altura mínima de 2 metros. Existe también protecciones individuales contra el mordisqueo, como protectores de malla metálica o sintética.
Periodo: después de la plantación, en cualquier momento, controlar continuamente hasta que las plantas ya no puedan ser dañadas
Objetivo: Protección de las obras de bioingeniería contra pastoreo, contra daños causados por animales de caza, contra paso no autorizado.

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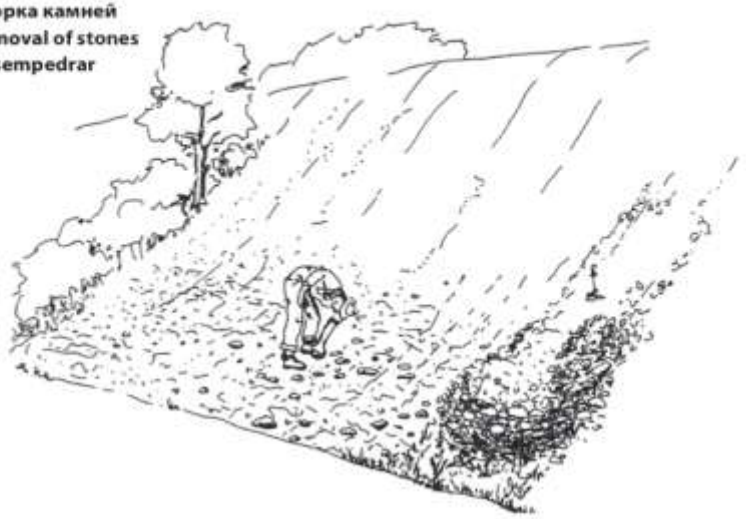
8.32 Entsteinen / Remoção de pedras / Уборка камней / Removal of stones / Desempedrar



Massnahme: Die durch Frost an die Oberfläche gelangten Steine werden gesammelt und an geeigneten, erosionsfreien Stellen zu Lesehaufen oder -mauern aufgesetzt. Bei Skipisten müssen diese weit ausserhalb der Piste angelegt werden, damit dadurch keine Gefährdung der Skifahrer entsteht. – Nach Lawinenabgängen und Hochwässern wird das Gelände von Steinen, Schutt und Holz oder Treibgut geräumt. Äste und Baumstrünke plaziert man im Kern der Lesehaufen.
Zeitpunkt: im zeitigen Frühjahr, nach Katastrophen
Ziel: Räumung des Geländes zur Wuchsförderung des Bestandes oder zur landwirtschaftlichen Nutzung.

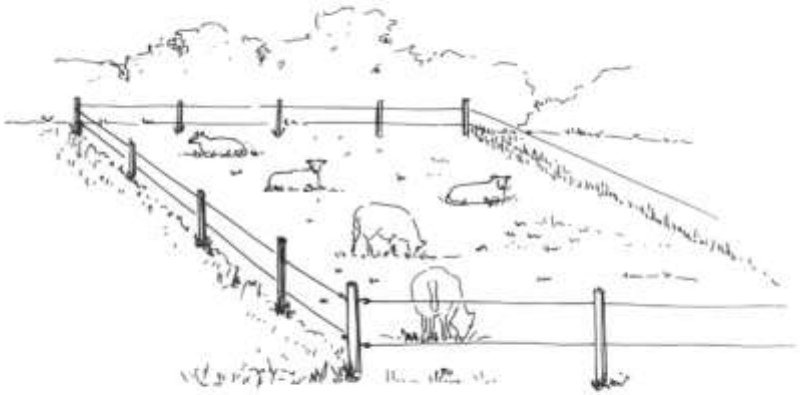
Medida: Retiram-se as pedras da superfície do terreno que tenham chegado com o gelo e colocam-se em sítios adequados fora de zonas de erosão. Ali podem-se construir pequenos muros ou montes de pedra. Devem ser colocadas fora das pistas de ski para não colocar os esquiadores em perigo. Depois de cheias ou inundações retiram-se da área as pedras, os escombros, troncos ou outros elementos. Os ramos e troncos podem ser colocados no centro das pilhas de pedra.
Período: No princípio da primavera depois de catástrofes.
Objectivo: Limpeza do terreno para favorecer o crescimento da vegetação ou para uso agrícola.

