

CHAPTER 9: AVOIDANCE AND MITIGATION OF IMPACTS

9.0 Introduction

The Mizoram State Roads Project is envisaged to alter (both beneficially and adversely) various environmental components within its area of influence. To minimize the adverse impacts of the project, avoidance and mitigation measures have been formulated and will be implemented during the tenure of the project. These Mitigation measures would be directed towards restoration of dynamic balance of nature. Avoidance and mitigation of negative impacts involves reduction in magnitude of the adverse impacts during various stages of the project through:

- Alterations during design, site clearance, construction and operation stages of the road project and
- Additional mitigation measures for unavoidable negative impacts on the environmental components.

These measures were incorporated into various stages of the project. Based on their applicability, both general and case specific measures were incorporated as follows:

- General measures: To avoid or mitigate impacts on environmental components, general mitigation measures were identified based on the characteristic features.
- Specific: At various sensitive locations site-specific designs have been formulated as mitigation / compensatory measures for addressing the negative impacts.

The following sections detail the mitigation measures adopted as part of the MSRP 2 to minimize the adverse impacts envisaged due to the project.

9.1 NATURAL AND BIOPHYSICAL ENVIRONMENT

9.1.1 Meteorological Parameters

Since the impact on meteorological parameters is not expected to be significant, there is little by way of project actions that can effectively alter the overall temperature, rainfall, or even wind speed patterns of the project area. Whatever localised impacts are anticipated, shall be offset over time by re-vegetation, taken up as part of the compensatory afforestation and additional tree plantation as part of the project along the existing and newly created slopes.

However, there would be some lag of 3 years before the vegetation on the slopes is sufficiently developed.

9.1.2 Air

Impacts on air quality are expected to be of far more serious concern during the construction period than during the operation phase. Several avoidance and mitigation measures have been considered and adopted as part of the environmental management plan to control pollution during the construction period.

9.1.2.1 Generation of Dust

The asphalt plants, crushers and the batching plants will be sited in the downwind direction from human settlements. A distance of a minimum 500m to 1km from the nearest settlement should be maintained in order to ensure that the concentration of the pollutants from these emissions diffuse enough to be within acceptable limits at settlement locations.

All precautions to reduce the dust emissions from the hot mix plants, crushers batching plants and other transportation of materials will be taken up including:

- Provision of wind breaking wall, bamboo screens around the sources of dust such as the vibrating screens, conveyors, etc. should be made and regularly checked for all stone crushers used to supply material for the project.
- Vehicles delivering loose and fine materials like crusher dust and soil/spoils shall be covered to reduce spills on existing roads
- Water will be sprayed on earthworks, temporary haulage and detour roads on a regular basis. During and after compaction of the sub-grade, water will be sprayed at regular intervals to prevent dust generation.
- The hot mix plant will be fitted with dust extraction units.
- In addition, quarterly monitoring shall be conducted at locations where earthworks or slope cutting operations are taking place.

9.1.2.2 Generation of Exhaust gases

Generation of exhaust gases is a concern especially from hot mix plants. To ensure the control of exhaust gas emissions from various construction activities, the contractor shall take up the following mitigation measures

- An adequate cyclone/scrubber to control emissions from the stack of hot mix plants will be provided. Other measures as planting of vegetation around periphery of the construction sites shall be taken up.
- To ensure efficacy of the mitigation measures suggested, air quality monitoring shall be carried out at least once a month during the period the plant is in operation.
- Contractors also should be required to obtain regularly *Pollution Under Control* Certificate from MPCB for their equipments and machinery as per prevalent norms. If adequate measures are taken then impacts from generated gases can be effectively controlled.
- Use of firewood in construction camps/preparation of asphalt mix shall be banned and kerosene as alternate fuel shall be supplied.

All vehicles, equipment and machinery used for construction will be regularly maintained to ensure that the pollution emission levels conform to the SPCB norms. Also pollution monitoring shall be conducted monthly at all these locations to measure the levels of polluting gases.

