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Environmental Impact Assessment of a Rural Road Project : Network and Matrix Method

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ABSTRACT

Environmental consciousness has taken a center stage in the planning and execution of development projects across the globe. It might not be as welcome as it seems to be because maximum damage has either been done or a road map has already been laid for further decimation and intoxication of natural resources. Today, the act of preserving has been replaced by the act of revival, which rings the alarm bell. In such a crucial time, the importance of Environmental Impact Assessment is conspicuously self-explanatory. Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse. The cognizance of the impact on the environment because of a development project is not only crucial for avoiding the negative impacts but is also of paramount importance for maximizing the positive impacts on the environment. To fulfill the purpose of EIA, it should be thoroughly performed at different stages of development, which includes pre-construction stage, construction stage and post construction stage in the case of development project related to construction activity, which is the focus of our paper. On the basis of secondary data, impact identification networks are created for pre-construction, construction and post-construction phases, to identify the impacts. Only a flowchart showing the co-relation of impacts is not sufficient if the impacts need to be classified further. So, to identify the impacts more categorically, impact identification matrix is created. Using the networks and matrix, mitigation measures are suggested on a broad basis which serves as the conclusion of the thesis.

Keywords: Environmental Impact Assessment, Rural Road, Network Analysis, Matrix Method

I. INTRODUCTION

Environmental Impact Assessment

In most of the developing countries, large scale projects like the hydro – dams, petroleum industries, iron and steel development, irrigation dams, highways and airports etc. are generally planned and executed by the federal government. Such projects are often justified in terms of high demand for the hydroelectric power for both, domestic and industrial use, slow agricultural growth, poor communication systems and increasing unemployment problems in the developing countries concerned. Further, for a developing country, any such developmental activity is an effort made towards improvement in the lifestyle or enriching the human environment. Environment Impact Assessment is concerned with the identification of the negative and the positive impacts of such large projects and proposing alternatives towards minimizing the negative impacts to maximize the benefits from the proposed action. The efficiency in decision making can be improved by suitably incorporating the EIA component right from the planning stage of the projects. EIA involves multi – disciplinary expertise in identifying, predicting and evaluating the potential impacts due to the actions under consideration. EIA also helps in identifying, alternatives to siting of the projects, choice of technology and alternative to the proposed development projects.

Indian history

The environmental impact assessment in India was started in 1976-77 when the Planning Commission asked the then Department of Science and Technology to examine the river-valley projects from environmental angle. This was subsequently extended to cover those projects, which required approval of the Public Investment Board. These were administrative decisions, and lacked the legislative support. The Government of

India enacted the Environment (Protection) Act on 23rd May 1986. To achieve the objectives of the Act, one of the decisions that were taken is to make environmental impact assessment statutory. The Ministry of Rural Development (MoRD), Government of India has undertaken development of various rural roads under PMGSY. The PMGSY roads besides having social and economic benefits to the communities, may lead to adverse social and environmental impacts triggering the need to carry out Environmental Impact Assessment

The Government of India under Environment (Protection) Act 1986 issued a number of notifications, which are related to environmental impact assessment. These are limited to specific geographical areas.

- Prohibiting location of industries except those related to Tourism in a belt of 1 km from high tide mark from the Revdanda Creek up to Devgarh Point (near Shrivardhan) as well as in 1 km belt along the banks of Rajpuri Creek in Murud Janjira area in the Raigarh district of Maharashtra (6th January 1989)
- Restricting location of industries, mining operations and regulating other activities in Doon Valley (1st February 1989)
- Regulating activities in the coastal stretches of the country by classifying them as coastal regulation zone and prohibiting certain activities (19th February 1991)
- Restricting location of industries and regulating other activities in Dahanu Taluka in Maharashtra (6th June 91)
- Restricting certain activities in specified areas of Aravalli Range in the Gurgaon district of Haryana and Alwar district of Rajasthan (7th May 1992)
- Regulating industrial and other activities, which could lead to pollution and congestion in an area north west of Numaligarh in Assam (5th July 1996)

II. METHODS AND MATERIAL

Need for EIA in Rural Road Projects

Rural connectivity and growth are linked intrinsically, be it in the area of Trade, Employment, Education or health care. Rural road connectivity is a key component of rural development in securing poverty alleviation by providing easy access to marketing centers for the agricultural produce at lower transportation cost resulting in higher price realization thereby increasing rural income. The roads further promote access to education, health care, increased employment opportunities, improve economic activities and generally result in higher standard of living. Against the above background of inadequate rural connectivity, the Prime Minister announced in 2000 the Pradhan Mantri Gram Sadak Yojana(PMGSY), a program to address this backlog of connecting the 3,30,000 unconnected habitations.

