Government of Rajasthan
Asian Development Bank

Technical Assistance

Project Number: 40031

India: Rajasthan Urban Sector Development Investment Program (RUSDIP)

INITIAL ENVIRONMENTAL EXAMINATION (DRAFT)

ALWAR: WATER SUPPLY SUBPROJECT

MARCH 2007

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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 will be implemented over a five year period beginning in late 2007, 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. Alwar, Jaisalmer and Jhalawar/Jhalrapatan are the towns chosen to benefit from the first tranche of RUSDIP investment.

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, 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 for the first tranche of funding were assessed by 13 Initial Environmental Examination (IEE) Reports and 3 Environmental Reviews, prepared according to ADB Environment Policy (2002) and Environmental Assessment Guidelines (2003). This document is the IEE report for the Alwar Water Supply Subproject.

B. Extent of 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 that 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 classed this program as Category B and following normal procedure for MFF loans has determined that one IEE 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. Category A projects require EC 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 the water supply sub-project that is the subject of this IEE.

3. Review and Approval Procedure

12. For Category B projects the Draft IEE 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 for the Alwar Water Supply Subproject. It discusses the environmental impacts and mitigation measures relating to the location, design, construction and operation of all physical works proposed under this subproject. It is one of 18 documents describing the environmental impacts and mitigation of all subprojects proposed in Tranche 1. These documents were prepared in January and February 2007 by one International and one Domestic Environmental Specialist via inputs of two and three months respectively.

II. DESCRIPTION OF THE PROJECT

A. Type, Category and Need

14. This is a water supply 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 because the present water supply infrastructure in Alwar is inadequate for the needs of the growing population. In particular the distribution system (which includes Asbestos Cement AC pipes) is old and beset with leaks, and as a result water pressure is very low and the supply is available to consumers for a few hours only per day. 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 Alwar 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 Alwar, the headquarters town of Alwar district, in the north-east of Rajasthan in north-western India (Figure 1). The improved infrastructure will extend throughout most parts of the town (repair and replacement of carrier and distribution mains, network expansion, overhead reservoirs, etc), where pipes will be buried within roadways, and

[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 (February 2007)

overhead reservoirs and other facilities will be located on small pockets of government land. There will also be an 8 km rising main outside the town, buried alongside the main road.

16. Detailed design will begin in the middle of 2007 and should be completed by the end of the year, after which construction will take up to 1½ years, so all work should be completed by the middle of 2009.

C. Description of the Sub-project

17. Table 1 shows the nature and size of the various components of the subproject. There are three main elements: augmentation of supply and infrastructure; a program to reduce unaccounted for water (UFW); and expansion of the distribution network. The descriptions shown in Table 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, particularly in the detailed design stage. It should also be noted that at this stage the infrastructure has been designed in outline only, to determine overall feasibility and budget costs, so certain aspects (such as exact locations of distribution pipes, etc) have not yet been finalised.

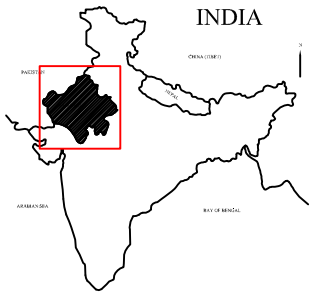
18. Improving the supply infrastructure will involve construction of a new pumping main to deliver water into the distribution system, and several new overhead reservoirs in the town. There will also be various actions to refurbish existing infrastructure (including new chlorination facilities, replacement of pumps and repair of tube-wells); and a subsurface barrier will be built to increase the supply of water to the aquifer.

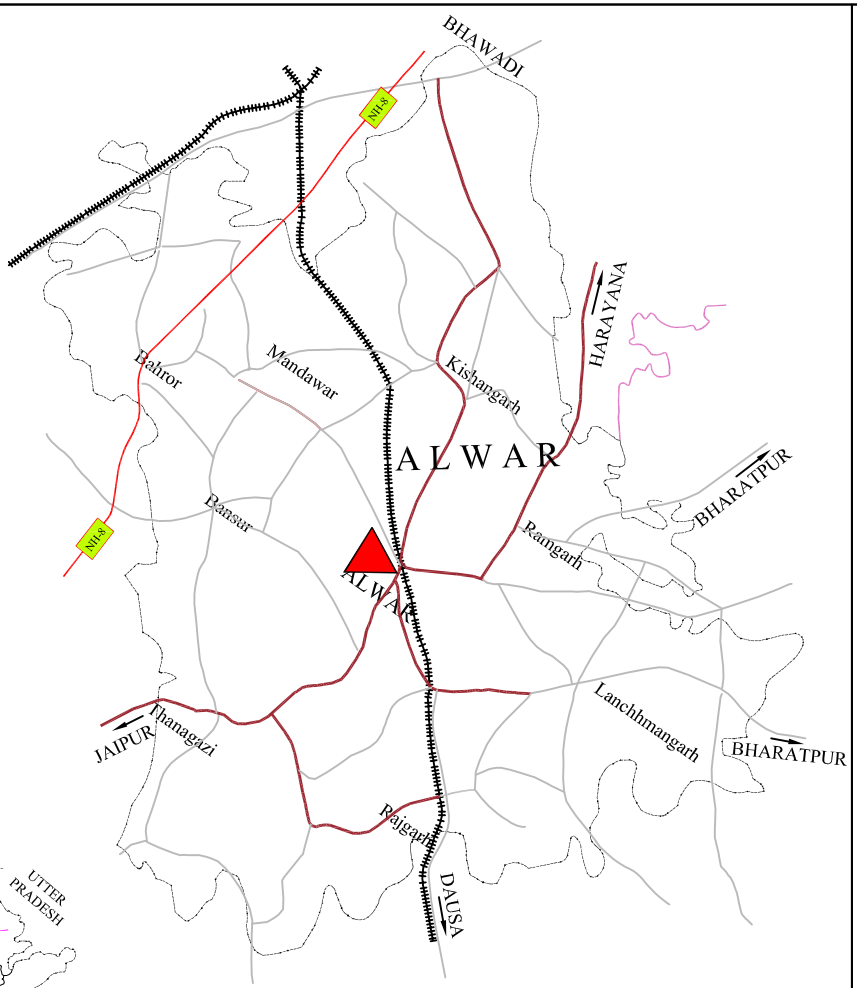
19. The pumping main will be a 500-600 mm diameter Ductile Iron pipe, 8 km in length, which will be buried in a trench (approximately 1.5 m deep) in the Right of Way (RoW) at the edge of the main road outside the town. At points where the road bends significantly the pipeline may take a shorter route across small areas of barren land and some cultivated farmland, although most of the route is expected to be adjacent to the road (Figure 2). The new overhead reservoirs in the town will be similar in size and construction to the OR shown in Photo 1, and will be located on small areas of government land, approximately 20 x 20 m.