9.1.3 Water Resources

The construction process is likely to have a significant adverse impact on water resources along the upgradation road unless adequate measures are framed and executed for the same as part of the EMP. The following mitigation measures shall be adopted to minimize impacts

9.1.3.1 Water Quality

Silt Fencing at Rivers and Water Bodies

To prevent any degradation of water quality of various surface and ground water resources due to the proposed project, the contractor shall work out the following measures during the construction period:

- Provision of necessary mitigation measures at various locations proposed in the design to prevent contamination and degradation of water quality.
- Construction work close to the streams or water bodies must be avoided during monsoon.
- Discharge standards promulgated under the Environmental Protection Act, 1986 for surface water bodies will be strictly adhered to.

runoff. Moreover, such techniques are expensive, need greater control/supervision over the process and would be superfluous.

9.1.3.2 Depletion of Water Resources due to Construction and Allied Activities

Water for construction will have to be procured from river and hauled or pumped to the construction site. The contractor will arrange for water required for construction in such a way that the water availability and supply to nearby communities remain unaffected.

While working across or close to perennial water bodies, the Contractor will not impede or block any flow of water. If for any bridgework, containment of flow is required, the Contractor will seek approval of the Engineer appointed by Supervision Consultant. The Engineer will have the right to ask the Contractor to serve notice on all downstream users in advance of any closure.

Construction over and close to any non-perennial streams shall be carried out in the dry season. Construction over irrigation canals should be carried out such that disruption to the flows is minimised and high quality of water is maintained. Construction will be undertaken with permission of the Department of Irrigation. The Contractor may use natural sources of water subject to the provision that any claim arising out of conflicts with other users of the said natural sources will be resolved by him.

1. Water Harvesting on Hillside.

Harvesting of natural runoff was observed at few locations on the hillside. Water can be harvested on hillside by constructing small check dams along the natural contour of the hillside where space is available. Water can thus be harvested along the natural course of the stream at available levels along the hill slope.

2. Water Harvesting on the Valley Side

It was observed along the project road that small check dams (upto 1.5m ht) can be constructed on the valley side to stop the outflow of natural water from culverts. Harvesting at valley sides would be especially manageable at sharp bends/curves of the Project Road .

3. Water Harvesting at Locations of Realignment

It is also feasible to store water at locations (on valley side) where the road has been realigned at sharp bends to straighten out curves and improve road geometrics. Runoff from

waterfalls/streams can be stored in the reservoir created by the natural curve of the road and the retaining wall of the proposed road.

4. Harvesting of water at Hill and Road Interface.

Along the upgradation corridor at locations of waterfalls/streams ample flat land was available between the base of the hill and the carriageway. Such locations offer space to create underground water storage tank along the path of the runoff.

9.1.3.3 Ground Water Resources

Roadside hand pumps are likely to be affected by the proposed widening of the upgradation corridor. These shall be replaced within the nearest settlement area after consultation with the local community and the village councils.

9.1.4 LAND

9.1.4.1 Drainage

To ensure that the project does not obstruct the existing course of the surface water flow and alter the hydrological setting by acting as an impediment to the natural drainage system of the region; detailed drainage surveys and hydrological investigations have been undertaken and suitable design of bridges and culverts proposed. All the existing cross-drainage structures will be replicated and additionally, cross-drainage structures will be provided at locations, where the natural drainage flow is obstructed at present.

Roadside drainage system has been provided for efficient and speedy flow of the surface water. V-shaped drains of 150 mm thick cement concrete and having top width of 600mm and depth of 300 mm has been provided on the hillside throughout the project road except where it is passing through inhabited areas.

9.1.4.2 Prevention of Local Flooding

The contractor will remove obstructions that may cause temporary flooding of local drainage channels, during construction especially at locations of waterfalls/streams In sections along watercourses, and close to cross-drainage channels, earth, stone or any other construction materials shall be disposed off such that the flow of water is not blocked. All necessary

measures will be taken to prevent earthwork, stonework and other debris from impeding cross-drainage at rivers, streams, water canals and existing irrigation and drainage systems.

In addition to the design requirements, the contractor will take all necessary measures to prevent temporary or permanent flooding of the work site or any adjacent area. Measures for the prevention of flooding shall include no loss of use, loss of access of any land or property thereon resulting from flowing or stagnant water as direct / indirect impact of construction.

9.1.4.3 Blasting and Cutting of the Hill faces

Cutting of the Hill faces is the most significant construction activity, and needs to be done in a highly controlled manner. The Explosives Act, 1884 and the Explosives Rules 1983 will be strictly followed during procurement transportation, handling, storage and use of explosive. Explosive will be used in accordance with the recommendations of the Indian Standard Code of practice and will be stored under proper security at a safe distance from the road and at least 300 m from any inhabited premises.

