

Environmental Assessment Report

Initial Environmental Examination: Barmer Urban Transports and Roads Sub Project
Project Number: 40031
November 2008

India: Rajasthan Urban Sector Development Investment Program

Prepared by Local Self Government Department

For the Government of Rajasthan
Rajasthan Urban Infrastructure Development Project

The initial environmental examination is a document of the borrower. The views expressed herein do not necessarily represent those of ADB's Board of Directors, Management, or staff, and may be preliminary in nature.

ABBREVIATION

ADB	- Asian Development Bank
DSC	- Design and Supervision Consultancy
EA	- Executing Agency
EAC	- Expert Appraisal Committee
FI	- Financial Intermediary
GoI	- Government of India
GoR	- Government of Rajasthan
GSI	- Geological Survey of India
IA	- Implementing Agency
IEE	- Initial Environmental Examination
IPMC	- Investment Programme Management Consultancy
IPMU	- Investment Programme Management Unit
JNNURM	- Jawaharlal Nehru National Urban Renewal Mission
lpcd	- liter per capita per day
lps	- liter per second
LSGD	- Local Self-Government Department
MFF	- Multi-tranche Financing Facility
MLD	- Million liter Per day
MoEF	- Ministry of Environment and Forests
NAAQS	- National Ambient Air Quality Standards
OD	- Outer Diameter
OM	- Operations Manual
PHED	- Public Health Engineering Department
PMU	- Project Management Unit
RCC	- Reinforced Cement Concrete

ROW	-	Right of Way
RPCB	-	Rajasthan State Pollution Control Board
RSPM	-	Respirable Suspended Particulate Matter
RUIDP	-	Rajasthan Urban Infrastructure Development Project
RUSDIP	-	Rajasthan Urban Sector Development Investment Program
SPM	-	Suspended Particulate Matter
STP	-	Sewerage Treatment Plant
ToR	-	Terms of Reference
UA	-	Urban Agglomeration
UIDSSMT	-	Urban Infrastructure Development Scheme for Small and Medium Towns
uPVC	-	Unplastized Poly Vinyl Chloride
USEPA	-	United States Environmental Protection Agency
WC	-	Water Closets

WEIGHTS AND MEASURES

lakh	–	100 thousand = 100,000
crore	–	100 lakhs = 10,000,000
$\mu\text{g}/\text{m}^3$	–	micrograms per cubic meter
km	–	kilometer
lpd	–	liters per day
m	–	meter
mg/l	–	milligrams per liter
mm	–	millimeter
ppm	–	parts per million

NOTE{S}

- (i) In this report, "\$" refers to US dollars.
- (ii) "INR" and "Rs" refer to Indian rupees

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I. INTRODUCTION

A. Purpose of the Report

1. Rajasthan Urban Sector Development Investment Program (RUSDIP) is intended to optimize social and economic development in 15 selected towns in the State, particularly district headquarters and towns with significant tourism potential. This will be achieved through investments in urban infrastructure (water supply; sewerage and sanitation; solid waste management; urban drainage; urban transport and roads), urban community upgrading (community infrastructure; livelihood promotion) and civic infrastructure (art, culture, heritage and tourism; medical services and health; fire services; and other services). RUSDIP will also provide policy reforms to strengthen urban governance, management, and support for urban infrastructure and services. The assistance will be based on the State-level framework for urban reforms, and institutional and governance reforms recommended by the Government of India (GoI) through the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT).

2. RUSDIP Phase II to be implemented over a seven year period beginning in 2008, and will be funded by a loan via the Multitranche Financing Facility (MFF) of the ADB. The Executing Agency (EA) is the Local Self-Government Department (LSGD) of the Government of Rajasthan (GoR); and the Implementing Agency (IA) is the Project Management Unit (PMU) of the Rajasthan Urban Infrastructure Development Project (RUIDP), which is currently in the construction stage.

3. RUSDIP will improve infrastructure through the design and implementation of a series of subprojects, each providing improvements in a particular sector (water supply, sewerage, solid waste etc) in one town. RUSDIP has been classified by ADB as environmental assessment category B (some negative impacts but less significant than category A). The impacts of subprojects prepared according to ADB Environment Policy (2002) and Environmental Assessment Guidelines (2003).

B. Extent of the IEE study

4. Indian law and ADB policy require that the environmental impacts of development projects are identified and assessed as part of the planning and design process, and that action is taken to reduce those impacts to acceptable levels. This is done through the environmental assessment process, which has become an integral part of lending operations and project development and implementation worldwide.

1. ADB Policy

5. ADB's Environment Policy requires the consideration of environmental issues in all aspects of the Bank's operations, and the requirements for Environmental Assessment are described in Operations Manual (OM) 20: Environmental Considerations in ADB Operations. This states that ADB requires environmental assessment of all project loans, programme loans, sector loans, sector development programme loans, financial intermediation loans and private sector investment operations.

6. The nature of the assessment required for a project depends on the significance of its environmental impacts, which are related to the type and location of the project, the sensitivity, scale, nature and magnitude of its potential impacts, and the availability of cost-effective

mitigation measures. Projects are screened for their expected environmental impacts and are assigned to one of the following categories:

- Category A: Projects that could have significant environmental impacts. An Environmental Impact Assessment (EIA) is required.
- Category B: Projects that could have some adverse environmental impacts, but of less significance than those for category A. An Initial Environmental Examination (IEE) is required to determine whether significant impacts warranting an EIA are likely. If an EIA is not needed, the IEE is regarded as the final environmental assessment report.
- Category C: Projects those are unlikely to have adverse environmental impacts. No EIA or IEE is required, although environmental implications are reviewed.
- Category FI: Projects that involve a credit line through a financial intermediary (FI) or an equity investment in a FI. The FI must apply an environmental management system, unless all subprojects will result in insignificant impacts.

7. The Bank has categorized this program as Category B and following normal procedure for MFF loans has determined that one Environmental Examination will be conducted for each subproject, with a subproject being the infrastructure improvements in a particular sector (water supply, sewerage, etc) in one town.

2. National Law

8. The GoI EIA Notification of 2006 (replacing the EIA Notification of 1994), sets out the requirement for Environmental Assessment in India. This states that Environmental Clearance (EC) is required for specified activities/projects, and this must be obtained before any construction work or land preparation (except land acquisition) may commence. Projects are categorised as A or B depending on the scale of the project and the nature of its impacts.

9. Categories A projects require Environmental Clearance from the National Ministry of Environment and Forests (MoEF). The proponent is required to provide preliminary details of the project in the form of a Notification, after which an Expert Appraisal Committee (EAC) of the MoEF prepares comprehensive Terms of Reference (ToR) for the EIA study, which are finalized within 60 days. On completion of the study and review of the report by the EAC, MoEF considers the recommendation of the EAC and provides the EC if appropriate.

10. Category B projects require environmental clearance from the State Environment Impact Assessment Authority (SEIAA). The State level EAC categorises the project as either B1 (requiring EIA study) or B2 (no EIA study), and prepares TOR for B1 projects within 60 days. On completion of the study and review of the report by the EAC, the SEIAA issues the EC based on the EAC recommendation. The Notification also provides that any project or activity classified as category B will be treated as category A if it is located in whole or in part within 10 km from the boundary of protected areas, notified areas or inter-state or international boundaries.

11. The only type of infrastructure provided by the RUSDIP that is specified in the EIA Notification is solid waste management, where EC is required for all Common Municipal Solid Waste Management Facilities (facilities that are shared by more than one town)¹. EC is thus not required for urban transport and road (ROB) sub-project that is the subject of this Environmental Examination.

3. Review and Approval Procedure

12. For Category B projects the Draft Environmental Status report and its summary (SIEE) are reviewed by ADB's Regional Department sector division and Environment and Social Safeguards Division, and by the Executing Agency, and additional comments may be sought from project affected people and other stakeholders. All comments are incorporated in preparing the final documents, which are reviewed by the Executing Agency and the national environmental protection agency (MoEF in this case). The EA then officially submits the IEE and SIEE reports to ADB for consideration by the Board of Directors. Completed reports are made available worldwide by ADB, via the depository library system and the ADB website.

4. Scope of Study

13. This is the IEE report for the Barmer road transport sector subproject. It discusses the generic environmental impacts and mitigation measures relating to the location, design, construction and operation of physical works proposed under this subproject.

II. DESCRIPTION OF THE PROJECT

A. Type, Category and Need

14. This is a transportation sub-project, and as explained above it has been classified by ADB as Category B, because it is not expected to have major negative environmental impacts. Under ADB procedures such projects require an IEE to identify and mitigate the impacts, and to determine whether further study or a more detailed EIA may be required. The sub-project is needed to help alleviate road congestion in the town, where the capacity of the network has not expanded to cope with increased traffic demand. It will provide a road over bridge (flyover) on NH 15 at level crossing no. 323, Barmer – Jaisalmer (ch. 151/200) near Circuit House, which currently have to be closed for substantial time in a day to allow the passage of trains. This is one of a series of subprojects designed by the RUSDIP that are intended to raise the standards of the municipal infrastructure and services of Barmer and the other urban centres to those expected of modern Asian towns.

B. Location, Size and Implementation Schedule

15. The sub-project is located in Barmer, the headquarters town of Barmer district, in the western part of Rajasthan (**Figure 2.1**). The infrastructure will consist of Road over Bridge (ROB) over railway crossing no. 323.

¹ According to the Rajasthan State Pollution Control Board, the MoEF intends to issue a clarification to the EIA Notification in due course, which will add all landfill facilities and Sewage Treatment Plants to the list of projects specified as requiring EC under the Notification. This has not yet been issued, so the text above indicates the correct legal position at the time of writing

16. Detailed design will begin in the middle of 2008 and work will be completed by the end of the 2009. Photographs of the project area are attached as **Appendix 1**

C. Existing Situation

17. Barmer comprises a road network of 242.5km, consisting of 220 km bituminous roads, 12.5 km cement concrete roads and 10 km WMM road. Municipal Board of Barmer (MBB) is maintaining 80% of total road network and remaining 20% of road is maintained by PWD.

18. National Highway 15 (NH-15) crosses the broad gauge single line (Jaisalmer - Barmer) at level crossing No. 323A on NH-15 Ch. 151/200 at Barmer near Circuit House. To avoid congestion at level crossing, construction of 2-lane ROB with footpath at both sides for pedestrians at 323A Railway Crossing and its approaches are necessary.

19. At present average 15 Trains are passing through the line and average 4627 fast moving vehicle & average 643 slow moving vehicles are passing through the above road. In peak hours the traffic congestion at level crossing no 323A creates chaotic situation due to closer of gates for passing the trains. Besides the above, congestion at above level crossing location are becoming worse day by day due to enormous growth of 2-wheelers and car/jeep/taxi. The subproject, when implemented, will benefit the population of town as well as through traffic of NH-15 with safe travel time & fuel consumption. The proposed subproject will substantiate the growth of traffic & population of Barmer for at least 20 years i.e. 2028. The following will be the key outcomes from the Subproject:

- a. Predominant traffic will be served
- b. Avoid any accident
- c. Saving of time
- d. Fuel saving
- e. Traffic congestion will be eased
- f. Social & Environmental hazards to be reduced.
- g. No psychological barrier

D. Description of the Sub-Project including detail scope of work

20. **Table 2.1** shows the nature of the subproject. There are main elements: construction of the ROB above the railway crossing, and improvements to the existing roads. The descriptions shown in **Table 2.1** are based on the present proposals, which are expected to be substantially correct, although certain details may change as development of the subproject progresses.

21. It is proposed a ROB on the NH 15 within the municipal area of Barmer. To avoid congestion at level crossing, construction of 2-lane ROB with footpath at both sides for pedestrians and its approaches are necessary.

Table 2.1: Improvements in transportation infrastructure proposed in Barmer

Infrastructure	Function	Description	Location
Road in Barmer	To make ease of Traffic movement	ROB at rail way crossing level crossing on NH-15	At level crossing no. 323 on NH-15, Barmer – Jaisalmer (ch. 151/200) near Circuit House

22. Average Train Vehicle Unit (ATVU) is 1, 02,336 as per Railway census on March 2007. As per IRC 62:1976, if the product of ADT (fast moving vehicles only) and nos. of trains per day i.e. Average Train Vehicle Unit (ATVU) exceeds 50,000 for last 5 years, the construction of ROB is necessary. As per *Table-3 of IRC 86:1984*, the capacity of 2-lane Road (both way) is 1500 PCU. From recent traffic survey & traffic projection, the existing peak hour traffic volume is less than 1000 PCU and it will be saturated in 2031 considering 5% growth rate. Hence, 2-lane ROB is justified only for 20 years design period.

23. Scope and components of the works consist of construction of ROB span, both side viaduct spans, embankment with RE (Reinforced Earth) wall, service road, footpath, provision of drain & utility space etc. Details of major works are as under;

- a. Construction of one 33.25m ROB span
- b. Construction of 4x22.5 m viaduct spans at Jaisalmer end and 7x22.5m viaduct span at Barmer end.
- c. Construction of 200m length of embankment of varying height with both sides RE wall at Jaisalmer end and 250m length of embankment of varying height with both sides RE wall at Barmer end
- d. Construction of Service road at both sides of ROB approaches.
- e. Provision of footpath, provision of drain, utility space, crash barrier, Road appurtenances

24. **Design Criteria:** As per railway norms at Barmer, minimum vertical clearance is 8.3m for freight corridor/Army requirement including raising of tracks. After construction of ROB, the level crossing shall be removed. Hence, provision of footpath with stairs for pedestrian shall be kept in ROB. The acquisition of land & structure shall be minimized and accordingly viaduct spans shall be finalized. The provision of service roads, footpath space for utility, drains etc. shall also be kept. The Geometry design, structural design shall be done as per IRC 86:1984, IRC 6:2000, IRC 18:2000, IRC 21:2000, IRC 37:2001, IRC 78:2000.

25. Topographical survey was conducted and the site visit was made by the experts. After studying the present Right of Way (ROW), the geometry of ROB along with its approaches is planned in such a way that minimum acquisition of land & structures are involved. Besides the above, both side service roads of minimum 5.5m wide along with 1.5m footpath are also planned to facilitate the existing shops & residential areas. The following design criteria are adopted for planning the geometry of ROB.

- i) Design speed has been achieved 65 kmph.

- ii) Skew angle has been reduced to 17⁰48'09" degree.
- iii) Radius of curvature is 250 m.
- iv) Vertical clearance is 8.3m over railway track.
- v) Vertical Gradient is limited to 3.33%
- vi) Intermediate Stopping Sight Distance

26. **Salient Details of ROB & Viaduct:** At present the existing broad gauge railway track is single line having ROW 32.000m. Considering future expansion of two tracks both sides of the existing one as per Railway norms, single span of 33.250m on skew is proposed for ROB. Besides the ROB span, viaduct/underpass spans (4x22.5m at Jaisalmer end and 7x22.5m Barmer end) at both end of ROB are proposed to minimize the acquisition, to provide proper circulation of ground level service road, to minimize the environmental hazards. Embankment with RE walls both sides are proposed at both ends after the viaduct spans. 5.5m (minimum) service road along with 1.5m footpath at outer edge has been proposed at one side of the viaduct to facilitate the local peoples and other side of viaduct existing road shall be facilitate the local traffic. The salient details of ROB, viaducts, embankment with RE walls, service roads etc. are presented below:-

Table 2.2: Salient Details of ROB & Viaduct

Sl. No.	Items	Details
1	ROB portion	1 No.x 33.250m
2	Viaducts spans on Barmer end	7x22.5m
3	Viaducts spans on Jaisalmer end	4x22.5m
4	Approach embankment with reinforced earth retaining walls along Jaisalmer end	200 m
5	Approach embankment with reinforced earth retaining walls along Barmer end	250 m
6	Total length of ROB including Railway portion, viaducts span and Approach embankment etc	730.25 m
7	Total length of the Project including Rotary, Tapering, merging length etc.	1600 m
8	Vertical clearance over the railway tracks	8.3 m
9	Gradient	3.333%
10	Width of Carriageway / Total width of ROB, viaducts and Approach embankment	7.5m/12.0m for main spans incl. ROB 7.5m/10m for viaducts & Approach embankment with RE walls
11	Footpath	1.5 m on either side for main span
12	Crash Barriers & Railing	Standard Railing as per MORTH Drawings.
13	Approaches	Approach embankment beyond viaduct spans with reinforced Earth retaining walls
14	Specification for Embankment Earth fill Sub-grade 500 mm G.S.B. WMM DBM SDBC	Soil shall have fines of 75 micron not exceeding 10%. Sub- grade fill shall have CBR of 8% 300mm 300mm 115mm(65+50) 25mm

15	Wearing coat over concrete decking	40 mm B.C + 25 mm mastic asphalt.
16	<p>Structural details of Railway portion & viaduct spans.</p> <p>(i) Railway Portion (Super-structure) PSC Pre-cast T- Beam and RCC cast in-situ Deck slab</p> <p>(ii) Via duct spans (Super-structure) PSC Pre-cast T- Beam and RCC cast in-situ Deck slab</p> <p>(iii) Sub-structure for Railway Portion and viaduct spans</p> <p>(iv) Foundations</p> <p>(v) Reference IRC Codes</p> <p>(vi) Seismic Zone</p> <p>(vii) Bearings</p> <p>(viii) Expansion joints</p>	<p>33.250m span</p> <p>4x22.5m + 7x22.5m</p> <p>Solid Rectangular piers with semi-circular end and rectangular pier cap</p> <p>1000mm, dia piles of 14m depth with 1500mm thick pile cap.</p> <p>a) IRC – 5 – 1998 b) IRC – 6 – 2000 c) IRC – 18 – 2000 d) IRC – 21 – 2000 e) IRC – 37 - 2001 f) IRC – 78 – 2000</p> <p>ZONE - IV</p> <p>Elastomeric Bearings.</p> <p>Strip seal expansion joints</p>
17	Service Roads	7.5m to 5.5 m wide service roads along with 1.5m footpath are proposed on all along the length of ROBs on either side except railway track portion.
18	Electrification	Provision has been made electrification of during night time to facilitate proper movement of traffic.
19	Shifting of utilities	Electric Post, OFC Line and Telephone Post have to be shifted to suitable location.
20	Felling of the trees	Few trees will be felled
21	Diversion road	Not required
22	Drainage	Drainage spouts, drain pipes to be provided in ROB, viaduct & RE wall portion and box/pipe drains to be provided below footpath

