IRC : 104 -1988

GUIDELINES FOR ENVIRONMENTAL IMPACT ASSESSMENT OF HIGHWAY PROJECTS

THE INDIAN ROADS CONGRESS
1988

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FOR
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OF
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Published by

THE INDIAN ROADS CONGRESS
Jamnagar House, Shahjahan Road,
New Delhi-110 011
1988

Price Rs.100/-
(Plus Packing & Postage)

IRC : 104-1988

First Published : February, 1989
Reprinted : April, 2002
Reprinted : December, 2004
Reprinted : July, 2008

Printed at Options Printofast, Delhi-110092
(500 copies)

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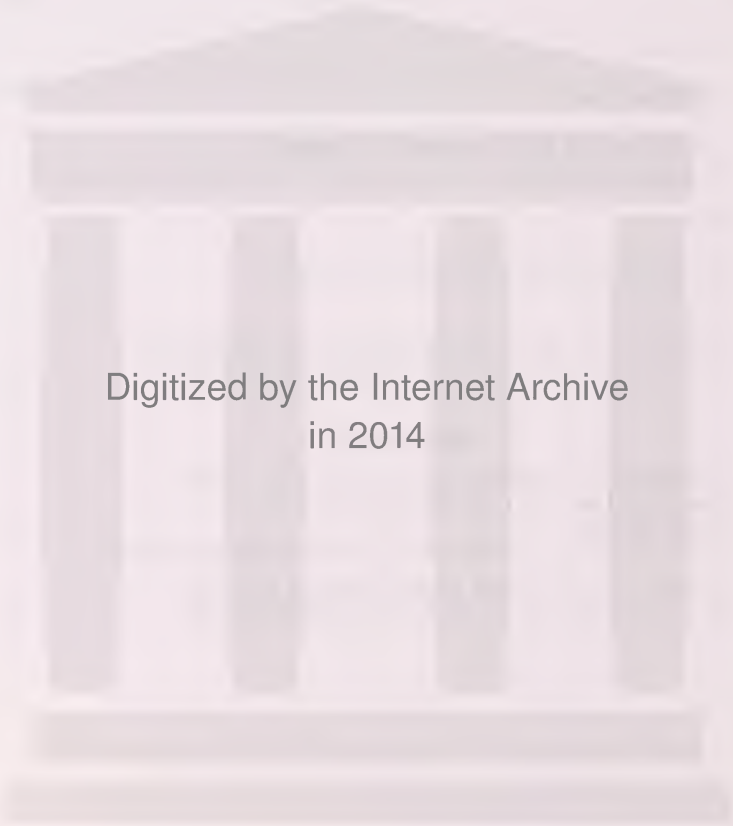

GUIDELINES FOR ENVIRONMENTAL IMPACT ASSESSMENT OF HIGHWAY PROJECTS

1. GENERAL

1.1. The Council of the Indian Roads Congress in their meeting held on 1st December, 1972 had set up a Committee to study the subject of Highway Environment and Pollution. The Committee had constituted two panels one for Environmental Impact Statement (E.I.S.) for Non-urban Roads and other for Urban Roads. Three case studies, Delhi-Palwal Section of National Highway No. 2, Delhi-Meerut Section of State Highway No. 45 and Ring Road between Indraprastha Estate and Dhaula Kuan for the Preparation of Environmental Impact Statement had been completed by the School of Planning and Architecture and one case Study of 40 km stretch of National Highway No. 47, on the Northern and Southern side of Trivandrum for the E.I.S. had been completed by National Transportation Planning and Research Centre. In light of the reports prepared as a result of the case studies, the draft Manual for preparation of E.I.S. for non-urban highway was prepared and discussed by the Committee (Personnel given below) in their meeting held at New Delhi on the 4th December, 1984. On the basis of the comments of the members the draft was finalised by Prof. M. S. V. Rao, Member-Secretary, of the Committee :

K. K. Nambiar	...	*Convenor*
Prof. M. S. V. Rao	...	*Member-Secretary*
Jose F. F. de Albuquerque		A. G. Pol
Amarjeet Singh		Prof. N. Ranganathan
Bhupinder Singh		N. Sivaguru
Y. N. Bahl		R. Thillainayagam
K. C. Bansal		C.E., P.W.D. B & R, Kerala
M. K. Bhalla		Director, Horticulture,
Prof. H. U. Bijlani		D.D.A. (Sahdeo Singh)
Prof. J. M. Dave		Director, Horticulture,
S. P. Gantayat		C.P.W.D. (Dr. K. Saddy)
I. C. Gupta		R. P. Sikka
R. G. Gupta		Lt. Col. G. B. Singh
R. S. Jindal		P. G. Valsankar
Dr. L. R. Kadiyali		A Rep. of Department of
V. P. Kamdar		Science and Technology
D. N. Khurana		A. Rep. of Department of
H. N. Kumar		Environment
K. S. Logavinayagam		D.G. (R.D.)—Ex-officio
L. Shivalingaiah		

1.2. The draft prepared by the Committee was discussed by the Specifications and Standards Committee in their meeting held at New Delhi on the 28th August, 1986. The Committee noted that after the draft was prepared, the Environment (Protection) Act, 1986 has come into force and the draft did not contain the quantification of standard of noise, air and environmental pollution and, therefore, would not help much in finalising new projects. The Convenor stated that a questionnaire need to be added to take care of the points and quantified factors to take care of environment factors, and the Committee decided that the draft should be revised by the group under the Chairmanship of the Convenor of the Committee.