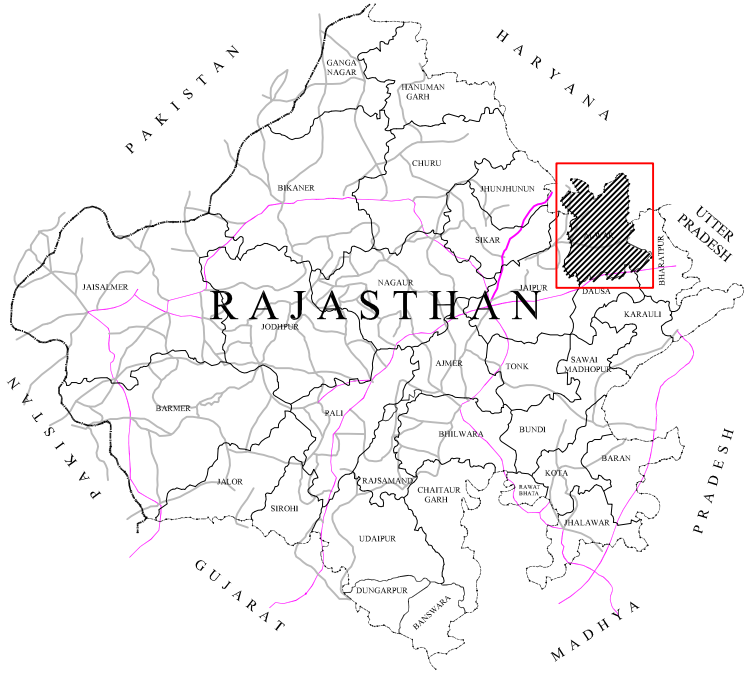
20. The main work to augment the water supply will involve construction of a clay barrier beneath the dry bed of Gazuki River, to deflect subsurface water flowing below the bed, down into the aquifer from which water is extracted by existing tube-wells (Figure 2). The barrier will stretch approximately 20 m across the entire river bed, and will be 10 m deep and lined with a continuous sheet of thick plastic on the upstream side.

21. Existing tube-wells that are faulty will be refurbished, and this will mainly involve replacement of pumps, although there may also be some re-drilling of wells and replacement of pipes. New chlorination facilities will also be provided at certain tube-well sites to improve water treatment. This will involve providing pumps and automatic chlorine injection cylinders, which will be located in existing or new brick buildings, approximately 5 x 5 x 3 m.

22. The program to reduce unaccounted-for water (UFW) will require repair and replacement of existing carrier and distribution mains, repair and replacement of house connections, provision of bulk meters to monitor flow in the network, and replacement of faulty consumer water meters.







Rajasthan Urban Sector
Development Investment Program
ADB TA 4814-IND

Alwar
Regional Setting Map

LEGEND:-

- International Boundary
- State Boundary
- District Boundary
- National Highway (NH)
- Other road
- Railway
- District Headquarter \Program Town

OVERLAY LEGEND:-

GOVT. OF RAJASTHAN

ASIAN DEVELOPMENT BANK

DRAWN :-	CHECKED :-
DATE :-	APPROVED :-
SCALE :-	

Figure :-

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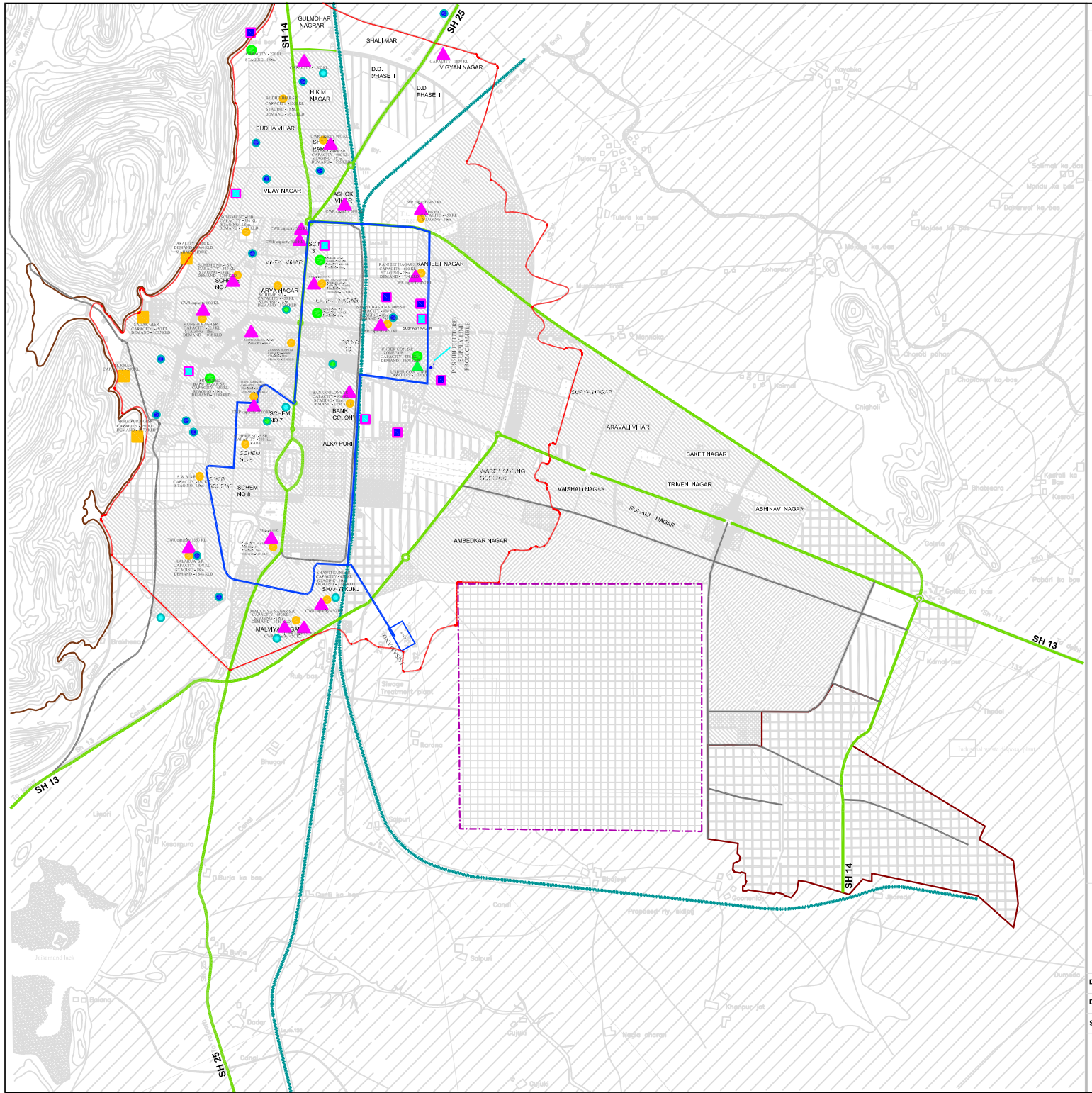

RAJASTHAN URBAN SECTOR DEVELOPMENT INVESTMENT PROGRAM

(ADB TA 4814 - IND)