The Ministry of Rural Development(MoRD) administers the program as a centrally sponsored scheme in all the States and six Union Territories. The MoRD has identified executing agencies in each of the states. These agencies have worked out mechanisms for implementation through setting up of Programme Implementation Units(PIU) in each of the districts

National Rural Roads Development Agency (NRRDA) has been set up under the aegis of Ministry of Rural Development, Government of India, and is the agency responsible for the overall management, supervision and execution of PMGSY on behalf of MoRD. Similar structures exist at State Level in the form of State Rural Road Development Agency (SRRDA) as the State Nodal Agency. The Programme is implemented through the State Government. The Programme Implementation Units (PIU's) at the District level actually execute the programme under this scheme. Under the present Project, State Rural Road Development Agency(SRRDA) under the aegis of NRRDA has taken up the construction / up – gradation of Rural Roads and CD works under PMGSY for Rural Roads.

The Indian Roads Congress (IRC) publication (IRC: SP: 20 – 2002) Rural Roads Manual(RRM), provides guidance on various aspects of rural road development, with the specific requirements of PMGSY. Further to this, to bring about clarity on various aspects of the programme, leading to its timely and successful implementation, an Operation Manual(OM) in respect of PMGSY roads has been prepared. Rural road improvements such as the PMGSY have the potential to bring in substantial economic and social benefits to the communities. At the same time, these projects may also lead to adverse social and environmental impacts such as loss of topsoil, erosion etc. thereby triggering the need to carry out Environmental Assessment with a view to identify the project activities that can have potential environmental impacts and to provide mitigation measures.

The increase in public concern regarding the "quality of life" has intensified the need for rational identification,

measurement and evaluation of environmental impacts. In order to achieve the desired harmony between the road and its surroundings, it becomes necessary to study the environmental effects at the planning stage itself. At present, in the course of planning and designing a road project the main aspects taken into account are those of economy and traffic flow. As a result of this limited approach, many environmental problems such as noise, air pollution, aesthetic deterioration and ecological disturbance that get created are overlooked. Such problems can be avoided if their cause and effects are understood at the planning stage and remedial measures incorporated during the design phase.

The EIA Cycle and Procedures

The EIA process in India is made up of the following phases:

- **Screening**: Screening is the first stage of the EIA process. The process of screening usually involves the review of the project proposal against a checklist of projects to determine whether an EIA is a mandatory requirement.

- **Scoping:** The term scoping is used to describe the process of deciding what should be included in an EIA. It may be seen as a means for identifying the main public concern about a proposal and for organizing the scientific work for the assessment. A Scoping process involves two important parts viz. Impact Identification and Public Involvement.

- **Baseline data collection:** Baseline data describes the existing environmental status of the identified study area. The site-specific primary data should be monitored for the identified parameters and supplemented by secondary data if available.

- **Impact prediction:** Prediction is essentially a quantification step. Impacts of project activities are predicted through mathematical modeling and simulation for all components of environment. A model needs calibration, verification and validation before use.

- **Consideration of alternatives:** Where the environmental impact of the project is expected to be significant, the EA reports should include the consideration of alternative projects or approaches which would achieve the same or equivalent result. Usually the consideration of alternatives is regarded as central in an EIA. Alternatives can be in locations, design alternatives or in means of implementation of a policy. There is also the " zero alternative " i.e. not to implement the proposal.

- **Evaluation:** An environmental evaluation is increasingly undertaken to confirm that the performance of the project, once constructed and operational, conforms to the specifications and environmental performance standards specified as part of the consent or funding arrangements.