Figure 2.1: Location of Project Area

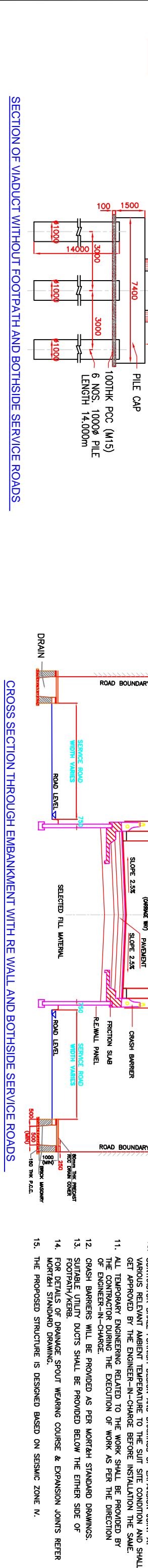
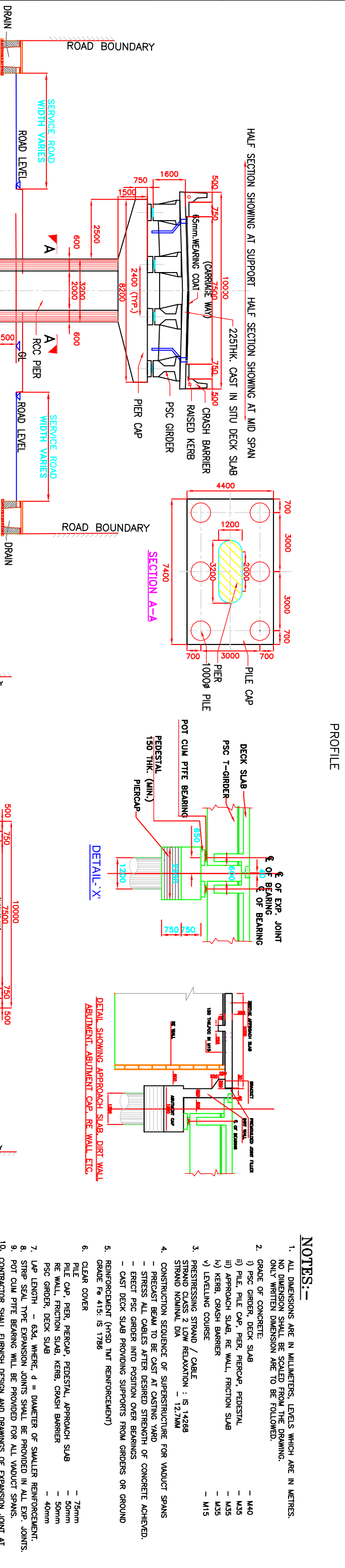
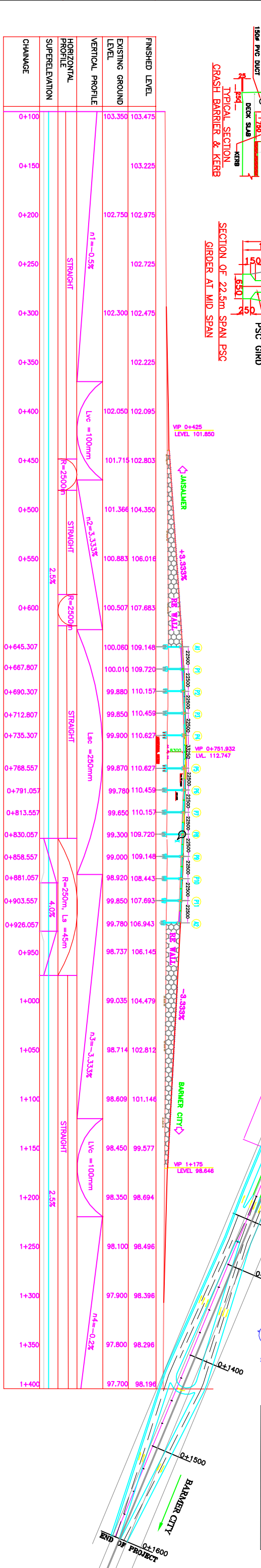
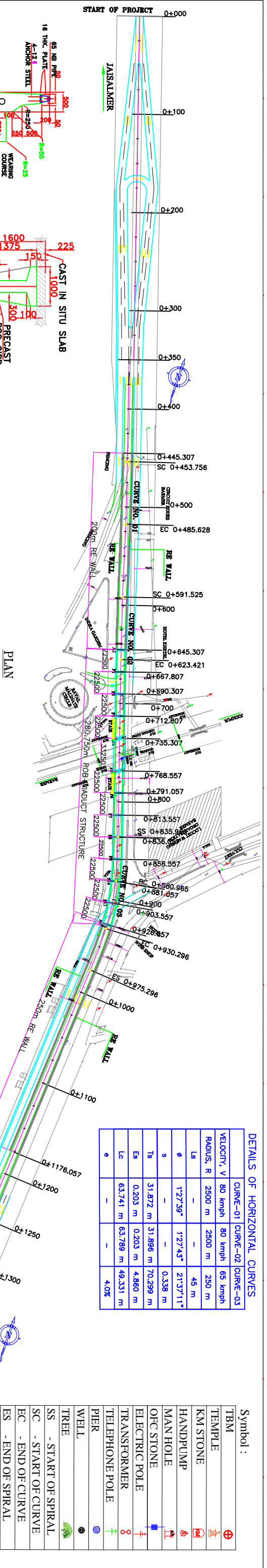


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Barmer Regional Map

Figure 2.2: Layout plan for proposed ROB



NOTES:-

- ALL DIMENSIONS ARE IN MILLIMETERS, LEVELS WHICH ARE IN METRES. NO DIMENSION SHALL BE SCALED FROM THE DRAWING. ONLY WRITTEN DIMENSION ARE TO BE FOLLOWED.
- GRADE OF CONCRETE:
 - i) PSC GIRDER, DECK SLAB - M40
 - ii) PILE CAP, PIER, PIERCAP, PEDESTAL - M35
 - iii) APPROACH SLAB, RE WALL, FRICTION SLAB - M35
 - iv) KERB, CRASH BARRIER - M35
 - v) LEVELLING COURSE - M15
- PRESTRESSING STRAND / CABLE STRAND CLASS 2 LOW RELAXATION : IS 14268 STRAND NOMINAL DIA - 12.7MM
- CONSTRUCTION SEQUENCE OF SUPERSTRUCTURE FOR VIADUCT SPANS
 - PRECAST BEAM TO BE CAST AT CASTING YARD
 - STRESS ALL CABLES AFTER DESIRED STRENGTH OF CONCRETE ACHIEVED.
 - ERECT PSC GIRDER INTO POSITION OVER BEARINGS
 - CAST DECK SLAB PROVIDING SUPPORTS FROM GIRDERS OR GROUND
- REINFORCEMENT (HYSD TMT REINFORCEMENT) GRADE Fe 415: IS 1786
- CLEAR COVER
 - 75mm PILE CAP, PIER, PIERCAP, PEDESTAL, APPROACH SLAB
 - 50mm RE WALL, FRICTION SLAB, KERB, CRASH BARRIER
 - 40mm PSC GIRDER, DECK SLAB
- LAP LENGTH - 63d, WHERE, d = DIAMETER OF SMALLER REINFORCEMENT.
- STRIP SEAL TYPE EXPANSION JOINTS SHALL BE PROVIDED IN ALL EXP. JOINTS.
- POT CUM PTFE BEARING WILL BE PROVIDED FOR ALL VIADUCT SPANS.
- CONTRACTOR SHALL FURNISH DESIGN AND DRAWINGS OF EXPANSION JOINT AT VARIOUS AMBIENT TEMPERATURE TO THE SUIT SITE CONDITION AND SHALL GET APPROVED BY THE ENGINEER-IN-CHARGE BEFORE INSTALLATION THE SAME.
- ALL TEMPORARY ENGINEERING RELATED TO THE WORK SHALL BE PROVIDED BY THE CONTRACTOR DURING THE EXECUTION OF WORK AS PER THE DIRECTION OF ENGINEER-IN-CHARGE.
- CRASH BARRIERS WILL BE PROVIDED AS PER MORTH STANDAR DRAWINGS.
- SUITABLE UTILITY DUCTS SHALL BE PROVIDED BELOW THE EITHER SIDE OF FOOTPATH/KERB.
- FOR DETAILS OF DRAINAGE SPOUT WEARING COURSE & EXPANSION JOINTS REFER MORTH STANDARD DRAWING.
- THE PROPOSED STRUCTURE IS DESIGNED BASED ON SEISMIC ZONE IV.

III. DESCRIPTION OF THE ENVIRONMENT

A. Physical Resources

1. Location

27. The Urban Agglomeration (UA) of Barmer district is located about 565 km from Jaipur. Barmer district is situated in the western part of Rajasthan and forms part of the Thar desert. It is surrounded by Jaisalmer in the north, Jalore in the south, Pali and Jodhpur in the east and Pakistan in the west. It is about 887 kms from Delhi, 565 kms from Jaipur. The nearest Airport is at Jodhpur.

28. The total area of the city is 10.29 sq. km. Barmer city is the administrative headquarter of the district. The district is divided into two sub-divisions viz., Barmer and Balotra. The district has 3 municipalities, 8 panchayat samitis, 225 gram panchayats, 1,640 revenue villages and 853 inhabited villages. District map of Barmer is shown in **Figure 3.1**.

2. Topography, Natural Hazard And Drought

29. **Topography** Barmer is the district headquarter. It is located at 25°45' North latitude and longitude 71°22' East longitude, at a height of about 250 meters above the mean sea level.

30. **Natural Hazards- Earthquake:** Barmer town lies in medium to high risk zone (III and IV). The area is prone to earthquakes as it is located on comparatively unstable geological plains based on evaluation of the available earthquake zone information. Figure 3.2 depicts the earthquake zones of Rajasthan. Figure 3.3 shows natural hazard zones of the Barmer district.

31. **Drought:** Low rainfall coupled with erratic behaviour of the monsoon in the State makes Rajasthan the most vulnerable to drought. Based upon the discussion with PHED officials the water table in the City continuously decreases by 4-5 meter on an annual basis combined with significant drawdown conditions.

Figure 3.1: District Map of Barmer

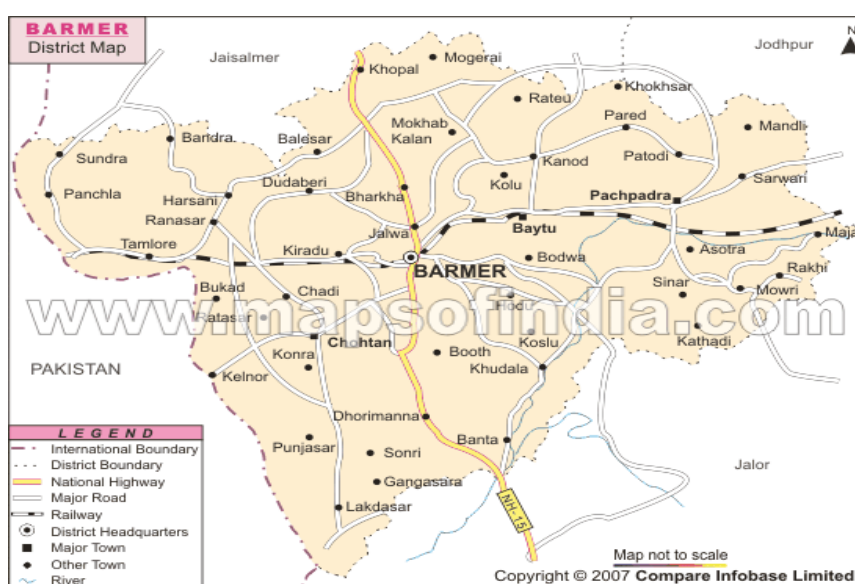


Figure 3.2: Earthquake Zones of Rajasthan

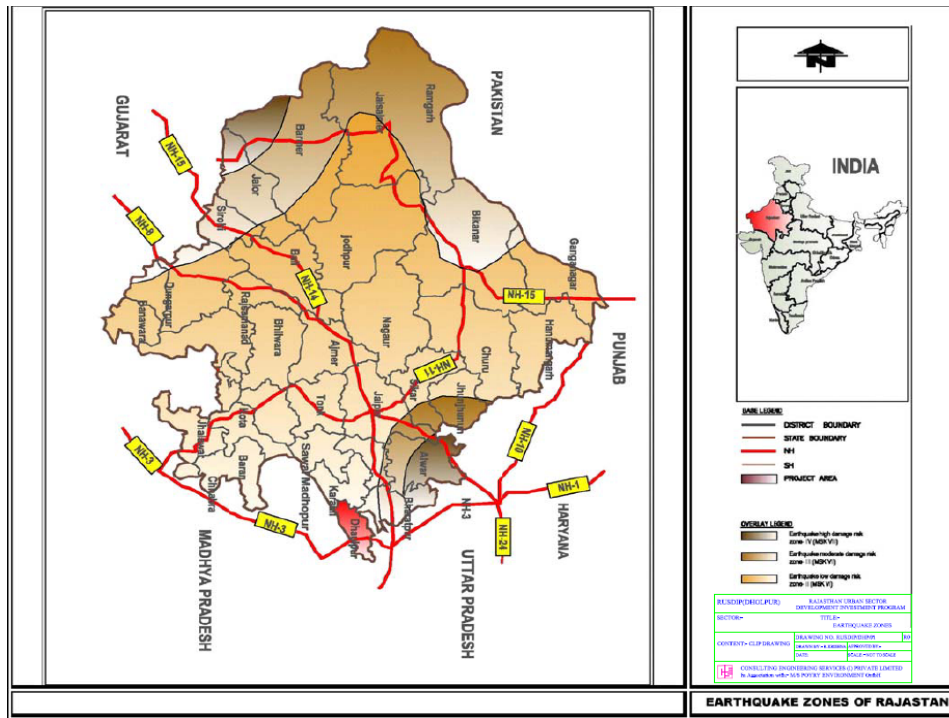
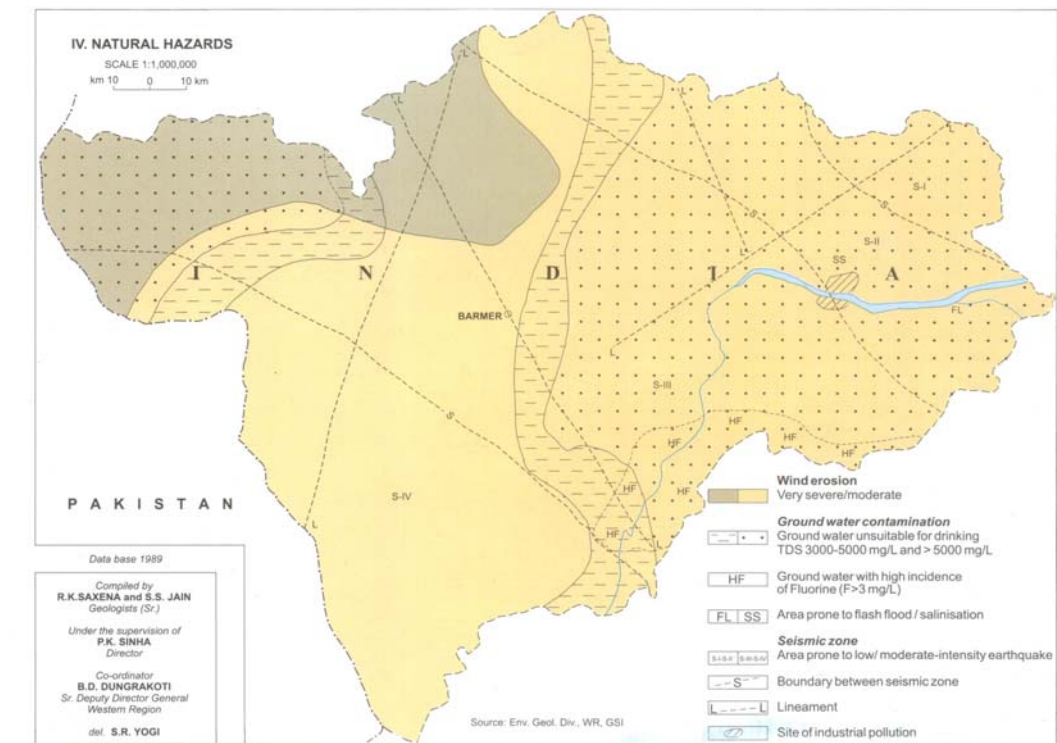


Figure 3.3: Natural Hazard Map of Barmer (GSI Resource Map)



3. Geology, Geomorphology, Mineral Resources And Soil

32. Barmer district is situated in the western part of the state, bordering Pakistan. It occupies the area of 28,287 km². Shiv, Baytu, Pachpadra, Barmer, Chauhtan, Siwana and Gudha Malani are the seven Tehsil in the district. The ephemeral Luni and Sukri rivers drains the eastern and southern part of the district. The district is having arid climate with average annual rainfall in the district is 27cm.