ALWAR

Water Supply System

LEGEND:

- Municipal Boundary
- Physical Barrier
- State Highway
- Major Roads
- Railway Track

OVERLAY LEGEND:

- Existing SR
- GLSR
- Proposed SR
- CWR
- Proposed CWR
- Tubewell proposed In 1st contingency
- Tubewell proposed in 2nd contingency
- Tubewell proposed in 3rd contingency
- Handpump proposed in 1st contingency
- Handpump proposed in 2nd contingency
- 700 MM D.I Main Line

GOVT. OF RAJASTHAN

ASIAN DEVELOPMENT BANK

DRAWN:	CHECKED:
DATE:	APPROVED:
SCALE:	

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Table 1: Improvements in water supply infrastructure proposed in Alwar

Infrastructure	Function	Description	Location
1. Augmentation of supply and infrastructure			
Pumping Main	Convey water from the wellfield into the distribution main in Alwar town	8 km of 500-600 mm diameter Ductile Iron (DI) pipe	Buried in a trench in the Right of Way (ROW) alongside existing roads. To avoid bends in the road the main may take a more direct route in places, across derelict land and some farm land.
Overhead Reservoirs (OR)	Provide increased water storage and a head of water required for gravity flow of water through the distribution system	5 Reinforced Cement Concrete (RCC) tanks, (ca 10 x 10 x 10 m), mounted 20 m above ground on an RCC supporting frame	On small parcels of government owned land, each < 35 m in diameter.
Chlorination facilities	Treat water provided by the municipal system to Indian drinking water standards	10 chlorination units, each comprising small pumps and automatic chlorine injection cylinders	10 facilities located in pump houses at sites of existing overhead reservoirs.
Subsurface barrier at Gazuki River	Augment the supply of groundwater at the existing abstraction site at Tuleda tube-well field, by deflecting water flowing beneath a river down into the aquifer	Clay barrier (ca 10 m deep, 20 m across and 200 mm wide), beneath a river bed, lined with plastic sheet on the upstream side	In the dry bed of Gazuki River, which flows for a maximum of two months during the monsoon season
Pump refurbishment/ replacement	Improve water pressure and distribution by resuming the storage of water in existing ORs	Replace 60-65 faulty water pumps	Existing pump houses at OR sites
Rehabilitation of existing tube-wells	Increase the quantity of water abstracted by existing tube-wells	Replace pumps and other faulty equipment	Existing tube-well sites
2. Reduction of Unaccounted For Water			
Ring main	Improve the distribution of water around the town, reduce leaks and increase pressure	17.5 km of 300-450 mm diameter DI pipes	Buried alongside existing roads
Replacement of leaking carrier mains	Prevent leaks and increase the amount of water available to consumers	10-12 km of 250-400 mm diameter DI pipes	Buried alongside existing roads
Repair and replacement of distribution mains	Prevent leaks and increase the amount of water available to consumers	30 km of 50-150 mm diameter DI pipes	Buried alongside existing roads
Repair and replacement of leaking house connections	Prevent leaks and increase the amount and pressure of water reaching consumers	5000-6000 small diameter DI pipes	Buried and above ground, connecting individual houses with the distribution main
Bulk flow meters	Monitor water flow in the improved network	20 small meters in brick-sided chambers (ca 1 x 1 x 1 m) with metal manhole cover	Chambers located in streets in various parts of the network

Infrastructure	Function	Description	Location
Replacement of non-functional consumer water meters	Monitor and regulate water usage by consumers and improve cost recovery	15,000 small meters	Attached to the outside of houses
3. Expansion of Distribution Network			
Network expansion in slums and new areas	Increase the number of slum dwellers with access to municipal water	20-30 km of DI or MDP pipe, 80-300 mm diameter	Buried within lanes and on the surface alongside pathways in slum areas
New house connections and water meters	Increase the number of houses supplied with municipal water and improve cost recovery	5000 house connections (small diameter DI or plastic pipe) and small meters	Attached to the outside of houses

23. The existing mains are of Asbestos Cement (AC), and because of the health risks (see below) these will be left in situ and replaced by new carrier and distribution mains of Ductile Iron (DI). These will be located in trenches within the ROW of main roads, both alongside the existing mains and in new alignments in other roads. The carrier main will utilise 10-12 km of 250-400 mm diameter DI pipe and the distribution main will use 30 km of 50-150 mm diameter DI pipe (Photo 2). The mains will include new bulk flow meters, located at joints between pipes, in small (ca 1 m^3) brick chambers beneath the road, accessed by metal manhole covers.

24. 5,000-6,000 leaking house connections will be replaced by new connections, provided in small-diameter DI pipe, mainly located above ground (Photo 3). New water meters will also be provided outside houses (Photo 4).

25. The program to expand the distribution network will involve the provision of connections in slum areas and other parts of the town that are not served by the existing system. This will require 20-30 km of DI or MDP (plastic) pipe, of 80-300 mm in diameter, which will be buried within trenches at the edges of roads, and may run over-ground near houses and slums (Photo 3). 5000 new house connections and water meters will be provided (Photo 4).

III. DESCRIPTION OF THE ENVIRONMENT

A. Physical Resources

1. Location

26. Alwar is located in the north-eastern part of Rajasthan, between the longitudes of 76° 35' to 76° 40' East, and latitudes of 27° 30' 20" to 27° 36' 30" North (Figure 1). The town is in the foothills of the Aravali Mountain range, at an altitude of 268 m above sea level, and is 160 km south of the national capital Delhi and 150 km north-east of the state capital Jaipur. Alwar is one of the fastest growing towns in Rajasthan, and is an important trading centre, with good road and rail links. The municipal area covers 49.3 km^2, and the population is 260,000.

2. Topography, soil and geology

27. Alwar township is relatively flat, located in the alluvial plain beneath the Arvali Mountains in the west. The soil is mainly alluvial and non-calcareous, semi-consolidated to consolidated, brown in colour, and loamy sand to sandy loam in texture. Exposed rocks belong to the Delhi Super-group of lower proterozoic age, consisting of schist, quartzites, slates and gneisses. Sub-surface layers of unconsolidated quaternary formations form the principal aquifer system.

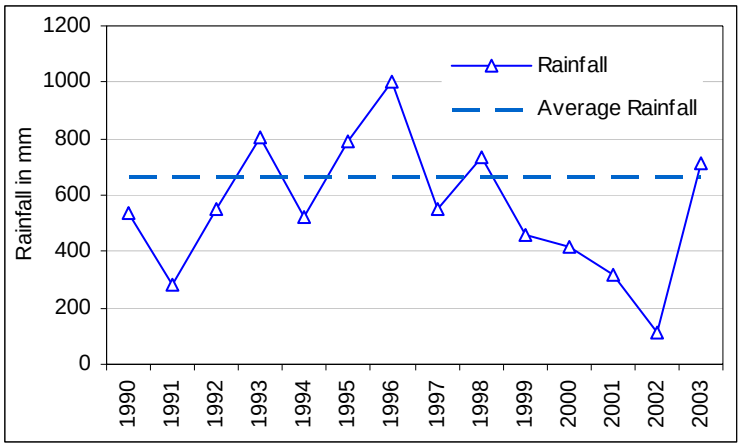
28. According to the Vulnerability Atlas of India, part of Alwar District, including Alwar Town, is in an area of high earthquake risk (Zone IV). Although Rajasthan has not experienced a major earthquake in the recent past, there have been 37 events with a magnitude of 5-7 since 1720, with the most recent occurring in 2001. This measured 6.9 on the Richter Scale, but because the epicentre was in neighbouring Gujarat, no major damage was reported in Alwar.