Among the important techniques and methodologies useful for assessing the impacts of development activities on the environment in developing countries are as follows:

- Ad hoc
- Checklists
- Matrices
- Networks
- Overlays
- Battelle Environmental Evaluation System

- **Public hearing:** Law requires that the public must be informed and consulted on a proposed development after the completion of EIA report. Any one likely to be affected by the proposed project is entitled to have access to the Executive Summary of the EIA. The affected persons may include:

- bonafied local residents;
- local associations;
- environmental groups active in the area
- any other person located at the project site / sites of displacement

They are to be given an opportunity to make oral/written suggestions to the State Pollution Control Board as per Schedule IV of Annex I.

- **Decision-making:** EIA is in itself a tool for decision making. The final report, Environment Impact Statement (EIS), is supposed to be used as a support for the decision makers. However, decisions are taken at all stages during the EIA process and the result will be dependent on these decisions. All through Screening and Scoping decisions on what impacts to consider by developers in consultation with the authorities and also rely on their own previous experience and professional judgement.

- **Mitigation Plan:** Feasible and cost – effective measures to reduce the identified potential adverse environmental impacts to acceptable levels should be discussed as well as opportunities for enhancing natural environmental values. The Mitigation Plan should state the capital and recurring costs arising from mitigation as well as the institutional, training and monitoring needs of the measures. Work programs and schedules should be included to ensure that the proposed environmental actions are in phase with engineering and other project activities throughout implementation. The Plan should consider compensation options if mitigation measures are not feasible or cost – effective .The costs of these mitigation measures should be included in the overall cost – benefit analysis of the project.

- **Monitoring the clearance conditions:** The objective of the plan is to ensure that all necessary environmental protection measures are carried out on a continuous basis as envisaged in the EA report and the additional measures are taken for containing any adverse impacts not envisaged at the time of report writing. The plan should specify the type of monitoring, who should do it, the costs involved and any other inputs (including training) that may be required. Monitoring will enable the regulatory agency to review the validity of predictions and the conditions of implementation of the Environmental Management Plan (EMP).

Types of Impacts:

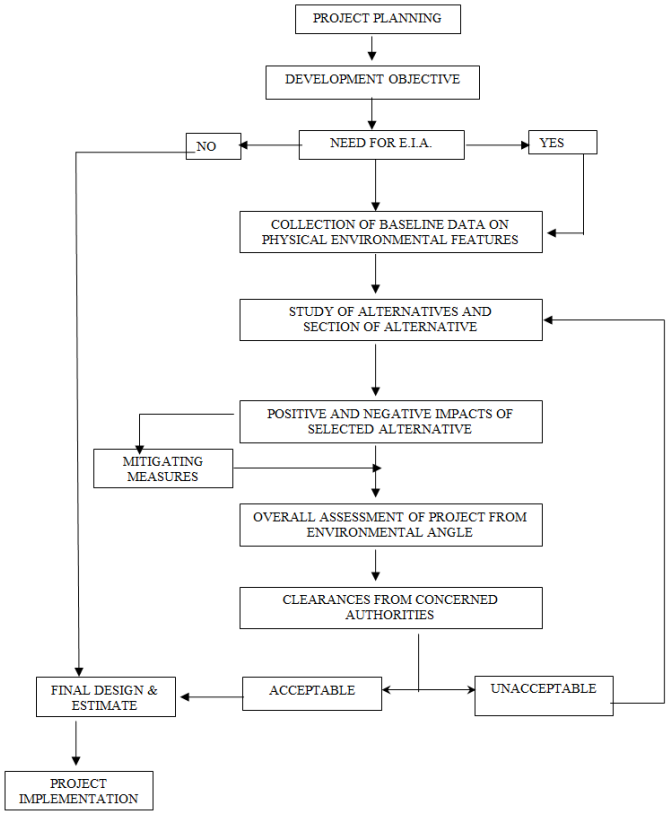
Environmental impacts arising from development projects fall into 3 categories:

(i) Direct Impacts
(ii) Indirect Impacts and
(iii) Cumulative Impacts.

These three groups can be further classified according to their nature, into ;

- Positive and Negative Impacts
- Random and Predictable Impacts
- Local and Wide spread Impacts
- Temporary and Permanent Impacts, and
- Short and Long – term Impacts.

