CHAPTER - 7 ENVIRONMENTAL IMPACTS

This chapter assesses the nature, type and magnitude of the potential impacts likely on the various relevant physical, biological and cultural components along the project corridor. The assessment of impacts has been based on the information furnished in the Individual EIS documents, supplemented by field surveys and additional secondary data collated during the consolidation and update of the EA. The description of impacts has been structured as per the discussions in Chapter 4: Baseline Environmental Profile of this report.

The environmental and social impacts can be direct as well as indirect. The direct area of influence includes the Corridor of Impact[1] and the construction sites[2] for the project. The indirect area of influence includes areas with potential indirect impacts, for example areas impacted from sediment-loaded runoff or areas impacted due to location of labour camps. The impacts on various environmental components can occur at any of the following stages of the project planning and implementation: (i) Planning and design stage; (ii) Construction stage; and (iii) Operation stage.

The description and magnitude of impacts for the various environmental components for the project corridors are presented in the following sections.

7.1 IMPACTS ON PHYSICAL ENVIRONMENT

7.1.1 IMPACT ON METEOROLOGY

By and large, there is no significant change expected in the macro-climatic setting (precipitation, temperature and wind) of the corridors. However the microclimate is likely to be modified slightly due to removal of roadside trees and the addition of increased pavement surface. In addition, temporary loss of shade giving roadside trees will cause discomfort to the slow moving traffic and pedestrians.

During cyclones, the existing road conditions along the coast do not facilitate quick evacuation and relief of the coastal communities. The improved road will minimize the losses suffered presently and beneficially impact the coastal communities. One of the beneficial impacts of the

[1] The Corridor-of-Impact (COI) is the corridor of direct impact. It is the strip of land required for the road works, including shoulders, support slopes, and necessary clear zone. The COI along the upgradation roads varies in width, according to the improvement strategy and cross-section type (rural/village/urban) applicable at a particular point. The CoI that has been arrived for the upgradation and maintenance corridors is discussed in Section 1.5 of Chapter 1.

[2] The Offsite works will include: site office for the Engineer; site office and laboratory for the contractor; special items store for petroleum, bitumen, toxic chemicals such as weed killers, small quantities of materials for use in the laboratory, and explosives (if required); construction equipment including mobile plant and specialized equipment; facilities for producing or handling concrete and precast concrete units, especially in proximity to the sites of new bridges; workshop for maintaining plant and equipment.

project will be roads with stronger sub-grade under cyclonic conditions (4 day soaked CBR test, Refer Feasibility Study Report, Section 5.5) and improved access to affected areas at the time of cyclone disasters.

The **Anti-Disaster Plan - State of Tamil Nadu** (Government of Tamil Nadu, 1978) advocates a range of pre-disaster physical planning measures to protect against disasters.

> *Firstly in terms of the road network, the measures would include provision of alternative access ways to neighbourhoods and zones, developing integrated network with major roads having adequate width to avoid blockage by collapsed buildings, providing bypass to high risk areas, establishing an evacuation and emergency routing system and alternate arrangements for bypassing collapsing or flooded under/over bridges, causeways, subways and tunnels etc. (p. 13).*

The project will provide much better protection against the immediate effects of cyclones by replacing bridges, by widening the road, by planting trees further back from the road, and by improving the hydraulic capacity of bridges and culverts.

7.1.2 IMPACT ON PHYSIOGRAPHY

Since most of the routes in TNRSP pass through predominantly plain terrain and no substantial cut-and-fill operations are planned, the overall impact on the physiography of the area would be limited. Though corridors of TNRSP 01(N) pass through rolling terrain (Refer **Table 4.5**), no significant impact on physiography is expected as no cutting is proposed.

Amongst the maintenance corridors, the Gudalor - Mysore, Calicut - Vythiri - Gudalor, Coonor - Kundah and Coonor - Kattubettu Corridors in Nilgiri District and the Hosur - Denkanikottah Corridor in Dharmapuri district pass through mountainous terrain. As no widening is proposed as part of the maintenance works, the impacts on physiography would be minimal.

7.1.3 IMPACT ON TOPOGRAPHY

No raising of the road embankment height is suggested in the designs along the upgradation roads apart from the stretches identified as low-lying areas. A total of 27.1 Km of the upgradation roads has been identified as low-lying areas (Refer **Table 4.6**). To ensure that raising of embankments does not aggravate the flood situations along the surroundings, it has been proposed to raise the road no more than the depth of the structural overlay to permit the water flow without raising the flood level. At these locations, the design has focussed on the improvement of roadside drainage conditions either through the improvement of existing cross-drainage structures or provision of new cross-drainage structures. Design of the cross drainage structures will follow IRC Guidelines (IRC, 1995).

7.1.4 IMPACT ON GEOLOGY

The project routes along upgradation as well as maintenance corridors traverses through seismic zone II as defined by the vulnerability zoning system, i.e., Low Damage Risk Zone (i.e. areas with a probable seismic intensity of VI on the Modified Mercalli Intensity Scale). Thus the project does not have any significant impact on the seismic stability of the area.

Likely impact on the geology is due to the uncontrolled blasting in the quarries supplying aggregates for construction. As these quarries are licensed, the prevalent rules on blasting will be adhered to. Hence, the impact on general geology of the region is insignificant.

At the construction sites, no major blasting is envisaged.

7.1.5 IMPACT ON SOIL

7.1.5.1 Loss of productive soil

Construction Stage

A total of 13 bypasses for a length of 95.4 km and 80 realignments for a length of 34 Km are proposed. Most of these sections pass through productive agricultural lands, thereby triggering the loss of productive topsoil. Apart from these fresh land acquisitions, there are stretches along the corridors where acquisition of agricultural lands has been unavoidable due to non-availability of sufficient road width to accommodate the proposed cross-sections. The agricultural lands to be acquired for the project is presented in the **Table 7.1.**

Table 7.1 Agricultural Land to be acquired for the Project

Contract Package	Productive Land (irrigated) to be Acquired (Ha)
TNRSP 01	174.46
TNRSP 02	65.92
TNRSP 03	6.34
TNRSP 04	2.48
Total	249.21
Source: Resettlement Action Plan, December 2002	

Loss of productive soil is envisaged during construction stage if workers camps, stockyards, storage godowns, borrow areas etc are located on fertile areas.

Temporary loss of productive soil is likely if haul roads for the transport of borrow materials, traffic detours during construction etc are routed through agricultural lands.

7.1.5.2 Soil Erosion

Construction Stage

Except for black cotton soils which has a moderate potential for erosion, the erosion potential for all other soil types along the upgradation roads (Red Sandy and Reddish Brown Loam, Recent Sandy and Immature) is high (Refer **Table 7.2**). Clearance of the roadside ground cover, especially along the raised sections is likely to exacerbate erosion, as it exposes the soil and destabilizes the slopes. Adequate slope protection measures shall need to be provided for in the project.

Table 7.2: Erosion Potential for Different Soil Types

Contract Package	Link	Soil Type	Erosion Potential
TNRSP 01(N) TNRSP 01(S) TNRSP 02 & 03	Arcot to Arani & Polur to Tirukkovilur Jayamkondam to Ariyalur Manora to Mimisal	Red Sandy and Reddish Brown Loam	Prone to gully erosion if velocity of surface run off is high
TNRSP 01(S) TNRSP 01(E) TNRSP 02 TNRSP 03& 04	Jayamkondam to Thiruvarur Sirkazhi Bypass Nagapattinam to Manora Mimisal to Ramanathapuram to Tuticorin	Black Cotton Soil	Moderate Potential
TNRSP 01(N) TNRSP 01(S) TNRSP 01(E)	Arani to Chengam & Tirukkovilur to Elavanasur Vridhachallam to Jayamkondam Chidambaram Bypass	Recent Sandy Soil	High Potential
TNRSP 01(N)	Tirukkovilur Bypass	Immature Soil	High Potential
Source: EIS for Northern Corridor, March 1999 & EIS for Corridor I, June 1999, Prepared by PCC.			

Elevated sections of road in all sections, particularly all high embankments along the bridges and the bridge approaches would be vulnerable to erosion. Construction of new bridges involves excavation of riverbed and banks for the construction of the foundations and piers. If the residual spoil is not properly disposed off, increased sedimentation downstream of the bridge is likely.

As both northern and the eastern corridors experience prolonged monsoons with heavy rains (twice a year), there is a potential for sedimentation of waterways and water bodies.

Operation Stage

No soil erosion is envisaged during the operation stage as all the slopes and embankments of the project road would have been stabilized through sound engineering techniques. The issue has been addressed at the design stage itself and all slopes have been designed for at least 1:2 slope, which shall ensure stability of the embankment.

7.1.5.3 Compaction of soil

Compaction of soil will occur, particularly during site clearance stage due to movement of heavy machinery and vehicles and during setting up of construction camps and stockyards. During construction, there is a likelihood of compaction beyond the carriageway within the CoI, due to the movement of vehicles and heavy machinery. Though this is a short duration impact, it is a permanent impact and needs to be mitigated.

7.1.5.4 Contamination of soil

Construction Stage

Contamination of soil may take place due to solid waste generated from the labour camps set up for the project. This impact is also significant at locations of stockyards and hot mix plants. During construction, contamination of soil will be primarily due to construction and allied activities. The sites where construction vehicles are parked and serviced are likely to be contaminated because of leakage or spillage of fuel and lubricants. Pollution of soil can also occur in hot-mix plants from leakage or spillage of asphalt or bitumen. Contamination of soil during construction is a major long-term residual negative impact. Unwarranted disposal of construction spoil and debris will add to soil contamination. This contamination is likely to be carried over to water bodies in case of dumping being done near water body locations.

The scarified bitumen material, generated during the construction stage, if not disposed properly can leach into the soil and also contaminate nearby water bodies. The existing bitumen surface can be utilized for the paving of cross roads, access roads, and paving works in construction sites and camps, temporary traffic diversions, haulage routes etc. Unusable bituminous wastes must be dumped in secure landfill sites only. At such locations dumping is to be carried out over a 60 mm thick layer of rammed clay so as to eliminate any chances of leaching.

Soil contamination is also anticipated due to dumping of construction debris along maintenance corridors, including waste bitumen at the construction and hot – mix plants

Operation Stage

During the operation stage, soil pollution due to accidental vehicle spills or leaks is a low probability but potentially disastrous to the receiving environment, should they occur. These impacts can be long term and irreversible depending upon the extent and type of spill.

7.1.6 IMPACT OF BORROW AREAS AND QUARRY SITES

The excavation of quarries and borrow pits used for obtaining rocks, soil and aggregate materials for road construction cause direct and indirect long-term adverse impacts on the environment. The proposed up-gradation works envisage use of significant quantities of earth, stone and grit and sand along with bitumen. The principal construction materials required for the upgradation of the TNRSP Corridors include:

- Quarry materials, used in asphalt and aggregate for upper pavement layers
- Sand, gravel, laterite, clay and other materials for fill and lower pavement layers

Contract documents specify the materials to be used, but not specific quarries, pits or borrow sites for obtaining the various materials. The contractor shall identify the source of materials and use them with the consent of the Supervision Consultant. The principal sources to be tapped by the Contractor includes:

- Quarry materials from licensed existing quarries
- Sand from riverbeds, normally dry and accessible except during the northeast monsoon (approvals for this extraction are necessary, as it is not permissible everywhere)
- Clays from tanks, many of which are near the road.
- Laterite available in the vicinity of Northern Corridor and from areas west of Eastern Corridor.

7.1.6.1 Quarries

Only existing quarries will be used for the project and no new quarries are proposed. These quarries are already in operation with the requisite environmental clearances, therefore no major impacts, which arise in making new quarries operational, are likely.