3. Climate

29. The climate is semi-arid and mostly dry, with a hot summer period in April to July, followed by a short monsoon in July to September, and a cool dry winter period between October and March. Average daily temperatures peak at around 41 °C in June (when the

minimum is 28 °C at night), and in January the temperature falls to an average of 23 °C during the day and 8 °C at night. The long term average annual rainfall is 638 mm, of which around 85% falls during the monsoon. However rainfall is highly variable, and has been generally low in most recent years (Figure 3).

30. Relative humidity is around 70% during the monsoon, but is much lower throughout the rest of the year, falling to 20-25% in the summer. Winds are generally light and variable during the cool winter period, and mainly from the north and north-west, and the strongest winds are the south-westerlies that bring the monsoon in June and July.



Source: Agriculture Dept 2007

Figure 3: Average Annual Rainfall in Alwar 1990-2004

4. Air Quality

31. The Rajasthan State Pollution Control Board (RPCB) monitors air quality at three stations in Alwar town, two in industrial areas and one in a residential quarter. Data shows that particulate matter is high because of the dry atmosphere, dusty roads and surrounding land, and Respirable Suspended Particulate Matter (RSPM: particles < 10μm) and Suspended Particulate Matter (SPM) frequently exceed National Ambient Air Quality Standards (NAAQS, Table 2). In contrast, levels of chemical pollutants (oxides of sulphur and nitrogen) are below national standards, presumably because of the limited development of heavy industry.

Table 2: Ambient Air Quality in Alwar (Annual Average 2005; units in μg/m^3)

Monitoring Station	Land use	RSPM		SPM		SO_x		NO_x	
		Ave	Max	Ave	Max	Ave	Max	Ave	Max
RPCB Office	Residential	161	668	285	1153	7.4	16.9	10.0	18.8
NAAQ Standard	*Residential*	*60*		*140*		*60*		*60*	
RIICO Pump House	Industrial	91	408	160	515	7.1	16.7	9.2	17.1
Gaurav Solvex	Industrial	99	320	173	509	7.9	18.3	9.8	20.3
NAAQ Standard	*Industrial*	*120*		*360*		*80*		*80*	

RSPM: Respirable Suspended Particulate Matter; SPM: Suspended Particulate Matter
Source: Rajasthan State Pollution Control Board (RPCB) 2005

5. Surface Water

32. The State of Rajasthan is predominantly dry, except for some parts of the south and south-east, and Chambal is the only perennial river. There are certain seasonal rivers in Alwar District, including the Ruparel, Sabi, Chuhar, Sidh and Landoha, which carry monsoon drainage from upland areas. Several of these have been impounded, to provide water for irrigation. Ruparel is the nearest seasonal river to Alwar, and passes through the Sariska Tiger Reserve and the village of Bara 19 km south of Alwar. This feeds Jaysamandh Lake through an 8 km long manmade feeder canal from Bara Weir.

33. There are no natural lakes in Alwar District, although there are a number of artificial lakes formed from water retained by manmade bunds, of which Jaysamandh and Siliserh are the largest. Jaysamandh Dam is 6 km south of the town between the villages of Ballana and Liwari, and is an earth and concrete structure built in 1910. The lake has a maximum capacity of 34 ML, but rarely fills to that level. Siliserh Lake is 13 km south-west of the town and is retained behind an earth embankment and masonry wall built in 1845 across a tributary of the Ruparel. The capacity of the lake is 14 ML, and water for irrigation feeds into two masonry canals running from the dam.

34. Hans Sarovar is another small lake 5 km south-east of the town, near Agyara village. It is formed behind an earth embankment built in 1910, and the water is used for pumped irrigation in nearby farms, although as the lake rarely fills to capacity, such usage is limited. The lake receives untreated and partially treated effluent from the nearby Matsya Industrial Area (MIA), where there are several chemical plants and other industries. In December 2006 the water was very low in volume and bright pink in colour (Photo 5), presumably from the discharge of dye and/or other chemicals.

6. Groundwater

35. The main aquifer around Alwar is contained within unconsolidated quaternary formations of silt, sand kankar and boulder, and is reported to have a potential yield of 20-30 m^3/h. According to the GoI Central Ground Water Board (CGWB 2006[2]), groundwater occurs under unconfined conditions at shallow depth (18-28 m below ground level) and in a semi-confined condition at deeper levels (around 65 m), and is tapped by a number of tube-wells, which discharge at a rate of between 25 and 68 m^3/h.

36. Seasonally the aquifer declines between November and May and recharge begins with the monsoon rains in mid-June. However there has been an alarming decline over the past 20 years from over-extraction and low rainfall, and CGWB reports that the water table in Alwar town has fallen from 9 m in 1984 to 27 m in 2004, at an average rate of 0.91 m per year. Agriculture accounts for more than 80% of the use, and major reductions occur during *Rabi* crop irrigation in October-April.

37. Groundwater quality has also declined as a result of urbanization, disposal of untreated domestic and industrial wastewater and excessive usage of fertilizers. Recent analyses by the Public Health Engineering Dept (PHED) shows high levels of nitrate and iron in water from existing tube-wells (Table 3).

[2] CGWB Western Region, Micro Level Studies, Ground Water Scenario, Alwar Urban Area, July 2006.

Table 3: Groundwater quality in Alwar, 2004-2005

Parameter	Monitoring Location								BIS Drinking Water Standard	
	Sivaji Park		Police Lane		Kala Kuva		Samola			
	May 04	Jan 05	May 04	Jan 05	May 04	Jan 05	May 04	Jan 05	Desirable	Acceptable
pH	7.75	8.16	7.62	8.29	8.12	7.84	7.1	8.68	6.5-9.0	NR
EC	1195	1140	580	650	700	1150	1900	1980	NLP	NLP
Co_3	Nil	Nil	Nil	Tr	Nil	Nil	Nil	120	NLP	NLP
HCO_3	183	256	207	220	146	451	659	793	NLP	NLP
Cl	213	234	43	92	107	121	149	57	250	1000
SO_4	125	11	28	20	45	30	110	142	200	400
NO_3	61	65	32	39	46	67	130	11	45	100
Total Hardness	300	360	160	210	150	250	160	140	300	600
Ca	32	44	36	40	24	92	12	36	75	200
Mg	54	61	17	27	22	4.9	32	12	30	100
Na	155	112	58	68	90	168	378	437	NLP	NLP
K	4.2	3.3	2.6	4.1	11	9.8	1.2	1	NLP	NLP
F	0	0.33	0	0.55	0	0.79	0	1.5	1.0	1.5
Zn	-	0.620	-	4.180	-	0.653	-	1.000	5.000	15.000
Cu	-	0.032	-	0.172	-	0.014	-	0.014	0.050	1.500
Ni	-	0.001	-	BDL	-	0.005	-	BDL	NLP	NLP
Mn	-	0.020	-	0.015	-	0.044	-	0.021	0.100	0.300
Fe	-	1.915	-	0.029	-	7.390	-	0.532	0.300	1.000
Pb	-	BDL	-	BDL	-	0.025	-	0.013	0.050	NR