33. The district forming the part of the 'Thar desert' is mostly covered by Aeolian sand. The area however exposes a variety of rock types ranging in age from upper Proterozoic to Quaternary. The pre- Malani ligneous Suit comprise volcanic phase (rhyolite, agglomerate tuff), plutonic phase (granite) and dyke phase rhyolite, felsites, prophyrite, basalt). The Malani volcanic are dominated by acid volcanic flows. Three phases of acid volcanism, separated from each other by pyroclastic material, have been identified. The Birmania formation comprising limestone, chert, shale, sandstone, (Upper Proterzoic) overlite the Malani rocks. The overlying Lathi formation (Jurassic) is represented by sandstone, siltstone, conglomerate and pockets of clay. Over most part of the area they are covered by Quaternary sediments and could be seen in dug well section. The Fategarh formation uncomfortably overlying the Lathi sandstone comprises sequences of conglomerate, gritty sandstone, phosphatic sandstone, siltstone and bentonite. Outliers of the Fategarh Formation are also seen around Sarnu. The emplacement of alkaline suite of rocks (alkali olivine basalt, hawaiite, trachyte, trachyandesite, syenite) within the Malanis. in the area around Sarnu and Dandali marks another magnetic phase. The Tertiary sequence, overlying the Fategarh Formation is represented by the Akli, the Mandai, and the Kapurdi Formations. The Akli Formation consisting of argillaceous sandstone, lignite, bentonic clay grades upward into the arenaceous Mandai Formation which includes conglomerate, sandstone, etc. The Kapurdi Formation (Eocene) consists mainly of Fuller's earth, variegated clay and ferruginous and gypseous concretions. The Bandah Formation consisting of friable and variegated sandstone and clay, seen in the western part of the district, is considered time equivalent of the Kapurdi Formation.

34. The Phalsund and Shumar Formation (Pleistocene age) comprising grit, conglomerate, iron stone, pebble spread etc occur in isolated patches at several places. Quaternary sediments of aeolian and fluvial phases conceal the older formations and cover large part of the district.

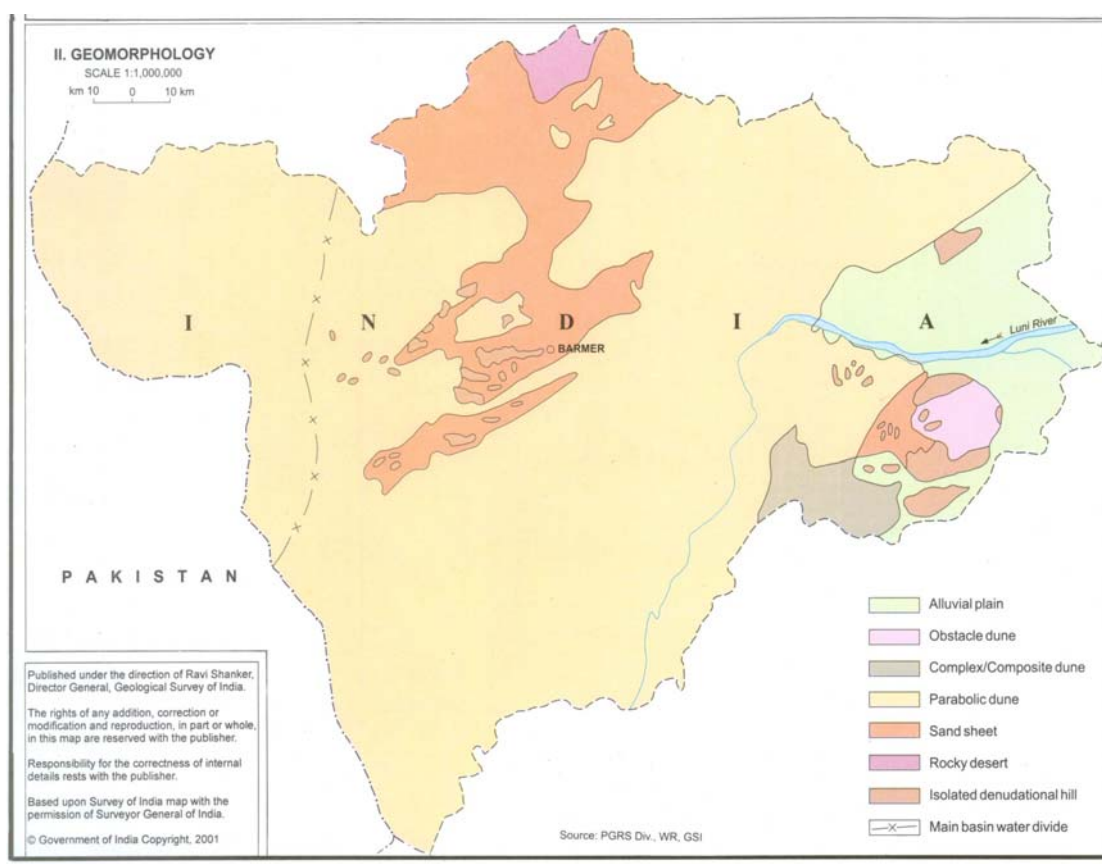
35. Geomorphologically, the district is classified into seven geomorphic units, namely, alluvial plain, obstacle dune, complex / composite dune, parabolic dune, sand sheet, rocky desert and denudational hill. Geo-hydrologically, the district is classified into three hydrological domains (unconsolidated alluvium and pebble; semi consolidated formations; and consolidated fissured formations) with ground water potential ranging from <10 to 100 LPS. Natural hazards include mainly wind erosion which is moderate to very severe.

36. Mineral resources: The district abounds in mineral resources of bentonite, China clay, fuller's earth, glass sand, lignite phosphorus, salt, vermiculite and Kankar. Bentonitic clay deposits swelling and non – swelling type are reported from Akli, Amba Bari, Bisu Kalan, Gunga, Narguida, Khoral, Shiv, Thumbli, Sonri, Bhadres, Jalipa, and Mahabar, with the total of 7.15 million tones of proved reserves. China clay beds, up to 2.4 m in thickness occur near Gunga, Nimla and Botiya. Fuller's earth deposits are located around Bharka, Kapurdi, Botiya. Gypsum occurrences are reported from. Talsar, mith ka Tala, Binjkar, Mithrau, Uttarlai, Kawas and Shivkar. Glass sand are suitable for glass industries are reported from Shiv. Lignite occurrences (from Mandai Formation) are reported from Kapurdi, Jalipa, Thumbli and Bharka areas. Mineral Exploration Corporation Limited estimated reserves of about 200 million tons

from Kapurdi – Jalipa area. Phosphorite horizon, 1 to 4 m thick, Comprising oolite, pellet, replaced fossil shell, is traceable from Bhiyar to Dharavi Khurd with 5.25 % P₂O₅ contents. Salt deposit are found around Pachpadra. Vermiculite has been reported from (west of) Simaliya. Kankar occurrences are reported from Saro – ki – Dhani, Kashmir, Redwali, salariya etc. where they are locally used as road material. Malani granite and rhyolite are extensively quarried for use as construction material near Mokalsar, Pataudi, Dharimanna, etc. They also possess vast reserves of road metal and railway ballast.

37. Geology and mineral map of the district is shown in **Figure 3.4** and geomorphological map of the district is depicted in **Figure 3.5**.

Figure 3.5: Geomorphology of Barmer District (Source: GSI Resource Map)



38. Soil characteristics: Soil of the region falls within low rainfall zone of 200- 400 mm. The soil is generally desert type and sand dunes. Specifically soil is aeolian, coarse sand in texture and some places calcareous. Table 3.1 shows nutrient level in the Barmer soil including area coverage of sodic soil. The nutrient status of the Barmer soil is graded as very low to medium level.

Table 3.1: Fertility status – major nutrients and problematic soils of Barmer district

	Nutrient			Saline Soil(Ha)	Sodic or Alkali(Ha)
	N	P	K		
Status	VL	M	M	-	1989

(Source: Vital Agricultural Statistics 2004-05, Directorate of Agriculture, Rajasthan)

4. Climate

39. The temperature of Barmer varies between minimum of 9 degrees celsius to the maximum of 45 degrees celsius. The normal rainfall is 27.75 cms. .

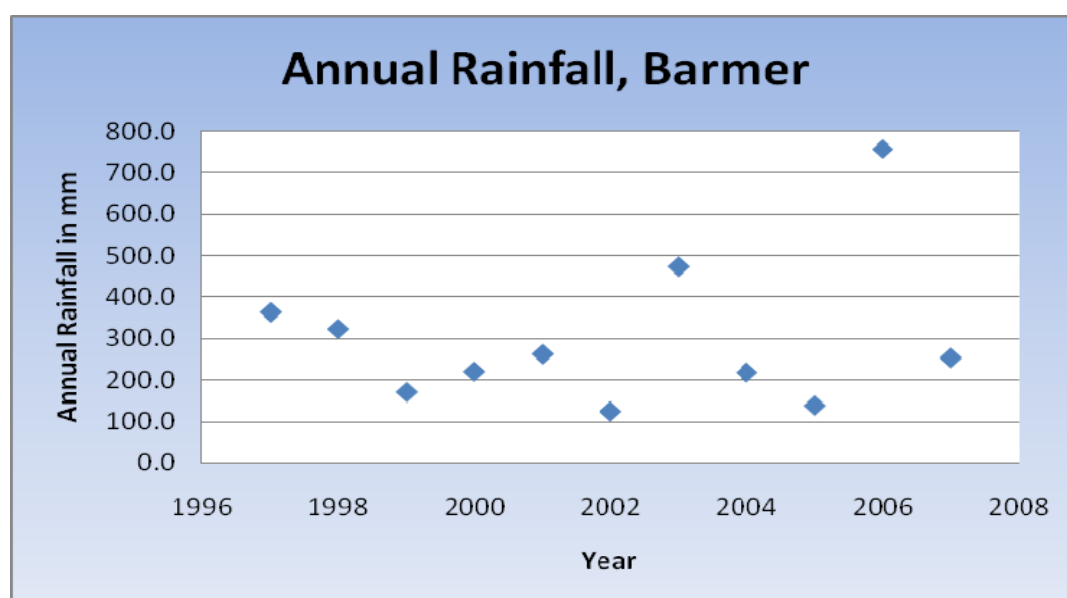
40. The rainfall over Barmer is scanty and is concentrated over four month i.e. from June to September. The rains are erratic and so is the distribution of the rainfall. However agriculture and the animal wealth are dependent on rains to large extent. Seasonal Rainfall data for the recent year (2005-2006) is shown in **Table 3.2**. **Figure 3.6** shows yearly variation (1997-2007) of rainfall at Barmer.

Table 3.2: Rainfall at Barmer in Recent Years (2005-06)

S.No.	Months	Rainfall (mm)
1	June	12
2	July	20
3	August	42
4	September	38
5	October	0
6	November	0
7	December	0
8	January	0
9	February	0
10	March	44
11	April	1
12	May	0
13	Monsoon Rainfall	112
14	Non monsoon rainfall	45
15	Annual Rainfall	157

(Source: Irrigation Department, Govt. of Rajasthan)

Figure 3.6: Rainfall at Barmer During 1997 to 2007.



Source: Deputy Director hydrology water resources ID and R, Jaipur

5. Air Quality

41. There are no data on ambient air quality of Barmer Town, which is not subject to monitoring by the Rajasthan State Pollution Control Board (RPCB) as there are no major industries. The nearest station is located at Jodhpur (222 km from Jodhpur). Traffic is the only significant pollutant in Barmer, so levels of oxides of sulphur and nitrogen are likely to be well within the National Ambient Air Quality Standards (NAAQS). The ambient air quality data is depicted in **Table 3.3**.

Table 3.3: Ambient Air Quality (Annual Average, 2004; units in µg/m³)

Monitoring Station	Land use	SO _x	NO _x	RSPM	SPM
Jodhpur Residential, Rural and others area	Residential	8.05	19.58	118	357
<i>NAAQ Standard</i>	<i>Residential</i>	<i>60</i>	<i>60</i>	<i>60</i>	<i>140</i>
Jodhpur Industrial area	Industrial	7.98	19.68	111	340
<i>NAAQ Standard</i>	<i>Industrial</i>	<i>80</i>	<i>80</i>	<i>120</i>	<i>360</i>

RSPM: Respirable Suspended Particulate Matter; SPM: Suspended Particulate Matter

Source: Annual Report 2005-2006 Rajasthan State Pollution Control Board

6. Surface Water

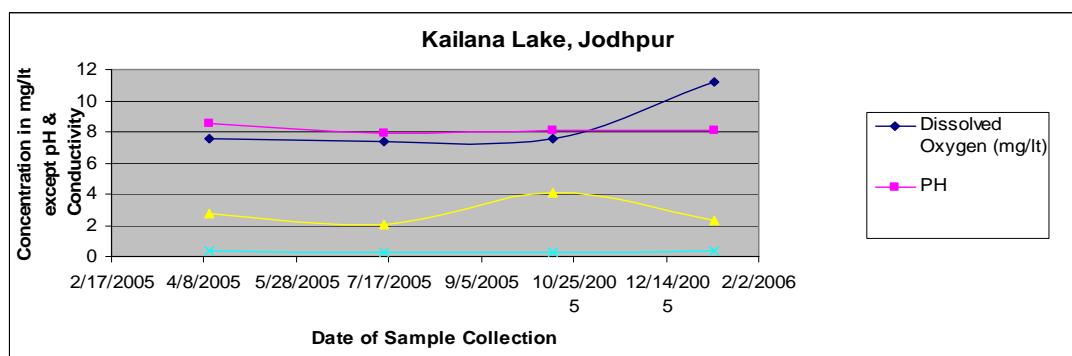
42. There is no water quality monitoring station at Barmer. The Kailana lake is located at Jodhpur district, 222 km from Barmer. The monitoring has been carried out by Rajasthan Pollution Control Board at Kailana lake. The data on DO, pH, BOD and Electrical conductivity is given in **Table 3.4**. During 2005 to 2006 DO, pH and BOD ranged from 7.4– 11.2 mg/l, 7.88 – 8.56 and 2.02 – 4.09 mg/l respectively.

Table 3.4: Kailana Lake Water Quality, Jodhpur

Date of Sample Collection	Dissolved Oxygen (mg/l)	P ^H	BOD (mg/l) (3 days at 27° C)	Conductivity at 25° C (m-MHO)
4/11/2005	7.6	8.56	2.75	0.4
7/14/2005	7.4	7.88	2.02	0.26
10/14/2005	7.6	8.05	4.09	0.29
1/9/2006	11.2	8.05	2.3	0.33

Source: Annual Report 2005-2006 Rajasthan State Pollution Control Board

Figure 3.7: Variation of water quality parameters



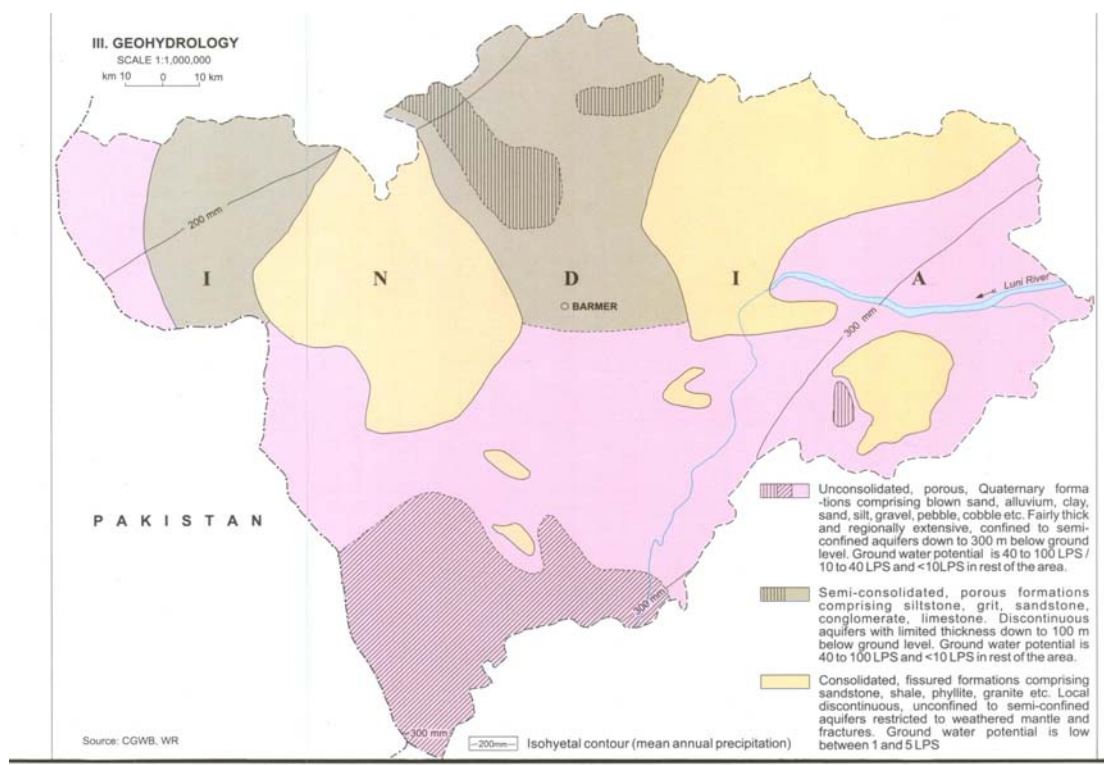
7. Geohydrology and Groundwater

43. Geohydrological map of the Barmer district is shown in **Figure 3.8**. For broadly grouping geological formations from ground water occurrence and movement considerations, the various lithological units have been classified into three groups on the basis of their degree of consolidation and related parameters. These are,

- Unconsolidated porous, quaternary formation
- Semi consolidated porous formation
- Fissured formations – consolidated sedimentary rocks.