As part of the project preparation, the PCC have carried out investigations on the quality and quantity of quarry materials around the corridors, based on which quarries suitable for the project have been identified. [Refer **Appendix 7.1 & Figure 7.1(A) & (B)**]. The contractor will identify the quarries from which materials will be procured at the time of execution after the approval of the Engineer. The Engineer will ensure that the selected quarries have approval

under Tamil Nadu Minor Mineral Concession Rules, 1959 [Corrected upto 31.3.2001]. The requirement of quarry material for each package is presented in **Table 7.3.**

Table 7.3: Requirement of Sand and Quarry Material

Sl No	Package	Requirement (cubic meter)		
		Aggregates	Sand	Gravel
1	TNRSP 01	3,801,771	862,375	244,296
2	TNRSP 02	784,211	188,890	130,844
3	TNRSP 03	606,435	115,094	26,442
4	TNRSP 04	585,085	118,091	27,639
	TOTAL	5,777,502	1,284,450	429,221
Source: Bill of Quantities, July 2002, Prepared by PCC.				

A major source of dust during the construction stage is from stone crushing operations from the crusher and the vibrating screen. The dust, in addition to being an eyesore, reduces visibility thereby increasing safety concerns. Dust is generated due to procurement and transport of raw materials from quarries and borrows sites to the construction site. These impacts will persist till the activity ceases. The regions especially downwind to the quarries/borrow areas are more vulnerable to air pollution. The issue of dust generation along the haul roads needs to be addressed through strict enforcement of dust suppression measures.

Table 7.4 presents the maximum, minimum and average (weighed) lead i.e. haulage distance for each package for construction materials such as aggregates, gravel and sand. It indicates the maximum, minimum and the average distance that has to be travelled with respect to each package for procuring the particular construction material. From the Table it can be observed that the quarry materials have to be transported over considerable distances, in case of TNRSP 01 (S) & (E), TNRSP 02, TNRSP 03 and TNRSP 04. However almost all the quarries identified have black topped access roads, and transportation in covered haulage trucks will ensure that no major impacts occur.

Figure 7.1(A)

Quarry Map – Northern Corridor

Figure 7.1(B)

Quarry Map – Eastern Corridor

Table 7.4: Haulage Distance for Construction Material

Sl. No	Package	Haulage Distance (km)	Haulage Distance (km)		
			Aggregates	Sand	Gravel
1	TNRSP01(N)	Maximum	15	16	16
		Minimum	7	10	10
		Weighed Avg.	11	14	14
2	TNRSP01(S)	Maximum	95	12	-
		Minimum	49	2	-
		Weighed Avg.	68	8	-
3	TNRSP01(E)	Maximum	134	13	15
		Minimum	68	3	3
		Weighed Avg.	91	12	12
4	TNRSP02	Maximum	139	12	139
		Minimum	67	2	67
		Weighed Avg.	95	8	95
5	TNRSP03	Maximum	91	26	23
		Minimum	60	0.5	2
		Weighed Avg.	84	14	18
6	TNRSP04	Maximum	91	28	16
		Minimum	49	12	5
		Weighed Avg.	72	18	11
Source: Bill of Quantities, July 2002, Prepared by PCC					

7.1.6.2 Borrow Areas

The total quantities of earthwork in excavation, stripped topsoil, the quantity of borrow material required as well as the quantity of excavated proposed to be reused (subject to approval) along the up-gradation routes are presented in **Table 7.5**. Borrow material will be collected from roadside ponds and tanks apart from designated borrow areas causing likely impacts on the hydrological regime of these water bodies incase of illegitimate borrowing. Borrowing is to be carried out in accordance to the guidelines laid out in IRC:10-1961.

Table 7.5: Earthwork & Borrow Material requirements

Sl No	Items	Quantities (m^3)				
		TNRSP 01	TNRSP 02	TNRSP 03	TNRSP 04	Total
1	Earth work in Excavation	1613964	295915	285478	63975	2259332
2	Stripping of Top Soil	546106	97119	79815	100933	823973
3	Borrow Material Required	2196157	704383	29586	24036	2954162
4	Reuse of Approved Excavated Material	752505	225370	188776	138438	1305089
Source: Bill of Quantities, July 2002, Prepared by PCC.						

Cartage of the borrow materials to the construction sites is of significance, as almost all such areas are accessible through dirt tracks only and therefore, spillage and compaction of soil along these tracks will be a significant impact. Protection measures need to be worked out for the minimizing of such impacts during the haulage of borrow materials.

As the borrowing is to be carried out in accordance to the guidelines laid out in IRC:10-1961, no major adverse impacts are anticipated. Also, productive agricultural areas will be avoided for borrowing. However, the borrow area pits, if not treated properly after the borrowing is complete, can form stagnant pools and pose health hazards. They can also act as breeding ground for vectors like mosquitoes just after monsoon. In addition, visual blight and safety issues are also of concern. It is expected that the implementation of the mitigation measures for borrow area redevelopment proposed as part of the TNRSP will reduce these impacts to acceptable levels.

7.1.6.3 Sand Mining locations

Significant quantity of sand would be required for the pavement and for the cross-drainage structures proposed. As the project corridor is in the vicinity of rivers such as Cheyiar, Ponnaiyar, Vellar and Kollidam along Northern Corridor and Vaigai, Agniar, Pambar and Vaippar along the Eastern Corridor, sand required for the construction will mostly be procured from their banks. The requirement of sand for each package is presented in **Table 7.3.** Such extractions will be carried out from sand quarries licensed under Tamil Nadu Minor Mineral Concession Rules, 1959 [Corrected upto 31.3.2001]. No additional adverse environmental impact, except those resulting from spillage during transportation and damage to the haul roads during transportation, is expected to occur.

7.1.7 IMPACT ON WATER RESOURCES

The typical impacts on water resources during road construction are summarized in **Table 7.6.**

Table 7.6: Impacts on Water Resources due to Construction Activities

Impacts Due To Construction	Indicators
Impact on water bodies	Offset distance from the CoI from the edge of the embankment
Loss of other water supply sources	Number of wells, hand pumps affected
Alteration of drainage, run off, flooding	No. of cross drainage channels
Depletion of Ground Water recharge	Area rendered impervious
Contamination from fuel and lubricants	Nature and quantum of contaminators
Contamination from improper sanitation and Waste Disposal in Construction Camps	Area of camp / disposal site and proximity to water bodies / channels
Use of Water Supply for Construction	Quantum of water used

7.1.7.1 Impact on water bodies

A total of 84 ponds/surface water bodies are directly impacted due to the project. Most of them are located within or alongside the RoW and are being used by the local community for washing/bathing purposes. Likely impacts on water bodies include:

- water bodies entirely lost
- water bodies partly filled
- Water bodies cut across by the new alignments
- Water bodies whose storage capacity is not impacted but embankment is cut across
- Water bodies not directly impacted but vulnerable to siltation from construction runoff.

7.1.7.2 Ground water sources

Apart from these surface water bodies, a total of 172 hand pumps and 26 wells located within the Corridor of Impact of the up-gradation roads would be impacted. The loss of these community ground water supplies would be a direct negative impact. The project envisages replacement of these sources prior to removing them. Similarly, the owners of private wells impacted by the project will be adequately compensated. Therefore, the eventual impact of the proposed widening will be negated to a considerable extent. The water resources affected in the project are given in **Table 7.7.**

Table 7.7: Water Resources Affected along TNRSP Corridors

Package	Hand Pump	Well	Pond
TNRSP 01	153	10	41
TNRSP 02	16	5	29
TNRSP 03	1	1	2
TNRSP 04	2	10	12
Total	172	26	84
Source: Resettlement Action Plan, December 2002.			

7.1.7.3 Alteration of drainage along water crossings

Impacts of road construction, which lead to alteration of drainage, are generally due to widening/ new construction at bridge and cross drainage locations. The project road traverses across the river basins of Palar, Ponnaiyar, Vellar and Kollidam along the Northern Corridor and Cauvery, Agniar, Pambar, Vaigai, Gundar and Vaippar along the Eastern Corridor. Apart from these, the project road cross many natural waterways and irrigation channels, served by bridges and culverts. As part of up-gradation of TNRSP corridors, 81 new bridges (16 major and 65 minor) are to be constructed and refurbishment work is to be carried out in 30 major and 64 minor bridges (Refer **Table 7.8**).

Table 7.8: Bridges proposed under Upgradation Corridors

Sl. No.	Package	Construction of New Bridge		Refurbishment		Total
		Major	Minor	Major	Minor	
1	TNRSP 01	10	36	2	25	73
2	TNRSP 02	3	19	1	18	41
3	TNRSP 03	0	6	23	17	46
4	TNRSP 04	3	4	4	4	15
	Total	16	65	30	64	175
Source: Design Drawings, March 1999, Prepared by PCC.						

Construction along the watercourses is to be carried out in the lean flow periods. As the rivers are seasonal, the construction activities will not necessitate any major diversion of the waterways. The construction and rehabilitation of bridges along the corridors will however involve some minor temporary diversion of waterways, which can impact the existing aquatic habitat, if any. By these temporary diversions the waterway will be constricted, thereby increasing velocity downstream of the bridge. This will mean increased sediment load with the flow, thereby allowing less sunlight to penetrate into the water and can reduce growth of micro flora. The impact will last as long as construction continues.

7.1.7.4 Drainage issues along flood prone sections

Design proposes that the new sub grade be 1 m above the flood level or perched water table in flood prone sections. It ensures that the finished pavement is above the High Flood Level so as to prevent any impacts due to any water seepage in the pavement. No significant impacts in the drainage pattern due to the raising of the road profile are likely, as the road design itself takes care of the cross-pavement drainage.

7.1.7.5 Increased surface run-off

One of the unavoidable aftermaths of road construction is the increased surface run off. The addition of hard paved shoulders, which essentially increase paved impervious surface, will cause increased surface runoff along the roadsides. Increase in surface run-off is due to the creation of impervious surfaces that prevent the flow of water into the ground. The increased runoff from the project has been worked out as follows:

Increase in runoff (cum.) = increase in runoff co-efficient due to construction * annual rainfall in the area (m) * area of the newly constructed surface.

The increase of the black top width has been considered according to the type of cross section proposed (For details Refer **Appendix 7.2.**) The runoff coefficient used for the calculations are 0.2 for red sandy and reddish brown loam, 0.15 for recent sandy and 0.55 for black cotton soil. The black top has a run-off coefficient of 0.95. Increase in the runoff co-efficient has been worked out as the difference between the runoff co-efficient of black top surface and different soil types. The increased run-offs along various packages are presented in **Table 7.9.**

Table 7.9: Increased Run-off along Upgradation Corridors

Sl. No	Package	Length (km)	Increase in Run off (m^3)
1	TNRSP 01(N)	197.1	789148.43
2	TNRSP 01(S)	175.1	479004.05
3	TNRSP 01(E)	25.7	212931.84
4	TNRSP 02	116.6	296365.23
5	TNRSP 03	99.8	147460.3025
6	TNRSP 04	118	94904.32
	Total	732.3	2019814.173

Impacts due to surface runoff include increased soil erosion and local flooding or water logging. However, as the proposed up-gradation has been designed with table drains to take care of runoff, surface runoff shall be drained to the nearest cross drainage structure. The engineering design includes design of cross drainage structures, which shall take care of the increased runoff.

7.1.7.6 Increased sedimentation and degradation of water quality

Construction Stage

The degradation of water quality can occur during construction stage from increased sediment load into watercourses near the construction site. This may be aggravated by removal of trees and consequent increase in soil erosion. Soil types along the corridors consist of predominantly red sandy and reddish brown loam along the Northern Corridor and black cotton soil along the Eastern Corridor. Impacts due to the increased sedimentation is likely to be more pronounced along the Northern Corridor as red sandy and reddish brown loamy soil has higher erosion potential than black cotton soil.

The impacts of increased run-off laden with fine sediment will make the water more turbid. This is a significant impact along the water bodies supporting fishes. If the concentrations are exceptionally high smaller fish can be harmed. Heavier sediment may smother the algae

growing in the lower strata and would completely alter the substratum of the watercourse. Excessive sediment loads may also mean disruption to areas where fish lay their eggs. The EMP includes contractual requirements for the contractor to avoid / mitigate impacts from increased sedimentation.