Source: CGWB (2006). All units are mg/l except EC in μmhos/cm. BIS = Bureau of Indian Standards
NLP-No Limit Prescribed; NR-No Relaxation; BDL-Below Detectable Level; Tr-Trace

B. Ecological Resources

38. Alwar Town is an urban area surrounded by land that was converted for agricultural use many years ago (Photo 6). There is no remaining natural habitat in the town, and the flora is limited to artificially planted trees and shrubs, and the fauna comprises domesticated animals (cows, goats, pigs and chickens), plus other species able to live close to man (urban birds, rodents and some insects). There are three Reserved Forests (RF) to the west of the city (Bhurasid RF, Alwar RF and Dholdhup RF), where hillslopes feature scrub vegetation and mixed dry deciduous forest. Although there are no rare species or important timber trees, the vegetation is reported to be important for soil conservation.

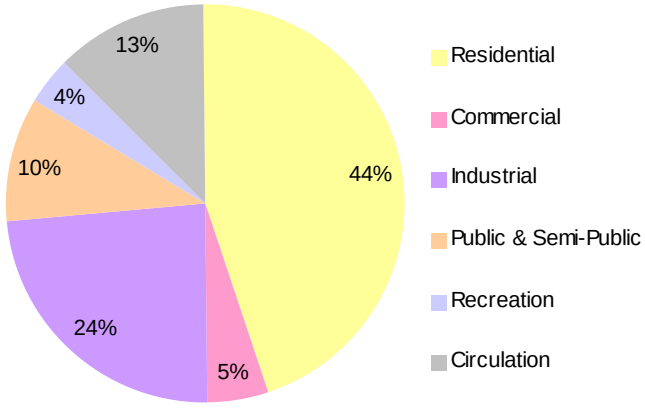
39. The closest protected area to Alwar is the Sariska Tiger Reserve, 40 km to the southwest, which was designated as a sanctuary in 1955 and a tiger reserve in 1979. The reserve covers 900 km^2 of forested hills and plateaux, although habitat has been degraded by agriculture and the fauna depleted by poaching, and there are reportedly now no tigers remaining.

C. Economic Development

1. Land use

40. Located close to the national capital, Alwar was traditionally a services and administrative town, with little industrial development. However as Delhi has grown, so Alwar has benefited from its trade, infrastructure and prosperity, and has experienced rapid economic growth over the past 20 years. Alwar was recently selected as a regional town under the National Capital Plan for integrated development of the area around Delhi. The urban area of

Alwar covers 49 km^2, and although almost half of this is in residential use there is also a significant amount of industry, occupying 24% of the total land (Figure 4).



Source: Alwar Urban Improvement Trust

Figure 4: Current land use in Alwar Town

2. Industry and Agriculture

41. There are two industrial areas: the Old Industrial Area covers 88 ha and houses 42 units, mostly small-scale engineering such as stone polishing because of the ready availability of decorative stone from quarries in the surrounding hillsides. The Matsya Industrial Area (MIA, Photo 7) was established more recently by the Rajasthan Industrial Infrastructure Corporation (RIICO) and covers over 1,000 ha in the west of the town. Currently there are 213 operating industries in MIA, mostly mineral-based (88 units) and chemical (61). Of these, 28 operations are of large or medium scale and the remainder are small-scale.

42. There are also many households engaged in handicrafts in the town, such as the manufacture of cotton and wool products, and there are large numbers of small shops and businesses alongside the roads, particularly in the centre of the town (Photo 8).

43. Agriculture is easily the most important industry, both in Alwar District (where 65% of the total area is cultivated) and outside the headquarters town. Over 80% of the cultivated area is irrigated, mostly by groundwater. Many areas practice double cropping and the main seasons are *Kharif* (April-September: maize, cotton, etc) and *Rabi* (October-March: wheat, barley, mustard, etc).

3. Infrastructure

44. PHED provides a piped municipal water supply to the whole city (Photo 3), which is entirely groundwater-based because of the lack of a dependable surface water source. The present usage is 26.8 MLD, extracted by 170 tube-wells located in and around the town. However water is only available for 1-2 hours per day, mainly because of system losses (estimated at 40%) and low and unequal network pressure.

45. Only two newly developed colonies (Shivaji Park and Ambedkar Colony, housing 10,000 people each) have an underground piped sewerage system, and as there is no treatment facility, raw sewage is discharged into natural drainage channels. Most households depend on pit

latrines and septic tanks, and some have made illegal connections through which sewage enters open storm water drains, polluting both surface and ground water.

46. There are 51 km of concrete storm water drains in the main city area (Photo 9), but these cover only 13% of the total road network and the contents (which frequently include raw sewage) are discharged untreated into a *nallah* (natural or man-made drainage channel).

47. There is no proper solid waste management system in the town, and although the Municipal Council (AMC) has provided dustbins in a few areas, in the rest of the town garbage is dumped in the streets and drains, and on vacant plots of land. Alwar generates an estimated 90 tons of solid waste per day and AMC collects around 57 tons from its manual street sweeping operation (conducted in the main city only), and removes other waste from open dumpsites irregularly. This is transported on open vehicles to the outskirts of the town, where it is dumped on open ground as there is no landfill.

48. Thermal power is the main source of energy in Rajasthan, contributing 89% of the electricity, compared to hydropower, which produces the remainder. State-level companies (Rajya Vidyut Utpadan Nigam Ltd, RVUN; and Rajya Vidyut Prasaran Nigam Ltd, RVPN) are responsible for power generation and transmission respectively, and distribution is provided by a regional company, the Jaipur Vidyut Vitran Nigyam Ltd (JVVNL). Power is supplied from the central grid by overhead cables carried on metal and concrete poles, mainly located in public areas alongside roads. The power supply is erratic and there are frequent outages in warmer months, and large fluctuations in voltage.

4. Transportation

49. Alwar is provided with a relatively good transportation system, particularly in the outer parts of the town, where streets are wide and not heavily utilised by traffic (Photo 10). The situation is different in the centre of the town however where roads are narrower and more congested (with both traffic and pedestrians), and the smaller roads are surfaced with concrete (Photo 11). The total road network is 421km in length, of which 70% are surfaced with bitumen/tar, 23% are concrete and 7% are WBM (Water-borne Macadam). The majority of roads (48%) are maintained by UIT, 38% by the Public Works Department (PWD) and 24% by AMC, and the condition is generally poor, with many roads in need of repairs and resurfacing.