1.3. The draft prepared by Shri K. Arunachalam under the guidance of the Convenor was discussed by the Highway Specifications and Standards Committee in their meeting held at New Delhi on the 21st September, 1988 and Committee desired that the document should be redrafted on the basis of the comments of the members by Shri K. Arunachalam assisted by the Member-Secretary and finalised by the Convenor. The document finalised by them got the approval of the Executive Committee and the Council in their meetings held on the 16th November, and 10th December, 1988 respectively.

1.4. These guidelines supplements the IRC : SP : 19 "Manual for Survey, Investigation and Preparation of Road Projects" in so far as environmental assessment are concerned and should be read in continuation of that manual.

2. INTRODUCTION

2.1. Highway network is one of the important components of transportation system at the National, State and local levels. In order to increase the efficiency of the transportation system, construction of new roads and improvements to existing roads are being undertaken in urban and rural areas. Construction of highways is often coupled with environmental deterioration. It is not only important but essential at planning stage itself to consider environmental impact of the proposed highway works. In the case of major works on existing highways, the impact of these works on the surroundings should be studied and attempts should be made to enhance the environmental quality through improvements.

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

ment 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 highway 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.

2.3. The factors influencing the environment can be considered in three categories. The first category "traffic factors,', comprises those that arise from the actions and characteristics of the traffic, viz. noise, air pollution and vibration. The second category, "highway factors", include visual intrusion, severence, land consumption and change in land access which, although affected by traffic, exist irrespective of use of the highway. Under the third category fall the noise and air pollution arising as a result of construction activities The guidelines contained in this publication are based on current knowledge and experience. The noise and air pollution can be related to riding quality of the road, traffic volumes, speeds and distances, but vibration levels are more difficult to predict. Visual intrusion usully has to be subjectively assessed at sites or from photographs, drawings and sketches.

2.4. It is observed that the methodologies for assessing environmental impact developed in other countries can not be applied in their original form under Indian conditions. Keeping in view the principal objectives, data resource and availability of technically equipped personnel for preparation of the assessment for new and existing highways, a combination of subjective and conjective procedure is suggested.

3. OBJECTIVES OF ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

3.1. The environmental impact assessment has become an integral part of the highway planning and design in many advanced countries. The main purpose of EIA is to identify environmental impacts of the project and the alternatives, weigh their significance, propose possible mitigating treatments and provide necessary information for making decision whether the project is acceptable from environmental angle or not.

3.2. The case for introducing such a tool in this country is even stronger, as many new highway projects are being planned and/or implemented at State and Central Government levels in the wake of rapid development in the country. It is vital to ensure that these new/improved highways are not only safer and more efficient but are also environmentally acceptable.

3.3. However, considering the paucity of information and non-availability of adequate technical expertise to perform the task of preparing such assessments it will be necessary to simplify the same initially. Subsequently, with advancement in the field, the procedure could be refined to make it a more comprehensive and sharper instrument to evaluate critically various alternatives and compare them.

4. SCOPE

4.1. This publication provides guidelines on the preparation of EIA for highway projects involving either construction of a new road or major improvements to an existing road. These guidelines assist in (i) providing useful information about the possible environmetnal impacts of the project, (ii) assessing and evaluating alternatives directed towards choice of the environmentally acceptable one which is also economically feasible, and (iii) identifying mitigating measures for incorporation in the project proposals.

4.2. The procedures for environmental impact assessment given in this publication are for general guidance of engineers preparing highway projects and not for any administrative action. It is intended that the assessment will be required only for major highway projects, in particular, construction of new highways. Also, the extent of investigations and data coverage will depend on the size and importance of the project and its anticipated impact on the environment. Where EIA is to be prepared for a project, it is recommended that the project authorities have close interaction with the Department of Environment and Forests.

4.3. Section 5 of this publication gives the procedure for environmental assessment and provides formats for recording baseline data, evaluation of alternatives and assessment of the environmental impact of the chosen alternatives. Section 6 provides an approach to data collection and evaluation for preparing the EIA as also measures for mitigating the adverse impacts.

4.4. It may be noted that the science of assessment of environmental impact of highway projects is still in its infancy in the country, and for many features there is no alternative but to resort to subjective assessment for the present. However, with more experience and information from results of research, it will be possible to refine the assessment procedures to make the EIA a more positive tool. Towards this end, this publication would need to be revised in course of time.

5. PROCEDURE FOR ENVIRONMENTAL IMPACT ASSESSMENT

5.1. General

Preparation of Environmental Impact Assessment for a highway project involves several steps, starting from a clear understanding of the development objectives, collection of baseline data, evaluation of alternatives to overall assessment of the environmental impact of the selected alternative. The involved activities are indicated in the form of a flow diagram in Fig. 1. Format for preparing the EIA is given in para 5.2.

5.2. Format for EIA for Highway Projects

5.2.1. **Introduction :** Give a broad description of the existing situation (the terrain, the existing road and its condition, etc.) as also of the proposal (length of new construction, major improvements, etc.); and the development objectives.

5.2.2. **Existing situation :** Give information on the existing situation as regards the road system, road transport, environmental features, etc., in the form shown in Table 1.