Degradation of water quality is also possible due to accidental discharges into watercourses from drainage of workers' camps and from spillage in vehicle parking and/or fuel and lubricant storage areas.

Operation Stage

During the operation stage, there is little chance of degradation of water quality during normal operations. The implications of accidental discharge are potentially disastrous. But, it must be emphasized that the probability of such an accident is quite low, indeed, as one of the objectives of the design is the enhancement of road safety.

7.1.7.7 Water requirements for construction

The water demand for construction activities for the Northern and Eastern Corridors is presented in **Table 7.10.** The total quantity of water required is 1280 m^3/day for the Northern Corridor and 910 m^3/day for the Eastern Corridor. This quantity is not required at a specific place and will be spaced over the entire corridor. Each corridor being divided into four packages, the total number of work places will be about 50 to 60 for each corridor. So the requirement of water at a particular place works out to be 20 to 25 m^3/day.

Table 7.10: Water Demand for Construction Activities

Purpose	Average Demand (m^3/day)	
	Northern Corridor	Eastern Corridor
Road Making	900	640
Dust Suppression	90	65
Drinking	90	65
Others	200	140
Total	1280	910
Source: MoEF Questionnaire for Environmental Appraisal, 1999.		

Along the Northern Corridor, this requirement will be preferentially sourced from surface water sources such as ponds, rivers etc. The list of the roadside water bodies along the Northern Corridor is presented in **Appendix 4.7.** Only in absence of any surface water source ground water sources will be tapped. However as required by MoEF prior permission from the ground water authorities will be obtained before effecting any such withdrawal.

Along the Eastern Corridor, the TDS concentrations in the ground water were found exceeding 2000 mg/l for distances upto 20km from the coast. Therefore, extraction of ground water is to be restricted along the eastern corridor to prevent any degradation of the water quality in this coastal belt. There are several surface water sources as ponds, tanks etc in almost every village the corridor passes through (1 pond for every 3.8 Km). The contractor will preferentially source all requirements from such surface water sources. The list of the roadside water bodies along the Eastern Corridor is presented in **Appendix 4.7**. The Tables also indicates the traverse distance between any two successive roadside water bodies. From the Tables is it observed that

only along TNRSP 04, two road stretches exist that are bereft of such roadside surface water bodies. They lie between:

- Vembar and Kulattur for a distance of 23.2 Km (Traverse Chainage Km 283.8 - 307.0)
- Kulattur and Tuticorin for a distance of 24.6 Km (Traverse Chainage Km 309.8 – 334.4)

Hence for these stretches some alternate source for construction water needs to be explored.

7.1.8 IMPACT ON AIR QUALITY

7.1.8.1 Generation of Dust

Construction Stage

- Generation of dust is likely due to:
- Site clearance and use of heavy vehicles and machinery etc.
- Procurement and transport of raw materials, borrow and quarry material to construction sites
- Earthworks
- Stone crushing operations at the crushers
- Handling and storage of aggregates at the asphalt plants
- Concrete batching plants and
- Asphalt mixing plants due to mixing of aggregates with bitumen.

Generation of dust is a critical issue and is likely to have adverse impact on health of workers in quarries, borrow areas and stone crushing units. This is a direct adverse impact, which will last almost throughout the construction stage and along the corridors.

Operation Stage

Dust generation will be minimal during the operation stage in all those sections where the 2LSS strategy has been adopted due to the presence of paved shoulders. In case of the other cross sections adopted some generation of dust will be inevitable due to the presence of the unsealed (earthen and gravel) shoulders. All slopes & embankments turfed as per best engineering practices will help to minimize the dust generation during operation of the road.

7.1.8.2 Generation of Exhaust Gases

Construction Stage

Generation of exhaust gases is likely due to movement of heavy machinery for clearance of the RoW for construction.

High levels of SO_2, HC and NO_x are likely from hot mix plant operations. Toxic gases are released through the heating process during bitumen production. Although the impact is very localised, it can spread down wind depending on the wind speeds. The Environmental Management Plan needs to ensure that adequate measures are taken in siting of the plants and to prevent any impact on the health and safety of workers.

Operation Stage

The major impact on the air quality during the operation stage will be due to plying of vehicles. The impact on air quality depends upon traffic volume/rate of vehicular emission within a given stretch and prevailing meteorological conditions. Excess discharge of exhaust gases can occur due to (i) inadequate vehicle maintenance; (ii) use of adulterated fuel in vehicles and/or (iii) poor road conditions.

Modeling of Air Impacts

To assess the likely operational impacts on the Ambient Air Quality due to the proposed project, prediction of the pollutant concentrations has been carried out using CALINE-4, a model based on Gaussian equation.

CALINE 4 is based on the Gaussian equation and employs a mixing zone concept to characterize pollutant dispersion over the highway. The model can be used to predict the pollutant concentrations for receptors located upto 500 m from the roadway for the various pollutants with reasonable accuracy

The input parameters for the modeling have been taken up from the following sources:

- The volume of traffic, proposed geometrics, design speeds proposed for the various packages have been taken from the Feasibility Report and design drawings of the individual packages;
- The emission factors for the vehicle types have been obtained from the Indian Institute of Petroleum (IIP), Dehra Dun.
- Ambient air quality from base line monitoring results carried out by LASA during May 2002.
- Meteorological conditions including wind, stability class etc, from the IMD data of the various locations along the corridor.

Concentrations of air pollutants such as SPM, CO & NOx have been predicted for the year 2017[3] at locations along the individual links. At each location the predictions have been made at distances of 5m, 9m and 13 m from the centre line of the road. The results are presented in **Table 7.11**. From the table it is observed that the predicted concentration for 2017 at all locations are well below the National Ambient Air Quality Standards specified by CPCB for Rural & Residential Areas. The maximum predicted concentrations are found along TNRSP 01(N) along Arcot Arani road (Km 0.500). The comparison between the predicted values for individual packages indicates that concentrations are comparatively higher for TNRSP 01 than for the other packages.

[3] The year 2017 represents a time period of 10 years after implementation of the project after 2006-2007 and can well be used to represent the worst case scenario with the present set of data.

Table 7. 11: Predicted Concentration along Upgradation Corridors (µg /m³) for 2017

Sl No.	Chainage	Link	Package	Land use	Receptor Distance	Predicted Concentration (µg /m³)		
						SPM	CO	NOx
1	0.500	Arcot Arani	TNRSP 01 (N)	Urban	5	162.9	498.0	46.6
					9	141.2	383.5	27.8
					13	130.1	269.0	9.0
2	39.700	Polur Chengam	TNRSP 01 (N)	Rural	5	96.3	269.0	5.3
					9	87.0	154.5	5.3
					13	82.2	154.5	5.3
3	105.000	Tiruvannamalai Tirukovillur	TNRSP 01 (N)	Urban	5	158.3	498.0	47.3
					9	137.9	383.5	28.5
					13	127.5	269.0	9.7
4	26.800	Tirukovillur Elavanasur	TNRSP 01 (N)	Rural	5	79.0	40.0	5.3
					9	75.1	40.0	5.3
					13	73.1	40.0	5.3
5	86.000	Jayamkondam Kumbakonam	TNRSP 01 (S)	Urban	5	150.0	383.5	35.5
					9	137.4	269.0	16.7
					13	131.0	269.0	16.7
6	2.800	Kumbakonam Thiruvarur	TNRSP 01 (S)	Rural	5	134.8	269.0	14.0
					9	123.8	269.0	14.0
					13	118.2	154.5	14.0
7	16.000	Nagapattinam Tiruppundi	TNRSP 02	Rural	5	128.4	498.0	23.1
					9	110.7	383.5	4.3
					13	101.6	269.0	4.3
8	70.700	Kattumavadi Mimisal	TNRSP 03	Rural	5	113.6	154.5	6.0
					9	108.0	40.0	6.0
					13	105.1	40.0	6.0
9	108.800	Tondi Devipattinam	TNRSP 03	Urban	5	100.4	78.0	8.7
					9	97.7	78.0	8.7
					13	96.3	78.0	8.7
10	22.500	Kilakarai Sayalkudi	TNRSP 04	Rural	5	130.7	154.5	17.0
					9	125.0	40.0	17.0
					13	122.1	40.0	17.0
National Ambient Air Quality Standards for Rural & Residential Areas						200	2000	80

So from the above discussion it can be inferred that the air quality impacts directly attributable to this project are not likely to alter drastically the present scenario. Monitoring of the ambient air quality at various locations along the Corridors have revealed a relatively unpolluted scenario. At all locations the concentrations of various air pollutant parameters were found to be lower than the National Ambient Air Quality Standards stipulated by the Central Pollution Control Board for rural and residential areas (Refer Section 4.1.8 of Chapter 4). Implementation of the project will cause a certain increase in the pollutants' concentrations due to the incremental traffic volume as shown in **Table 7.11**. But on the other hand improved road surface conditions and traffic capacity of the corridor will remove the local congestion and facilitate smooth traffic flow, which would reduce significantly the pollutant levels especially in the inhabited areas. Moreover the construction of the 13 bypasses and 34 km of other localized deviations has been proposed. This will contribute significantly in improving the ambient air quality by diverting the road away from built-up areas that include residential development and community facilities located very close to the existing corridor. So in totality the impacts are expected to be beneficial or at least neutral.

Additional measures being implemented by the Central Government could further reduce air pollution related to vehicle emissions (MoEF, 1997). These measures include:

- the introduction of catalytic converters
- making low-lead petrol and unleaded petrol available throughout the country
- more stringent emission norms for vehicles at the manufacturing stage
- the notification of emission standards for 2-stroke engines.

The overall conclusion of the Air Quality Study conducted as part of this environmental impact assessment is that the operational impact of the upgraded road on urban, village and rural air pollution would be negligible.

7.1.9 IMPACT ON NOISE LEVELS

Existing noise levels in urban areas along the Project Roads are generally in excess of relevant standards (Refer **Section 4.1.9** of Chapter 4).

Construction stage

Noise impacts during the construction stage will be associated with heavy vehicle movements and mechanical equipment used for earthworks, pavement laying, and bridge construction. People living in close proximity to the work sites will principally experience these impacts. The nature and duration of these impacts will vary depending on the type of work to be undertaken. For example, noise associated with the construction of major bridges will involve periods of pile driving which generates intermittent, high level noise and vibration, whereas areas of straightforward road widening may be completed relatively quickly and with lower noise levels. The noise levels associated with the various construction activities and the various construction equipments should not exceed 75 dB(A) as per the Environmental Protection Act of India.

Though the noise levels for the various construction activities exceed the permissible standards, it is important to note that the construction noise is generally intermittent and depends on the type of operation, location and function of the equipment. Mitigation measures as to regulate the timings of construction, employing noise protection measures etc. need to be worked out.

Operation stage

To assess the impact of increased traffic on noise levels at various locations along the corridor, prediction of noise levels[4] has been done using the FHWA Transport Noise Model. The model

[4] Operational noise for the highway are predicted through the model developed by Federal Highway Administration, Department of Transportation of the U.S. Likely noise levels at various receptor locations predicted through FHWA noise model. The various assumptions predicting the noise levels along the corridor through the FHWA model were:

- No significant change in the vehicle characteristics is anticipated during the projected period;
- There are no major grade differences in the project area as it is generally a plain terrain and no significant effect of grade on the noise levels is anticipated;
- The traffic along the proposed section is assumed to flow simultaneously in both the lanes and in both directions;

is developed by Federal Highway Administration, Department of Transportation of the U.S. Noise levels are predicted for the year 2017 at locations along the individual links. At each location the predictions have been made at distances of 5m, 9m and 13 m from the centre line of the road. The predicted noise levels are presented in **Table 7.12**. From **Table 7.12** it is observed that the predicted noise levels (Leq day and night values) are exceeding the limits stipulated by MoEF for residential and sensitive areas. The daytime predicted equivalent noise levels were found to vary from 62.61 dB(A) [Kattumavadi Mimisal Link, Km 70.700] to 72.79 dB(A) [Arcot Arani Link, Km 0.500]. The night time predicted equivalent noise levels were found to vary from 60.67 dB(A) [Kattumavadi Mimisal Link, Km 70.700] to 70.86 dB(A) [Arcot Arani Link, Km 0.500]. The maximum predicted concentrations are found along TNRSP 01(N) along Arcot Arani road (Km 0.500).