44. On an average 60-70 % of the district area (mostly south and eastern part of the district) covered with unconsolidated porous formations.

Figure 3.8: Geohydrological Map of Barmer (Source: GSI Resource map)



45. There are number of National Hydrographic monitoring stations of Central Ground Water Board in and around Barmer. Fluctuation of ground water level is shown in **Table 3.5**. In most of the cases ground water table ranged between 20-60 m bgl.

Table 3.5: Number and Percentage of National Hydrograph Network Station (Barmer) with Water Fluctuation Range

Period	No of wells analyzed	Range		0-2 m		2-5 m		5-10m		10-20m		20-60m		>60 m	
		Min	Max	No	%	No	%	No	%	No	%	No	%	No	%
Jan-06	58	5.13	76.55	0	0	0	0	9	15.52	11	18.97	31	53.45	7	12.07
Nov-05	58	5.49	76.5	0	0	0	0	9	15.52	11	18.97	31	53.45	7	12.07
Aug-05	58	5.45	101.24	0	0	0	0	10	17.24	11	18.97	33	56.9	6	10.34
May-05	59	5.67	76.5	0	0	0	0	9	15.25	10	16.95	34	57.63	6	10.34

Source: Ground water year book 2005-06 Rajasthan, Central Ground Water Board, Jaipur (2007)

46. The Central Ground Water Board carried out chemical testing of tube well water seasonally. The average concentrations of major constituents are shown in **Table 3.6**.

Table 3.6: Ground Water Quality in and around Barmer

Parameters	Maximum Level	Minimum Level	Standard of Drinking water (IS: 10500: 1991)	
			Desirable limit (mg/l)	Maximum Permissible limit (mg/l)
pH	8.7	7.45		
EC (micro-mhos/cm at 25 °C)	17520	835		
Cl (mg/l)	8130	50	250	1000
SO ₄ (mg/l)	1825	20	200	400 (if Mg does not exceeds 30 ppm)
NO ₃ (mg/l)	745	0	-	100
PO ₄ (mg/l)	0.44	0		
Total Hardness(mg/l)	3060	70	300	600
Ca(mg/l)	412	4	75	200
Mg(mg/l)	554	5	30	100
Na(mg/l)	4750	4	-	-
K(mg/l)	125	1	-	-
F(mg/l)	5.34	0.36	1.0	1.5
Fe(mg/l)	3.18	0	0.3	1.0
SiO ₂ (mg/l)	56	12		
TDS (mg/l)	11388	543	500	2000

Note: Total – 18 nos. samples

Source: Ground water year book 2005-06 Rajasthan, Central Ground Water Board, Jaipur (2007)

47. As per PHED TDS level is more than 2020 mg/l and Fluoride between 1.4 to 1.7 mg/l. Groundwater quality of Barmer city is not in conformity with the set norms of Government of Rajasthan. Consumption of this high fluoride content has resulted in bone deformity and joint pains (as evident from Public perception).

Table 3.7: Present Supply water quality at Barmer

Total supply per day (lac liter)	Type of Sources Surface / Ground	Ground	Surface	No. of CWR	No. of SR	F ⁻ Min	F ⁻ Max	TDS Min	TDS Max	NO ₃ ⁻ Min	NO ₃ ⁻ Max
16	Ground	100	0	9	7	1.9	2.2	2020	2460	10	10

B. Ecological Resources

48. Barmer Town is, surrounded by a harsh desert environment of wind-blown sand and dunes. The municipal area includes large swathes of uninhabited rocky hills and sand dunes, with alluvial soil and sand in the intervening valleys, which are cultivated where there is enough rain. Natural vegetation is very limited, and consists of mainly sparse, scattered shrubs and grasses. The fauna of the town comprises mainly domesticated animals (camels, cows, goats,

pigs and chickens), plus other species able to live close to man (urban birds, rodents and some insects). In the desert away from the inhabited area there is a more natural fauna, which includes hyaenas (*Hyaena hyaena*), desert fox (*Vulpes pusilla*), jackal (*Canis aures*) and chinkara gazelle (*Gazella gazella pallas*).

49. There is no forest area nearby the city. Therefore no endangered floral and faunal species are expected.

C. Economic Development

50. Barmer being a desert district generally faces famines & drought. The bulk of population depends upon agriculture & animal husbandry. Being district headquarter, Barmer town is the main regional centre for the entire district and is working as service centre for providing services like trade and commerce, transport, commercial and other higher level public facilities for the entire district.

51. The economic condition of people in Barmer is not satisfactory. As per information in 1998 about 28% population comprised of families below poverty line. These people are mostly labour class working in industries, shops, restaurant, construction, transport and certain other. This aspect has to be given due consideration while designing the housing projects.

52. *Work force*: In 1991 the total working force was 17,943, which was 26.15% of total population. In 2001 the total workers were 24,360, which was about 29.14% of total population. Out of the total workers 21,871 were main workers and 2560 marginal workers. The male workers participation rate was 48.41% while in the case of females 6.5% were workers.

53. The occupational structure as per 2001 census is assessed as follows:

Table 3.8: Distribution of Work Force 2001

Category		Numbers	% of Total
Main Workers	Male	20,419	93.67
	Female	1,381	6.33
	Total	21,800	100.00
Marginal Workers	Male	1452	56.72
	Female	1108	43.28
	Total	2,560	100.00
Total Workers	Male	21,871	89.78
	Female	2,489	10.22
	Total		100.00

54. The occupational structure data for 2001 census has not been given in category wise details. Therefore, 2001 occupational data are based on estimates of data for 1971 to 1991 census. The economic structure of the town is associated with the regional character. Being the seat of district administration, about 31% of the total workers are employed in other services category. Trade and commerce is the next important function where 28.5% workers are engaged. Barmer is also a centre of household and small industries like furniture making and

dying and printing. About 21% workers are employed in various industrial units. It is also a transport terminus and 7.5% workers are engaged in this activity. The agriculture and allied activities also provide employment to about 4.5% workers. The following table and figure shows the occupational structure of the total population in 1981 to 2001.

Table 3.9: Occupational Structure of Barmer Town

S. No.	Occupation	1981		1991		2001	
		Persons	% of Total Workers	Persons	% of Total Workers	Persons	% of Total Workers
1.	Agriculture and allied activities	1238	7.85	981	5.47	609	2.50
2.	Industry	2998	19.02	3734	20.81	5480	22.50
3.	Trade and Commerce	3348	21.24	4909	27.36	6943	28.50
4.	Construction	726	4.61	1424	7.94	1949	8.00
5.	Transport and Communication	1108	7.03	1276	7.11	1827	7.50
6.	Other service	6343	40.25	5619	31.32	7552	31.00
	Total	15761	100.00	17943	100.00	24360	100.00

Source: Census of India and estimates

55. **Power status of the area:** There is no power generation unit at Barmer. The consumption of electricity by different sectors is shown in Table below.

Table 3.10: Consumption of Electricity in Million Kwh (2003-04)

District	Domestic	Non-Domestic (Commercial)	Industrial	Public Lighting	Public Water Works	District	Domestic
			Small	Medium	Large		
Barmer	39.833	15.172	8.41	22.326	3.20	1.566	44.137

(Source: District Statistics Book)

1. Land use

56. The municipal limits of Barmer encompass an area of about 3,290 acres, out of which about 2,100 acres can be called urban area. The remaining is undeveloped vacant land, forest and hilly. About 130 acres of land contiguous to the municipal limit in the east is also developed urban area. Thus total urban area of Barmer town is 2,230 acres. Out of the total urban area, about 1,540 acres is developed area, the remaining land is either government land, reserved or vacant land. Residential use is the most dominant urban component, which constitutes about 57.80% of the developed area, which is high in comparison to other towns. This is due to lack of industrial areas, parks and open spaces and other community facilities in the town. The area under public and semi public use comprising educational, medical facilities, public utilities etc. is about 11.36% of developed area. Circulation covers about 18.84% of the total developed area. Table shows the existing land use analysis of Barmer town based on survey conducted in 1985.

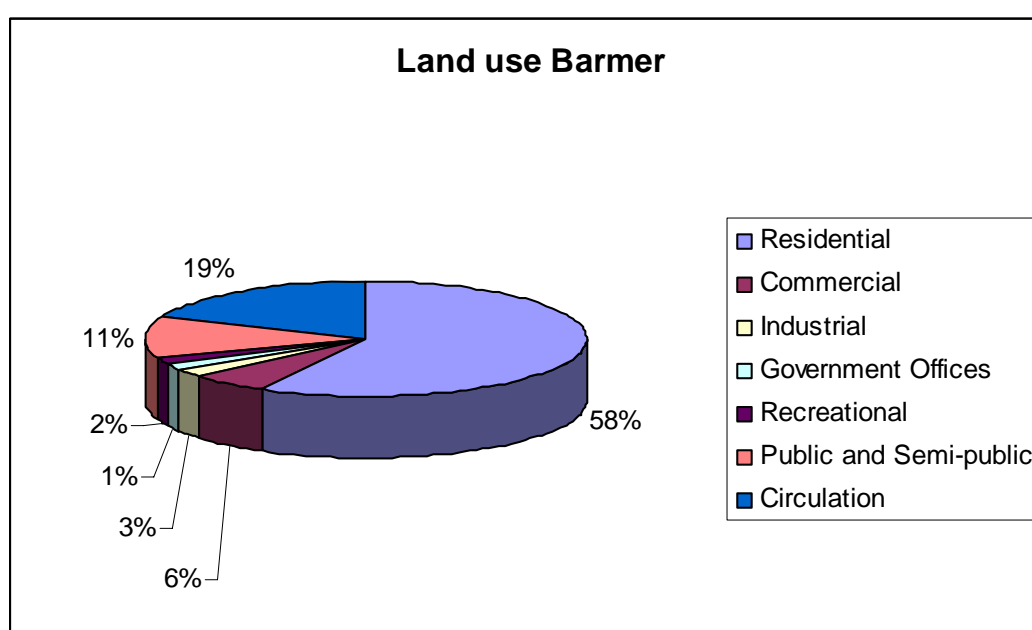
Table 3.11: Land Use of Barmer City – 1985

S.No.	Land use	Area in acres	%
1.	Residential	890	57.79
2.	Commercial	90	5.84

S.No.	Land use	Area in acres	%
3.	Industrial	40	2.60
4.	Government Offices	20	1.30
5.	Recreational	35	2.27
6.	Public and Semi-public	175	11.36
7.	Circulation	290	18.83
	Total Developed Area	1540	100.00
8.	Government Reserved	370	
9.	Other vacant un-developed land	320	

Source: Town Planning Department

Figure 3.9: Land use proportion for Barmer Developed area



2. Commerce, Industry and Agriculture

57. Most of the business activities are carried out along roads namely station road, Chohtan road, Panghat road, Dhani Bazar, Laxmi Bazar, Sadar Bazar, Ratan Singh Bazar, Subhash Chowk, Gandhi Chowk, Hanumanji Ka Chowk and Pratapji Ki Pole. The business in cloth is generally carried out in Laxmi bazaar. Station road and Ahinsa Chowk constitute the main markets of the town where retail business in cloth, watches, books and stationary and general merchandise is carried out. A small shopping centre has been developed in Mahaveer Nagar residential scheme. Except this scheme new developments generally lack in organised shopping facilities. There is no shopping centre for the localities in the north. Due to this unauthorised construction of shops have taken place in scattered manner, mostly along main roads like NH-15, Defence road and Jodhpur road. A wholesale grain market covering an area of 63 acres has been developed along Defence road. FCI godowns have been built along Jodhpur road. Some warehouses have also been constructed near industrial area.

58. The desertic climatic conditions and lack of infrastructure such as water supply and electricity, industrial development in Barmer town is not very much. As per 1991 census, there were 3734 industrial workers which was about 21% of total workers. There has been increase in

workers percentage from 16.7% in 1971 to about 22.5% by 2001. Household industries play a significant role in Barmer and out of the total industrial employments 50% are engaged in household industries. The household industries mostly consists of dyeing and printing of textile, shoe making, iron goods, black smithy, woollen carpet etc.

59. In RIICO industrial area out of 271 plots in 240 plots industrial units are functioning mostly dealing with guar gum, gypsum, bentonite powder, iron and steel utensils, dyeing and printing of cotton textile. The industrial prospects of the town are brighter in view of availability of water from IGNP and power supply from recent petroleum / gas investigations.

60. In and around the Barmer city area there are about 80% of lands used for agricultural purpose. Crop production statistics as depicted in **Table 3.12** indicates more crop production at Kharif season in compared to Rabi season.

Table 3.12: Crop production in around Barmer

Type of Crops	Under Rabi Crops 2003-04 (Prod in Tonnes)	Under Kharif Crops 2003-04 (Prod in Tonnes)
Cereals	20199	564907
Pulses	602	251777
Food Grains	20801	816684
Oilseeds	13679	14343
Others	69769	146805
Total	104249	977832

(Source: Vital Agricultural Statistics 2004-05, Directorate of Agriculture, Rajasthan)

3. Infrastructure

61. *Water supply:* In Barmer town water is available from underground source. The water is drawn from 28 tube wells near NH-15 at Bhadka situated 38 Km. from Barmer city and is boosted through 300 mm AC / 200 mm CI conveyance mains to Barmer city with intermediate boosting at Harsani Phanta and Jalipa Head Works. The total production is 9 MLD and per capita supply is about 100 liters. Out of the 9 MLD available from current sources, PHED supplies around 0.22 MLD to Commercial Consumers, 0.88 MLD to Industrial consumers and 7.90 MLD to Domestic consumers. The city is divided into 11 water supply zones covering 35 municipal wards. The approximate total length of the existing water supply distribution network is 144 km and includes all localized distribution networks.

62. *Sewerage System:* As is the case with all medium towns in Rajasthan, Barmer too does not have any sewerage system. Water Closets (WC) are connected to septic tanks in most of the houses, while some houses, due to lack of space, discharge WC effluent directly in to open drains. In some households, especially in slum areas, open defecation is still a common practice. Sullage generated from houses is directly discharged in to open drains, forming pools. The open drains carrying wastewater and the resultant pools are causing unsanitary conditions, which are threat to public health.

63. Scarcity of water, undulated topography and above all the lack of financial resources restrained planning of underground sewerage system. At present there is no plan for a sewerage system. It is necessary that feasibility and detailed project reports be prepared by experienced consulting agencies for the comprehensive scheme covering topographic survey, designing of conveyance system, treatment and disposal of treated effluent and its reuse. The

city lies on both sides of railway track. The natural slope is from west to east. According to natural slope at present, the sewerage of Northern Zone is flowing near Jodhpur road causing nuisance and ugly appearance. For southern zone outfall of sewer is likely to be behind Saint Paul's school at Shivkar road.

64. *Sanitation:* Only 50-60 % of the households reportedly has septic tanks and soaks well as the system of sewerage disposal. The remaining accounted for cases of open defecation which is an unacceptable and unhygienic practice. The raw settled sewage from septic tank is periodically flushed out by sanitary workers of the Municipal Board and discharge to open spaces, agricultural lands in an indiscriminate manner. Slum areas were also not equipped with requisite sanitation (LCS etc.) resulting in open defecation.

65. *Drainage:* The topography of Barmer city is cup shaped, the town being surrounded by sand dunes. Due to scanty rains in the region, natural drainage system has not been so far evolved. In fact there is no river/rivulet in the entire Barmer district. In Barmer town itself, no natural drainage system exists to drain away the rainwater or wastewater from the town. Presently there exists a minimal network of storm water drains in the city. The existing network of (roadside) storm water drains in Barmer has been identified under three broad categories as follows: (i) open *pucca* and (ii) closed *pucca*. (iii) Kutchha

66. *Industrial Effluents.* Small industries exists in under RIICO, which is out side the city area and small amount of effluent disposed scattered in local nallahs. As reported by the local MC, the responsibility of effluent disposal is under RIICO's own and could not be connected to the proposed sewer network. The individual industry should treat their effluent to bring it to the required standard before final disposal.

67. *Solid Waste:* MBB's jurisdiction is spread over an area of 10.29 sq.km, which includes core old city area and some rural parts at the fringes. 30 tons of solid waste is collected daily. In addition to household (domestic) solid waste, the main waste generation sources in the town are vegetable and fruit markets, commercial and institutional establishments including hotels and eateries, construction activities, and other tourism related activities. MBB jurisdiction includes core old city area and slum area at fringes. The entire area is divided in to 35 wards.

68. *Waste Collection* - The MSW generated in the Barmer city (including slum area) mainly consist of domestic refuses, waste from Commercial Area, Vegetable-Fruit market, bio-medical waste, waste from Hotels and Restaurants, Industries etc. The waste collection system being followed is quite primitive, individual households/units throw the garbage on road side/open drains close to their houses and the sweepers collect the garbage in the form of small heaps on road sides. Similarly the open drains are also cleaned periodically and the sludge is heaped adjacent to the drain where it is left for 2-3 days to get dried and lifted. Tractor trolleys then lift these dumps the heaped garbage once or twice a day. In the process part of the garbage gets dispersed on the road or finds it way into to the open drains or open low lying pits (Ginanis).

69. The Municipality owns five tractors, 3 taxis for door to door collection of solid waste. Capacity of five tractors is approximately 7 cum. The waste material is lifted by a loader and placed on trolleys for transportation to disposal site. Details of quantity of garbage collected and disposed off are not available. However based on the information gathered from the concerned engineer, an approximate quantity of MSW generated has been assessed as 25 tonnes / day. Estimated quantities of MSW generated from different sections of the town is given in the following table:

Table 3.13. Waste Generation in 2006

Type of waste generation	Quantity of waste in TPD
Residential Area (Domestic)	17
Commercial Area	4
Industrial	2
Bio-medical and Hospital	2
Total	25

70. This gives per capita generation of MSW as 300 gms/day, which is in line with garbage generated in similar towns, e.g. Pushkar, in Rajasthan.