Graphical Presentation of EIA Process in India



Environment Impact Assessment of a rural road project:

The identification of impacts was done for a hypothetical rural road project using two methods viz.

- Network Analysis
- Matrix Method

During this potential negative as well as positive impacts and their types were analyzed during the pre, during and post construction phases separately and linked to each other in an attempt to generate a rough idea as to how an EIA of a rural road project would look. All the analysis has been presented in the forms of flow charts and a table below.

Network Analysis

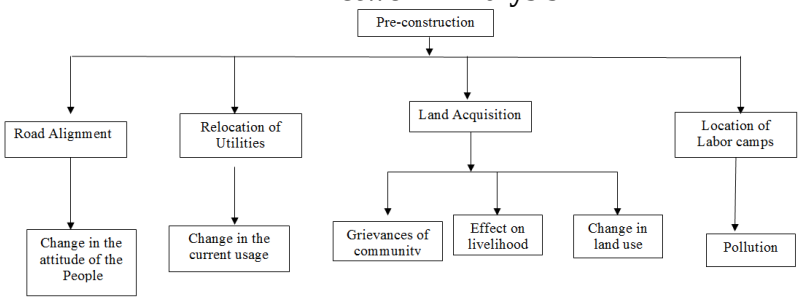


Figure 1: Impact Identification Network Pre-Construction Phase

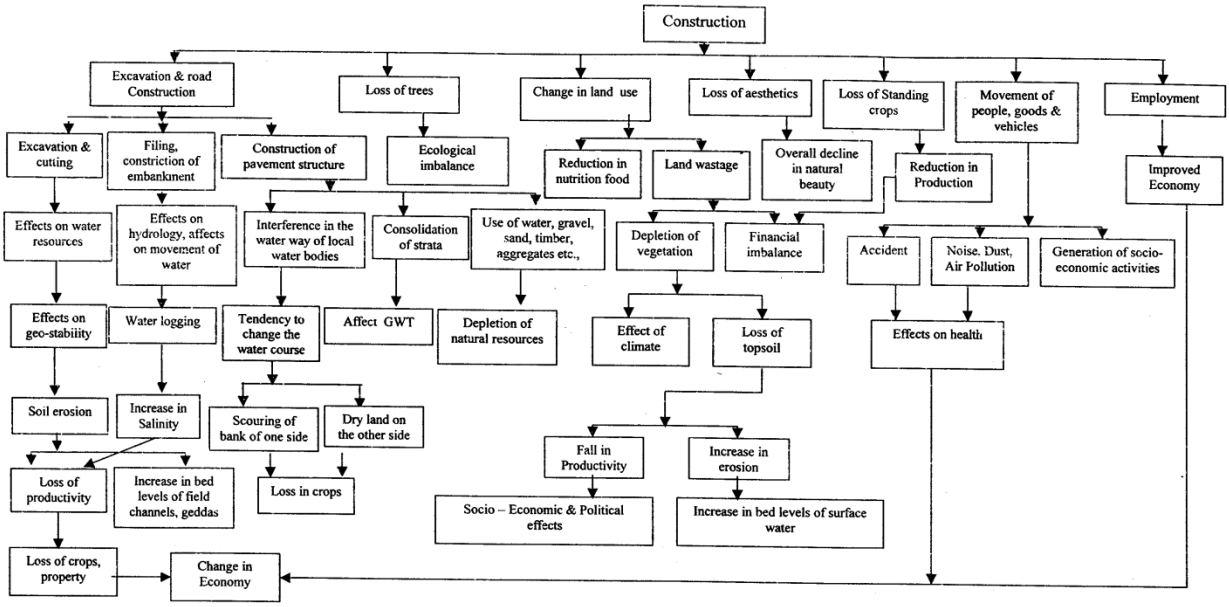


Figure 2: Impact Identification Network Construction Phase

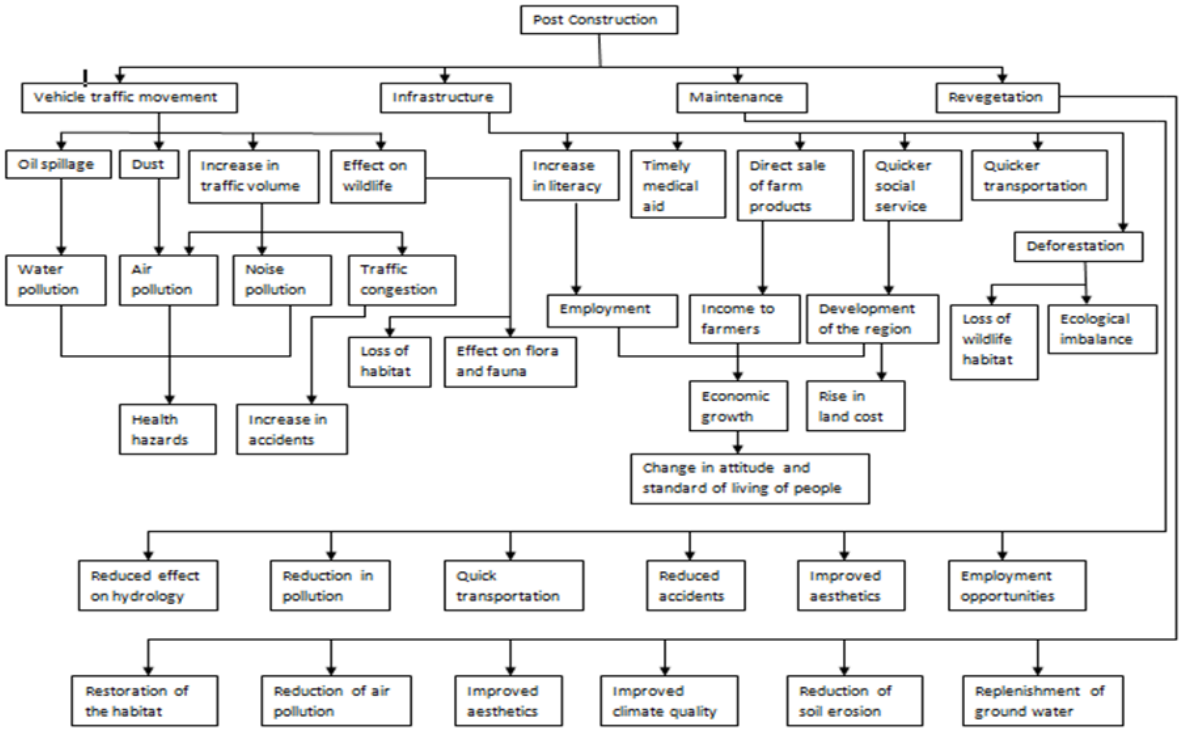


Figure 3: Impact Identification network post construction activities

Matrix Method

Phase of project	environmental parameters																														
Activities	soil	land use pattern	terrestrial wildlife	attitude of community	air quality	noise	dust	employment	forests	natural resources	economy	education	surface water hydrology	surface water quality	surface water quantity	flora/fauna	rehabilitation	lifestyle	drainage	poaching	aesthetics	disease vectors	risk hazards	health	groundwater	recharge percolation	climate quality	soil erosion	minority groups
Pre-Construction																															
land acquisition		LT IR L		LT R L							LT ST W						LT IR L												LT L