Table 7.12: Predicted Noise Levels along Upgradation Corridors for 2017

Sl No.	Chainage	Link	Package	Land use	Receptor Distance	Predicted Noise Levels in dB(A)	
						Leq (day)	Leq (night)
1	0.500	Arcot Arani	TNRSP 01 (N)	Urban	5	72.79	70.86
					9	69.73	67.79
					13	67.81	65.88
2	39.700	Polur Chengam	TNRSP 01 (N)	Rural	5	69.09	67.11
					9	66.02	64.05
					13	64.11	62.14
3	105.000	Tiruvannamalai Tirukovillur	TNRSP 01 (N)	Urban	5	74.79	72.98
					9	71.73	69.91
					13	69.81	68.00
4	26.800	Tirukovillur Elavanasur	TNRSP 01 (N)	Rural	5	70.26	68.57
					9	66.43	64.74
					13	64.03	62.34
5	86.000	Jayamkondam Kumbakonam	TNRSP 01 (S)	Urban	5	77.25	75.35
					9	73.42	71.52
					13	71.02	69.13
6	2.800	Kumbakonam Thiruvarur	TNRSP 01 (S)	Rural	5	71.95	69.96
					9	68.88	66.90
					13	66.97	64.98
7	16.000	Nagapattinam Tiruppundi	TNRSP 02	Rural	5	75.05	72.95
					9	71.99	69.89
					13	70.07	67.97
8	70.700	Kattumavadi Mimisal	TNRSP 03	Rural	5	67.59	65.65
					9	64.53	62.59
					13	62.61	60.67
9	108.800	Tondi Devipattinam	TNRSP 03	Urban	5	68.72	66.61
					9	65.66	63.54
					13	63.74	61.63
10	22.500	Kilakarai Sayalkudi	TNRSP 04	Rural	5	69.12	67.07
					9	66.05	64.01
					13	64.14	62.09

- Noise from other sources apart from the highway is not being accounted for in the modeling; and
- The receptor is considered to be independent of the noise emitted from the adjacent stretches.

Overall impacts on the noise environment during the operation stage can be summarized as follows:

- Impact on existing urban noise pollution would be insignificant because the high existing urban noise levels generated by local traffic and other urban and cultural activities mask the incremental noise produced by through traffic. In addition 13 of the urban areas along the route are being bypassed
- The impact on the existing rural acoustic environment would be negligible because of the high dispersion of noise in open rural areas and the improved road and traffic conditions that tend to reduce noise
- The impact on village noise pollution would be significant because a large percentage of village noise is caused by through traffic and any increase in through traffic will exacerbate this situation. Therefore, measures are required to reduce noise from traffic passing through villages.

As the impact on village noise pollution is recognized to be significant, it is necessary to identify the noise sensitive zones. So based on the field monitoring and other reconnaissance surveys a list of critical locations have been prepared which are likely to be adversely affected as a result of the implementation of the project. Primary Health Centres and other medical facilities that do not have bedding facilities have been excluded as the impact at these locations is of intermittent nature. At such locations the necessity of providing certain mitigation measures for the attenuation of noise levels is called for.

Table 7.13: Sensitive Receptors with respect to Noise Pollution

Sl. No.	Package	Link	Chainage	Direction	Distance form Existing C/L (m)	Remarks
1	TNRSP 01(N)	Arcot Arani	9.000-10.000	Right	10	Timiri School
2	TNRSP 01(N)	Arcot Arani	17.000-18.000	Right	10	School (Tamarapakkam)
3	TNRSP 01(N)	Arcot Arani	23.500	Right	9	MGR College (Arani)
4	TNRSP 01(N)	Polur Chengam	5.000-6.000	Left	20	Kamayansur School
5	TNRSP 01(N)	Tiruvannamalai Tirukkovilur	104.000-103.000	Right	15	College (Tiruvannamalai)
6	TNRSP 01(N)	Tirukkovilur Elavanasur	27.000-28.000	Right	10	Pugaipatti Primary School
7	TNRSP 01(S)	Vridhachallam Jayamkondam	15.600	Right	12	Soubhagya School (Andimadam)
8	TNRSP 01(S)	Jayamkondam Ariyalur	0.400	Right	15	School (Jayamkondam)
9	TNRSP 01(S)	Jayamkondam Ariyalur	12.100	Left	6	School (Marudu)
10	TNRSP 01(S)	Jayamkondam Ariyalur	16.8	Right	4	School (Ponparappi)
11	TNRSP 01(S)	Jayamkondam Ariyalur	24.500	Right	15	School (Senthurai)
12	TNRSP 01(S)	Jayamkondam Ariyalur	8.500	Left	15	School (Wattakoil)
13	TNRSP 01(S)	Jayamkondam Ariyalur	6.200	Right	10	School (Thamrakulam)
14	TNRSP 01(S)	Jayamkondam Ariyalur	2.800	Left	15	School (Anayalur)
15	TNRSP 01(S)	Jayamkondam Kumbakonam	87.600	Right	10	School (Chingawalaiyam)
16	TNRSP 01(S)	Jayamkondam Kumbakonam	94.800	Right	20	School (Vircholapuram)
17	TNRSP 01(S)	Kumbakonam Thiruvarur	27.000	Left	7	KVS College
18	TNRSP 01(S)	Kumbakonam Thiruvarur	23.600	Left	7	School (Kudavasal)
19	TNRSP 01(S)	Kumbakonam Thiruvarur	21.100	Right	10	School (Kudavasal)
20	TNRSP 01(S)	Kumbakonam Thiruvarur	16.800	Right	15	School (Pudukkudil)
21	TNRSP 02	Nagapattinam Tiruthuraipundi	15.000-16.000	Left	10	School (Tiruppundi)
22	TNRSP 02	Nagapattinam Tiruthuraipundi	20.500	Left	20	School (Tiruvankudi)
23	TNRSP 02	Tiruthuraipundi Muthupet	80.000-81.000	Right	15	School (Adayur)
24	TNRSP 02	Muthupet Kattumavadi	65.500	Right	8.0	Brilliant Matriculation School (Muthupet)
25	TNRSP 02	Muthupet Kattumavadi	11.500	Right	20	School (Karisaikkaddu)
26	TNRSP 02	Muthupet Kattumavadi	28.4	Right	22	School (Pillayarthidal)
27	TNRSP 03	Kattumavadi SP Pattinam	53.100-53.300	Left	20	School (Manmelkudi)
28	TNRSP 03	Kattumavadi SP Pattinam	53.100-53.300	Left	15	School (Manmelkudi)
29	TNRSP 03	Kattumavadi SP Pattinam	62.100	Right	15	School (Kottaipattinam)

Sl. No.	Package	Link	Chainage	Direction	Distance form Existing C/L (m)	Remarks
30	TNRSP 03	Kattumavadi SP Pattinam	62.400	Left	6	Govt. secondary High School
31	TNRSP 03	Kattumavadi SP Pattinam	65.600	Left	15	School (Jagdampattinam)
32	TNRSP 03	Devipattinam Ramanathapuram	63.000-64.000	Left	25	Bakhriya Matriculation School (Devipattinam)
33	TNRSP 04	Ervadi Sayalkudi	22.000	Left	15	School (Sikkal)
34	TNRSP 04	Ervadi Sayalkudi	21.000-22.000	Right	20	School (Sayalkudi)
35	TNRSP 04	Vembar Kulattur	36.000-35.000	Right	20	School (Melmondai)
36	TNRSP 04	Vembar Kulattur	63.400	Right	15	School (Kulattur)
37	TNRSP 04	Kulattur Tuticorin	1.500	Right	8	School (Pannaiyur)
38	TNRSP 04	Kulattur Tuticorin	1.000-0.000	Left	10	School (Within 1 Km from end point of TNRSP 04)
Source: Field Surveys by LASA, 2002						

7.2 IMPACT ON ECOLOGICAL ENVIRONMENT

7.2.1 RESERVE FOREST

Though the alignment has been routed to minimize forestland acquisition, the acquisition of 3.2 Ha. of forestland has been unavoidable. It includes 2.9 Ha. in Kelur Forest Range (Arani Polur Road) and 0.3 Ha. in Mundanai Forest Range (Polur Chengam Road). However no trees will be cut within Kelur as well as Mundanai Reserve Forests. Acquisition of forestland is being taken up in accordance with the Forest (Conservation) Act. The proposed upgradation and maintenance corridors are likely to impact some Reserve Forest areas as described in the subsequent sections.

7.2.1.1 Impact on Reserved forests along Northern corridor

(I) KASAMBADI (KELUR) RESERVE FOREST - ARANI POLUR ROAD LINK

The Project Road passes through this Reserve Forest at two locations between Km 17.6 – 18.0 (148.6) – 148.3 and Km 147.0-146.4. The forest is patchy because of human settlements (villages) inside the forest at several places. Adverse impacts of the road upgrade on the flora at this area are not expected. No trees will be cut from the forest area. Instances of animal movement, especially of spotted deer, across the road were reported in the EIS document prepared by the PCC. The Forest Department has constructed check dams in several places in this forest to make it unnecessary for the deer to cross the road for water. But consultations with Forest Officials have revealed the fact that chances of such crossings are very remote [Refer **Appendix 6.2 (i)**]. Since it is not a frequent phenomenon no mitigation measures are proposed.

(II) PARVATHAMALAI RESERVE FOREST – POLUR CHENGAM ROAD LINK

The Parvathamalai Forest is an undisturbed portion of the Eastern Ghats, all of which was once densely forested. The protected land and forest run parallel to the road on the northern side. This is an important and protected area, the hills of which are considered by people to be the "Southern Himalayas". The area is also of heritage and historical value with its plants well known for their medicinal value. On the top of the hill, at an elevation of about 4300 feet, Lord Shiva and Goddess Amman temples are constructed. An ashram and meditation hall is

also found there. The forest stretches especially leading to the temple tops are degraded due to the disposal of polythene materials (bags, cups etc) by devotees and due to clearing of vegetation by the pilgrims to keep away the poisonous snakes from the path

The impact of the road upgrade will be greatest between Kadaladi and Munnurmangdam between Km 22.0 - 23.0, where Sri Amman and Ayyanar temples are situated and where the road is closest to the forest. Here, a Ficus benghalensis tree (a sacred tree) is found on the northern side of the road, at a distance of 3 meters from the edge of the road. On this tree, many birds reside during the night hours. At this location there are many monkeys crossing the road often. Deer cross the road at this site from the forest to the southern cultivated area during the summer season when there is water scarcity in the forest area.

Thus birds, monkeys and deer may be directly affected due to the proposed road upgrade. Further, increased noise from increased traffic flows might disturb the animals occurring in the interior forest area. In most locations the roadside plants that will be affected by the road upgrade are common shrubs and thorny species and not any forest species.

(III) MUNNARMANGALAM AND MUDANAI RESERVE FOREST – POLUR CHENGAM ROAD LINK

The forests are a part of the continuous vegetation of the Western Ghats. The existing road runs parallel to the road from Km 38.0 – Km 40.0. Adverse impacts of the road upgrade on the flora at this area are not expected. No trees will be cut from the forest area. However, animals that live in this forest may be disturbed due to the noise of the vehicular transport after the upgrade of the road. Increased road noise is expected to cause the animals to move further into the dense interior areas of the forest. Deer cross the road during the summer season to get water from the cultivable land area due to scarcity of water in the forest. This detail was confirmed by local forest officials [Refer **Appendix 6.2 (i)**]. It should be noted here that no animal deaths have been reported due to collisions with the traffic.

At Km 39.0 a percolation pond exists on the right hand side at a distance of 15 m from the centre line of the road. It is one of the four ponds that have been created by the Forest Department to prevent road crossing of the spotted deer. A trench to prevent the entry of cattle in the Reserve Forest has also been made along the toe line of the existing embankment on the right side.