71. As regards quality of MSW, there is no data available. Physical inspection carried out during the visits indicates very little presence of organic matter. Presence of plastic bags and wrappers of pan masala / tobacco pouches are source of nuisance around the points of garbage collection and along the roads and disposal sites. The garbage as such cannot be used for composting and is primarily being disposed off as landfill at a site near Somayon Ki Dhani.

4. Transportation

72. *Road Transport:* The district is linked by road with Jaisalmer, Jodhpur, Pali, Jalore, Jaipur, Ajmer and Ahmedabad. The total length of roads in the district was 5,109 kms as on 31 March 2000.

73. *Rail Transport:* The district is linked with neighbouring districts of Jodhpur, Jalore and Jaipur in the State and with Agra in UP and Munawa in Pakistan, by railway line. The total length of rail line in the district is 254 kms with 30 railway stations.

74. Important roads of the town are NH-15, State Highway No.-16 (Jodhpur road). The NH-15 runs in north-south direction making the eastern boundary of the town and is known as defence road. A number of developments have taken place on other side of the road such as RIICO area, dairy as well as katchi basties. These are creating problems on free movement of traffic on this important road. The station road, which is an important road, is narrow with shops on both sides and has mixed traffic. All streets of old town are narrow ranging from 5' to 30'. The town does not have organised bus stand or truck stand. The bus stand is located near railway crossing, but it does not have adequate land for proper functioning. Trucks are parked by the side of the road on carriage way creating traffic congestion.

75. The **Table 3.14** provides a breakdown of road surface composition in physical growth of the city has resulted in a corresponding increase in vehicular traffic greater than that of the city's population growth due to improving economic status of the city.

Table 3.14: Jurisdiction of Authorities Responsible for the Road of the City

Type	Maintaining Authority	Length in km	%
Bitumen road	MBB	170	70.10
Cement-concrete road	MBB	12.5	5.15
WBM (Metalled)	MBB	10	4.13
NH & State Highway	PWD	50	20.62
Total		242.50	

Source: PWD Barmer

76. As per IRC 62:1976, if the product of ADT (fast moving vehicles only) and nos. of trains per day i.e. Average Train Vehicle Unit (ATVU) exceeds 50,000 for last 5 years, the construction of ROB is necessary.

Average Daily Traffic (fast moving vehicles only)	=	4627 nos.
Number of Trains passing per day	=	15 nos.
Average Train Vehicle Unit (ATVU)	=	69405 units > 50000

Hence ROB is absolutely necessary as per calculated Average Train Vehicle Unit (ATVU) which exceeds the value as mentioned in IRC 62:1976.

77. As per Railway census on March 2007 Average Train Vehicle Unit (ATVU) is 1, 02,336. But authenticity of data is not proved.

78. Traffic Study: The 3 days (16.06.08 to 18.06.08) traffic Survey is conducted at level crossing location to determine the ADT (Average Daily Traffic) in terms of Nos & PCUs. **Table 3.15** shows the average daily traffic in Nos. passing through the existing level crossing. **Table 3.16** shows the average daily traffic in PCUs. From the above table, it is observed that peak hour is 17.00PM to 18.00PM. From **Table 3.15** it is also observed that 2-Wheelers, 3-Wheelers, Car/Jeep/Taxi, Trucks and Cycles are more dominating in this section of road. PCU Values for different vehicles are taken from IRC-86:1983.

Table 3.15: Average Hourly Traffic in Nos.

Time	Nos. of Different Vehicles									Total
	2-Wheeler	3-Wheeler	Car, Jeep Taxi	Bus	2-axle Truck	Multi-axle Track	Agri-Trailor	Cycle	Camel Cart	
19.00 to 20.00 PM	84	23	58	3	24	29	6	27	5	259
20.00 to 21.00 PM	97	16	73	6	33	34	7	22	2	289
21.00 to 22.00 PM	58	6	37	3	17	21	3	13	1	158
22.00 to 23.00 PM	32	6	36	1	15	23	3	6	1	122
23.00 to 24.00 PM	15	1	16	1	4	9	2	4	1	52
00.00 to 01.00 AM	6	0	10	0	14	13	1	0	0	45
01.00 to 02.00 AM	3	0	5	0	5	11	1	0	0	26
02.00 to 03.00 AM	1	0	4	0	4	11	0	0	0	20
03.00 to 04.00 AM	1	1	5	0	5	12	0	0	0	25
04.00 to 05.00 AM	1	2	5	0	4	8	0	2	0	22
05.00 to 06.00 AM	11	6	15	2	8	8	1	14	0	65
06.00 to 07.00 AM	22	3	23	0	9	12	2	16	1	88
07.00 to 08.00 AM	73	18	50	8	20	26	5	27	2	229
08.00 to 09.00 AM	79	39	82	9	16	22	7	53	4	310
09.00 to 10.00 AM	108	70	65	4	25	26	9	60	3	370
10.00 to 11.00 AM	116	72	68	6	29	19	10	43	3	366
11.00 to 12.00 AM	121	78	69	4	26	27	8	40	3	376
12.00 to 13.00 PM	140	87	92	7	28	24	10	50	4	441

Time	Nos. of Different Vehicles									
	2-Wheeler	3-Wheeler	Car, Jeep Taxi	Bus	2-axle Truck	Multi-axle Truck	Agri-Trailor	Cycle	Camel Cart	Total
13.00 to 14.00 PM	97	58	78	10	13	24	9	26	5	318
14.00 to 15.00 PM	90	44	66	7	20	30	8	36	1	302
15.00 to 16.00 PM	95	70	62	8	24	25	7	35	3	328
16.00 to 17.00 PM	90	58	76	5	25	31	7	41	3	335
17.00 to 18.00 PM	116	58	89	5	40	46	5	48	2	409
18.00 to 19.00 PM	108	50	57	5	18	30	9	33	4	314
Total vehicles	1565	764	1141	92	424	521	121	594	49	5271
Total Fast moving vehicles	4627									

Table 3.16: Average Hourly Traffic in PCU

Time	Nos. of Different Vehicles									
	2-Wheeler	3-Wheeler	Car, Jeep, Taxi	Bus	2-axle Truck	Multi-axle Truck	Agri-Trailor	Cycle	Camel Cart	Total
PCU Values	0.5	0.5	1	3	3	3	3	0.5	8	
19.00 to 20.00 PM	42	11	58	9	73	88	17	14	37	349
20.00 to 21.00 PM	49	8	73	17	98	101	22	11	19	397
21.00 to 22.00 PM	29	3	37	8	50	63	10	6	8	214
22.00 to 23.00 PM	16	3	36	2	46	68	10	3	5	189
23.00 to 24.00 PM	7	1	16	3	13	28	5	2	5	80
00.00 to 01.00 AM	3	0	10	0	42	40	4	0	0	99
01.00 to 02.00 AM	2	0	5	0	16	34	3	0	0	60
02.00 to 03.00 AM	1	0	4	0	12	32	0	0	0	49
03.00 to 04.00 AM	1	1	5	0	15	36	0	0	3	60
04.00 to 05.00 AM	1	1	5	1	11	25	1	1	0	45
05.00 to 06.00 AM	6	3	15	5	24	24	3	7	3	89
06.00 to 07.00 AM	11	2	23	1	26	35	7	8	5	118
07.00 to 08.00 AM	37	9	50	25	60	77	15	13	19	305
08.00 to 09.00 AM	40	20	82	26	47	65	20	27	35	360
09.00 to 10.00 AM	54	35	65	11	75	78	27	30	27	402
10.00 to 11.00 AM	58	36	68	17	87	57	30	22	27	401
11.00 to 12.00 AM	61	39	69	12	77	82	25	20	24	409
12.00 to 13.00 PM	70	43	92	21	83	72	30	25	32	468
13.00 to 14.00 PM	48	29	78	29	38	71	26	13	43	375
14.00 to 15.00 PM	45	22	66	20	61	90	23	18	8	353
15.00 to 16.00 PM	48	35	62	23	71	75	21	17	24	376
16.00 to 17.00 PM	45	29	76	14	75	92	22	21	24	397
17.00 to 18.00 PM	58	29	89	16	119	138	16	24	19	507

18.00 to 19.00 PM	54	25	57	16	54	91	26	16	29	369
Total vehicles	783	382	1141	276	1273	1562	363	297	395	6471

79. **Traffic Projection & Justification:** The road width in urban areas is designed to accommodate the design peak hour traffic. The design peak hour traffic is estimated based on a simple projection of present peak hour traffic for a design period of 15-20 years (adopted for arterial roads as per IRC-86:1984). The growth rate of different vehicles is estimated by Transport Demand Elasticity Method considering past traffic data, vehicle registration data, change of socio-economic pattern in urban areas, future development plan etc. In absence of such data, it is very difficult to estimate the actual growth rate for different vehicles.

80. In general, the average traffic growth rate for this type of urban areas (Barmer) is around 5%. The growth rate as per IRC 37-2001 is 7.5% which is higher than the actual growth at present. The present traffic is projected for both the growth rates i.e. 7.5% & 5% for design period of 20 years and the projected traffic is presented in **Table 3.17**.

Table 3.17: Traffic Projection

Sl. No.	Year	PCU in Peak hour	PCU in Peak hour
Growth Rate (%)		7.5	5.0
1	2008	507	507
2	2009	545	532
3	2010	586	559
4	2011	630	587
5	2012	677	616
6	2013	728	647
7	2014	782	679
8	2015	841	713
9	2016	904	749
10	2017	972	787
11	2018	1045	826
12	2019	1123	867
13	2020	1208	910
14	2021	1298	956
15	2022	1395	1004
16	2023	1500	1054
17	2024	1613	1107
18	2025	1734	1162
19	2026	1864	1220
20	2027	2003	1281
20	2028	2154	1345
20	2029	2315	1412
20	2030	2489	1483
20	2031	2675	1557

81. As per **Table 3.15** of IRC 86:1984, the capacity of 2-lane Road (both way) is **1500 PCU**. From the **Table 3.17**-Traffic Projection, it is observed that two lane road is to be saturated in 2031 considering 5% growth rate which is more realistic. Hence, 2-lane ROB is justified only as per the projected peak hour traffic.

D. Social and Cultural Resources

1. Demography

82. Barmer city has nearly 58% of total urban population of the district. In 2001 its population was 83591 persons. Growth rate has not been significant during last two decades because of lack of economic factor. During last decade (1991-2001) the growth rate was 21.8% only which was even less than the national population growth rate. Thus migration is negligible. Scheduled caste and Scheduled Tribe population is 10.10% and 0.5% respectively. **Table 3.18** gives the features of the city. Projected population growth of the city is shown in **Table 3.19**.

Table 3.18: Demographic Features of Barmer

Details	Barmer City	District
Total Population	83,591	1,964,835
Urban Population	83,591	1,45,404
Urban Area (sq.km.)	10.29	59.29
Population Density (persons / sq. km.)	8123	2107
SC	12,009 (10.10%)	3,08,996 (15.70%)
ST	1,298 (0.50%)	1,18,688 (6.00%)
Sex Ratio (Females per 1000 Males)	851	892
Literacy Rate (%)	76.90	59.00
Female Literacy Rate (%)	61.20	43.40

Source: Compiled from Primary Census Abstract Data 2001

Table 3.19: Population and Growth Rate

Year	Population
1901	6064
1911	6380
1921	7184
1931	9240
1941	12051
1951	20812
1961	27600
1971	38630
1981	55554
1991	68625
2001	83591
2011	104,113
2021	129,253
2031	160,230
2041	198,640

Source: District Census Handbook Data 2001

2. Health and educational facilities

83. There are good educational facilities in Barmer district, which serve both townspeople and inhabitants of surrounding villages and towns in the hinterland. There are 2714 primary schools, 130 secondary and higher secondary schools, plus 2 general degree colleges and 2 industrial training institutes (ITI).

Table 3.20: Educational facility of Barmer District

Facility	No.
Primary Schools	2,714
Middle Schools	451
Higher Secondary and Secondary Schools	130
Colleges	2
Polytechnics	1
ITI	2
STC	1

(Source: Official website of District)

84. In Barmer district number of private and government hospital and health centers are recorded.

3. History, culture and tourism

85. Barmer has moderate tourist inflows with main attractions being Juna Barmer is important from heritage point of view. There are number of festivals held in Barmer, the most famous of which is cattle fair held every year at Talwara village situated on the banks of the Luni river. The fair goes on for a fortnight in the months of March-April. The other predominant festival is the Barmer Thar Festival, started as a practice to enhance the tourism potential of the town. During the annual Barmer Festival in March, the town is at its colourful best and that is the best time to visit Barmer. 'Safed Akra Mahadev Mela' is celebrated on Mahashivratri.

86. Projects in Line for development of tourism in Barmer: Municipal Board Barmer have framed following schemes to promote tourism.

- **Development of Son Nadi:** Development of Son Nadi is proposed to promote tourism. This will include construction of CC road near protection wall, development of park, providing and furnishing play ground equipments, installation of fountains and development of Ghats.
- **Development of Vensa Nadi:** The area of Vensa Nadi has also been included in Tourist Development Plan. This includes development of park, providing and furnishing play ground equipment.
- **Construction of Cement Concrete road** from Peepla Devi Temple to Tourist Point: A cement concrete road is proposed from Peepla Devi Temple to Venasar and tourist point. This will facilitate easy transportation of tourist.
- **Development of Kareli Nadi;** Kareli Nadi area is proposed to be developed for tourists.

IV. ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES: LOCATION AND DESIGN

87. ADB Environmental Assessment Guidelines require that an IEE should evaluate impacts due to the location, design, construction and operation of the project. Construction and operation are the two activities in which the project interacts physically with the environment, so they are the two activities during which the environmental impacts occur. In assessing the effects of these processes therefore, all potential impacts of the project are identified, and mitigation is devised for any negative impacts. This has been done in Sections V and VI below and no other.

88. In many environmental assessments there are certain effects that, although they will occur during either the construction or operation stage, should be considered as impacts primarily of the location or design of the project, as they would not occur if an alternative location or design was chosen. For example, if a road was built in an area of great landscape beauty there would be severe visual impacts as a result of the location, as these would not occur if the road was routed around the outskirts of a neighbouring city.

89. However in the case of this subproject it is not considered that there are any impacts that are a result of the design or location. This is because:

- The project will be built at a single relatively small location and involves straightforward construction and low-maintenance operation, in an environment that is not especially sensitive, so it is unlikely that there will be major impacts;
- Most of the predicted impacts are associated with the construction process, and are produced because that process involves quite extensive groundwork. However the routine nature of the impacts means that most can be easily mitigated.

V. POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES: INFRASTRUCTURE CONSTRUCTION

A. Screening out areas of no significant impact

90. From the descriptions given in Section II.C it is clear that implementation of the subproject should not have major negative impacts because it will affect only one site, at which all construction will be conducted within a relatively small area.

91. Because of this there are several aspects of the environment that are not expected to be affected by the construction process and these can be screened out of the assessment at this stage as required by ADB procedure. These are shown in **Table 5.1**, with an explanation of the reasoning in each case.

Table 5.1: Fields in which construction is not expected to have significant impacts

Field	Rationale
Climate	Short-term production of dust is the only effect on atmosphere
Geology and seismology	Excavation will not be large enough to affect these features
Fisheries & aquatic biology	No rivers or lakes will be affected by the construction work

Wildlife and rare or endangered species	No wildlife and endangered species nearby
Coastal resources	Barmer is not located in a coastal area
Development of agriculture, minerals and tourism	There are none of these developments near the site
Population and communities	Construction will not affect population numbers, location or composition

92. These environmental factors have thus been screened out presently but will be assessed again before starting of the work.

93. Rapid Environmental Impact Assessment checklist is attached as **Appendix 2**

B. Road over Bridge (ROB)

1. Construction method

94. As explained above, this subproject will involve construction of a ROB, 8.3 m high, 33.25 m span. At present the existing broad gauge railway track is single line having ROW 32.000m. Considering future expansion of two tracks both sides of the existing one as per Railway norms, single span of 33.250m on skew is proposed for ROB. Besides the ROB span, viaduct/underpass spans (4x22.5m at Jaisalmer end and 7x22.5m Barmer end) at both end of ROB are proposed to minimize the acquisition, to provide proper circulation of ground level service road, to minimize the environmental hazards.

95. Construction will begin with the removal of the existing road surface by backhoe diggers. A series of RCC box-sections will then be built, each slightly higher than the preceding one, to form the approach ramps. Foundations will be dug to about 1 m depth, and metal reinforcing bars will be added to form the floor and sides of each box. Portions of these will be encased in wooden shuttering, and concrete (mixed on site) will be poured in and allowed to set. This will be repeated to gradually create each RCC box, which will then be filled with sand and stone, imported on trucks and tipped into each structure. Once each is filled a layer of RCC will be added to the top, with a slight incline, so that the upper surface rises gradually to the 8.3 m height of the ROB.

96. At the same time the foundations for the bridge piers will be excavated by backhoe diggers, and deeper portions will be dug by a drilling machine. Heavy-duty metal reinforcing rods will be placed into the voids, followed by a concrete and aggregate mix. The reinforcing rods will extend out of the foundations to create the structure of each pier, and these will then be encased in shuttering, into which more concrete will be poured to form each pillar. The pre-cast RCC bridge sections will then be brought in from the manufacturing plant on large vehicles, placed into position by cranes and attached to the piers by heavy-duty bolts and concrete. The pre-cast safety barriers will also be positioned by crane at the edges of the bridge and ramps, after which the tarmac surface will be applied by road-laying machine and roller vehicles, with gravel layers tipped out from trucks.