Controlled blasting will be used to limit the volume and extent of rock throw, and to reduce the disturbances of local flora and fauna.

Regular monitoring studies shall be conducted for assessment of land stability and landslide occurrence.

9.1.4.4 Quarrying Operations

Materials will be procured from quarries having NoC from mining and geology department of Mizoram or licensed as per the gazette notification, 2000 and regulations of the concerned State Government Departments. Redevelopment plans for quarry areas from which material is extracted and have exhausted in the construction period, shall be developed by the PWD and implemented in co-ordination with the mining & geology dept., Mizoram and the Forest Department, Mizoram.

9.1.4.5 Measures for Control of Erosion /Slope Stabilization

Retaining walls

The road design incorporates appropriate type of treatments of slopes to reduce the potential for erosion of high embankments and bridge fills. Appropriate retaining structures like breast walls, revetment has been provided at vulnerable locations to stabilize slopes. Details about

the type and size of breast walls provided at different locations of the project are given in the Engineering design volume of the report.

To prevent destabilization of slopes at locations where the road is to be widened by filling on the valley side retaining walls shall be provided. Three types of retaining walls have been designed for different locations of the Project Road.

1. Dry Random Rubble Masonry for heights \leq 2.0m
2. Composite Random Rubble masonry for Heights \geq 2.0m \leq 5.0m
3. Mortared Random Rubble Masonry for Heights $>$ 5.0m \leq 15.0m

Breast Walls

Breast walls shall be provided to protect the slope on the hillside at different locations of the project Road. To enhance the stability of the hillside, three types of designs have been proposed.

1. Dry Random Rubble Masonry for heights \leq 2.0m
2. Composite Random Rubble masonry for Heights \geq 2.0m \leq 4.0m
3. Mortared Random Rubble Masonry for Heights $>$ 4.0m \leq 6.0m

9.1.4.6 Disposal of Debris/Construction Spoil

The debris generated will be utilized in construction works such as filling, construction of retaining walls, embankments etc. However, a large quantum of debris will still remain to be disposed off. Dumping sites shall be identified to ensure environmentally safe disposal of the construction debris. The locations of dumping sites have to be selected such that -

- No residential areas are not located downwind side of these locations,
- Dumping sites are not located in bio diversity rich or sensitive locations,
- Dumping sites do not contaminate any water sources, rivers etc, and
- Dumping sites have adequate capacity equal to the amount of debris generated.

Provision of Toe Walls to contain dumping spread

Toe Walls shall be provided to lend back support to the excavated rock/soil dumped on the valley side. Depending on the extent of dumped material the following types of designs are proposed to be used for constructing the Toe walls.

1. Dry Random Rubble Masonry for Heights \leq 2.0m

2. Bamboo/Gabion wire crates/bamboo crib walls for Heights, $\leq 2.0\text{m}$
3. Gabions for Heights $> 2.0\text{m} \leq 5.0\text{m}$
4. Composite Random rubble masonry for Heights $> 2.0\text{m} \leq 5.0\text{m}$

In addition the contractor shall take the following precautions during disposal of debris:

- i. During the site clearance and disposal of debris, contractor will take full care to ensure that public or private properties are not damaged/affected and that the traffic is not interrupted.
- ii. Contractor will dispose off debris only to dumping locations having prior approval of PWD/ Engineer-in-Charge of works.
- iii. Contractor will also dispose the debris for improvement of public utilities with the consent of villagers and approval of PWD/ Engineer-in-Charge of works.
- iv. In the event of any spoil or debris from the sites being deposited on any adjacent land, the contractor will immediately remove all such spoil/debris and restore the affected area to its original state to the satisfaction of the PWD/ Engineer-in-Charge of works.
- v. The contractor will at all times ensure that the entire existing streams, watercourses and drains within and adjacent to the site are kept clean, safe and free from any debris.
- vi. Contractor will utilize effectively, water sprays during the delivery and handling of materials when dust is likely to be created and to dampen stored materials during dry and windy weather.
- vii. Materials having the potential to produce dust will not be loaded to a level higher than the side and tail boards and will be covered with a tarpaulin in good condition.
- viii. During cutting of hills and disposal of debris proper warning signs will be installed to the satisfaction of PWD/ Engineer-in-Charge of works.
- ix. Any diversion required for traffic during disposal of debris shall be provided with traffic control signals and barriers after the discussion with local people and permission of PWD/ Engineer-in-Charge of works.
- x. During the debris disposal, contractor will take care of surrounding features and avoid any damage to it.