(IV) ATTIPAKKAM RESERVE FOREST - TIRUVANNAMALAI TIRUKKOVILUR ROAD LINK

The link road passes through the core of Attipakkam Reserve Forest from Km 85.6 – 83.8. Clearing of vegetation and grazing of cattle are the two major disturbances to the forest. Most of the natural vegetation of this forest has been removed by the State Forest Department in pursuing its programme of creating a monoculture of Eucalyptus. The proposed road works is not likely to have any significant impact on these forests.

(V) THIPPAKKADU RESERVE FOREST - TIRUVANNAMALAI TIRUKKOVILUR ROAD LINK

The road link passes through the western end of the Thippakkadu Reserve Forest for a distance of about 1km between Km 102.0-103.0. Cattle's grazing is the only disturbance to this Reserve Forest. About 750 cattle including cows, bulls, sheep, and goats graze in the forest daily. Traversing the forest, particularly during the monsoon, are many water channels that serve the drinking needs of forest animals. Additionally, the Forest Department has built several dams to provide animals with drinking water during drought.

Because the road passes along the edge of this Reserve Forest, the impact of the proposed road works will be negligible.

(VI) NATTAMUR RESERVE FOREST – TIRUKKOVILUR ELAVANASUR ROAD LINK

The road passes through one end (western side) of the forest between Km 17.0-19.0. Clearing of natural vegetation by the Forest Department for *Eucalyptus* and *Acacia* plantation is the major disturbance to the natural vegetation of this area. The Forest Department first introduced *Acacia* plants, which showed very slow growth, and so *Eucalyptus* is now being planted by clearing the forest. Such clearing and planting programmes are done every year.

Cattle's grazing is another threat to this habitat. About 500 cattle are grazing regularly in this forest.

The proposed road upgrade is not likely to have any adverse impact on the plant species of the forest because the road passes through only one end of the forest and the roadside areas have already been cleared for *Eucalyptus* plantation.

The threatened deer, which occur in the forest area, are said to cross the road from the forest side to the opposite cultivated land area occasionally during the summer season to drink water. Hence mitigation measures are necessary to avoid any adverse impact.

(VII) SILUVAICHERI RESERVE FOREST - VRIDHACHALLAM JAYAMKONDAM ROAD LINK

The road traverses 1.5 km of the forest in a north-south direction from Km 17.0-16.4. From Jayamkondam to Siluvaicheri, Eucalyptus and Cashew plantations are seen on both sides of the road. Clearing of the forest area for raising *Cashew* and *Eucalyptus* plantations is the only disturbance to the natural vegetation of this area. The Tamil Nadu Forest Department has raised a protected nursery for forest plantation on the eastern side of the road. Mostly, the vegetation along the border of the road remains undisturbed. The proposed road works will have negligible impact on the forest.

(VIII) PERIAVALAYAM RESERVE FOREST - JAYAMKONDAM KUMBAKONAM ROAD LINK

Periavalayam Reserve Forest, 2 km to the east of Jayamkondam, is traversed for 1.5 km by the road between Km 95.0-96.5. The previous disturbances to the site have been clearing the natural vegetation for *Eucalyptus* and Cashew plantations, and installing a tar tank used for road construction on the southern side of the road in the reserve forest area.

The impact on the forest resources will be minimal, as the natural vegetation has been already cleared for Eucalyptus plantations. As the road cuts across the forest, the cross-movement of hares and monitor lizards, and the noise impacts on the Grey Partridge (common in this forest) needs to be taken care of in the project.

7.2.1.2 Impact on Reserved Forests along Eastern Corridor

(I) MUTHUPET RESERVED FOREST - NAGAPPATTINAM KATTUMAVADI ROAD LINK

The Muthupet Reserve Forest, essentially a mangrove forest, lies at a distance of about 5 Km form the proposed road upgrade between Km 91.0 – 92.0. No impact is expected on the Muthupet mangroves as the area is at considerable distance from the existing road.

(II) MARAVAKKADU RESERVE FOREST - NAGAPPATTINAM KATTUMAVADI ROAD LINK

On the southern side of the proposed road upgrade dense mangrove vegetation occurs at a distance of about 3 Km between Km 7.0 – 8.0. Maravakkadu mangroves are still healthy in spite of the fact that the local people are cutting the mangroves for fuel wood. Cattle's grazing is also prevalent which would damage the mangroves in the long run. The State Forest Department is adopting adequate measures for afforestation and conservation of mangroves. However the proposed road upgrade, being at a distance of 3 Km from the mangrove vegetation, is not likely to cause any adverse impact.

(III) KODIAKKADU RESERVE FOREST – KATTUMAVADI RAMANATHAPURAM ROAD LINK

Kodiakkadu is a scrub jungle forest extending over about 100 Ha. on the eastern side of Manmelkudi in Pudukkottai district. It is located 3 km away from the proposed road upgrade between Km 54.0 – 55.0. There will not be any significant impact on the Kodiakkadu Forest as it is located about 3 km away from the proposed road upgrade.

7.2.1.3 Impact on Reserve Forests along Maintenance Corridors

One of the maintenance corridors, the Salem Vaniyambadi Road, in Dharmapuri district passes through Reserve Forest. About 2 Km of the corridor from Km 73.8 to 75.8 crosses the RF. Deer crossings along this stretch are also reported. During the operation stage, the impacts may arise from the increased accessibility of the area, which can lead to increased human influence. Adequate safety measures have been worked out for the minimisation of adverse impacts during construction.

7.2.2 WILD LIFE SANCTUARY / BIOSPHERE RESERVE

The Udayamarthandapuram Birds Sanctuary and Gulf of Mannar Biosphere Reserve occur within 10 km of the Eastern Corridor. A third sanctuary, Point Calimere Sanctuary, lies at a distance of 25km off the Eastern Corridor. It is at quite a significant distance from the road to get impacted in any manner. There are no Wild life Sanctuaries or National Parks along or in close proximity to the Northern Corridor.

7.2.2.1 Impact on Wildlife Sanctuary / Reserves along Eastern Corridor

(I) UDAYAMARTHANDAPURAM BIRDS SANCTUARY

The Sanctuary with an area of 45 ha comprises a buffer storage irrigation tank, and is enclosed within a bund wall. It provides a suitable wetland habitat for approximately 25 to 30,000 resident and migratory birds, comprising at least 55 species (*Tamil Nadu Forest Department Management Plan*). The Sanctuary is located at a distance of about 500 m from the road upgrade.

Upgrading the road will cause disturbance to the avifauna of the Sanctuary due to the increased traffic noise. In order to minimize the disturbance about 1 km stretch of the road in both the directions should be declared as Silence Zone. As regards to the migratory species no localized impact due to the road development is likely as most of the species are high flying [Refer **Appendix 6.2 (ii)**]. However adequate care must be taken during the construction stage to avoid setting up of labour camps /construction sites within 1 km radius of the sanctuary and prevent movement of any noise generating construction machinery / vehicles close to such area

7.2.2.2 Gulf of Mannar Biosphere Reserve

The Gulf of Mannar Biosphere Reserve is a marine reserve that lies off the east coast of Tamil Nadu and particularly off the districts of Ramanathapuram and Tuticorin. Nearest among the 21 islands, Kariyashuli, lies at a distance of about 7 km from the road upgrade. Hence no major impacts on the Biosphere Reserve likely due to the proposed project [Refer **Appendix 6.2 (ii)**].

7.2.2.3 Impact on Wild life Sanctuary along Maintenance Corridors

Majority of the maintenance corridors does not pass through or close to any Sanctuary or National Park. Only one of the corridors, the Ambasamudram Papanasam Road, in Tirunelveli District is in close proximity to the Mundanthurai Wild life Sanctuary. As major maintenance of the corridors does not include any land up take, no adverse impact on the roadside plantation or the flora outside the Corridor of Impact is anticipated. During the operation stage, the impacts arise mainly from the increased accessibility of the area, which can lead to increased human influence. Adequate safety measures have been worked out for the minimisation of adverse impacts during construction.

7.2.3 ROADSIDE TREES

7.2.3.1 Along Upgradation Corridors

The principal impact on flora involves the removal of trees for the creation of a clear zone within the Corridor of Impact. Reason for clearing trees is threefold:

- To prevent single-vehicle collision with the roadside trees, trees very close to the road need to be cleared. Roadside trees with strong and rigid stems can pose safety hazard. Some trees preclude clear sight distances. Others (such as *Tamarindus indica*) have a propensity to overturn when old and are potential safety hazards depending upon age and decay condition. All such trees that are safety hazards need to be cleared.
- To ease construction of the embankment for the widened road formation and, to permit construction of adequate roadside drainage structure, trees located within the clear zone need to be removed.

- Trees need to be cleared to facilitate construction of traffic detours.

The stage wise impact on roadside trees and plantation has been described in the following sections.

Construction Stage

The project has a significant, direct and long-term impact on Roadside trees in the construction stage. The cutting of trees shall have manifold impact. Most visible impact is the loss of shade. Also, there is a possibility of the local people being deprived of tree products, such as wood, fruits, leaves etc. This is a significant loss considering the fact that the most common species being impacted is Tamarind along Northern Corridor and Palmyrah Palm along Eastern Corridor, both fruit bearing trees. Removal of roadside tress will also reduce comfort levels for slow moving traffic and pedestrians. The removal of roadside trees will not only lead to erosion, but also to the loss of the micro-ecosystems developed on the roadside.

This negative implication needs to be taken into consideration by compensating with new plantation along the RoW of the project corridors. **Table 7.14** presents an estimate for the loss of roadside trees as indicated in the final design drawings and the bill of quantities. The link wise estimate of the trees impacted is presented in **Appendix 7.3.** A total of about 5700 trees will be impacted as a result of the proposed upgradation of the TNRSP Corridors.

Table 7.14: Estimate of Roadside Tree Loss

Package	Number of Trees Impacted				Total
	300-600 mm	600-900 mm	900-1800 mm	> 1800 mm	
TNRSP 01	1728	876	1283	589	4476
TNRSP 02	461	62	18	150	691
TNRSP 03	212	15	3	0	230
TNRSP 04	157	78	62	2	299
TOTAL	2558	1031	1366	741	5696
Source: Bill of Quantities, July 2002, Prepared by PCC.					

Accidental cutting of roadside trees might occur during the construction stage. It can also occur due to negligence from the construction crew. Therefore, it is essential that all trees that are to be felled be clearly marked. No other trees should be cut on site. Cutting of trees for fuel by workers, especially near their camps is of major concern. Therefore adequate training of the workers, and availability of their fuel requirements are to be ensured by contractual obligations.

Operation Stage

The impacts on roadside trees during the operation stage can occur due to accidental collision of vehicles. Though improved safety on the road is an objective of the project, the increased speed will mean that collisions will be more damaging to the roadside flora than before.

7.2.3.2 Along Maintenance Corridors

As major maintenance of the corridors does not involve any land up take, no adverse impact on the roadside plantation is anticipated. . Only those trees that are safety hazards will be felled or

removed with prior approval from the Engineer. The Engineer shall approve such felling on the advice of the TNPWD and only when the TNPWD receives a "clearance" for such felling from the Forest Department, as applicable.

7.2.4 SOCIAL FORESTRY

At certain places along the upgradation corridors Social Forestry areas are observed. The Forest Department has carried out the plantations of Acacia, Prosopis and Eucalyptus in most places. The ecological setup of such areas is presented in Section 4.2.4 of Chapter 4. The only area on which the road upgrade can have some adverse impact is Peria Odai (Km 4.2 - 5.0) along Vridhachallam Jayamkondam road along the Northern Corridor. Major disturbance to the area is due to overgrazing by cattle (about 1000). Dumping of solid wastes is also occurring. The only potential impact is on monkeys crossing the road in this area. No trees planted under the social forestry schemes will be cut due to the road upgradation.