97. The operation will be conducted by a team of around one hundred men, roughly 50% unskilled labour and 50% with various skills including truck drivers, vehicle and machine operatives, surveyors, foremen and supervisors, etc. The operation should be completed in around 18 months.

2. Physical Resources

98. Although all work will be conducted at a single, relatively small site, construction will involve a great deal of excavation and earth moving over a period of approximately six months, so physical impacts could be quite considerable.

99. During construction time great deal of material, which could cause significant changes in topography, drainage, air quality (dust), soil quality and other features at the extraction site if it were sourced from adjacent land. However these impacts can be avoided relatively easily by utilising two readily available sources of waste sand and stone, which are:

- Material excavated to create the foundations of the piers that will support the ROB structure (if suitable);
- Sand and stone excavated to create treatment ponds at the STP site

100. Using these sources would have the additional benefit of providing a beneficial use for what would otherwise be large quantities of waste material, so it will be very important to coordinate these activities to enable this to be done.

101. Moving such a large quantity of material could cause further physical impacts, including the creation of dust during dry weather and silt-laden runoff during rainfall, both of which would affect people who live and work near the site and reduce the quality of adjacent land. The Contractor will almost certainly plan the work to ensure that all earthworks are conducted during the dry season to avoid the difficult working conditions that prevail during the monsoon, so this will avoid any problems from runoff. It will however be necessary to prevent dust, so the Contractor should be required to:

- Excavate the bridge foundations at the same time as the access ramps are built so that dug material is used immediately, avoiding the need to stockpile on site;
- Damp down exposed soil and any sand stockpiled on site by spraying with water when necessary during dry weather;
- Use tarpaulins to cover sand and other loose material when transported by truck.

102. Conducting the work in the dry season should avoid any drainage problems from rainfall collecting in the bridge- and ramp- foundations during excavation, and although groundwater often collects in deeper voids, this should also not be a problem at this site because of the very low water table in Barmer.

103. The creation of ramps will gradually alter the topography and appearance of the site, and the work to install the pre-cast ROB sections will be especially visible in the local landscape. Visual impacts could be mitigated by erecting wooden fences to screen the site from view, but it is not considered that this will be necessary at this site, which is a congested road and rail junction with a very disrupted and "busy" appearance, that will not be significantly exacerbated by the construction activities.

3. Ecological Resources

104. There are no protected areas in or around project site of Barmer, and no known areas of ecological interest, only few trees at the site that needs to be removed. The work should therefore have no major ecological impacts.

4. Economic Development

105. Although much of this work will be conducted within the ROW of the existing roads and railway, there may be a need to acquire some land at the periphery of the site and for the construction of temporary access roads. This will be obtained through the legal mechanism of the Land Acquisition Act (1894) through which the government purchases the land compulsorily from the owners at a rate that is established on the basis of recent transactions. ADB policy on Involuntary Resettlement requires that no-one should be worse-off as a result of the project, so a Resettlement Plan and Resettlement Framework have been prepared to examine these issues. This establishes that no more than 10 % of the total land of any owner or occupant should be acquired, and that if any business premises have to be removed, the owners or tenants should be provided with:

- Compensation equivalent to the amount of business income lost;
- Compensation at replacement cost for any income-generating assets (eg shop premises) that have to be removed.

106. Certain roadside shops that are not purchased may still lose income because the presence of the construction site will deter customers, and access will be impeded by road closures, the presence of heavy vehicles and machinery, etc. These issues are also dealt with by the Resettlement Plan and Framework, which indicate that these impacts will be mitigated by:

- Keeping road closures to the minimum in terms of frequency, duration and extent;
- Maintaining vehicle and pedestrian access to roadside businesses wherever possible;
- Providing owners and tenants with financial compensation equivalent to the amount of business income lost.

107. Transportation is the other principal economic activity that will be impeded by this work, as the existing road will be removed at the location of the access ramps and gradually replaced by the new embankments. Trains will also have to travel slowly in the vicinity of the site, and when work is conducted close to the line, the train service may need to be interrupted temporarily. These impacts could be significant given the amount of traffic using this crossing. These impacts will need to be mitigated by careful planning of the construction program, in conjunction with the road, rail and municipal authorities and the police, in order to:

- Maintain safe passage for vehicles and pedestrians throughout the construction period;

- Provide effective, well signposted diversions and alternative routes when required;
- Conduct work that requires the closure of roads and the level crossing at times of low traffic volume;
- Conduct work on or close to the railway line at times when there are fewer trains;
- Schedule truck deliveries of soil to the site for periods of low traffic volume.

108. Excavation could also damage existing infrastructure (such as water distribution pipes, electricity pylons, etc) located alongside the roads. It will be particularly important to avoid damaging existing water pipes as these are mainly manufactured from Asbestos Cement (AC), which can be carcinogenic if inhaled, so there are serious health risks for both workers and citizens (see below). It will be important therefore to avoid these impacts by:

- Obtaining details from the Municipal Council of the nature and location of all existing infrastructure, and planning excavation carefully to avoid any such sites if possible;
- Integrating construction of the various infrastructure subprojects conducted in Barmer (transport, water supply, sewerage) so that:
 - Different infrastructure is located on opposite sides of the road where feasible;
 - Roads and inhabitants are not subject to repeated disturbance by construction in the same area at different times for different purposes.

5. Social and Cultural Resources

109. Rajasthan is an area with a rich and varied cultural heritage that includes many forts and palaces from the Rajput and Mughal periods, and large numbers of temples and other religious sites, so there is a risk that any work involving ground disturbance could uncover and damage archaeological and historical remains. In this case the excavation will occur in and around an existing roadway, so it could be that there is a low risk of such impacts. Nevertheless this should be ascertained by consulting the appropriate authorities and steps should be taken according to the nature of the risk. This should involve:

- Consulting historical and archaeological authorities at both national and state level to obtain an expert assessment of the archaeological potential of the site;
- Considering an alternative transportation sub-project if the site is found to be of medium or high risk;
- Including state and local archaeological, cultural and historical authorities and interest groups in consultation forums as project stakeholders so that their expertise can be made available to the project;

- Developing a protocol for use by the Contractor in conducting any excavation work, to ensure that any chance finds are recognized and measures are taken to ensure they are protected and conserved. This should involve:
 - Having excavation observed by a person with archaeological field training;
 - Stopping work immediately to allow further investigation if any finds are suspected;
 - Calling in the state archaeological authority if a find is suspected, and taking any action they require ensuring its removal or protection in situ.

110. There are no modern-day social and cultural resources (such as schools and hospitals) near the site, and no areas that are used for religious or other purposes, so there is no risk of other impacts on such community assets.

111. Although this is not a major residential area, there are some living quarters in the vicinity of the site, so action should be taken to minimise disturbance as far as possible. This will require:

- Consultation with the local community to inform them of the nature, duration and likely effects of the construction work, and to identify any local concerns so that these can be addressed;
- Involving the community in planning the work programme so that any particularly noisy or otherwise invasive activities can be scheduled to avoid sensitive times;
- Avoiding conducting noise-generating activities at night;
- Implementing the measures described in Section V.B.2 above to reduce dust;
- Utilising modern vehicles and machinery with the requisite adaptations to limit noise and exhaust emissions, and ensuring that these are maintained to manufacturers' specifications at all times.

112. There is invariably a safety risk when substantial construction such as this is conducted in an urban area, and precautions will thus be needed to ensure the safety of both workers and citizens. The Contractor will be required to produce and implement a site Health and Safety Plan, and this should include such measures as:

- Excluding the public from the site;
- Ensuring that all workers are provided with and use appropriate Personal Protective Equipment;
- Health and Safety Training for all site personnel;
- Documented procedures to be followed for all site activities;
- Accident reports and records; Etc.

113. An additional, particularly acute health risk derives from the fact that, as mentioned above, the existing water supply system comprises mainly AC pipes, so there is a risk of contact with carcinogenic material if these pipes are uncovered in the course of the work. Precautions have already been introduced into the design of the project to avoid this, of which the most important is that:

- The locations of all new infrastructures will be planned to avoid locations of existing AC pipes so AC pipes should not be discovered accidentally.

114. Given the dangerous nature of this material for both workers and the public, additional precautions should be taken to protect the health of all parties in the event (however unlikely) that AC pipes are encountered. The design consultant should therefore develop a protocol to be applied in any instance that AC pipes are found, to ensure that appropriate action is taken. This should be based on the approach recommended by the United States Environmental Protection Agency (USEPA)², and amongst other things, should involve:

- Training of all personnel (including manual labourers) to enable them to understand the dangers of AC pipes and to be able to recognize them in situ;
- Reporting procedures to inform management immediately if AC pipes are encountered;
- Development and application of a detailed H&S procedure to protect both workers and citizens. This should comply with national and international standards for dealing with asbestos, and should include:
 - Removal of all persons to a safe distance;
 - Usage of appropriate breathing apparatus and protective equipment by persons delegated to deal with the AC material;
 - Procedures for the safe removal and long-term disposal of all asbestos-containing material encountered.

115. Finally, there could be some short-term socio-economic benefits from the construction work if local people are able to gain employment in the construction workforce. To direct these benefits to the communities directly affected by the work, the Contractor should be required to employ at least 50% of his labour force from communities in the vicinity of the site. This will have the added benefit of avoiding social problems that sometimes occur when workers are imported into host communities, and avoiding environmental and social problems from workers housed in poorly serviced camp accommodation.

² In the USA, standards and approaches for handling asbestos are prescribed by the Occupational Health and Safety Administration (OHSA) and the Environmental Protection Agency (EPA) and can be found at <http://www.osha.gov/SLTC/asbestos>

VI. POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES: OPERATION AND MAINTENANCE

A. Screening out Areas of No Significant Impact

116. Because roads and bridges generally operate without the need for major repair and maintenance (see below), there are several environmental sectors that should be unaffected once the new ROB begins to function. These are identified in **Table 6.1** below, with an explanation of the reasoning in each case. These factors are thus screened out of the impact assessment and will not be mentioned further.

Table 6.1: Fields in which operation and maintenance of the completed road improvement is not expected to have significant impacts

Field	Rationale
Climate	Exhaust gases affect air quality but a new road does not alter climate
Fisheries & aquatic biology	There are no rivers or lakes close to the ROB site
Wildlife, forests, rare species, protected areas	No wildlife and forest near location of ROB
Coastal resources	Barmer is not located in a coastal area

B. Operation and Maintenance of the New ROB

117. The new ROB will have a design life of 25- 30 years, during which time it should require no major repair or refurbishment, beyond routine maintenance, which will include:

- Small scale *ad hoc* repairs of surface damage caused by traffic use or accidents;
- Repairs and replacement of damaged safety barriers and signs;
- Regular unblocking of drains to prevent damage from flooding in the monsoon.

118. The stability and integrity of the bridge should also be monitored periodically to detect any problems and allow remedial action if required.

119. These operations will be the responsibility of the municipal highway department, who will be given training by this programme and provided with an operating budget for these purposes.

C. Environmental Impacts and Benefits of the Operating ROB

1 Physical Resources

120. Once the ROB is completed and operating it will improve the physical environment by removing the severe traffic congestion that is such a feature of this location at present, with the resulting concentration of vehicle noise and pollution. This will be replaced by a modern elevated roadway, which allows the maintenance of a smooth flow of traffic into and out of the town and avoids the obstruction created by the former level crossing.

121. The ROB will however elevate the traffic above 8 m above ground level, making the traffic and the structure significantly more visible than at present. This would not necessarily be a negative visual impact if the scheme included measures to mask the structure and give it a more pleasing appearance, for example by planting large-growing native trees at the periphery. As well as a visual screen this would also provide a natural barrier to noise, dust and exhaust gases so the planting of trees should be incorporated into the scheme.

122. When routine repairs are conducted to the road and ancillary facilities (signage, etc), the work will be very small in scale, and conducted manually by small teams of men with simple equipment (shovels, wheelbarrows, tarmac blender, etc). Even if larger vehicles are used to refurbish larger portions of the road the work will be very short in duration and will not cause significant physical impacts.

123. Although the ROB is located in an area of seismic risk, it will be designed according to standard Indian Engineering Design Codes, which include measures to allow the structure to withstand tremors of the expected magnitude and above. There should therefore be little risk of the structure failing, even if the area is subject to seismic events of greater magnitude than those that have occurred over recent years.

2 Ecological Resources

124. As there are no significant ecological resources in or around the town, the operation of the ROB and the routine maintenance and repair of the road and surroundings will have no ecological impacts. There would be some small ecological gain from the planting of trees to mask the visual impact of the structure.

3 Economic Development

125. The ROB will improve the infrastructure of the town by providing a more efficient and effective transportation route, and this should have positive impacts on the overall economy by reducing time spent idle in stationary traffic by delivery vehicles, employees and customers. It may also make further positive contributions to the development of particular sectors, for example by making the area more attractive to tourists and allowing the more efficient transportation of agricultural produce and other goods to and from the town.

126. Traffic may be interrupted temporarily if the road or bridge is repaired and maintained, but this work will be very small in scale, infrequent, and short in duration, so there should be no economic or other implications. To maintain the safety of workers and road-users, such work should be coordinated with the local police department so that adequate warning signs and traffic diversions can be set up when necessary.

4 Social and Cultural Resources

127. Effects of the operating ROB on social and cultural resources in the town will be relatively small in scale and intangible in nature, and are thus difficult to assess and quantify.

128. The citizens of the town will benefit from a more effective transportation route as they will spend less time in stationary traffic exposed to noise, pollution and the associated physical and psychological stresses. People may also benefit from an improvement in the economy of the town, although it would require much larger improvements in transportation and other infrastructure for this to be recordable.

129. Repairs to the road and bridge will not be physically invasive so there are no areas or resources of social or cultural importance in the vicinity and therefore there will be no risk to historical remains

VII. INSTITUTIONAL REQUIREMENTS AND ENVIRONMENTAL MONITORING PLAN

A. Summary of environmental impacts and mitigation measures

130. **Table 7.1** lists the potential adverse impacts of the Barmer transportation subproject as identified and discussed in Sections IV, V and VI, and the mitigation proposed to reduce these impacts to acceptable levels. The table also shows how the mitigation will be implemented, who will be responsible, and where and when the mitigation activities will take place. The mitigation programme is shown as the quarter of each year in which each activity will occur, which relates to the project programme described in Section II.B. The final column assesses whether the proposed action will successfully mitigate the impact (shown as 0), and indicates that some of the measures will provide an additional benefit (shown as +).

B. Institutional arrangements for project implementation

131. The main agencies involved in managing and implementing the subproject are,

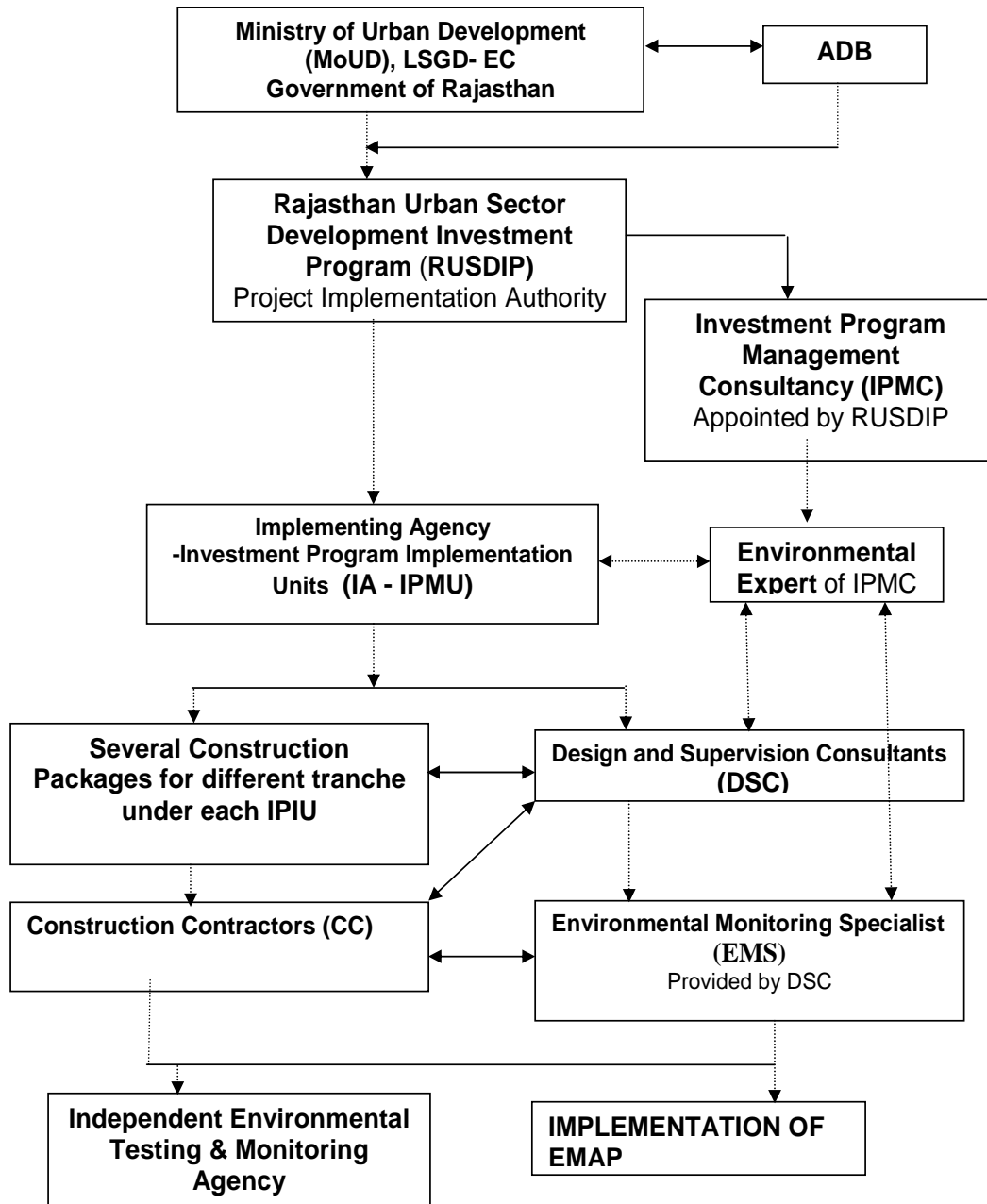
- LSGD is the Executing Agency (EA) responsible for management, coordination and execution of all activities funded under the loan.
- The Implementing Agency (IA) is the Project Management Unit of the ongoing RUIDP, which will be expanded to include a broader range of skills and representation from the Urban Local Bodies (ULB, the local government in each town). Assigned as the RUSDIP Investment Program Management Unit (IPMU), this body will coordinate construction of subprojects across all towns, and ensure consistency of approach and performance.
- The IPMU will be assisted by Investment Program Management Consultants (IPMC) who will manage the program and assure technical quality of design and construction; and Design and Supervision Consultants (DSC), who will design the infrastructure, manage tendering of Contractors and supervise the construction process.
- Investment Program Implementation Units (IPIU) will be established in seven zones across the State to manage implementation of subprojects in their area. IPIUs will be staffed by professionals seconded from government departments (PHED, PWD), ULBs, and other agencies, and will be assisted by consultants from the IPMC and DSC as necessary.
- The IPMU will appoint Construction Contractors (CC) to build elements of the infrastructure in a particular town. The CCs will be managed by the IPIU, and construction will be supervised by the DSC.
- LSGD will be assisted by an inter-ministerial Empowered Committee (EC), to provide policy guidance and coordination across all towns and subprojects. The EC will be chaired by the Minister of Urban Development and LSG, and

members will include Ministers, Directors and/or representatives of other relevant Government Ministries and Departments.