During the debris disposal contractor will take care about wind direction and situation of the settlements, so that any dust problem will be avoided.

Debris disposal shall be monitored by the representatives by local people of habitation nearest to the dumping location. Reporting of the activity shall be done regularly by the NGO's village council presidents.

9.1.5 Noise Levels

Noise and vibration during construction is a significant impact especially around settlements and inhabited areas. Following mitigation measures need to be worked out by the contractor for the noise impacts associated with the various construction activities:

- Noise standards will be strictly enforced for all vehicles, plants, equipment, and construction machinery. All construction equipment used for an 8-hour shift will conform to a standard of less than 90dB (A). If required, machinery producing high noise as concrete mixers, generators etc, must be provided with noise shields and their usage timings can be regulated.
- Machinery and vehicles will be maintained regularly, with particular attention to silencers and mufflers, to keep construction noise levels to minimum.
- Workers in the vicinity of high noise levels must wear earplugs, helmets and be engaged in diversified activities to prevent prolonged exposure to noise levels of more than 90dB(A) per 8-hour shift.
- No hot mix, batching and aggregate crushing plants shall be located within 500m of sensitive land uses as schools, hospitals etc.

Blasting when required shall be restricted to daytime hours. All the statutory laws, regulations, rules etc, pertaining to acquisition, transport, storage, handling and use of explosives will be strictly followed. Blasting will be carried out only during fixed hours as permitted by the Engineer.

During the operation stage, sensitive receptors will be clearly marked by providing regulatory signage. Enforcement of these will be the responsibility of the local authorities.

9.1.6 Flora

9.1.6.1 Road Side Plantation

At the ratio of 10 trees shall be planted for every tree cut by the Forests Department. The project will transfer funds as per their estimate so that compensatory afforestation can be

carried out for trees cut for the project. The project will involve the local NGOs to revegetate the slopes at space available on lands identified by the NGOs. While plantation is a one time cost to the project, there is provision for financial incentive to local NGOs for maintenance.

Indigenous species shall be used as far as practicable, strictly avoiding any exotic species like *Eucalyptus* that can have far-reaching adverse effects on the ecology and water regime of the area. Furthermore, thorny plants like *Zizypus* spp., etc., should not be ideally used in highway planting. Saplings should be planted in 2x2 ft. pits, wherever possible on small terraces created on the valley side, with adequate amount of cow-dung and dolomite added as organic and mineral nutrients.

Species to be used on road shoulders:

Cytisus sp. (Broom grass), *Mikania* spp., *Lycopodium* spp., *Selaginella* spp., *Polytrichum* spp. And *Sphagnum* spp. Besides bamboo clump could be planted on the upper side of the shoulder.

On Valley slope:

Species recommended for afforestation on the Valley side are Thatch grass (*Imperata* spp.), *Cynodon* spp., *Mikania* spp., *Hydrocotyl* spp., *Oxalis* spp., *Eupatorium* spp., various species of bamboo, etc.

Loss of Forest Cover/Green Cover

Various **Bio Engineering Measures** have been proposed to regenerate the cover lost due to the cutting of hill slopes. Such measures include transplantation / inoculation of soil-binding plant species on the exposed surfaces resulting from shoulder-cutting to widen the roads, as well as on the valley slope to further strengthen the soil-binding there. The following species need to be planted to reinforce the slopes.

Among the different species suggested, *Cytisus* and *Imperata* have laterally spreading adventitious roots and clump-forming tendency that results in effective soil-binding. *Mikania* gives off roots from nodes while creeping that penetrates the exposed surface and clings to the soil. The bryophytes and pteridophytes, on the other hand, are provided with rhizoids that have a high cumulative soil-binding capacity. Besides, these plants, because of their habit of forming extensive spongy mats on exposed soil, protect the soil effectively against the bombardment of raindrops.

While shoulder-cutting, attempts should be made to create a slope of at least 80°, avoiding totally vertical cuts, Small terraces about 4-6 ft. high may be carved out on the road shoulder and protected by planting grasses and other ground flora. These measures would go a long way in preventing soil erosion and landslides.