7.2.5 OTHER SENSITIVE AREAS

An ecologically sensitive area of high floral diversity is observed close to the river Kollidam at Anaikarai along Jayamkondam Kumbakonam road along the Northern Corridor (Refer Section 4.2.5.1). The threatened reptilian species, Crocodilus porosus, is reported near this area. They have been spotted next to the Anaikarai regulator. Regarding presence of crocodiles on the river bank at Anaikarai, it is uncommon to observe crocodile in terrestrial environment [Refer **Appendix 6.2 (iv)**]. As the bridge across Kollidam is not to be reconstructed, the impacts are not likely to be significant. Therefore, no mitigation measures are envisaged. Among the other sensitive areas, the Ariyalur fossil beds lie at a distance of about 4 km from the project corridor and hence no impacts are expected due to the road upgradation.

7.2.6 COASTAL AND MARINE RESOURCES

7.2.6.1 Mangroves

The project roads along the Eastern Corridor pass near areas with mangrove vegetation. The details of such areas have been delineated in Section 4.2.6.5 of Chapter 4 of this report. However none of these areas are significantly close to the road to be impacted or within the Right-of-Way of the road to warrant removal. Hence implementation of the project will not cause any removal or degradation of mangrove species. Setting up of labour camps /construction sites near such areas and movement of any construction machinery / vehicles close to such area will impact the ecosystem. Though the impact is reversible with appropriate remedial measures, it is a long term impact.

7.2.6.2 Aquaculture

Aquaculture has concentrated mainly on shrimp (prawn) farming. Brackish water shrimp farming is rampant along the eastern corridor. The industry has been at its operational peak during 1993-1996 and gradually subsided due to several infections associated with the proliferation in limited areas. Further, increasing the traffic carrying capacity of the corridor is not likely to have impact on the intensification of production from the industry as it operates on another set of indicators that are independent of the quality of connectivity. Proliferation of

this industry is mostly dependent on availability of quality shrimp seeds and infection free areas, in proximity to the coast, which are gradually becoming scarce. Consultations carried out with the prawn farm owners along the eastern corridor also endorse this fact [Refer **Appendix 6.2 (viii)**].

However, impacts that would occur if proliferation of the industry by itself takes place is studied and presented below. The Department of Fisheries categorizes the methods of production into three types extensive, semi-intensive and intensive. The environmental impacts associated with these categories range from extensive (which the Department of Fisheries promotes as being environmentally responsible), to intensive (seen as environmentally damaging). The traditional extensive shrimp culture system utilises ponds for paddy cultivation in the wet season and then converts them to shrimp culture ponds for the remainder of the season. The intensive method uses chemical equipment and deeper, purpose-built ponds. Despite the recycling of processing wastes (e.g. heads and prawn shells) into fishmeal and poultry food, the industry has a poor reputation for environmental responsibility. The various adverse environmental impacts to aquaculture are:

- Agricultural lands being converted into commercial aquaculture farms, causing unemployment to land less labourers and loss of cultivable land.
- Saline water from commercial aquaculture farms located near cultivated land damages the productivity of adjoining land.
- Contamination of ground water due to seepage of impounded water from the aquaculture ponds.
- Pollution of water bodies by effluents containing chemical fertilizers, antibiotics and pesticides
- Damage to fishing nets by pipelines and pumps;
- Man power loss due to non approachability of the fishermen to the coast directly
- Removal of trees to construct ponds
- Loss of grazing grounds for cattle

Within Tamil Nadu, a total of 910 aquaculture farms and hatcheries cover an area of 6,223 ha (*details obtained from the affidavit filed in the High Court by the PCB, 1996*). The largest farms are in the districts of Nagapattinam, Ramanathapuram and Tuticorin.

7.2.6.3 Saltpans

Tamil Nadu is the second largest salt producing State after Gujarat. Large areas of former coastal wetlands are now saltpans. Although saltpans provide temporary feeding habitat for wader bird species, they are generally low in diversity. Along the upgradation corridors some isolated pockets were observed (TNRSP 03 & TNRSP 04) where the salt pan industry is flourishing (Refer **Table 4.2.6.4**). These industries are using the brackish groundwater which otherwise finds no use. So no major adverse impact is expected in these areas due to existence of such industries. Areas suitable for the industry are already being used for salt farming as the industry is in operation for the past 200 years in the region and is a traditional family run businesses apart from few corporate manufacturers [Refer **Appendix 6.2 (viii)**]. Hence, improving the connectivity is no way going to aid in increasing the industry's extent.

7.3 IMPACT ON CULTURAL ENVIRONMENT

7.3.1 IMPACT ON RELIGIOUS AND HISTORIC SITES

The conservation of sites of cultural, heritage and religious significance in Tamil Nadu depends on visits by pilgrims and tourists to provide the necessary funds. The upgrading of Corridors will be beneficial to conservation of the many historic and religious sites on or near the Corridors by improving accessibility and therefore the number of visitors.

Construction stage

Potential impacts on religious and historic sites during the construction stage relate to the possibility for physical damage to occur to structures located close to the road works. However, it is required to relocate some cultural properties that are within the CoI. A total of 279 cultural properties (places of worship) are affected and structures completely affected will be relocated for which generic designs have been prepared (Refer **Table 7.19**).

Operation stage

In the longer term, the construction of the ten bypasses along the Northern Corridor and three bypasses along the Eastern Corridor will make a direct contribution to the conservation of monuments in congested towns such as Tiruvannamalai, Chidambaram etc. by diversion of through traffic.

7.3.2 IMPACT ON SACRED GROVES

The details of sacred groves along upgradation and maintenance corridors is presented in Section 4.3.4 of Chapter 4.The significance of these sites in religious, aesthetic as well as ecological terms has been taken into account in the design of the road upgrade. The Sadakatti sacred grove (Km 11.0-12.0) along Tiruvannamalai Tirukkovilur road will get partially affected due to the proposed road upgrade. The sacred puththu (termite mount), worshipped by the local people, located off the shoulder of the road needs to be removed. No other significant impact is expected on the sacred groves due to the road widening activities.

7.3.3 VISUAL AND AESTHETIC IMPACT

In the past, Tamil Nadu's highway engineers have, of necessity, concentrated on the extension of road mileage to meet basic needs, and paid little attention to aesthetic considerations (Government of Madras 1960). The upgrading of the TNRSP Corridors will provide an opportunity to redress the balance between additional tree planting, the easing of curves, the standardization of the roadway cross-section, and the raising of landscaped embankments.

Construction stage

During construction, the initial visual impacts will be associated with the removal of encroachments from the right-of-way and structures on land acquired for deviations, as well as the clearing of mature trees and other vegetation. These activities will create significant differences in the local aesthetics; some negative such as the loss of mature trees that contribute so much to the landscape character of rural areas and villages; and some positive

such as the creation of clearer views along roads or from roadside houses and other buildings that were previously blocked by encroachments.

As construction proceeds, local views will change as earthworks are undertaken, stockpiles created, and road formations raised. Some of these changes will be temporary; for example until the stockpile of material is used while other changes in view will be permanent; for example changes in local views as a result of embankments for bridges and the introduction of the bridge structure.

Operation stage

The view of and from the roadway along the Corridors will change significantly after the construction stage. The ultimate roadside landscape character resulting from the upgrade works will take some time to emerge, as the new trees will take many years to mature. Some sections of the Eastern Corridor afford opportunities to incorporate pleasant views of the sea, historic monuments, and natural coastal landscapes, especially on those sections where it is necessary to raise the height of the road to avoid flooding. Currently, the height of the road embankment is often insufficient to permit any view over adjoining scrub. Improvements in views will be of particular value on Corridor roads as many pilgrims and tourists will use this road.

7.4 IMPACT ON SOCIO ECONOMIC ENVIRONMENT

The impact of the proposed upgradation of TNRSP Corridors on the socio-economic environment are systematically discussed under the following categories:

- Influx of construction workers
- Economic impacts
- Acquisition of land and structures
- Resettlement of people within the corridor-of-impact
- Relocation of community structures within the corridor-of-impact

The socio-economic impact is expected to be overwhelmingly beneficial. The whole purpose of this World Bank financed project, worth some $US 411 m, is the strengthening of road infrastructure in the State of Tamil Nadu. Such strengthened infrastructure is expected to contribute to the economic growth of the State and socio-economic well being of the people.

However, road improvement and widening will require the relocation of people and structures that are close to the edge of the existing road. The Resettlement Action Plan (RAP), specifies:

- measures that will be taken to minimize disruption and resettlement of people living within the corridor-of-impact
- the manner of resettling and rehabilitating project-affected-people (PAP)
- the manner of relocating project affected community assets
- a programme of monitoring the rehabilitation and resettlement of each PAP
- a programme of monitoring the treatment of each project affected community assets

- a mechanism for keeping the PIU accountable for the right implementation of the RAP

7.4.1 INFLUX OF CONSTRUCTION WORKERS

TNRSP has the potential for changes in the demographic structure in both the short and longer terms.

Construction stage

Although the construction contractors are likely to use unskilled labour drawn from local communities, use of specialized road building equipment will require trained personnel not likely to be found locally. Sudden and relatively short-lived influxes of construction workers to communities along the Corridors will have the potential to 'skew' certain demographic variables such as the ratio of males to females and the traditional social coherence of towns and villages not used to sudden changes in the population size or composition.

It is anticipated that the construction labour inputs for the TNRSP Corridor works will be in the order of 6100 person-years, with a peak total labour force of about 9200. However, this number will fluctuate, and the number in any particular district will be lower (Refer **Table 7.15**).

Table 7.15: Estimate of Construction Workforce

Contract Package	Person-years				Peak Workforce (Number)
	Supervision	Skilled	Unskilled	Total	
TNRSP 01	13.4	40.0	666.6	720.0	1080
TNRSP 02	19.8	59.6	994.8	1074.4	1612
TNRSP 03	19.4	58.2	970.4	1048.0	1572
TNRSP 04	22.8	68.4	1139.6	1230.8	1846
Bypasses	37.8	113.2	1885.8	2036.6	3055
Total	113.2	339.4	5657.2	6109.8	9165
Source : EIS for Corridor I, June 1999, Prepared by PCC.					

The construction workforce will be made up of the following groups:

- Supervision, specialist and administrative personnel, normally about 5 per cent of the workforce - the contractor would probably arrange local accommodation using hotels, boarding houses or rented houses.
- Skilled workers, normally about 30 per cent of the workforce - the contractor will probably establish a construction camp for the skilled workers.
- Unskilled workers, normally about 65 per cent of the workforce - contractors normally recruit these workers locally and do not need to provide accommodation.

The contract documents will require the contractor to obtain all necessary approvals before building a construction camp.

Operation stage

In general upgradation of roads creates a potential to stimulate development and thus population growth (mainly through migration) in nearby areas. However, most of the TNRSP Corridors lie in areas of low population growth (Refer Section 4.4.1 of Chapter 4) and low

urbanization. Any indirect impacts of the road on population growth are expected to be marginal.

7.4.2 ECONOMIC IMPACTS

Besides the "flow on" economic benefits that derive from strengthening the State's transport infrastructure, the direct economic benefits are estimated to include:

- reduced recurrent HD repair costs of 26%;
- reduced vehicle operating costs of 42%;
- reduced passenger time costs of 28%; and
- reduced accident costs of 4%.

Construction stage

The relatively short-lived economic impacts of the construction stage are likely to be experienced in local communities for the duration of construction as workers make everyday purchases from local traders. This is likely to give a short-lived stimulus to these traders that will disappear as soon as the construction is complete. Wider, flow-on economic impacts will be experienced in other sectors of the Tamil Nadu economy as a result of purchase of construction materials and the payment of wages and salaries.

Operation stage

Once the upgrading is complete, there is likely to be some long-term changes in the economic structures of the urban and rural areas served by the road. For example, improved accessibility to larger markets may stimulate the production of 'cash' crops relative to staple food crops.

7.4.3 ACQUISITION OF LAND AND STRUCTURES

Major impact of the project will arise from the acquisition of land for road widening or realignment and for bypasses. Also the loss of dwelling units in some cases will be inevitable.