- City Level Committees (CLCs) have also been established in each town, chaired by the District Collector, with members including officials of the ULB, local representatives of state government agencies, the IPIU, and local NGOs and CBOs. The CLCs will monitor project implementation in the town and provide recommendations to the IPIU where necessary.

132. **Figure 7.1** shows institutional responsibility for implementation of environmental safeguard at different level.

Figure 7.1: Institutional Responsibility- RUSDIP



**Table 7.1: Environmental impacts and mitigation for the Barmer Transportation Subproject
(Black = continuous activity; Grey = intermittent)**

Potential Negative Impacts	Sig	Dur	Mitigation Activities and Method	Responsibility	Location	08	2009				2010			3	
						D	1	2	3	4	1	2	Op		
Construction: Road Over Bridge															
Excavation of material to fill access ramps will change drainage, air & soil quality, topography at extraction site	M	P	Use waste sand and stone from sewerage subproject and material dug to create bridge pier foundations	DSC and Contractor	STP/ROB										+
Transporting sand and building ramps could create dust	M	T	Use tarpaulins to cover sand when carried on trucks	Contractor	On/off site										0
			Spray ramps and soil stockpiles with water in dry weather	Contractor	ROB site										0
Dust could be blown from soil stockpiled on site	M	T	Excavate foundations at same time as ramps are built so that dug soil can be used immediately without stockpiling	Contractor	ROB site										0
Rain may collect in dug areas and wash soil off stockpiles	M	T	Conduct excavation and ground works in dry season	Contractor	ROB site										0
Some owners will lose land needed for the project	M	P	*Purchase land as described in Resettlement Framework	LSGD	ROB site										0
			Avoid taking >10% of the total land of any occupant	DSC	ROB site										0
Some business premises may need to be removed	M	P	*Compensate business owners/tenants for lost income	LSGD	ROB site										0
			*Compensate owners for lost income-generating assets											0	
Shops that remain may lose income if access is difficult for customers	M	T	*Compensate owners/tenants for lost business income	LSGD	ROB site										0
			Keep road closure to minimum (frequency, duration)	Contractor	ROB site									0	
			Maintain vehicle and pedestrian access when possible										0		
Road and rail traffic will be disrupted by construction work	M	T	Plan work with road, rail and town authorities and police	DSC and Contractor	ROB site										0
			Keep road and railway closures to a minimum	Contractor	ROB site									0	
			Maintain safe passage of vehicles/pedestrians at all times										0		
			Provide effective diversions & alternative routes if needed										0		
			Conduct work that requires road and railway closure at times when traffic volume is low										0		

Sig = Significance of Impact (NS = Not Significant; M = Moderately Significant; S = Significant). Dur = Duration of Impact (T = Temporary; P = Permanent)

D = Detailed Design Period; Op = Period when infrastructure is operating

³ This column shows impacts remaining after mitigation: 0 = zero impact (impact successfully mitigated); + = positive impact (mitigation provides a benefit)

* Mitigation of these impacts will be provided through a separate Resettlement Plan, see Section VII.B

133. Resettlement issues will be coordinated centrally by a Resettlement Specialist within the IPMU, who will ensure consistency of approach between towns. A local Resettlement Specialist will also be appointed to IPIUs of zones in which there are resettlement impacts and they will prepare and implement local Resettlement Plans following the framework established in Tranche 1.

134. Environmental issues will be coordinated by an Environmental Specialist within the IPMU/ IPMC, who will ensure that all subprojects comply with environmental safeguards. An Environmental Monitoring Specialist (EMS) who is part of the DSC team will implement the Environmental Monitoring Plan from each IEE (see below), to ensure that mitigation measures are provided and protect the environment as intended. Domestic Environmental Consultants (DEC) will be appointed by each IPIU to update the existing IEEs in the detailed design stage, and to prepare IEEs or EIAs for new subprojects, where required to comply with national law and/or ADB procedure.

C. Environmental Monitoring Plan

135. **Table 7.1** shows that most mitigation activities are the responsibility of the Construction Contractors (CC) employed to build the infrastructure during the construction stage or the O&M Contractors employed to conduct maintenance or repair work when the system is operating. Responsibility for the relevant measures will be assigned to the Contractors via the contracts through which they are appointed (prepared by the DSC during the detailed design stage), so they will be legally required to take the necessary action. There are also some actions that need to be taken by LSGD in their role as project proponent, and some actions related to the design that will be implemented by the DSC.

136. A program of monitoring will be conducted to ensure that all parties take the specified action to provide the required mitigation, to assess whether the action has adequately protected the environment, and to determine whether any additional measures may be necessary. This will be conducted by a qualified Environmental Monitoring Specialist (EMS) from the DSC. The EMS will be responsible for all monitoring activities and reporting the results and conclusions to the IPMU, and will recommend remedial action if measures are not being provided or are not protecting the environment effectively. The EMS may be assisted by environmental specialists in particular technical fields, and junior or medium-level engineers who can make many of the routine observations on site. Post-construction monitoring will be conducted by the relevant Government Agency (GA) to whom responsibility for the infrastructure will pass once it begins to operate⁴.

137. **Table 7.1** shows that most of the mitigation measures are fairly standard methods of minimising disturbance from building in urban areas (maintaining access, planning work to avoid sensitive times, finding uses for waste material, etc), and experienced Contractors should be familiar with most of the requirements. Monitoring of such measures normally involves making observations in the course of site visits, although some require more formal checking of records and other aspects. There will also be some surveys of residents, as most of the measures are aimed at preventing impacts on people and the human environment.

⁴ In the operational period some infrastructure will be the responsibility of the Municipal Boards/Councils, whilst others will be the responsibility of the appropriate branch of the State government (such as PWD, PHED, etc)

138. **Table 7.3** shows the proposed Environmental Monitoring Plan (EMP) for this subproject, which specifies the various monitoring activities to be conducted during all phases. Some of the measures shown in **Table 7.1** have been consolidated to avoid repetition, and there has been some re-ordering to present together those measures that relate to the same activity or site. The EMP describes: (i) mitigation measures, (ii) location, (iii) measurement method, (iv) frequency of monitoring and (v) responsibility (for both mitigation and monitoring). It does not show specific parameters to be measured because as indicated above, most measures will be checked by simple observation, by checking of records, or by interviews with residents or workers.

D. Environmental management and monitoring costs

139. Most of the mitigation measures require the Construction Contractors (CC) to adopt good site practice, which should be part of their normal procedures already, so there are unlikely to be major costs associated with compliance. Regardless of this, any costs of mitigation by the CC or DSC are included in the budgets for the civil works and do not need to be estimated separately here. Mitigation that is the responsibility of LSGD will be provided as part of their management of the project, so this also does not need to be duplicated here. Costs of acquiring land and compensating businesses for loss of income during the construction period (**Table 7.1**) are calculated separately in the budgets for the Resettlement Framework and Resettlement Plans so are also excluded from this analysis.

140. The remaining actions in the Environmental Management Plan are the various environmental monitoring activities to be conducted by the EMS. These have not been budgeted elsewhere, and their costs are shown in **Table 7.3**. The figures show that the total cost of environmental management and monitoring for this subproject as a whole (covering design and construction) is INR 0.79 million, ie US\$ 18372.

Table 7.2: Environmental management and monitoring costs (INR)

Item	Quantity	Unit Cost	Total Cost	Sub-total
1. Implementation of EMP (2 years)				
Domestic Environmental Monitoring Specialist	1 x 3 month	130,000 ⁵	390,000	
Survey Expenses	LumpSum	150,000	150,000	540,000
2. improvement of aesthetics including plantation	LumpSum	2,50,000	2,50,000	2,50,000
TOTAL				790,000

⁵ Unit costs of domestic consultants include fee, travel, accommodation and subsistence

Table 7.3: Environmental Monitoring Plan

Mitigation Activities and Method	Location	Responsible for Mitigation	Monitoring Method	Monitoring Frequency	Responsible for Monitoring
CONSTRUCTION					
Use waste sand/stone from STP ponds and bridge foundations	STP/ROB site	DSC/CC	Site observations; CC records	Monthly	EMS
Use tarpaulins to cover sand when carried on trucks	On/off site	CC	Observations on/off site	Weekly	EMS
Spray soil ramps and stockpiles with water in dry weather	ROB site	CC	Site observations	Weekly	EMS
Excavate foundations at same time as ramps are built	ROB site	CC	Site observations	Monthly	EMS
Conduct excavation and ground works in dry season	ROB site	CC	Site observations	Monthly	EMS
*Purchase land as described in Resettlement Framework	ROB site	LSGD	Landowner surveys; LSGD records	As needed	IMA ⁶
Avoid taking >10% of the total land of any occupant	ROB site	DSC	Landowner survey; DSC records	As needed	IMA
*Compensate business owners/tenants for lost income	ROB site	LSGD	Owner/tenant surveys; LSGD records	As needed	IMA
*Compensate owners for lost income-generating assets	ROB site	LSGD	Owner surveys; LSGD records	As needed	IMA
Keep road and rail closure to a minimum frequency and duration	ROB site	CC	Site observations; CC records	Monthly	EMS
Maintain vehicle and pedestrian access when possible	ROB site	CC	Site observations; shopkeeper survey	Weekly	EMS
Plan work with road, rail and town authorities and police	ROB site	DSC/CC	Design reports	Monthly	EMS
Maintain safe passage of vehicles and pedestrians at all times	ROB site	CC	Site observations; CC records	Weekly	EMS
Provide effective diversions and alternative routes if needed	ROB site	CC	Site observations; CC records	Weekly	EMS
Conduct work requiring road/railway closure at times of low traffic	ROB site	CC	Site observations; CC records	Weekly	EMS
Conduct work near railway at times when trains are fewer	ROB site	CC	Site observations; CC records	Weekly	EMS
Schedule sand deliveries by truck for periods of low traffic	ROB site	CC	Site observations; CC records	Weekly	EMS
Determine locations of infrastructure and design scheme to avoid	ROB site	DSC	DSC records; design reports	As needed	EMS
Locate different infrastructure on opposite sides of roads	ROB site	DSC	Site observation; design reports	Monthly	EMS
Integrate subprojects to conduct excavation at same time	ROB site	DSC/LSGD	Site observation; design reports	Monthly	EMS
Request archaeological authorities to assess potential of all sites	ROB site	DSC	DSC records; design reports	As needed	EMS
Select alternatives if sites have medium or high potential	ROB site	DSC	DSC records; design reports	As needed	EMS
Include state and town historical authorities as stakeholders	ROB site	LSGD	LSGD records; meeting records	As needed	EMS
Develop and apply archaeological protocol to protect chance finds	ROB site	DSC/CC	DSC and CC records; site observations	Weekly	EMS

⁶ Resettlement issues (asterisked) will be monitored by an Independent Monitoring Agency (IMA) established under the Resettlement Framework

Mitigation Activities and Method	Location	Responsible for Mitigation	Monitoring Method	Monitoring Frequency	Responsible for Monitoring
Inform community of work in advance and address their concerns	ROB site	CC	CC records; resident surveys	Monthly	EMS
Plan work with the community; avoid working at sensitive times	ROB site	CC	Resident surveys; site observations	Weekly	EMS
Avoid conducting noise-generating activities at night	ROB site	CC	Resident surveys; site observations	Weekly	EMS
Use modern vehicles and machinery and maintain as specified	ROB site	CC	Site observations; CC records	Monthly	EMS
Prepare and implement a site H&S Plan including personal protection from transmission of HIV/AIDS (safety of workers/public)	ROB site	CC	Site observations; CC records	Monthly	EMS
Exclude public from the site	ROB site	CC	Site observations; CC records	Monthly	EMS
Ensure that workers wear Personal Protective Equipment	ROB site	CC	Site observations; CC records	Monthly	EMS
Provide Health and Safety training including process of transmission of HIV/AIDS for all personnel	ROB site	CC	CC records; worker interviews	Monthly	EMS
Follow documented procedures for all site activities	ROB site	CC	Site observations; CC records	Monthly	EMS
Keep accident reports and records	ROB site	CC	CC records	Monthly	EMS
Design infrastructure to avoid known locations of AC pipes	All sites	DSC	DSC records; design reports	As needed	EMS
Train all personnel in dangers and recognition of AC pipes	All sites	CC	Site observations; CC records	Monthly	EMS
Develop and apply protocol if AC pipes are encountered	All sites	DSC/CC	DSC & CC records; site observations	Weekly	EMS
If AC pipes are encountered, report to management immediately	All sites	CC	Site observations; CC records	Weekly	EMS
Remove all persons to safe distance	All sites	CC	Site observations; CC records	Weekly	EMS
Workers handling AC: wear breathing apparatus; protective suits	All sites	CC	Site observations; CC records	Weekly	EMS
All AC material must be removed and disposed of safely	All sites	CC	Observations on and off site; CC records	As needed	EMS
Employ at least 50% of workforce from communities near sites	ROB site	CC	CC records; worker interviews	Monthly	EMS
OPERATION AND MAINTENANCE					
Plant and maintain large growing native trees at periphery of site	ROB site	DSC/CC	Site observations; CC records	As needed	EMS
Coordinate repairs with police – provide warning signs/diversions	ROB site	OMC	Site observations	As needed	GA

VIII. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

A. Project stakeholders

141. Most of the main stakeholders have already been identified preliminary. If any other stakeholders that are identified during project implementation will be brought into the process in the future. Primary stakeholders are:

- Residents, shopkeepers and businesspeople who live and work alongside the roads in which network improvements will be provided and near sites where facilities will be built
- Owners and users of any land that is acquired along the transmission main route;
- Custodians and users of socially and culturally important buildings in affected areas;
- State and local authorities responsible for the protection and conservation of archaeological relics, historical sites and artefacts;
- State and local tourism authorities.

142. Secondary stakeholders are:

- LSGD as the Executing Agency;
- Other government institutions whose remit includes areas or issues affected by the project (state and local planning authorities, Department of Public Health Engineering, Local Government Dept, Ministry of Environment and Forests, Roads and Highways Division, etc);
- NGOs and CBOs working in the affected communities;
- Other community representatives (prominent citizens, religious leaders, elders, women's groups);
- The beneficiary community in general; and
- The ADB.

B. Consultation and disclosure to date

143. Some informal discussion was held with the local people during site visit. Issues discussed are

- Awareness and extent of the project and development components
- Benefits of Project for the economic and social upliftment of Community
- Labour availability in the Project area or requirement of outside labour involvement

- Local disturbances due to Project Construction Work
- Necessity of tree felling etc. at project sites
- Water logging and drainage problem if any
- Drinking water problem
- Forest and sensitive area nearby the project site
- Movement of wild animals etc.

144. Local populations are very much interested on the project and they will help project authorities in all aspects. Public consultation results specifically on environmental issues are shown in **Appendix 3**.

145. Major concerns were made on the necessity of adequate access road during construction and the possible dust and noise problems during construction phase. Also some concerns made on the necessity of proper safety arrangements. Hence necessary provisions shall be provided to avoid the traffic snarls during the construction.

146. The public Consultation and group discussion meeting were conduct by RUIDP on Date 7 June, 2008 after advertising in Local NEWS papers. The objective of the meeting was to appraise the stakeholders about the environmental and social impacts of the proposed program and the safeguards provided in the program to mitigate the same. In the specific context of Barmer, the environmental and social impacts of the proposed subprojects under Tranche 2 in Barmer were discussed.