relocation of utilities		LT IR L		LT R L							LT W																		LT L
location of labour camps		ST R L		ST R L	ST IR W	ST R L																							ST L
road alignment	LT IR L	LT IR L																											
Construction																													
vegetation clearing	LT IR L	LT IR L			ST IR W	ST	ST R L	ST		LT IR L						LT					LT		ST		LT R L	LT IR L	LT IR W	LT IR L	
construction camp	ST IR L	ST IR L		ST R L	ST R L	ST	ST R L	ST		ST IR L	ST			ST R L		ST				ST		LT		ST		ST IR L		ST IR L	
construction equipment	ST IR L				ST R L	ST R L	ST R L						ST	LT R L									ST				ST IR W		
cutting and filling	LT IR L	LT IR L			ST R L	ST	ST R L	ST			ST		LT	ST R L				LT		ST	ST	ST	ST		LT R L	LT IR L		LT IR L	
blasting	LT IR L	LT IR L			ST IR W	ST R L	ST R L			LT IR L				ST R L							ST	LT	LT		LT R L	LT IR L		LT IR L	
quarry management	LT IR L		ST IR L		ST IR W	ST R L	ST R L	ST		LT IR L											ST	ST	ST		ST R L		ST IR W		
construction material/w	ST IR L				ST R L	ST R L	ST R L	ST	ST	LT IR L	ST			ST R L	ST						LT		ST			LT IR L			
storage of deisel/oils	LT IR L													ST R L								ST			LT R L				
Post-Construction																													
vehicle traffic movement			LT IR L		LT IR W	LT IR L	ST R L	LT			LT	LT		LT R L		LT		LT					LT		ST R L		LT IR W		LT
road maintanance					LT IR W	LT	LT	ST			LT		ST						LT		LT		LT		LT R L				LT
infrastructure developm	LT IR L		LT IR L	LT				LT	LT	LT IR L	LT	LT		LT R L	LT	LT		LT	LT	LT			LT	LT		LT IR L	LT IR W	LT IR L	
revegetation	LT				LT	LT	LT	ST													LT				LT	LT	LT	LT	