Construction stage

Land acquisition shall mean loss of productive land, loss of community space along the existing road and loss of private and public properties along the road. The road design has minimized the number of project affected people by reducing the CoI and designing deviations and bypasses around areas of high social impact. **Table 7.16** provides an estimate of the likely impact of land acquisition for each package.

Table 7.16: Land to be Acquired for the Project

Type of Land	Contract Package-wise Land Requirements (in ha)				
	TNRSP-01	TNRSP-02	TNRSP-03	TNRSP-04	Total
Private Wet Land	174.47	65.93	6.34	2.49	249.22
Private Dry Land	69.45	17.2605	15.9818	21.84	124.53
Urban Land	5.005	5.0000	1.0000	0.06	11.06
Other (Government Land)	109.55	48.4486	22.9955	6.93	197.93
Total	358.48	136.64	46.32	31.32	572.74
Source: Resettlement Action Plan, December 2002.					

The upgradation of the TNRSP Corridors will also involve loss of certain temporary, semi-permanent and permanent structures (Refer **Table 7.17**). The project restricts itself to the maximum extent possible to widening within the RoW only, therefore, in most cases the only properties that need to be acquired belong to squatters/encroachers that have come up on PWD land. Most of the structures are safety risks- for the road users as well as residents in case of accidents. It is to be noted that the entire RoW is not being cleared to limit the extent of impact of the project. The structures being removed are only within the CoI. Owners of these properties will face uncertainties and possibly hardships until the compensation, as specified in the RAP, is paid to them.

Table 7.17: Number of Project Affected Structures

Contract Package	Type of Structures				
	Temporary	Semi Permanent	Permanent	Others	Total
TNRSP 01	1636	512	342	39	2529
TNRSP 02	484	101	74	1	660
TNRSP 03	112	40	10	1	163
TNRSP 04	55	20	40	-	115
Total	2287	673	466	41	3467

Source: Resettlement Action Plan, December 2002.

7.4.4 RESETTLEMENT OF PEOPLE WITHIN THE CORRIDOR-OF-IMPACT

The major social impact will be the resettlement of people living or working within the corridor-of-impact. The Resettlement Action Plan addresses the compensation and resettlement issues in detail.

Construction stage

Most resettlement will take place before or during the early days of construction stage. The most severe impacts will be in villages where project-affected-people living within the corridor-of-impact are concentrated. The number of project affected households is presented in **Table 7.18**. For considering the magnitude of the impact the following categorization has been adopted.

The PAH suffering the following impacts are categorized as **major** impact PAH:

- Loss of place of dwelling , or
- Loss of place of business, or
- Suffers material damage to main structural support members, or
- Loss of livelihood
- Loss of 25% or more of agriculturally productive land out of the affected land holding, or
- Loss of land due to severance or acquisition and the remaining land is not economically viable

A project affected household (PAH) or person (PAP) suffering **minor** impact is one who is impacted to a lesser degree in any other way than the impacts specified under major impact.

Table 7.18: Number of Project Affected House holds Impacted

Impact Category	Contract Package				Total
	TNRSP01	TNRSP02	TNRSP03	TNRSP04	
Major Impacts					
Number of PAHs losing Agricultural Land	3338	844	246	366	4794
Number of PAHs losing Residence	1477	422	76	46	2021
Number of PAHs losing Commercial Structure	762	153	67	61	1043
Number of PAHs losing R & C Structure	290	85	20	8	403
All major impacts	5867	1504	409	481	8261
All Minor impacts	3791	1334	653	937	6715
Total	**9658**	**2838**	**1062**	**1418**	**14976**
Source: Resettlement Action Plan, December 2002					

Operation stage

As a result of this major resettlement programme, there are likely to be longer-term impacts that will take time to manifest considering all social and property adjustments that are to be made in various communities.

Occupants of encroachments generally come from vulnerable groups disproportionately to the general population. In rural Tamil Nadu, there is a strong correlation between low caste, land lessness, and extreme poverty (Kapadia, 1996). The rights of peasants are protected, but the rights and interests of land less labourers who depend on casual wage-labour, and who are the most vulnerable group, are largely unprotected. However, the purpose of the *Resettlement Action Plan* is to ensure that nobody is worse off as a consequence of the proposed upgrading of TNRSP Corridors. The process for the resettlement will be based on the agreed entitlement framework.

7.4.5 RELOCATION OF COMMUNITY STRUCTURES

Construction stage

The major community impact will be the relocation of community structures within the corridor-of-impact and the creation of a psycho-physical barrier (the upgraded road) which may tend to divide or fragment a village community

The project will require the removal and relocation of about 1804 community assets along the road (**Table 7.19**). Efforts have been made during the final designs to avoid or minimize impacts to the extent possible. The project will relocate these facilities prior to commencement of construction.

Table 7.19: Project Affected Community Assets

Impact Categories	Contract Package				Project Total
	TNRSP 01	TNRSP 02	TNRSP 03	TNRSP 04	
Well	10	5	1	10	26
Water Supply Tap	395	137	18	15	565
Hand Pump	170	16	1	2	189
Bus Shelter	167	74	23	24	288
Place Of Worship	188	62	15	14	279
Pond	42	30	2	12	86
Pumping Station	6	0	0	3	9
TV/Radio Room	6	2	1	0	9
Motor Shed	7	2	0	1	10
Compound Wall Religious	12	0	0	0	12

Impact Categories	Contract Package				Project Total
	TNRSP 01	TNRSP 02	TNRSP 03	TNRSP 04	
Panchayat Buildings	10	3	0	1	14
Compound Wall Other Buildings	12	3	0	0	15
Other Community Building	6	4	0	5	15
School Building	12	3	0	1	16
Graveyard	7	7	2	0	16
Water Tank	8	4	1	5	18
Check Post	0	10	5	4	19
Other Government Buildings	16	0	6	1	23
Statue	20	5	0	5	30
Valve	9	10	13	13	45
Other Community Assets*	10	110	1	1	122
Total	1113	485	89	117	1804
Note: * Other Community Assets include dust beans, compound walls, etc. Source: Resettlement Action Plan, December 2002					

The ponds will be rehabilitated, not relocated. The components of rehabilitation could include the following:

- Desilting of tank bed
- Clearing and shaping inlet and outlet channels
- Strengthening bunds
- Reconditioning sluice or weir
- Renovating steps or bathing ghat

7.5 IMPACT ON SAFETY AND PUBLIC HEALTH

7.5.1 IMPACT ON SAFETY

Construction stage

Adverse impact on safety of pedestrians and passage of traffic approaching or passing through the section of the road under improvement are likely if construction works are not managed properly. It is essential that all works should be planned before hand by the Contractor with due considerations for safety of pedestrians and workers during the nighttime. Adequate warning signs, barricades etc to inform the road users are essential in this regard.

Operation stage

Once the upgrading work is complete, the safety aspects will include both adverse and beneficial impacts. Improvement of roads as part of the TNRSP will entail double lane road with improved road condition. With the proposed project, the traffic volumes and speeds are likely to increase, which would have a direct bearing on the risk exposure to accidents. There will be the potential for increased collisions between vehicular traffic travelling at higher speeds than previously and lower speed vehicles as well as pedestrians using the roads. Although the design speeds have been kept lower in the major settlement areas, some amount of severance is expected in the rural areas. Road safety was a major concern at the various community consultation sessions carried out along the corridor. There was a strong representation pointing out the need to introduce effective measures to ensure safety of pedestrians, school children and other road users.

The improved roads on the other hand will increase accessibility to local and regional health centres and other community support facilities. The project will be implemented with due considerations for safety of pedestrians and school children. The measures will include speed humps, speed delimiting signs, side walks, cross walks, provisions for animal crossings etc at desired locations especially near habitations and sensitive locations such as schools and colleges. Moreover the upgraded road with improved geometrics will itself reduce the chances of accidents by eliminating the sharp bends and curves present along certain sections of the existing road. So all these factors will cumulatively help to beneficially impact the safety aspects of the road users and the local populace.

7.5.2 IMPACT ON PUBLIC HEALTH

Construction stage

During the construction stage, dismantling of the structures for CoI clearance and other road construction activities may result in the following health hazards:

Breaking and dismantling of properties has psychological impacts on their owners and others associated with them. Debris generated on account of these activities if not properly disposed might give rise to health problems in the area. However, the structures to be dismantled will mainly be of semi-permanent and temporary nature and much of the waste shall be salvageable.

In case of non-local labour (if so is arranged by the contractor), labour camps are set up at one or more sites adjacent to the alignment, and at some ancillary sites, like aggregate quarries. These labourers hired from outside can have clashes with the local population on account of cultural and religious differences. The influx of a large work force to an area can impose additional stress on these facilities (medical services, power, water supply, etc.).

Unsanitary conditions in the labour camps might also result in impact on health of labourers as well as the local population. Transmission of diseases is also facilitated by the migration of people. During the construction stage work, crews and their dependents may bring with them a multitude of communicable diseases including sexually transmitted diseases (STDs) like AIDS. This is more so if the nature of the project requires more male-workers, who have migrated from other parts of the state or country.

During road construction allied activities like quarrying and crushing operations, traffic diversions, etc., may cause disruption of social and economic life of the local population. Dust and noise generated in crushing and blasting operations may cause nuisance to the nearby communities. Other problems perceived is loss of access and other road accident risks, as a result of diversion of traffic and construction work on road.

Operation stage

Once the upgrading work is complete, the public health benefits will include both adverse and beneficial impacts. The improved road standard will increase accessibility to local and regional health centres and other community support facilities. The adverse impacts on public health that can result if adequate safeguards will include:

Health impacts due to vehicular pollution: Health impacts associated with road projects in operation stage are long-term impacts. General health impacts will be respiratory infections and lung infections. Respiratory Particulate Matter (RPM) i.e., particulates of size less than 10µm are a major cause of the infections and allergies. They enter human body through inhalation. These particulates are more in the emissions of heavy diesel vehicles. Hence, higher volumes of heavy vehicles increase the pollution load and consequent health impacts.

Prolonged exposure to exhaust emissions of petrol engines would cause lead poisoning. The source being, lead used as anti-knocking agent in petrol. Since lead accumulates in human body, if cumulative concentrations exceed the tolerance level, it causes poisoning and brain damage at higher concentrations. Hydrocarbons from exhaust emissions are carcinogenic at high concentrations. Though impacts due to higher emissions exist, such severe impacts shall be at concentrations higher than those generated by the project. However, there will be the potential for adverse impacts on public health related to increases in noise, especially as traffic volumes increase Impacts associated with noise are also long term and restricted to the direct area of influence.

Health impacts due to Water logging: Water logging can result if the borrow pits and any other depressions created by the contractor during the construction process is not surfaced and filled up adequately. Such pits if not surfaced can act as breeding ground for mosquitoes (carrier for Malaria) and other vectors especially after torrential showers. The impact is more pronounced if the pits are located within a kilometer of habitations as the gravid, blood-laden mosquitoes cannot fly very far, so they generally bite within a kilometer of their breeding place. So adequate measures are necessary during construction to prevent the spread of Malaria and other waterborne and vector borne diseases.

Health impacts Due to Water contamination: Water contamination is likely if the sanitary and other construction effluents are discharged into the nearby water bodies without proper treatment. It can adversely affect the health of the local communities using this water for their domestic needs. They can get afflicted with a number of gastrointestinal and other water borne diseases. So proper precautions on the part of the contractor are necessary.