50. Transport in the town is mainly by personal vehicles (bicycles and motor cycles) or auto- and bicycle-rickshaws, and privately owned mini-vans provide a form of intermediate public transport system. There are good road links between Alwar and surrounding towns, and a good quality road to the State capital Jaipur in the south-west and the national capital Delhi in the north-east (Figure 1). The national railway also runs through Alwar, and there are daily services through Rewari and Delhi in the north and Dausa and Jaipur in the south. The nearest airports are at Jaipur (150 km away) and Delhi (160 km).

D. Social and Cultural Resources

1. Demography

51. According to the national census the population of Alwar was 0.2 million in 1991 and 0.27 million in 2001, which shows an annual increase of 3.5% over the decade. The local authority however estimates that there are now 350,000 people in the town, which is occupied at an average population density of 6420 persons per km^2.

52. Overall literacy is 82.8%, reported at 91.4% for males and 72.9% for females, which is considerably better than literacy in the state as a whole, which is 60.4% overall, and 75.7% for males and 44.0% for females. The sex ratio is however significantly below the natural 1:1 ratio, being 853 females per 1000 males, lower than both the state and national averages (879 and 929 respectively).

53. According to the census, in 2001 only 28.8% of the population was in paid employment, significantly lower than both the state and national averages (42.1 and 39.1% respectively). This indicates that most of the townspeople are engaged in the informal sector, earning a living where they can, from small trading, casual labour, etc. Of those that are employed, almost all (98%) are involved in the service and industrial sectors, with the remainder being engaged in agricultural activities.

54. Between 85-90% of people are Hindus and the remainder are mainly Muslims, Sikhs and Jains. The main local languages are Khariboli and Mewati, although almost all people speak the national language of Hindi and a few also speak English. Other languages spoken include Sindhi, Punjabi and Urdu, because Rajasthan borders Pakistan. About 3% of the population are from Scheduled Tribes (ST), but these are all part of the mainstream population; around 16% of the population belong to scheduled castes (SC).

2. Health and educational facilities

55. There are good educational facilities in Alwar, which serve both townspeople and inhabitants of surrounding villages and towns. There are 71 primary schools, 189 secondary schools and 43 higher secondary schools, plus six general degree colleges and nine professional educational institutes.

56. As the district headquarters town, Alwar is the main centre for health facilities in the area and there are six hospitals, plus a special TB hospital, 42 clinics, two family welfare centres, and three homeopathic hospitals in the city.

3. History, culture and tourism

57. Legend suggests that the town of Alwar was founded in 1049 by Maharaja Alaghraj. In the mediaeval period it was ruled by the Yadu dynasty in the 11th century, Shamsuddin Altamash the Sultan of Delhi in the 12th century, the Chauhans in the 13th century, followed by Mewatis, Mughals, Marathas and Jats, until finally it was captured by the Kachhwaha Rajputs in the late 1600's.

58. Alwar Fort, known locally as Bala Quila, was built in 1550 by Hasan Khan Mewati, and is one of the few forts in Rajasthan to pre-date the rise of the Mughals. It stands on a hill and rises 330 m above the city (Photo 12), and measures 5 km by 1.5 km. There are six entrances to the fort and 5 km of ramparts.

59. Tourism has risen in importance in Alwar over the past 20 years, and in 2005 there were 85,000 visitors, 90% from within India and 10% from abroad. Alwar Fort and Sariska Tiger Reserve 40 km away are the main attractions, but there are other interesting locations in and around the town including:

- The City Palace complex, which lies immediately below the fort, and was once the home of the maharajah. It has an impressive architecture (Photo 13), with many intricate ghats (staircases) and pavilions. The palace now houses government offices, and there is a museum and a large ornate pond (known as Sagar), surrounded by 12 chhatries or cenotaphs of red marble;

- Siliserh Lake, provides a dam (Photo 14 and Photo 15), lake and four-storey palace dating from the mid-19th century, which has now been converted to a hotel and restaurant. The lake is both functional and attractive, set amongst low wooded hills, and attracts tourists from Alwar and beyond;

- Jaisamandh Dam is in a more remote location and reached by a narrow rural road, and its architecture and the surrounding landscape (Photo 16) make it a further attraction for increasing numbers of tourists.

IV. ENVIRONMENTAL IMPACTS AND MITIGATION: INFRASTRUCTURE CONSTRUCTION

A. Screening out areas of no significant impact

60. From the descriptions given in Section III.C it is clear that implementation of the project will affect most of the town as a high proportion of the roads and streets will contain branches of the existing or expanded network, either mains or smaller distribution branches. Areas outside the town will also be affected by construction of the pumping main.

61. However it is not expected that the construction work will cause major negative impacts, mainly because:

- Most network improvements will be located on unused ground alongside existing roads and can be constructed without causing major disruption to road users and adjacent houses, shops and other businesses;
- New facilities in the town (ORs, chlorination units, etc) will be located on government-owned land that is not occupied or used for any other purpose;
- Most network construction will be conducted by small teams working on short lengths at a time so most impacts will be localised and short in duration;
- The overall construction programme will be relatively short for a project of this nature, and is expected to be completed in 1.5 years.

62. As a result 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 4, with an explanation of the reasoning in each case.

63. These environmental factors have thus been screened out and will not be mentioned further in assessing the impacts of the construction process.

Table 4: 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	There is no wildlife or rare or endangered species in or around the town
Coastal resources	Alwar is not located in a coastal area
Population and communities	Construction will not affect population numbers, location or composition

B. Augmentation of supply and infrastructure

1. Construction method

66. As explained above, augmentation of the water supply and infrastructure will involve construction of:

- An 8 km pumping main of 500-600 mm DI, to transport water into the carrier main in the town;
- A clay barrier, 20 m wide and 10 m deep in the bed of Gazuki River to direct water into the aquifer below, from which water is extracted by the present tube wells;
- New Overhead Reservoirs (OR) on small parcels of government land in the town; and
- Replacement of pumps and pipes, re-drilling of wells, and provision of chlorine injection equipment at certain existing TWs.

67. Most of this work is relatively small in scale, and will involve straightforward construction. Creation of a barrier beneath the Gazuki River will require excavation of a trench across the river bed, approximately 10 m deep, 20 m long across the channel, and 300-500 mm wide. This will be done by backhoe digger, and waste sand and stone will be loaded onto trucks for offsite disposal. A continuous thick polythene sheet will then be laid against the upstream side of the trench, and a liquefied clay mixture will be poured into the void behind and allowed to dry. A layer of sand and stone will then be applied at the top to bring the surface to the same level as the river bed.