Мероприятие: Появляющиеся на поверхности камни (выдавливаются при низких температурах) собирают и вывозят в места, где нет эрозии, и там сооружают из них стены или складывают в кучи (вдали от лыжных трасс, чтобы избежать опасности для лыжников). После схода лавин и наводнений с территории убираются камни, щебень, древесина. Ветви и бревна складируют в кучи.
Время проведения: Ранней весной, после катастроф.
Цель: Очистка территорий и создание условий для развития растений или использования в сельском хозяйстве.

Measure: Stones brought to the surface by frost are picked up and deposited on erosion-free spots in the form of piles or walls. In skiing areas, they have to be placed at sufficient distance from pistes so as not to endanger skiers. After the release of avalanches and after floods, the terrain is cleared of stones, debris, wood and drift material. Branches and tree stumps are placed in the center of the pile.
Time: in early spring, after disasters
Objective: Clearing of site to promote growth or for agricultural use.

Medida: Se retiran las piedras de la superficie del terreno que han llegado con las heladas y se colocan en sitios adecuados sin riesgos de erosión. Allí se construyen pequeños muros de piedras o bien se amontonan. Hay que colocarlas fuera de las pistas de esquí, para que no pongan en peligro a los esquiadores. Después de aludes o inundaciones, se despeja la área de piedras, escombros, troncos u otros elementos. Ramas y tocones se ponen en el centro de las pilas de piedras.
Periodo: a principios de primavera, después de catástrofes
Objetivo: Despejar del terreno para favorecer el crecimiento de la vegetación o para el uso agrario.

8.8 Temporär Beweiden
Pastoreio temporário
Ротационные пастбища
Temporary grazing
Pastoreo temporal



Massnahme: Zeitlich beschränkte Beweidung mit leichtgewichtigem Weidevieh wie Schafe und Jungrinder. Örtlich ist die Beweidung durch Abzäunen mit einem Elektrozaun oder durch Hüten (Hirte mit Hund) zu begrenzen. Die Einrichtung mehrerer Rotationsflächen ist zweckmässig.
Zeitpunkt: während der Vegetationszeit; zeitlich so begrenzen, dass Schäden am Boden vermieden werden
Ziel: Förderung der Narbendichte und des Wurzelwachstums. Kurzhalten der Rasen aus landschaftsgestalterischen Gründen und zur Erhaltung der Funktionsfähigkeit z.B. von Skipisten.

Medida: Pastoreio efectuado temporariamente por gado de pouco peso, como ovelhas ou novilhos. Pode confinar-se no espaço com utilização de vedações eléctricas ou com um pastor. A promoção da rotatividade das parcelas de pasto poderá ser vantajosa.
Período de execução: Durante o período vegetativo, delimitar o pastoreio temporalmente para evitar danos ao nível dos solos.
Objectivo: Favorecer a densidade e desenvolvimento dos sistemas radiculares. Manter o prado baixo por razões paisagísticas e para a manutenção das suas funções específicas, p.e. em pistas de esqui.

Мероприятия: Ротационные участки для выпаса мелкого скота, такого как овцы и молодняк крупнорогатого скота. На местности участки пастбища ограждают электрической или иной изгородью, где находятся пастух с собакой. Целесообразно сооружать значительное количество ротационных участков.
Время проведения: В вегетационный период; во избежание повреждения почвы длительность выпаса на участках ограничивают.
Цель: Сохранение поверхности почвы и корневищ. Сохранение внешнего вида и функциональности открытых участков, например, на лыжных трассах.

Measure: Temporary grazing by light-weight animals, such as sheep and young cattle. The grazing area has to be confined in space by providing electric fences or by shepherding (shepherd with dog). Providing several rotation areas may be advantageous.
Time: during the vegetation period; to be limited in time to prevent damage to the ground
Objective: To promote turf density and root growth, to keep the turf short for landscaping reasons and to maintain the respective function, e.g. as ski-pistes.

Medida: Pastoreo, temporalmente limitado, de ganado de poco peso, como ovejas y novillos. Se puede limitar espacialmente el pastoreo con pastor eléctrico o con pastor con perro. Las parcelas de pastos rotatorias son aconsejables.
Periodo: Durante el periodo vegetativo, limitar el pasto temporalmente para evitar daños al suelo.
Objetivo: Favorecer la densidad del césped y el desarrollo de las raíces. Mantener el prado corto por razones paisajísticas y para el mantenimiento de funciones específicas, p.e. en pistas de esquí.