TABLE 1. EXISTING FEATURES

Feature	Information
(a) **Road factors**	
(i) Land width available (m)	
(ii) Geometrics—curvature, gradient, roadway/ pavement widths, etc.	
(iii) Structural condition of road and road structures	
(b) **Terrain**	
(i) Type of terrain (plain, rolling, hilly)	

Feature	Information
(c) **Traffic factors***	
(i) Traffic volume (veh/day)	
(ii) Traffic composition	
(iii) Average speed of travel	
(iv) Time delays at railway level crossing, etc.	
(v) Presence of road intersection (Nos./km)	
(vi) Access control	
(vii) Accidents (Fatal and injury accidents per year)	
(d) **Land use**	
(i) Type of area (urban, semi-urban, rural)	
(ii) Number of towns/villages traversed enroute with population figures	
(iii) Location of major land-use types such as commercial, residential, industrial, recreational, agricultural, etc. Show this on a map	
(e) **Environmental factors**	
(i) Climate (annual rainfall (mm), snowfall, maximum and minimum temperatures (°C)	
(ii) Vegetation	
(iii) Ribbon development and encroachments	
(iv) Roadside facilities	
(v) Air pollution level (very high, high, moderate, low)	
(vi) Noise level (very high, moderate, low)	
(vii) Wildlife (any endangered species)	

*For new roads, provide information on traffic likely to use the road on completion.

5.2.3. **Need for the proposed project :** Need for the project may be for fulfilling the development objectives of satisfying the transport demand, for providing access. for improving the environment, etc. These should be discussed keeping the following points in view :

(a) Transportation demand—present demand, projection for design year.

(b) Access —present position about access to the area and the importance.

(c) Capacity —the highway width and type needed to cater to design traffic

(d) If "No action alternative" is to be chosen (i.e. the proposed action is not implemented), discuss the anticipated adverse effects on the following :

(i) Traffic convenience —free traffic movement/congestion, delays, safety.

(ii) Environmental —air quality, noise, vibration, general aesthetic quality, etc.

(iii) Economic —costs of vehicle operation, road maintenance/improvement, accidents, etc.

5.2.4. **Proposed project.**

5.2.4.1. In this part, the physical and environmental features of the alternatives investigated for the proposed project should be brought out. The information may be recorded in a tabular form for all the alternatives, vide format suggested in Table 2.

TABLE 2. PROFORMA FOR RECORDING THE PHYSICAL AND ENVIRONMENTAL FEATURES OF ALTERNATIVES INVESTIGATED

Particulars	Selected alternative	Alternative A	Alternative B
1	2	3	4
1. Length (km)			
—New construction			
—Improvement of existing road			
2. Terrain (plain rolling/hilly)			
3. Land width proposed (m)			
4. Category of land proposed to be acquired (ha)			
—Forest land			
—Agricultural land			
—Waste land			
—Swampy land			

1	2	3	4
5. Displacement of households (Nos.)			
6. Cut sections —Length in cut (km) —Max. depth of cut (m)			
7. Fill sections —Length in fill (km) —Max. height of fill (m)			
8. Vegetation —No. of trees exceeding 60 cm in girth to be cut			
9. Flood hazard (encroachment on flood plain)			
10. Erosion potential			
11. Landslide potential			
12. Stretch in geologically unstable areas			
13. Drainage and adverse impact on water flow			
14. Number of major river crossings (exceeding 60 m)			
15. No. of road intersections			
16. No. of railway crossings			
17. Schools, colleges, hospitals falling enroute			
18. Number and type of utilities requiring relocation			
19. Possibility of providing wayside amenities			
20. Air quality (very poor, poor, fair, good)			
21. Noise level			
22. Estimated cost			

5.2.4.2. Based on the investigations made on the alternatives, bring out the reasons for choosing the selected alternative. Highlight the specific merits of the chosen alternative from environmental angle.