Symbols	Type of Impact
LT	Long Term Impact
ST	Short Term Impact
R	Reversible Impact
IR	Irreversible Impact
L	Local Impact
W	Wide range Impact

Note:

- Red color indicates negative impact.
- Green color indicates positive impact.

Environmental Management Plan:

The project activities will result in a number of impacts on various environmental components. These impacts could be significant, marginal, short term, long term, beneficial or adverse. Many of the adverse impacts could be mitigated or eliminated by implementing appropriate management plan during Pre – construction, Construction, Construction/Operational phases of the project.

Table 1 : Environmental Management Plan

Activity	**Environmental Impact**	**Recommended Mitigation Measure**
Pre - Construction		
Land Acquisition	Loss of land and crop	• Monetary compensation by the Panchayat Secretary according to the Andhra Pradesh Act.
Site Clearance	Damage to sensitive terrestrial ecosystems	• Minimize disturbance of native flora (vegetation) during construction • Minimize the amount of clearing. Clear small areas for active work one at a time • Wherever possible, remove large plants and turf without disturbing them, and preserve them for replanting in temporary nurseries • Move earth and remove vegetation only during dry periods. Store top soil for respreading, if vegetation must be removed during wet periods, disturb ground only just before actual construction • Install erosion control measures such as hay bales, berms, straw or fabric barriers, as appropriate • Revegetate with recovered plants and other appropriate local flora immediately after equipment is removed from a section of the site • Carry out periodic maintenance of drains, side slopes to check scouring of soil • Limit construction activities of culverts and bridges to dry season

Activity	Environmental Impact	Recommended Mitigation Measure
Construction		
Construction camp for labour	• Damage to local habitat, compact soil and create erosion via building and occupation of construction camp • Contamination of surface water and spread of disease via solid waste and feces generated by camp • Spread communicable diseases including malaria, tuberculosis etc. • Generate trash due to lack of solid waste management	▪ Explore off site accommodation for labour. Avoid wet, muddy sites ▪ Keep camp size to a minimum ▪ Provide temporary sanitation on site. ▪ Use local or regional labor, if possible. Provide hygiene and public health training • Provide facilities for collection and disposal of all solid waste
Use of heavy equipment and hazardous materials	• Cause erosion due to machinery tracks, damage to roads, streams, banks etc. • Compact soil, changing surface and ground water flows and adversely affecting future use for agriculture • Contamination of ground or surface water when i) Machinery repairs result in spill or dumping of hydraulic oil, motor oil or other harmful mechanical fluids. ii) Hazardous construction materials are spilled or dumped • Risk to workers from exposure to hazardous materials	▪ Minimize use of heavy machinery ▪ Prevent dumping of hazardous materials ▪ Capture leaks or spills with drop cloths • Investigate and use less toxic alternative products
Excavation Cutting / Filling	• Soil erosion, changes in natural water flow, alter hydrology, damage valuable ecosystems and habitats when excavated soil is piled inappropriately • Risk of falls and injuries in excavation pits. • Aesthetics	• Cover pile with plastic sheeting, prevent runoff with suitable measures • Balance the cuts and fills (to minimize earthwork movement) wherever possible • Place fence around excavation. • Investigate alternatives, such as shallow excavation or no excavation • Road side plantation will add to the visual appearance of the area
Compacting to improve road.	• Depletion of freshwater resources	• Water the road immediately before compacting to strengthen the road surface (otherwise traffic will soon beat back the road surface to pre – bladed condition) • When possible delay compaction activities until the beginning of the wet season or when water becomes more available
Blasting	• Soil erosion • Hazard to worker	• Minimize blasting • Take safety precautions to protect workers and others from being injured by flying or falling rock and avalanches