ANNEX 7 INSTRUMENTATION AND MONITORING PLAN

A7.1 Tentative Specifications and Cost Estimate for a Microseismic Network

A7.1.1 Applicability

No such network was planned as yet for Rogun HPP. The following cost estimate is based on a (preliminary) proposal for such a network for an HPP in Turkey, cost basis 2004. therefore, this can only give an approximate idea about costs for such a network for Rogun HPP.

A7.1.2 Specifications for Microseismic Network

The cost estimate for the microseismic network shall comprise the following supplies:

- Seven autonomous microseismic stations, one of them shall serve as control centre, where the seismic signals from all the stations are collected electronically and analyzed. Cost estimate is required for 5 stations and two additional stations.
- The microseismic stations must be capable to record and locate events with magnitudes larger or equal than 0.5. The location of the microseismic stations is not known yet and will have to be agreed upon with DSI.
- Software and hardware for the automatic analysis and storage of microseismic activity and seismic events, i.e. evaluation of time, epicentre, hypocentre, focal depth, magnitude, focal mechanism, plotting of epicentres in map etc.
- Continuous data transmission from microseismic stations to main control station by radio (maximum distance 70 km, average distance of other stations ca. 30 km).
- Annual maintenance costs of whole system.

A7.1.3 Quotation by GeoSIG

On the basis on the above Specifications GeoSIG, Switzerland was asked for a preliminary budgetary quotation for 5 plus two additional stations including VHF telemetry.

The quotation was submitted with the following remarks:

- A network with spread spectrum is in the same price range but not recommended for that part of terrain in Turkey, because line of sight is very critical in spread spectrum.
- The data acquisition centre declares the common trigger from the continuously received data streams and event parameters are sent to required locations via GSM / SMS.
- The automatic evaluation of events is not recommended because it is not reliable. It is better to operate it manually. This is valid especially for a micro-seismic network.

- For the operation of the system a minimum of 1man month (e.g. a DSI Engineer) per year plus the costs for GSM or telemetry fees /taxes must be considered. These costs are not included in the following quotation.
- Furthermore the following items would have cost implications which are not considered in the following quotation:
  - Power supply
  - Licenses for the communication system
  - Required autonomy for stations and centre (4 days autonomy of instruments is provided)
  - Data storage space required (16 MB storage is provided)
  - Selection and preparation of station and centre locations; relevant communication tests
- Delivery time approximately 16-20 weeks. The time for commissioning depends on the site conditions.

A7.1.4 Preliminary Budgetary Quotation GeoSIG Ltd., March 25, 2004

Item	**Cost (CHF)**
Field Stations & Data Acquisition Centre (5 stations): 5 GSD-24 5 CMG-40T-1 5 GPS 5 TEL-VHFO 5 Antenna Station 1 TEL-VHFC 1 Antenna Central 1 Central Computer System 1 GeoDAS Seismic Central Software 1 GSM functionality including transmitter	197'000.-
Additonal Stations (2 extra stations) 2 GSD-24 2 CMG-40T-1 2 GPS 2 TEL-VHFO 2 Antenna Station	54'000.-
Packing & Freight & Insurance	10'000.-
Commissioning & Training	46'000.-
Optional Repeater 2 TEL-VHFO 2 Antenna Repeaters	21'000.-
Maintenance (1 included; annual costs)	25'000.-
GRAND TOTAL	**353'000.-**

A7.1.5 Cost Estimate for Rogun HPP

Two issues have to be considered:

- The above cost estimate was made in 2004 for a hydropower project in Turkey.
- In the case of Rogun, Nurek should be integrated.

For these reasons it has to be assumed that additional stations would be required; a more detailed analysis would have to be made for determining the required number. Furthermore, an update would have to be made for actual (2013) prices.

For these reasons, at the present stage the cost for a microseismic network for Rogun HPP are estimated at USD 500'000.

ANNEX 8 SCHEDULE

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ANNEX 9 COSTS OF ESMP IMPLEMENTATION

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