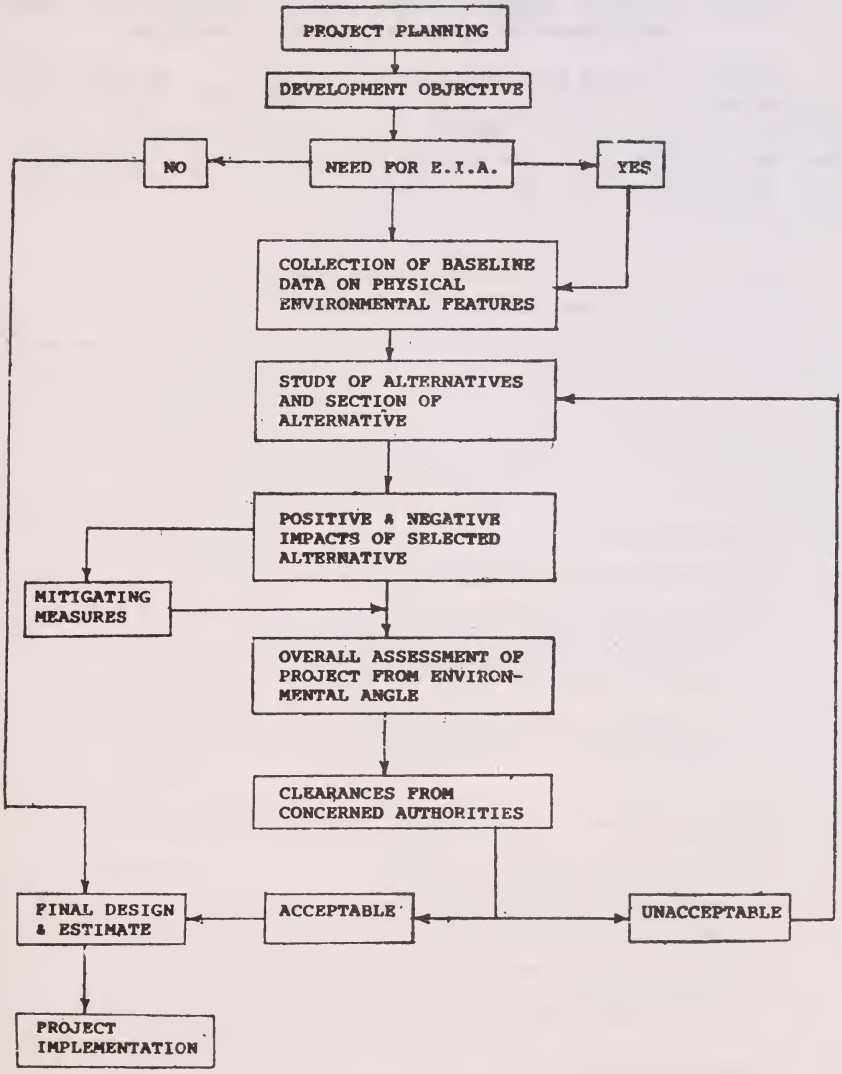

Fig. 1. Flow diagram for environmental assessment of highway projects

5.2.5. Probable impact of the selected alternative on the environment and proposed mitigating measures

5.2.5.1. In this para the probable impact of the selected alternative on the environment should be discussed Both beneficial and adverse impacts should be included. Measures proposed for mitigating the adverse impacts should be highlighted. The information may be provided in the form of replies to questionnaire as in Table 3.

TABLE 3. IMPACT OF THE SELECTED ALTERNATIVE ON THE ENVIRONMENT AND ACTION PROPOSED FOR MITIGATION

S. No.	Particulars	Probable impact in brief/ proposed action
1	2	3
1.	**Land acquisition**	
	(a) Is acquisition of forest land involved ?	
	(b) If so, whether discussions have been held with Forest Deptt. Also state as to what action has been taken to get clearance from forest angle.	
	(c) Is acquisition of wet land/swampy land/ mangroves/ wildlife habitat involved ?	
2.	**Highway location**	
	(a) Is the road to traverse any unstable area, avalanche area, marsh, etc ? If so, have necessary remedial measures been planned ?	
	(b) Have geological maps been studied or local Geological Deptt. consulted to avoid unstable strata ?	
3	**Highway alignment**	
	(a) Does the alignment follow lie of the land and avoid large scale cutting ?	
	(b) Is any section susceptible to damage/ erosion by streams and torrents ? If so, have protection measures been planned ?	

1	2	3
4.	**Highway cross-section**	
	(a) Does the road cross-section involve a lot of disturbance to the natural ground ?	
	(b) For sections in cut, is the half cut and half fill type of cross-section which involves least disturbance to the natural ground being adopted ?	
	(c) Are the proposed cut slopes stable for the strata ?	
	(d) Are slope stabilising structures like breast walls, pitching, etc., required and being proposed ?	
	(e) Does the cut hill face require any special treatment to prevent slips. If so, are such measures being proposed ?	
5.	**Erosion control**	
	(a) Has erosion potential been considered for the alignment ?	
	(b) Are erosion control measures before start of work and between successive construction stages required ? If so, have these been worked out ?	
	(c) Have location and alignment of culverts been chosen to avoid severe erosion at outlets and siltation at inlets ?	
	(d) Are necessary erosion control measures proposed at outfall of culverts ?	
6.	**Drainage**	
	(a) Does the project provide for necessary cross drainage structures so as not to obstruct the natural drainage of the area ?	
	(b) Does the project provide for necessary side drains, catchwater drains, etc., for safe disposal of surface water ?	
	(c) Will the road cause undue increase in the HFL or create ponding situation for long periods ?	
7.	**Vegetation**	
	(a) Does the project provide for sodding/ grassing all embankment/cut slopes and other bared areas ?	

1	2	3

(b) Does the project provide for planting trees/plants on the roadside at the appropriate location.

8. **Traffic movement**

(a) Does the road affect the traffic circulation in the area ? If so, have necessary measures been taken to provide suitable access to crossing roads ?

(b) Will the proposed highway improve traffic movement, in terms of speed, convenience and safety ?

(c) Are school children, hospitals, etc., affected by the highway ? If so, are necessary traffic control measures taken into account ?

(d) Are road user facilities like fuel-filling station, rest areas, truck-parks, etc., planned along the highway ?

9. **Construction**

(a) Has the proper disposal of surplus excavated material been thought of and provided for ?

(b) Have the type of equipment to be used for construction been identified ? Will it be specified that these equipment are provided with pollution control devices ?

(c) Have quarry/material sources/ borrow areas been identified ? Is opening up of new quary/material sources involved ? If so, will this affect the inhabitants in the nearby areas ?

(d) What measures have been planned to control dust from construction site ?

(e) Will the proposed borrow areas affect the environment by way of soil erosion, water ponding, projecting a shabby look, etc. If so, have the necessary remedial measures been planned ?

10. **Air quality**

(a) What is the estimated number of motorised vehicles expected on the highway in the design year.
—petrol vehicles (nos.)
—diesel vehicles (nos.)

1	2	3
	(b) Volume—capacity ratio and traffic flow condition expected on the proposed highway in the design year.	
	(c) Will the highway improve or deteriorate the air quality in the population centres enroute ?	
11.	**Traffic noise and vibrations**	
	(a) What is the existing noise levels and noise level expected on completion of project ?	
	(b) What is the type of surfacing proposed for the highway ?	
	(c) Are residential institutional areas located within a distance of 100 m from the centreline of the highway ?	
	(d) If so, have noise—abatement measures like noise screens/screen plantation, etc., been included in the project ?	
12.	**Water quality**	
	Is any pollution expected to affect water quality on completion of the project ?	
13.	Any other point ?	

5.2.6. Overall assessment of selected alternative

5.2.6.1. In this part, overall assessment of the impact of the selected alternative on the environment, based on the information in Table 3 should be made. Both the positive and negative impacts should be listed out. The proposed remedial measures for mitigating the negative impacts along with their possible effect should also be brought out.