147. Meetings and individual interviews were held at potentially temporarily affected areas; and local informal interviews were conducted to determine the potential impacts of sub-project construction to prepare the sample Environmental Framework. A town-wise stakeholder consultation workshop was conducted which provided an overview of the Program and sub-projects to be undertaken in Barmer; and discussed the Government and ADB's Environment policies acts and potential environment impacts of the sub-projects in Barmer. During the workshop, Hindi versions of the Environmental Framework were provided to ensure participants understood the objectives, policy principles and procedures related to Environment, English and Hindi versions of the Environmental Framework have been placed in the Urban Local Body (ULB) office and Environmental Framework will be provided later on. The NGO to be engaged to implement the Mitigation Measures will continue consultations, information dissemination, and disclosure. The Environmental Framework will be made available in the ULB office, Investment Program Project Management Unit and Implementation Unit (IPMU and IPIU) offices, and the town library. The finalized IEE containing Mitigation Measures will also be disclosed in ADB's website, the State Government website, the local government website, and the IPMU and IPIU websites. ADB review and approval of the RP is required prior to award of civil works contracts.

C. Major Issues discussed during Public consultation are

- (I) Proposed ROB sub project is to ensure proper movement of city traffic round the clock
- (II) Executive agency should give preference to engage internationally reputed contractor like Gammon, HCC, etc as people do not have faith about the local contractors in respect of quality of works as well as timely completion of work;
- (III) Livelihood affected households should be given assistance in the mode of cash compensation;
- (IV) Local people should be employed by the contractor during construction work;
- (V) Adequate safety measures should be taken during construction work;
- (VI) Mobile kiosks/vendors/hawkers have shown willingness to shift in nearby places without taking any compensation and assistance from the Executing Agency;
- (VII) Local people have appreciated the ROB proposal of the government and they have ensured that they will cooperate with the Executing Agency during project implementation.

D. Future consultation and disclosure

148. LSGD will extend and expand the consultation and disclosure process significantly during implementation of RUSDIP. They will appoint an experienced NGO to handle this key aspect of the programme, who will conduct a wide range of activities in relation to all subprojects in each town, to ensure that the needs and concerns of stakeholders are registered, and are addressed in project design, construction or operation where appropriate. The programme of activities will be developed during the detailed design stage, and is likely to include the following:

- Consultation during detailed design:
 - Focus-group discussions with affected persons and other stakeholders (including women's groups, NGOs and CBOs) to hear their views and concerns, so that these can be addressed in subproject design where necessary;
 - Structured consultation meetings with the institutional stakeholders (government bodies and NGOs) to discuss and approve key aspects of the project.
- Consultation during construction:
 - Public meetings with affected communities to discuss and plan work programmes and allow issues to be raised and addressed once construction has started;

- Smaller-scale meetings to discuss and plan construction work with individual communities to reduce disturbance and other impacts, and provide a mechanism through which stakeholders can participate in subproject monitoring and evaluation;
- Project disclosure:
 - Public information campaigns (via newspaper, TV and radio) to explain the project to the wider city population and prepare them for disruption they may experience once the construction programme is underway;
 - Public disclosure meetings at key project stages to inform the public of progress and future plans, and to provide copies of summary documents in Hindi;
 - Formal disclosure of completed project reports by making copies of IEE available at convenient locations in the study towns, informing the public of their availability, and providing a mechanism through which comments can be made.

IX. FINDINGS AND RECOMMENDATIONS

A. Findings

149. The Project is designed to improve the quality of life of small town residents and enhance the small towns' roles as market, services, and manufacturing centers. . It has a strong community development focus reinforced by integrated poverty reduction, health and hygiene improvement investment projects. Moreover, urban residents including nearby the rural residents in surrounding hinterland will benefit from improved roads and bridges allowing better access to urban markets and social services provided in the Project towns. The towns' economies will benefit from enhanced productivity as a result of health improvement, time savings in collecting water, as well as from increased urban efficiency arising from improved roads, bridges, drainage, drinking water and sanitation.

150. During project design, community meetings were held with beneficiaries to discuss sanitation, poverty, resettlement, affordability issues, and environmental concerns. Socioeconomic surveys obtained information and individual views on current situations and future preferences. Potential environmental impacts of urban infrastructure improvements are mainly short-term during the construction period and can be minimized by the proposed mitigating measures and environmentally sound engineering and construction practices.

151. The process described in this document has assessed the environmental impacts of the infrastructure proposed under the Barmer Urban Transport and Roads Subproject. Potential negative impacts were identified in relation to both construction and operation of the improved infrastructure, but no impacts were identified as being due to either the project design or location. Mitigation measures have been developed to reduce all negative impacts to acceptable levels. These were discussed with specialists responsible for the engineering aspects, and as a result some measures have already been included in the outline designs for the infrastructure. These include:

- Locating all design components within the ROW of existing roads, to avoid the need to acquire land or relocate people;
- Locating pipelines on unused land adjacent to roads wherever possible, to avoid damaging roads and disrupting traffic and other activities.

152. This means that the number of impacts and their significance has already been reduced by amending the design.

153. A change has also been made to the location of elements of the project to further reduce impacts. This is to:

- Locate as much of the proposed road improvement within the ROW of the existing roads and rail line to reduce the need to acquire land and avoid relocating people.

154. Regardless of these and various other actions taken during the IEE process and in developing the project, there will still be impacts on the environment when the ROB is built and when it is operating. This is mainly because of the relatively large size of the structure, its location at a busy road and rail intersection, and the fact that the work involves some excavation so there could be a risk of uncovering historical remains from the rich cultural history of Rajasthan. Because of these factors the most significant impacts are on the physical environment, the human environment, and the cultural heritage.

155. During the construction phase, impacts mainly arise from the need to import a large quantity of waste soil to fill RCC box-units built to raise the level of the approach roads, and because the work will inevitably cause some disruption to road and rail traffic. These are common impacts of construction in urban areas, and there are well developed methods for their mitigation. These include:

- Covering soil during transportation and when stored on site;
- Watering exposed soil during dry and windy weather;
- Planning work with the appropriate authorities to minimise disruption of road/rail traffic.

156. There could also be a need to acquire a small amount of land at the periphery of the site, which includes a thin strip inside the boundary of some establishments. Such impacts are also frequently encountered and are dealt with by a combination of the legal process and additional measures required by ADB policy on Involuntary Resettlement. Actions are discussed in a separate Resettlement Plan and Resettlement Framework, and include:

- Acquisition of land through the Gol Land Acquisition Act, through which the market value is paid, based on an analysis of recent transactions;
- Ensuring that no more than 10% of the land of a single owner or occupant is acquired;
- Providing additional compensation for loss of business and income-generating assets.

157. One field in which impacts are much less routine is archaeology, and here a series of specific measures have been developed to avoid damaging important remains. These include:

- Assessing the archaeological potential of the site, and selecting an alternative subproject if the site is considered to be of medium or high risk;
- Including archaeological, cultural and historical authorities and interest groups as project stakeholders to benefit from their expertise;
- Developing a protocol for use in conducting all excavation to ensure that any chance finds are recognised, protected and conserved.

158. Special measures were also developed to protect workers and the public from exposure to carcinogenic asbestos fibres in the event that Asbestos Cement pipes used in the existing water supply system are uncovered accidentally during excavation work. These are to:

- Avoid all known sites of AC pipes when the locations of new infrastructure are planned in the detailed design stage;
- Train all construction personnel to raise awareness of the dangers of AC and enable early recognition of such pipes if encountered;
- Develop and apply a protocol to protect workers and the public if AC pipes are encountered (including evacuation of the immediate area, use of protective equipment by workers, and safe removal and disposal of AC material).

159. There were limited opportunities to provide environmental enhancements, but certain measures were included. For example it is proposed that the project will:

- Employ in the workforce people who live in the vicinity of the construction site to provide them with a short-term economic gain;
- Plant large-growing trees at the periphery of the site to mask it from view and give it a more natural and pleasing appearance.

160. These and the other mitigation and enhancement measures are summarised in **Table 7.1**, which also shows the location of the impact, the body responsible for the mitigation, and the programme for its implementation.

161. Once the ROB is completed, it will operate with routine maintenance (such as occasional repairs of the road, safety barriers and signs), which will be small-scale, infrequent and short in duration and should not affect the environment. The only mitigation required in this period is to plan any maintenance work with the town authorities and police to ensure adequate precautions are taken to maintain the safety of workers and road users.

162. The main impacts of the operating ROB will be beneficial in improving the infrastructure of the town by providing a more efficient and effective transport route, which should improve the overall economy by reducing time spent idle in traffic by delivery vehicles, employees and customers. The general environment will also be improved at this location as the daily concentration of vehicular noise and pollution from exhaust gases will be removed.

163. **Table 7.1** also assesses the effectiveness of each mitigation measure in reducing each impact to an acceptable level. This is shown as the level of significance of the residual impact (remaining after the mitigation is applied). This shows that all impacts will be rendered at least neutral (successfully mitigated), and that certain measures will produce a benefit (in addition to the major benefits provided by the operating schemes).

164. Mitigation will be assured by a programme of environmental monitoring conducted during both construction and operation to ensure that all measures are provided as intended, and to determine whether the environment is protected as envisaged. This will include observations on and off site, document checks, and interviews with workers and beneficiaries, and any requirements for remedial action will be reported to the IPMU.

B. Recommendations

165. There are two straightforward but essential recommendations that need to be followed to ensure that the environmental impacts of the project are successfully mitigated. These are that LSGD should ensure that:

- All mitigation, compensation and enhancement measures proposed in this IEE report (**Table 7.1**) and in the Resettlement Framework for the RUSDIP are implemented in full, as described in these two documents;
- The Environmental Monitoring Plan proposed in Section VII.C of this report and the internal and external monitoring proposed in the Resettlement Framework are also implemented in full.

X. CONCLUSIONS

166. The environmental status of the proposed improvements in urban transport and road (ROB) sector in Barmer Town has been assessed. Issues related to Involuntary Resettlement were assessed by a parallel process of resettlement planning and will be compensated by measures set out in detail in the Resettlement Framework for the subproject.

167. The overall conclusion of the above process is that provided the mitigation, compensation and enhancement measures are implemented in full, there should be no significant negative environmental impacts as a result of location, design, construction or operation of the subproject. There should in fact be some small benefits from recommended mitigation and enhancement measures, and major improvements in quality of life and individual and public health once the scheme is in operation.

168. There are no uncertainties in the analysis, and no further studies are required to comply with ADB procedure or national law.

Appendix 1
Photo gallery

Photo gallery Barmer ROB



Site for Proposed ROB



Empty land along the Roads near ROB site



Day Time traffic on Railway Crossing



Site for Proposed ROB



Site for Proposed ROB

APPENDIX 2: RAPID ENVIRONMENTAL ASSESSMENT (REA) CHECKLIST

Country/Project Title: India/Rajasthan (Barmer) Urban Sector Development Investment Programme (Tranche-II).

Sub-Project: Construction of ROB in Barmer

SCREENING QUESTIONS	Yes	No	REMARKS
A. Project Siting			There is no protected/environmental sensitive area along the proposed ROB.
Is The Project Area...			
▪ Densely Populated?		No	
▪ Heavy with Development Activities?		No	
▪ Adjacent to or Within Any Environmentally Sensitive Areas?		No	
• Cultural Heritage Site		No	
• Protected Area		No	
• Wetland		No	
• Mangrove		No	
• Estuarine		No	
• Buffer Zone of Protected Area		No	
• Special Area for Protecting Biodiversity		No	
• Bay		No	
B. Potential Environmental Impacts		No	
Will The Project Cause...			

SCREENING QUESTIONS	Yes	No	REMARKS
<ul style="list-style-type: none"> ▪ Encroachment on historical/cultural areas; disfiguration of landscape by road embankments 		No	There is no historical/cultural areas and landscape in the project area.
<ul style="list-style-type: none"> ▪ Encroachment of precious ecology (e.g sensitive or protected areas) 		No	There is no encroachment on precious ecology in this area, only few trees may be impacted. There is one water pond "Jader" near this ROB. This pond is dry hence there will be no impact on this pond due to construction of ROB.
<ul style="list-style-type: none"> ▪ Alteration of surface water hydrology of waterways crossed by roads, resulting in increased sediments in streams affected by increased soil erosion at 		No	There is no surface water resources exist in this area.
<ul style="list-style-type: none"> ▪ Deterioration of surface water quality due to silt runoff and sanitary wastes from workers based camps. 		No	There is no surface water resources exist in this area.
<ul style="list-style-type: none"> ▪ Increase local air pollution due to rock crushing cutting and filling works, and chemicals from asphalt processing. 	Yes		During construction phase there will be increased air pollution due to asphalt processing and rock cutting. The location of asphalt processing and rock cutting machinery will be established far from human settlements and any environmental sensitive location to avoid impacts from increased air pollution.
<ul style="list-style-type: none"> ▪ Noise and vibration due to blasting and other civil works. 		No	There is no blasting work involved in ROB construction.
<ul style="list-style-type: none"> ▪ Dislocation or involuntary resettlement of people. 		No	No resettlement is involved in this project.
<ul style="list-style-type: none"> ▪ Other social concerns relating to inconveniences in living condition in the project areas that may trigger cases of upper respiratory problems and stress. 		No	Project site is located far from residential area. There will be decrease in air pollution in this area once this bridge will be in operation as there will be no hindrance in traffic movement.
<ul style="list-style-type: none"> ▪ Hazardous driving conditions where construction interferes with pre-existing roads. 		No	Contractor will provide alternate road during period of construction and maintain traffic management to avoid any hazardous driving condition.

SCREENING QUESTIONS	Yes	No	REMARKS
<ul style="list-style-type: none"> ▪ Poor sanitation and solid waste disposal in construction camps and work sites, and possible transmission of communicable diseases from workers to local population. 		No	Local labour will be employed for this work if required then contractor will provide all necessary facilities in workers camp to avoid any sanitation and solid waste disposal problem.
<ul style="list-style-type: none"> ▪ Creation of temporary breeding habitats for mosquito vectors of diseases. 		No	Climate of this area is dry and desert type. Also this is a water scare area. There are no chances of creation of temporary breeding habitat for mosquito vectors during construction period of ROB.
<ul style="list-style-type: none"> ▪ Dislocation and compulsory resettlement of people living in right of way. 		No	There is no settlement in Right of way (ROW) hence no need of compulsory resettlement of people living in ROW.
<ul style="list-style-type: none"> ▪ Accident risks associated with increased vehicular traffic, leading to accidental spills of toxic materials and loss of life. 		No	There are not much increase in traffic volume. During construction period contractor will take all precaution to avoid any accidental spill as per Environmental management Plan.
<ul style="list-style-type: none"> ▪ Increase noise and air pollution resulting from traffic volume. 	Yes		Air and noise pollution may be increase due to operation of construction machinery and increase in traffic volume for a short period.
<ul style="list-style-type: none"> ▪ Increased risks of water pollution from oil, grease and fuel spills, and other materials from vehicles using the road. 		No	There is no surface and ground water resource in this area

APPENDIX – 3: PUBLIC CONSULTATION- ENVIRONMENT

ROB Barmer

Issues discussed

- Awareness and extent of the project and development components
 - Benefits of Project for the economic and social Upliftment of Community
 - Labour availability in the Project area or requirement of outside labour involvement
 - Local disturbances due to Project Construction Work
 - Necessity of tree felling etc. at project sites
 - Water logging and drainage problem if any
 - Drinking water problem
 - Forest and sensitive area nearby the project site
 - Movement of wild animal near project site
1. Date & time of Consultation 6 PM on 20/06/08
 2. Location Utter Lai Chungi Naka.

.Table: Issues of the Public Consultation- Design phase

Sr. No.	Key Issues/Demands	Perception of community
1	Awareness of the project – including coverage area	Few people have knowledge on the project and coverage area
2	In what way they may associate with the project	People want some job and employment during construction phase of project.
3	Presence of any forest, wild life or any sensitive / unique environmental components nearby the project area	No forest land exists in the vicinity of project site. Also there is no wild life in nearby area.
4	Presence of historical/ cultural/ religious sites nearby	No historical / cultural / religious site in this location. Only one agricultural department farm nearby this area.
5	Un favorable climatic condition	Day temperature in summer goes very high make difficult to work during day time
6	Occurrence of flood	Very rare.
7	Drainage and sewerage problem facing	Sewerage problem due to one waste water <i>nallah</i> flowing in the vicinity of project location, leading foul smell problem
8	Present drinking water problem – quantity and quality	Both quantity and quality of drinking water is problem in this area
9	Present solid waste collection and disposal problem	No waste disposal facility available in this area.
10	Availability of labour during construction time	Surplus labour available.
11	Access road to project site	Good accessibility.
12	Perception on tree felling and	Two – Three Neem trees located nearby those

Sr. No.	Key Issues/Demands	Perception of community
	afforestation	need to fell during construction
13	Dust and noise pollution and disturbances during construction work	Dust and noise pollution will not increase after this project as discussed with local people.
14	Setting up worker camp site within the village/ project locality	This is road side area and there is govt. land available for setting up workers camp.
15	Safety of residents during construction phase and plying of vehicle for construction activities	If contractor will arrange some alternate route and traffic diversion for vehicles, accident chances are less.
16	Requirement of enhancement of other facilities	Jas der water pond is another site nearby this project area which should be enhanced beside this ROB project
17	Whether local people agreed to sacrifice their lands (cultivable or not) for beneficial project after getting proper compensation	People are not agreeing to sacrifice their land even after getting proper compensation.

NAME AND POSITION OF PERSONS CONSULTED

1. Mr Bholam Ram	Farmer
2. Mr. Balla Ram	Farmer
3. Mr. Magga Ram	Worker
4. Mr. Tikma Ram	Worker
5. Mr. Gorkha Ram	Farmer
6. Mr. Lekha Ram	Worker
7. Mr. Deva Ram	Factory worker
8. Mr. Uma Ram	Farmer
9. Mr. Deeba Ram	Farmer
10. Mr. Hira Ram	Farmer