68. The five new Overhead Reservoirs (Photo 1) will be built in the town, on small areas of government land. At each site the cavity for the foundations will be dug to about 1 m depth by backhoe, with soil being loaded into trucks for disposal. Aggregate and concrete will be tipped into the void to create the foundations and floor, after which metal reinforcing rods will be inserted vertically to form the structure of the vertical supports. Sections of reinforcing will then be encased in wooden shuttering and concrete will be poured in, and this process will be repeated to gradually form the supporting pillars and tank. After drying, concrete surfaces will be smoothed and finished where necessary by hand.

69. Construction of the 8 km pumping main is described in Section IV.C below, as the approach and environmental impacts are similar to those of the distribution network and are somewhat different from those of the components considered here.

70. The remaining work will be conducted at sites of existing tube wells (TW). Faulty pumps will be replaced by new units, which will be brought in on trucks and positioned by crane and by hand in existing pump houses. New chlorination facilities will be provided in a similar way, by installing new equipment (in this case chlorine cylinders, meters, etc) in existing pump houses. If any tube-wells need to be re-bored, a small drilling rig (Photo 17) will be used to drill a small tunnel vertically down into the aquifer, into which lengths of 200-500 mm diameter Mild Steel pipe are gradually inserted. Any new boreholes will be located alongside existing wells.

2. Physical Resources

71. Although construction of these facilities will involve excavation, the work will be small in scale and will not produce large quantities of waste, so physical impacts should not be greatly significant.

72. Excavation of the trench for the river barrier will produce around 100 m^3 of waste soil and stone, and creation of the foundations for the overhead reservoirs will generate a similar amount. This quantity can be dumped via normal waste disposal procedures and there should be no need to take special precautions to reduce the amount of material. However, as the present system of waste disposal involves the municipality dumping garbage on open ground outside the towns, it would be beneficial if this work was scheduled to take place after the new landfill has been provided by the Solid Waste Management Subproject, so that the material can be disposed of appropriately at the new facility.

73. Excavation work often requires precautions to reduce dust during the operation, but this will also not be necessary at the site of the river barrier, as there are no people living nearby. Precautions will be necessary however at the overhead reservoir sites, as these are located in the town. At these sites the Contractor should be required to:

- Reduce dust by removing waste soil as soon as it is excavated;
- Damp down soil to reduce dust in windy weather;
- Use tarpaulins to cover waste soil when transported on trucks for disposal.

74. Excavation can affect local drainage patterns if surface- and groundwater- collects in voids as they are being dug, but this should also not be a problem in this case as the work is small in scale, and will almost certainly be conducted in the dry season.

3. Ecological Resources

75. There are no protected areas in the proximity of Alwar town, and no known areas of ecological interest in the town or its environs, so it is unlikely that the work will have any ecological impacts. Even construction of the subsurface barrier in Gazuki River will not affect any flora or fauna as the river only runs for a few weeks in the monsoon, and is dry and barren for the rest of the year.

4. Economic Development

76. This work will all be conducted on government owned land, so there should be no need to acquire land from private owners, which might affect the income and assets of landowners or tenants. There should also be no effects on other features with economic implications (such as infrastructure, industry and commerce), as there are none of these facilities on these sites.

There should also be no effects on traffic or transport, as there are no roads near the part of Gazuki River in which the barrier will be built, and all of the other work will be conducted at existing tube-well sites in the town, or on other small parcels of government land.

5. Social and Cultural Resources

77. Social and Cultural Resources in the one sector in which this work may cause significant damage, so careful mitigation and strict adherence by the EA and Contractor will be necessary. 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. It will be necessary therefore to adopt a series of measures, to both avoid sensitive sites and recognise and protect any chance discoveries. These include:

- Consulting historical and archaeological authorities at both national and state level to obtain an expert assessment of the archaeological potential of all proposed sites;
- Selecting alternative sites for any facilities proposed in areas 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 recognised 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 to ensure its removal or protection in situ.

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

79. 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 construction sites.

C. Network improvement

1. Construction method

80. The programme to reduce unaccounted-for water will involve construction of:

- A new 17.5 km ring main, of 300-450 mm diameter DI pipe;
- A new 10-12 km carrier main, of 250-400 mm diameter DI pipe;
- A new 30 km distribution main, of 50-150 mm diameter DI pipe;
- Replacement of 5000-6000 leaking house connections, using small diameter DI pipe;

- 20 new bulk flow meters in the new mains;
- 15,000 household water meters to replace malfunctioning units.

81. Expansion of the distribution network will involve construction of:

- 20-30 km of 80-300 mm diameter DI or MDP pipe to supply slums and new housing;
- 5,000 new house connections, via small diameter DI or MDP pipe and water meters.

82. These all involve the same kinds of construction and will produce similar effects on the environment, so their impacts are considered together. As explained above, the impacts of the 8 km pumping main are also considered here, for the same reasons.

83. Most of the pipe-work will be buried in trenches immediately adjacent to roads, in the un-used area within the ROW, alongside the edge of the tarmac. In narrower roads, where this area is occupied by drains or the edges of shops and houses etc, the trenches will be dug into the edge of the road. Trenches will be dug using a backhoe digger (Photo 18), supplemented by manual digging where necessary (Photo 19). The ring-, carrier- and distribution mains will be located in the larger roads where there is generally sufficient space at the edge of the road that has not been encroached by structures. Excavated soil will be placed nearby, and the pipes (brought to site on trucks and stored on unused land nearby) will be placed in the trench by crane or using a small rig (Photo 19). Pipes will be joined by hand, after which sand from local quarries will be shovelled into the trench beneath and around the pipe for support and protection. Soil will then be replaced manually on top of the pipe and compacted by a vibrating compressor.

84. Pipes are normally covered by 1.2 m of soil, and a clearance of 100 mm is left between the pipe and each side of the trench to allow backfilling. Trenches will therefore be a maximum of 1.9 m deep and 0.8 m wide for the pumping main, and a minimum of 1.4 m deep and 0.3 m wide for the distribution main.

85. At intervals in the new mains, small chambers (ca 1 x 1 x 1 m) will be created to house the bulk flow meters. The chambers will be excavated by backhoe, and hardcore and concrete (mixed on site) will be tipped in to form the base. Brick sides will then be added by masons by hand, and the top will be sealed at ground level by a metal manhole cover.

86. The smaller pipes will be located in smaller narrower roads, some of which are constructed of concrete and have no available space at the edge because of the presence of municipal drains, or even shop- and house-fronts encroaching into the RoW (Photo 20). In these places it may be necessary to break open the surface of the road using hand-held pneumatic drills, after which the trench and pipeline will be constructed as described above. On completion a concrete layer will be re-applied to the surface to repair the road.

87. Replacement or new house connections will run from the distribution main to individual dwellings, and the DI or plastic pipes will be located in small hand-dug trenches, or may be located on the surface (Photo 3). Household meters will be provided at all such connections, and these will be located outside each house (Photo 4). In slum areas water will be provided via communal taps (Photo 21) from where people will collect their water.

2. Physical Resources

88. This work will involve more extensive excavation than the source augmentation component and as all the work will be located in the town, the impacts are likely to be more significant.