5.2.6.2. Some of the positive impacts could be :

(i) Employment opportunity to local people

(ii) Enhancement of local industry and handicraft

(iii) Enhancement of rural development through quick transportation of inputs/outputs

(iv) Quicker approach access to social services

(v) Reduction in traffic congestion through city/town

(vi) Development of tourism

(vii) Reduced pollution and quicker transportation due to better quality of road

(viii) Improved road safety

5.2.6.3. Some of the negative impacts could be :

(i) Soil erosion, sedimentation of lakes and reservoirs

(ii) Obstruction to natural drainage, water ponding, etc.

(iii) Increase in traffic litter, noise and dust pollution

(iv) Air pollution due to exhaust of vehicles

(v) Cutting of trees and loss of forest/agricultural land

(vi) Spills of toxic and hazardous chemicals from carriers of such materials

(vii) Effect on wildlife through habitat loss.

5.2.6.4 Make an overall assessment whether the project is acceptable or unacceptable from environmental angle. If unacceptable, the project should be investigated further for identifying the alternative having better acceptability.

6. APPROACH TO DATA COLLECTION AND INVESTIGATIONS FOR PREPARING E.I.A. AND MITIGATING MEASURES

6.1. General

6.1.1. For preparing a highway project, surveys and investigations are usually conducted in different stages. First is the Reconnaissance Survey** during which a number of alternative alignments are studied on maps/drawings/photographs, etc., and then investigated in the field. During this phase, information on terrain, topographic features, soils, materials, drainage, etc., are collected and analysed. A plan-profile drawing to the scale of 1:50,000 is also prepared. Based on the information, the alternative alignments are evaluated alongwith cost factors so as to enable the choice of the most suitable alignment for further detailed investigations. The collected information, analysis of alternatives and recommendations are presented in the Reconnaissance Report.

6.1.2. The time of reconnaissance survey is considered appropriate for collecting information for preparation of the draft E.I.A. The draft E.I.A. should be prepared side by side

**See IRC SP : 19 "Manual for Survey, Investigation and Preparation of Road Projects" for survey procedures, data to be collected, etc.

the with the Rconnaissance Report so that both are evaluated together for selection of the most appropriate alignment/route on which more detailed investigations in the Preliminary Survey** phase are to be conducted. The draft E.I.A. should then be finalised based on any new information coming forth from the Preliminary Survey.

6.2. **Investigations**

6.2.1. The degree of impact of road construction on the different environmental aspects vary depending on factors such as the types of area (urban or rural), the terrain (plain, rolling or hilly), the land-use pattern of the area (residential, educational, industrial, etc.). For example, road construction in the hills is beset with problems like landslides, soil erosion, etc., which are of serious environmental consequences. In residential and other urban areas, quality of air, noise pollution, proper traffic circulation and the like are more important. In the rural areas where speeds are high, it is more a question of having an aesthetically pleasing alignment fitted gracefully into the surroundings and providing pleasing visual experience. Where a road has to pass through forest land, obtaining necessary clearance from the Department of Forests and Wildlife is important. Thus, depending on the situation, the aspects requiring detailed study should be identified and the investigations organised accordingly.

6.2.2. It is desirable that the investigations for preparing E.I.A. are conducted by a multi-disciplinary team comprising a Highway/Traffic Engineer, an Environmental Specialist and an Horticulturist. For roads in urban areas, a Town Planner should be included. Similarly, for roads in the hills, a Geologist/ Goetechnical Engineer should be included.

6.2.3. **Investigations for the existing roads**

6.2.3.1. Table 1 of the E.I.A. format will be required to be filled in for cases where major redevelopment of the existing road is envisaged or a new road along a different route (e.g. bypass) is to be constructed. The data to be collected would include :

(i) Inventory data of the road—from Inventory Survey

(ii) Terrain—from topo sheets and site inspection

(iii) Structural condition of road and road structures—from site investigations

**See IRC : SP : 19 for survey procedures, data to be collected, etc.

(iv) Land-use—from Town planning organisations, area/city development authority

(v) Traffic —from traffic count and classification study, speed-delay studies, etc.

(vi) Accident —from police authorities

(vii) Environmental factors

Climatic features—from Meterological Deptt.
Wild life —from Wildlife Deptt.
Air pollution —see para 6.2.6.
Noise level —see para 6.2.7..
Others —from site inspection

6.2.3.2. The road should be divided into sections of similar physical and environmental features, and data collected and presented for each section separately.

6.2.3.3. The purpose of assessment of the environmental quality of the existing route is for comparison with the estimated environmental quality after the implementation of the proposed highway alternative.

6.2.4. Road construction in hilly areas

6.2.4.1. Construction of a road in the hills is a human necessity for providing the basic communication facility, but this activity invariably disturbs the natural setting and creates conditions conducive to large-scale landslides in the first few years of construction. Even dense forests are not immune to this problem. With the removal of vegetative cover, destructive action of water gets further pronounced and accelerates the process of soil erosion and formation of deep gullies. Consequently, the hill faces are bared of soil and vegetative cover and enormous quantities of soil and rock move down the rivers, and in some cases the road itself is washed out.

6.2.4.2. While the adverse effects of hill road construction on the environmental/ecological system cannot be eliminated altogether, counter measures must be taken by the road construction agencies to bring down the adverse effects to the barest minimum possible. This calls for careful attention right from the stage of conception of the road to surveys and investigations, alignment selection and project formulation, construction, and subsequent maintenance. To ensure that best results are achieved and expensive maintenance is avoided, measures taken should not be considered in isolation but built into

the road project itself as an integral part with all necessary provisions for the purpose. Important among these are brought out under broad activity headings in *Appendix* 1.