7.6 INDUCED DEVELOPMENT ALONG EASTERN CORRIDOR

7.6.1 THE ISSUE

The 332 km long Eastern Corridor between Nagapattinam and Tuticorin runs for a major length within 3-4 km of the coast. The corridor cuts across 5 districts (Nagapattinam, Thanjavur, Tiruvarur, Pudukkottai, Ramanathapuram and Tuticorin). The GoTN has declared most of the taluks along the corridor (especially along the southern stretch of the corridor) as socially and economically backward due to the low level of infrastructure facilities and resource availability. The project has been conceived with an objective of connecting these backward coastal villages with a better road and thereby enabling an improvement in the socio-economic profile of the coastal population. As has been confirmed from the various discussions with the road users, the development of this road will not change the preference of the long distance

road users between the two major ports of Chennai and Tuticorin. The existing NH-45 / 45B will remain the preferred route as it is not only shorter but also is of a higher standard, compared to the improvements suggested in this project. Though the improvements proposed involve only the widening of the existing highway, there is a likelihood of the project leading to opening of the coastal region to development. This has the potential of leading to land use succession along the road. The entire eastern coast, due to its sedimentary formation has been susceptible to intrusion of seawater, leading to scarcity of potable water. The development of a two-lane highway might induce other land uses, including water intensive industrial uses. The issue of landuse planning along the Eastern Corridor covering policy, institutional setting, impacts, analyses of possible mitigation and monitoring measures and implementation arrangements have been presented in a separate Appendix titled "Land use Management along the Eastern Corridor" (**Appendix 4.9**). The impacts associated with the issue have been presented in this Chapter.

7.6.2 DEVELOPMENT TRENDS & POTENTIAL FOR INDUCED DEVELOPMENT

As part of the consolidation exercise, an effort has been made to provide a direction for land use planning along the eastern corridor by integrating development with resource availability, factoring in environmental concerns and thresholds along the eastern coast. To undertake an indepth analysis of the issue the land uses along the project road for a distance of 100 meters on either side were inventoried through a reconnaissance survey wherein the adjoining land uses along the corridor were recorded.

To understand the development trends of the individual settlements and to assess their potential for induced development, extensive consultations were held with the community and various stakeholders along the corridor. Discussions held focused around the recent developments along the corridors, proposals for any major activities in the region and the likely impacts that could result due to the implementation of the project. These discussions together with a basic analysis of the census and socio-economic data of the project districts provided the basis for identifying areas susceptible to induced development impacts. These include:

- Urban areas and fringe areas of major settlements
- Productive agricultural lands along Bypasses/Realignments;
- Small agricultural patches between settlements;
- Stretches around locations of cultural/tourist/ecological interests;
- Existing market centers;
- Expansion of existing activities viz., shrimp farms, salt pans, etc and Intersections of ECR with other major roads.

Accordingly, a total length of 46.2 km was found to be susceptible to change in land uses, which would mean the conversion of agricultural land uses for development purposes. The locations identified are presented in the **Table 7.20** below. **Figure 7.2** represents these locations along the corridor.

Table 7.20: Locations Vulnerable to Induced Development along the Eastern Corridor

Sl. No	Category	Locations	Length (km)	Potentials for development
1	Bypasses/ Realignment	Nagapattinam	10.200	The agricultural lands along the bypass will be subject to development pressures due to the recent industrial developments towards the western side of the town. As the sea and the port form physical barriers to the east, the development trends are towards the west.
		Tiruthuraipundi	3.100	An important religious place for Hindus and Christians. The natural growth of the town will induce developments along the bypass and around the fringes.
		Tiruppundi	1.000	The agricultural land between proposed bypass alignment and the exiting route is vulnerable for conversion.
		Muthupet	4.800	The proposed bypass alignment is on the western side. The existing developments are towards the northern side. The starting and end points of the bypass are located at the fringe of the existing settlement and are likely to witness fresh developments.
		Ramanathapuram	11.268	The alignment has been suggested on the eastern side. The development of the town has been towards the eastern side due to the Sakarakkottai tank, a major source of irrigation forming a natural barrier in the western side. Being a major urban center and a district headquarter, the bypass alignment has the potential for development.
2	Tourism Towns (Recreational/Religious)	Velankanni	1.000	An important pilgrim center for the Christians.
		Udayamarthand-apuram	0.500	Udayamarthandapuram, a small settlement, the Bird Sanctuary is located at a distance of 800m, which has potential to attract tourist population.
		Manora	0.800	A historical site, attracts visitors from the nearby villages, a picnic spot.
		Ervadi	0.200	A religious place, with asylums, attracts many visitors.
3	Commercial Centers	Kilakarai	1.000	A major commercial settlement for Ramanathapuram district. Since the corridor passes through the institutional areas, has a high potential to grow
		Sayalkudi	1.000	A major commercial center serving the nearby villages.
		Kulattur (East and West)	1.000	Settlement located on NH to Tuticorin on one side and on eastern corridor the other side. Heavy commercial activity & stopover for truck and tourist traffic.
		Tondi	1.000	A commercial center catering to nearby villages. It's a noted marketing center for fishery and sea products.
4	Major Settlements (Administrative Towns & Populous settlements)	Adirampattinam	1.000	Settlement with commercial activities.
		Kattumavadi	0.400	A major fishermen settlement and is a noted fish market. The northern side is more susceptible to new developments as southern side has dense commercial developments.
		Manamelkudi	1.000	A recently declared Taluk headquarter. Has been developing ever since declaration as the Taluk HQ.
		Mimisal	0.500	A Major settlement with commercial activities along the road side. Natural growth of the settlement can induce development
		Devipattinam	0.500	-do-
		Sikkal	0.400	-do-
5	Smaller Settlement with Development potentials	Surangudi	0.900	Junction point connecting with Vilathikulam, Surangudi road. Likely to attract commercial activities due to increased traffic
		Nambuthulai	0.600	Though the settlement is large, the development along the roadside is sparse.
6	Industries	3 kms at the end of the corridor towards Tuticorin	3.000	The corridor does not reach Tuticorin, the corridor joining the bypass, about 8 km from the town. Recently, the lands along the corridor have been plotted by private entrepreneurs for industrial development.
		1 km after Nagapattinam Bypass	1.000	At the end of Nagapattinam bypass some settlements are already developed. There is a potential to grow towards Velankanni side.
	Total Length		46.168	

Figure 7.2

POTENTIAL AREAS FOR INDUCED DEVELOPMENT

7.6.3 ENVIRONMENTAL CONSTRAINTS & POTENTIALS FOR DEVELOPMENT

The evaluation of the environmental components along the corridor revealed that water availability is the determining factor for the sustenance of any particular development along the coast. To assess the water situation along the coast and to understand the implications of the developments that can be induced due to the project on the existing water situation, extensive data collection on the ground water resources, (of about 200 wells within 30km from the coast) was carried out. The environmental components analyzed included:

- Geomorphological characteristics,
- Soil types and characteristics
- Water resources including,
- Water potential of river basins
- Categorization of blocks based on ground water potential and degree of exploitation
- Ground water table
- Total Dissolved Solids (TDS) and Salinity levels of the wells within 30km from the coast and,
- Forests and other protected areas

The thematic maps prepared for these components are presented in **Figures 7.3** through **Figure 7.9**. The thematic map preparation also involved the plotting of the TDS and salinity contours within a band of 30km from the coast using SURFER 32.

Figure 7.3

WATER POTENTIAL OF RIVER BASINS

Figure 7.4

BLOCK WISE GROUND WATER POTENTIAL

Figure 7.5

FOREST AREAS

Figure 7.6

WATER LEVEL CONTOURS

Figure 7.7

DEPTH OF WATER TABLE BELOW GROUND LEVEL

Figure 7.8

TOTAL DISSOLVED SOLIDS

Figure 7.9

SALINITY LEVELS

7.6.4 INTRINSIC SUITABILITY FOR SPECIFIC LAND USES

Analysis of the data collected for the environmental components formed the basis for the identification of criteria for each of the components. For e.g. criteria for assessing the ground water potential of the blocks was based on the level of extraction as over exploited, dark, grey and white. Such criteria were worked out for each of the components. The criteria are presented in **Table 7.21.**

Table 7.21: Criteria for Assessing Intrinsic Suitability of Various Landuses

	A	B	C	D	E	F	G	H
1	**Environmental Component**	**Residential**		**Commercial**		**Industrial**		**Recreational**
		LD	**HD**	**LD**	**HD**	**WI**	**NWI**	**(A)**
2	(I) Geology (Marine Sedimentary Formations)	√		√	√	√ (B)	√	√
3	(II) Soil (Coastal Alluvium)	√		√	√	√ (B)	√	√
4	(III) Water Resources							
5	(a) Ground Water Potential							
6	Grey (Extraction 65-85%)	√		√			√	
7	Saline (Intruded)			√			√	
8	White (Extraction < 65%)	√		√		√	√	
9	(b) Salinity levels							
10	Upto 0.5 ppt (Upto 250 ppm of Cl^-)	√	√	√	√	√	√	√
11	0.5-1.0 ppt (250-555 ppm of Cl^-)	√		√			√	
12	1.0-1.5 ppt (555-832.5 ppm of Cl^-)			√			√	
13	1.5-2.0 ppt (832.5-1110 ppm of Cl^-)						√	
14	2.0-5.0 ppt (1110-2800 ppm of Cl^-)							
15	5.0-10.0 ppt (2800-5550 ppm of Cl^-)							
16	Above 10.0 ppt (Above 5550 ppm of Cl^-)							
17	(c) Ground Water Levels							
18	Levels < 10 m	√	√	√	√	√	√	√
19	Levels 10-30 m	√		√			√	
20	Levels > 30 m						√	

LEGEND

√ Can Occur, LD: Low Density, HD: High Density, W1: Water Intensive and NW1: Non Water Intensive
WI: Petrochemicals, Paper, Distilleries, Sugar, Food, Pharmaceuticals, Power plants, Tanneries, Chemicals, Textiles
NWI: Electronics, Steel, Fabrication, Leather products, Export Garments
(A) Beach Resorts more than 25 Ha
(B) Except Paper
Row 2 More stable Geology. This will not deter development
Row 3 More suitable and non flooding. This will not deter development
Row 6 HD Development will be deterred due to suspected longevity
Row 7 Residential development will be automatically deterred
Row 8 HD Residential & Commercial Development is not expected due to the fear of longevity of aquifer yield
Row 10 Normally getting 0.5 ppt salinity is rare and will be welcome for development
Row 11, 12 , 13 Even if water is desalted, it will be difficult to dispose the rejects
Row 14, 15, 16 The salinity will deter almost all development
Row 18 At a depth of less than 3 m, aquifer availability is accepted as normal for all development
Row 19 HD Development will not arise as they will be skeptical about longevity of this water elevation
Row 20 This will not deter NWI as long as the salinity is acceptable

INFERENCES

Salinity levels of over 2 ppt/ 2000 mg/l will automatically deter even the NWI besides commercial
Even if aquifer is over 30 m from GL, the NWI will not be deterred as long as salinity is agreeable
Superimposing these inferences on the base map permits culling Development Control guidelines

FIGURE 7.10

COMPOSITE OVERLAY

assessed for various land uses. The land uses included, residential –low and high density development, commercial – low and high density development, industrial – water intensive and non-water intensive industries, and recreational development.

7.6.5 OVERLAY & COMPOSITE SUITABILITY

The thematic maps were overlaid to identify and delineate areas that are suitable for development. This also enabled the identification of areas not suitable for residential, commercial and industrial uses, through exclusion. Such a suitability analysis was done for all land uses identified. These individual suitability maps were overlaid to work out a composite overlay. The composite suitability identifying areas suitable/ unsuitable for the different land uses is presented in **Figure 7.10**.

Based on the overlays and the composite suitability exercise, the following inferences have been arrived at:

- 78 km of the corridor falls in the saline blocks and hence no residential and commercial landuses can occur. However, low-density commercial landuses can occur.
- Degraded forests are present along 34 kms of the corridor between Ramanathapuram and Tuticorin and another 1 km of the corridor is close to the mangroves between Muthupet and Manora. No activities are to be allowed in these areas.
- 51.5 km of the corridor is in areas of high salinity content (>5 ppt) and therefore, no residential or commercial activities can take place in this region.
- Development controls to be exercised for a stretch of 164.5 km (inclusive of the saline blocks, degraded forests and mangroves) to regulate land use proliferation.
- In areas other than the mangroves, forests and high salinity zones, which includes a corridor stretch of 170 Km, non-water intensive industries, low-density residential and commercial uses will be suitable.

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