Activity	Environmental Impact	Recommended Mitigation Measure
Materials extraction, Quarrying, logging	• Damage to aquatic ecosystems through erosion and siltation • Harm to terrestrial ecosystems via harvesting of timber or other natural products • Spread of water – borne diseases when stagnant water accumulates in active or abandoned quarries or borrow pits and breeds insect vectors • The quarry may become a safety hazard	• Identify the most environmentally sound source of materials that is within budget • Use material from local road cuts first, but only if it produces a fairly suitable, durable aggregate for either embankment fill or surface stabilization material • Local borrow materials can be very cost – effective. Upon removal of material, the area should be restored and receive erosion control measures • Decommission/restore area so it is suitable for sustainable use after extraction is completed • Employment of measures (e.g. improved land scaping, filling or drainage) to avoid creating habitats. • Implement safety protocols to minimize risks from falling rock or debris, collapsing quarry walls, or accidental falls from cliffs
Drainage	• Cause soil erosion • Degradation of water quality • Alteration in hydrology • Damage to valuable ecosystems and habitats	• Install drainage structures during construction instead of after construction • Install frequent diversion structures, such as cross drains, drivable rolling dips or water bars, to move water off the road frequently and minimize concentration of water • To prevent accumulation of water by the road side, adequate CD structures in the form of culverts with adequate discharge capacity shall be constructed
Constructing road surface	• Increased sedimentation • Discomfort to road users • Air quality deterioration • Noise impact	• Stabilize the road surface with gravel / murram and other rocky surfacing material • Elevate road surface • Control dust by sprinkling water on the project and quarry roads • Installation of hot mix plant at least 500 meters away from settlements in non – wind direction • Vehicles carrying earth, sand and other construction materials should be covered with tarpaulins to avoid spilling of fugitive dust • Regular maintenance of equipment and vehicles should be carried out • Provide workers with appropriate safety equipment e.g. Earplugs or headgear to mute noise from very load equipment, masks for workers exposed to large amount of dust, safety glasses for workers doing jobs that may generate sharp projectiles • Maintenance of equipment in good condition and proper design of engine enclosures

Post - Construction Increase in traffic volume and transport	• Accident risks associated with increased vehicular traffic • Increase in spills of toxic substances • Air pollution due to vehicular exhaust gases • Noise Pollution	• Road bumps should be provided to prevent accidents. • Regulation of transport of toxic materials to minimize danger • A spillage containment mechanism should be developed along with the participation of police and the fire department • Regular maintenance of vehicles should be carried out • Maintenance of engine in good condition • Maintain a smooth road surface without grooves and cracks in order to keep the noise level to a minimum • The avenue plantation will damper the noise levels to a considerable extent and in addition implementation of proper land use control will be the required measure

III. CONCLUSION

The environment today is degrading with the human development. Today the population is increasing so the basic needs to be fulfilled are also increasing. With the increasing demands of the people, the valuable natural resources are excessively used creating an imbalance in the nature. The natural resources like the petroleum, which are most important for the human development are exhaustible and are in a state of getting exhausted completely. In the race for the human development we are losing environment, which may lead to many hazards in the near future.

For the betterment of the present and the future generations we need to plan the projects of human development with environment as the first priority. The environment should be taken into consideration at the planning stage itself. Conducting an Environmental Impact Assessment and developing an Environment Management Plan at the planning stage itself to decide the feasibility of the project with respect to the environment can achieve this.

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