6.2.4.3. To ensure that measures for prevention of soil erosion and land degradation are planned and executed in a systematic manner and that no important features are lost sight of, a check list is suggested, vide *Appendix* 2. Preferably this check list should form a part of the road project itself for facilitating cross checking of the requirements at different stages.

6.2.5. **Pollution control - general**

6.2.5.1. There are about 30 major enactments related to control of pollution now being administered by the Central and State Govts. The enforcement of the Acts for Prevention and Control of Pollution of Water (1974) and Air (1981), as also in respect of Water Cess Act (1977) is carried out through the Central Board for Prevention and Control of Water Pollution (CBP CWP). The Central Board also coordinates activities of the 18 State Central Boards statutorily constituted in various States and Union Territories for nationwide implementation of pollution control. For providing a single focus for all environmental issues in the country and to plug loopholes in the existing Acts, the Govt. of India enacted the Environment (Protection) Act, 1986. This Act confers on the Central Govt. to take all necessary measures for protecting the quality of environment, to lay down standards for discharge of environmental pollutants, etc.

6.2.5.2. Towards monitoring air quality, the Ministry of Environment and Forests have set up 75 ambient air quality monitoring stations spread throughout the country. Similarly, monitoring stations have been set up on the river systems for assessment of water quality.

6.2.6. **Air pollution**

6.2.6.1. Air pollution to the highway environment is caused by road vehicles. For petrol driven vehicles, carbon monoxide (CO) discharged from the exhaust of vehicles is the pollutant. For diesel driven vehicles it is the density of the smoke emitted which though of not of major importance in respect of health is serious from the point of view of obstruction to visibility, soiling of structures, public property, etc.

6.2.6.2. The Bureau of Indian Standards have prepared emission standards for both petrol and diesel vehicles. These are :

(a) IS : 9057-1979, "Emission Limits for Carbon Monoxide for Vehicles Powered by Spark Ignition Engines". This Standard stipulates the following emission standards for CO :

(i) Vehicles which have completed 5 years of life or 80,000 km distance, whichever is earlier. CO content of exhaust gases by volume during idling ...Max. 3 per cent

(ii) Other vehicles. CO content of exhaust gases by volume during idling ...Max. 4.5 per cent

The CO content is to be determined as prescribed in IS : 5182 (Part X)—1977, "Methods for Measurement of Air Pollution : Part X—Carbon Monoxide.

(b) IS : 8118-1976, "Smoke Emission Levels for Diesel Vehicles." This standard prescribes the following maximum smoke density levels :

(i) For vehicles operating in urban areas, the smoke density shall not exceed 65 Hartridge smoke units as measured by free acceleration method; or 5.2 Bosch or 75 Hartridge smoke units as measured by full load method.

(ii) For vehicles operating in non-urban areas, the smoke density shall not exceed 70 Hartridge smoke units as measured by free acceleration method; or 5.5 Bosch or 80 Hartidge smoke units as measured by full load method.

The above standard also includes the procedure for measurement.

6.2.6.3. The above mentioned vehicle emission standards have not yet been made statutory. Also, there is no national standard for ambient air quality. The present efforts as regards controlling air pollution from automobiles have been restricted to survey of the level of discharge of pollutants from the vehicles and making suitable recommendations.

6.2.6.4. The level of ambient air pollution because of road vehicles depends on several factors such as the condition of the vehicles, the level of traffic congestion causing frequent acceleration/deceleration or stopping, the wind velocity and direction, etc. At present, no indigenous data or models are available for predicting the level of ambient air pollution under given sets of conditions. Till such time the data/models are available, it is suggested that both the number of motorised vehicles and the volume/capacity ratio (lower the ratio, lesser is the congestion

and lower pollution) be taken as indicators for air pollution levels.

6.2.7. Noise pollution

6.2.7.1. Road traffic causes noise. The noise level depends on factors such as traffic intensity, the type and condition of the vehicles, acceleration/deceleration depending on the level of congestion, smoothness of road surface, etc. The BIS has recommended the acceptable noise levels under different situations. The noise levels for residential areas as given in IS : 4954-1968 are as follows :

Sl. No.	Location	Acceptable outdoor noise levels in residential areas d_B (A)
1.	Rural	25 - 35
2	Suburban	30 - 40
3.	Residential (urban)	35 - 45
4.	Urban (residential and business)	40 - 50
5.	City	45 - 50
6.	Industrial area	50 - 60

The BIS has also brought out a number of standards on the measurement of noise. These are :

(i) IS : 3028-1980, Measurement of Noise Emitted by Moving Road Vehicles.

(ii) IS : 4758-1968, Method of Measurement of Noise Emitted by Machines.

(iii) IS : 9779—1981, Sound Level Meters.

(iv) IS : 10399—1982, Method of Measurement of Noise Emitted by Stationary Road Vehicles.

(v) IS : 10423—1982, Personal Sound Exposure Meter.

6.2 7.2. Noise pollution is an irritant and affects human health and efficiency. This will therefore be required to be considered in urban areas and other residential areas falling within 100 m of the road.

6.2.7.3. With the available data, it is not possible to predict noise levels for a given set of road and traffic conditions. However, it may be judged subjectively that a road with lower

traffic, lower volume/capacity ratio and smoother surfacing will develop lower noise levels than the one otherwise. Where higher noise levels are experienced or anticipated, it would be advisable to provide screen plantations and other noise attenuating devices.