Besides serving the purpose of soil binding, plants like broom and thatch grasses could also benefit the local community, who could maintain these patches on a sustainable utilization basis, thus boosting the social welfare component of the road project.

9.1.6.2 Loss of Medicinal Plants

Medicinal plants are found in the EidAs and Red, orange zones identified. The contractor shall not set up construction camps, hot mix plants etc at these locations. Also dumping locations have been selected so that no material is tipped within 100m of such locations.

Regular monitoring of Biodiversity in the region is to be carried out to assess the effectiveness of the suggested mitigation measures.

9.2 SOCIO ECONOMIC ENVIRONMENT

9.2.1 Loss of Access

The contractor shall provide safe and convenient passage for vehicles, pedestrians and livestock to and from side roads and property accesses connecting the project road. Construction activities that shall affect the use of side roads and existing access to individual properties shall not be undertaken without providing adequate provisions.

Construction works will not interfere with the convenience of the public or the access use and occupation of public or private roads, railways and any other access footpaths to or of properties, whether public or private.

9.2.2 Road Safety during Construction

The Contractor is responsible for ensuring road safety along stretches where construction is in progress. All the construction period road safety plans will be subject to scrutiny and approval by the Engineer. Due to the special nature of hill roads, special provisions will be incorporated in the plan.

This includes stoppage of construction for two hours during peak periods in the morning and two hours in the evening to allow commuters to go through.

The contractor will provide and maintain barriers, fencing and lighting around the site and where necessary for the safety, security and convenience of the public including traffic on road and as otherwise needed to suit his working methods and timings.

The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, marking, flags, lights and flagmen as may be required by the Engineer for the information and protection of traffic approaching or passing through the section of the highway under improvement. Before taking up any construction, an agreed phased programme for the diversion of traffic or closer of traffic on the state highway shall be drawn up in consultation with the PWD Engineer-in-Charge of works.

At the points where traffic is to deviate from its normal path (whether on temporary diversion or part width of the carriageway) the lane width path for traffic shall be clearly marked with the aid of pavement markings, painted drums or a similar device to the directions of the PWD Engineer-in-Charge of works. At night, the passage shall be delineated with lanterns or other suitable light source.

One-way traffic operation shall be established whenever the traffic is to be passed over part of the carriageway inadequate for two-lane traffic. This shall be done with the help of temporary traffic signals or flagmen kept positioned on opposite sides during all hours. For regulation of traffic, the flagmen shall be equipped with red and green flags and lanterns / lights.

On both sides, suitable regulatory / warnings signs showing timings when road will be open for traffic as approved by the PWD Engineer-in-Charge of works, shall be installed for the guidance of road users. On each approach, at least two signs shall be put up, one close to the point where transition of carriageway begins and the other 120 m away. The signs shall be of specified design and of reflectory type, if so directed by the PWD Engineer-in-Charge of works.

Provision of regulatory signage at sensitive receptor locations such as schools, hospitals and warning signs at known accident spots.

Stockpiling of material will be planned such that smooth traffic flow is ensured. Spills at accident sites will be cleared immediately. The left over spills will be scraped and reclaimed to small lined pits at identified sites.

In case of accidental spillage, immediate report to relevant departments will be made and instructions followed in taking up the corrective measures as soon as possible.

9.2.3 Maintenance of Temporary Diversions and Traffic Control Devices

Signs, lights, barriers and other traffic control devices, as well as the riding surface of diversion shall be maintained in a satisfactory condition till such time they are required as directed by the PWD/ Engineer-in-Charge of works. Temporary roads shall be kept PWD free of dust by frequent applications of water, if necessary.

9.2.4 Other Social impacts

Mitigation Measures for all social impacts have been detailed in the R&IPDP.

9.2.5 Induced developments

Road side development

The MPWD has acquired 5m reserve land on either side of the existing road, to curb roadside development outside the existing settlement areas. In the settlement area, village council is responsible for allotment of land other than agricultural purposes. During consultations with the village council presidents it was agreed that allotment of land abutting the road shall be avoided.

Trade and Tourism

Influx of tourists and visitors may increase due to improved accessibility. Eco-tourism can be promoted in the area for control of impacts associated with tourism. Awareness generation among tourists shall be taken up with the involvement of NGO/CBO and church.