6.2.8. **Highway aesthetics**

6.2.8.1. An aesthetically designed, constructed and maintained highway is not only pleasing to the eye and enhancing the environmental quality but also is safe in operation. The activity involves several steps such as choice of location, selection of pleasing alignment which merges with the natural environment, grassing and planting the roadside, provision of wayside facilities to travellers, etc. The Indian Roads Congress have published detailed guidelines on these aspects, vide (i) IRC : SP : 21-1979, Manual on Landscaping of Roads and (ii) Environmental Consideration sin Planning and Design of Highways in India (1979) with Discussions. These guidelines should invariably be consulted in the preparation of highway projects.

6.2.8.2. Borrowing earth from roadside borrowpits for embankment construction has been a common practice in the country. Quite often the pits are dug in irregular shapes and left without any provision for drainage. This not only makes the roadside unpleasant but also causes water stagnation with concomitant adverse effect on the road and the environment. It is, therefore, necessary that the borrowpits should be dug in regular shape and in a manner to merge these with the natural ground and provided with drainage arrangements.

6.2.9. **Pollution during construction operations**

6.2.9.1. During road construction operations, the main sources of pollution are :

(i) exhaust and flue gases from the road construction equipment; and

(ii) dust resulting from construction operations.

6.2.9.2. Most of the road construction equipment are governed by standards of BIS or foreign standards which provide for pollution control devices for the equipment. The contract-conditions should stipulate that the equipment to be used for the works should be provided with pollution control devices. Also before start of construction operations, the Engineer should ensure that the equipment brought to work site are of standard type with necessary pollution control devices.

6.2.9.3. Loading, unloading and transport of materials like soil, sand, moorum, etc., will cause dust nuisance, particularly when high velocity wind is prevailing. In such cases, it will be advisable to slightly wet the materials at the source itself before loading and to cover the loaded vehicles with tarpaulin or similar such material. When construction activities cause excessive dust and noise nuisance to adjoining residential/institutional areas, temporary screens may be erected.

Appendix I

MEASURES TO PREVENT SOIL EROSION AND LAND DEGRADATION IN ROAD DEVELOPMENT IN HILLY AREAS

1. Project Conception and Planning

1.1. The length of new roads to be constructed should be bare minimum so that disturbance to the natural surroundings is least. A Master Plan of entire development of hill region should be prepared showing integrated road network of all kinds of roads to the extent possible and practicable covering the planning at macro and micro levels. It is necessary that the main road should touch the cluster of villages, and separate feeder roads, bridal paths, foot tracks, etc., may be provided as connections. The specification of such connections will depend upon the importance of the village.

1.2. All road construction activities should be coordinated through a single agency within the State or at Centre so that all care is exercised to have proper planning, implementation and funding of the projects.

1.3. All road projects should be planned, designed and executed in accordance with the standards and specifications laid down by the Indian Roads Congress.

2. Alignment Selection

2.1. While selecting new road alignments, attention must be paid to avoid areas prone to landslides, soil erosion and other damaging features. It should be made obligatory to associate geotechnical engineers, geologists, forest and soil conservation experts, economists and other specialists right from the inception stage to ensure selection of most suitable alignment.

2.2. Road alignments should avoid large scale cuttings and fillings and follow the lie of the land as far as possible. Use of tunnels to avoid deep cuts should be considered where feasible and economical.

2.3. To the extent feasible, roads should be aligned away from streams and torrents except where these are to be crossed. Since the greatest damage always occurs along water courses, special attention is necessary to create protection belts of forests on both sides.

2.4. Before finalising the alignment, erosion potential of each alternative should be carefully examined, and the one involving least disturbance to the natural ground should be preferred.

3. Design

3.1. Where the road is in cutting, half cut and half fill type section which involves least disturbance to the natural ground should be adopted subject to considerations of economy and road stability being satisfied.

3.2. The cut slopes should be made stable for the type of strata in the initial construction stage itself by adoption of appropriate slopes with benches, etc., including the use of stabilising structures like breast walls, pitching, etc.

4. Construction

4.1. Area for clearing and grubbing should be kept the minimum subject

to the technical requirements of the road. The clearing area should be properly demarcated to save desirable trees and shrubs and to keep tree cutting to the minimum.

4.2. Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise temporary erosion control measures should be provided between successive construction stages. Under no circumstances, however, should very large surface area of erodible earth material be exposed at any one time by clearing and grubbing.

4.3. The method of balanced cut and fill formation should be adopted to avoid large difference in cut and fill quantities.

4.4. The cut slopes should be suitably protected by breast walls, provision of flat stable slopes, construction of catchwater and intercepting drains, treatment of slopes and unstable areas above and underneath the road, etc. This must be planned in advance and specific provisions made in the project estimate.

4.5. Where rock blasting is involved, controlled blasting techniques should be adopted to avoid over-shattering of hill faces.

4.6. Excavated material should not be thrown hapazardly but dumped duly dressed up in a suitable form at suitable places where it cannot get easily washed away by rain, and such spoil deposits may be duly turfed or provided with some vegetative cover.

5. **Drainage**

5.1. Drainage of the water from hill slopes and road surface is very important. All artificial drains must be linked with the existing natural drainage system for which separate detailed engineering survey may be carried out and planning done. Before the road is opened to traffic, proper drainage system including suitable interceptor and catchwater drains must be completed. This part of the project must be given all importance as most of the road damages are caused because of negligence in providing proper drainage system and much will be saved in subsequent road maintenance.

5.2. The surface drains should have gentle slopes. Where falls in levels are to be negotiated, check dams with silting basins should be constructed and that soil is not eroded and carried away by high velocity flows.

5.3. Location and alignment of culverts should be so chosen as to avoid severe erosion at outlets and siltation at inlets.

5.4. The cross-drainage structures should discharge safely on the valley side, and in this connection, all necessary precautions/safeguards should be taken to ensure that the discharging waters do not cause erosion even when they flow for long periods. For this purpose, all necessary channel training and erosion control works like pitching/paving of the channel and outfall points, drop walls, flexible apron, etc., should be considered and provided for as a part of initial design and construction.

5.5. Along with other road components, due attention should be paid to the maintenance of drainage and soil conservation works. Drains, catchpits

etc., should be cleared of all debris and repaired where necessary before the on set of the rainy season. Eroded areas should be promptly made up and provided with vegetative cover.

6. **Grassing and Planting**

6.1. Deforestation for road construction/works should be bare minimum and strict control must be exercised in consultation with the forest authorities. Equivalent amount of new trees must be planted as integral part of the project within the available land and if necessary, separate additional land may be acquired for this purpose. Suitable provisions may be made in the project estimate.

6.2. Depending on the availability of land and other resources, afforestation of roadside land should be carried out to a sufficient distance on either side of the road. The selection of plant species will depend on climate, altitude and soil conditions, but preference should be given to deep rooted trees and plants. For preparing the detailed scheme of afforestation, persons having knowledge of soil conservation or forestory should desirably be associated.

6.3. Vegetative cover should be established on all cut/fill slopes through any one of the techniques described in IRC : 56-1974 "Recommended Practice for Treatment of Embankment Slopes for Erosion Control". The activity of establishing vegetation on barren slopes should be treated as part of the regular maintenance operations on all hill roads.

6.4. Strip forests suitable for the site conditions for a minimum distance of 30 m on either side of the road boundary should be provided. These shall be raised and maintained by forest authorities. No felling except of dead or dying trees should be permitted in this area.

7. **Consultations**

7.1. Local Geological Department should be consulted to avoid unstable strata while fixing road alignment.

7.2. It will be advisable, at least for important roads, to have consultation with the officers of the Forest Department at the stages of route alignment selection, surveys and investigations, etc.. so as to ensure that the selected alignment has minimum potential for soil erosion and that the project designs and estimates provide for the necessary soil erosion control measures. The idea is that with such joint consultation pursuits practiced for some selected roads, the PWD Engineers would get conversant and should be able to take care of such requirements by themselves for other road projects in general.

7.3. For any seriously problematic areas where normal measures are not likely to be successful, specialist organisations like the CRRI, GSI, etc., may be consulted for evolving suitable remedial measures.

8. **Project Estimate**

8.1. The road construction project estimates should provide for not only the requisite scale of investigations but also the necessary measures against soil erosion so that these can be built into the project with adequate financial provision.

8.2. For treatment of unstable areas, say 50 m above and 30 m below the road level, depending on the site conditions, cost of necessary corrective measures should be provided in the project estimates. This may even be in the

form of certain percentage of total cost but based on assessment of treatment works possibly needed.

9. **Training**

Training of road engineers in hilly areas should be intensive and practice oriented. On every major on-going project, training facilities should be created. The Institutes having road research facilities may be associated for organising class room and field training and solving specific problems, if any. The training should lay emphasis on preservation of ecology, forests, environment, etc., to avoid denundation of fertile soil of the hill slopes and check the causes leading to landslides, etc. For efficient handling of the project, only experienced persons with proven ability should be selected.

10. **Check List**

To help the project preparing Engineer and the project approving authorities in determining whether all aspects, considerations and items of work with regard to soil conservation and erosion prevention have been duly taken into account, and to facilitate review at different stages, a check list is suggested, vide *Appendix* 2. The check list should form a part of the road project report.

Appendix 2

CHECK LIST OF POINTS ABOUT EROSION CONTROL IN THE CONSTRUCTION OF ROADS IN HILLY AREAS

1. Does the road construction project estimate provide for the necessary measures against soil erosion ?
2. Have soil maps and aerial photographs studies and investigations made to locate areas or sections with high erosion potential?
3. Has erosion potential been considered for each alignment ?
4. Have geological maps been studied or local Geological Department consulted to avoid unstable strata ?
5. Does the selected alignment follow the lie of the land and avoid large scale cutting ?
6. Has use of tunnels to avoid deep cuts been investigated ?
7. Is the road alignment susceptible to damage/erosion by streams and torrents ?
8. Is consultation/coordination with other departments like Forest Department necessary ? If so, have they been consulted ?
9. How will adjacent and nearby streams, ponds and lakes be affected by project construction ?
10. Will special erosion control measures be required to protect adjacent properties ?
11. Does the road cross-section involve a lot of disturbance to the natural ground ?
12. Are the design cuts slopes stable for the type of strata ?
13. Are slope stabilising structure like breast walls, pitching, etc., required ?
14. Does the cut hill face require any special treatment to prevent slips ?
15. Has the area for clearing and grubbing been clearly demarcated ?
16. Has a work schedule been worked out for the different construction operations ?
17. What erosion control works are required before clearing and other work is started ?
18. Are any temporary erosion control measures required between successive construction stages ?
19. Have sediment traps, benches, catch water drains, side drains, sodding, ditch paving, slope protection works and other erosion control items been identified on the plans and provided in the contract ?
20. Have the location and alignment of culverts been fixed with due consideration to erosion at outlets and siltation at inlets ?

21. Have the necessary erosion control measures been taken at the outfalls of culverts ?

22. Has the proper disposal of surplus excavated material been thought of and provided for ?

23. What action has been taken to establish vegetative cover on cut/fill slopes and plantings on the disturbed roadside land ?

24. Are the existing drainage facilities maintained in good order ?

25. Have any inadequacies in planning, design and construction been identified and reported to higher authorities ?

26. Do any of the design measures require modification in the light of field conditions ?

27. Do any of the problems require consultation with specialist organisations like the CRRI, GSI, etc. ?