89. If the average dimensions of the trenches are assumed to be 1.8 x 0.7 m for the 8 km transmission main, 1.7 x 0.6 m for the 17.5 km ring main, 1.6 x 0.5 m for the 11 km carrier main and 1.4 x 0.3 m for the 30 km distribution main, then trench construction will excavate 50,000 m^3 of material. After construction, approximately 25% of the trench will be occupied by the pipe, 50% by backfilled sand, and 25% by excavated soil will replaced on top of the pipe. This means that around 25,000 m^3 of sand will be brought to site, 12,500 m^3 of soil will be retained for replacement in the trench, and 37,500 m^3 of waste material will be left over. There will therefore be quite large physical changes at the construction sites, and this quantity of waste could not be dumped without causing further physical impacts (on air quality, topography, soil quality, etc) at the point of disposal. The work will almost certainly be conducted in the dry season, so there is also a lot of potential for the creation of dust, from the excavation of dry soil and its storage and removal for disposal, and from the importation and storage of large quantities of sand for backfill.

90. Action will therefore be needed to reduce physical impacts at both the construction and disposal sites, by controlling dust and reducing the amount of material to be dumped. The Contractor should therefore be required to:

- Contact the town authorities to find beneficial uses for as much waste material as possible, in construction projects, to raise the level of land prior to construction of roads or buildings, or to fill previously excavated areas, such as brickworks;
- Prevent the generation of dust by removing waste material as soon as it is excavated (by loading directly into trucks);
- Plan the work carefully so that sand is only brought to site when it is needed;
- Cover or damp down sand and soil retained on site to reduce dust in windy weather;
- Use tarpaulins to cover loose material that is transported to and from the site by truck.

91. The other physical impact commonly associated with large-scale excavation (effects on surface and groundwater drainage) should again be negated by the fact that this work will be conducted in the dry season, and by the fact that the water table is very low in Alwar.

92. Physical impacts will also be reduced by the method of working, whereby the network will probably be constructed by small teams working on short lengths at a time, so that impacts will be mainly localised and short in duration. Physical impacts are also mainly temporary as trenches will be refilled and compacted after pipes are installed, and any disturbed road surfaces will be repaired. Because of these factors and the mitigation measures proposed above, impacts on the physical environment are not expected to be of major significance.

3. Ecological Resources

93. There are no significant ecological resources in the town (protected areas or rare or important species or habitats), so the network improvements should have no ecological impacts. Roadside trees should not be removed unnecessarily to build the trenches, and to mitigate any such losses the Contractor should be required to plant and maintain two new trees (of the same species) for each one that is removed.

4. Economic Development

94. With the exception of any areas where the transmission main diverges from the road to take a more direct route, the rest of the network improvements will be conducted in the RoW of existing roads (either adjacent to the road, or beneath the road surface in narrower streets). At most locations there should thus be no need to acquire land from private owners, so there should be no direct effect on the income or assets of landowners, or the livelihoods of tenants.

95. Where land needs to be acquired for parts of the transmission main route, this will be obtained through the Land Acquisition Ordnance (1894), by which the government purchases the land compulsorily at a rate established on the basis of recent transactions. ADB policy on Involuntary Resettlement requires that the owners and users of acquired land do not suffer economically as a result of the project, and a separate Resettlement Plan and Resettlement Framework have been prepared to examine these and related issues. This establishes that no more than 10% of the land of any owner or occupant should be acquired, and that in addition to the price of the land, farmers should be compensated for any standing crops or trees they lose.

96. Although most of the work will not require land acquisition it could still have economic impacts, if the presence of trenches, excavated material, workers and machinery discourage customers from visiting shops and other businesses, which lose income as a result. These losses will be short in duration as work at any one site should be completed in a week or less. However the loss of income could still be significant for small traders and other businesses that exist on low profit margins. These impacts should therefore be mitigated by:

- Compensating shopkeepers and other affected businesses for lost income;
- Leaving spaces for access between mounds of excavated soil, and providing footbridges so that pedestrians can cross open trenches;
- Increasing the workforce in these areas to ensure that work is completed quickly;
- Consulting affected businesspeople and informing them in advance when work will occur.

97. Excavation could also damage existing infrastructure, such as storm drains, which run alongside many of the roads in the town. 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 infrastructure, and planning pipeline routes carefully to avoid any conflict or damage;
- Integrating construction of the various infrastructure subprojects conducted in Alwar (in particular water supply and 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.

98. Transport is another type of infrastructure that will be affected by some of the work, as in the narrower streets there is not enough space for excavated soil to be piled off the road. The road itself may also be excavated in places where there is no available land to locate pipelines alongside. Traffic will therefore be disrupted, and in some very narrow streets the whole road

may need to be closed for short periods. The Contractor should therefore plan this work in conjunction with the town authorities and the police force, so that work can be carried out during periods when traffic is known to be lighter, and alternative routes and diversions can be provided where necessary. The Contractor should also increase the workforce in areas such as this, so that the work is completed in the shortest possible time.

99. It is inevitable that there will be an increase in the number of heavy vehicles in the town (particularly trucks removing waste and importing sand), and this could disrupt traffic and other activities, as well as damage fragile buildings if vibration is excessive. These impacts will therefore need to be mitigated by:

- Careful planning of transportation routes with the municipal authorities to avoid sensitive areas as far as possible, including narrow streets, congested roads, important or fragile buildings and key sites of religious, cultural or tourism importance;
- Scheduling the transportation of waste to avoid peak traffic periods, the main tourism season, and other important times.

5. Social and Cultural Resources

100. As was the case for the supply augmentation works, there is again a risk that the excavation work could damage undiscovered archaeological or historical remains, or even undiscovered sites. The risks are in fact more significant in this case, because the work is much larger in scale and will all be conducted in Alwar town, which has been inhabited for a long period. The preventative measures described in Section IV.B.5 will thus need to be employed and strictly enforced. These are:

- Consulting national and state historical and archaeological authorities to assess the archaeological potential of all network construction sites;
- Selecting alternative routes to avoid any areas of medium or high risk;
- Including state and local archaeological, cultural and historical authorities and interest groups as project stakeholders to benefit from their expertise;
- Developing a protocol for use in conducting all trenching, to recognise, protect and conserve any chance finds (see Section IV.B.5 for details).

101. The network improvements will also disturb some modern-day social and cultural resources, such as schools, hospitals, temples, and sites that are of interest to tourists (such as the fort and City Palace complex). Impacts will include noise, dust, interrupted access for pedestrians and vehicles, and in cases where pneumatic drills are used to break the surface of concrete roads, there could be a risk of damage from vibration. Mitigation will therefore be needed to protect these resources and to enable usage by local people and visitors to continue throughout the construction work. This will be achieved through several of the measures recommended above, including:

- Consulting the town authorities to identify any buildings at risk from vibration damage and avoiding any use of pneumatic drills or heavy vehicles in the vicinity;
- Limiting dust by removing waste soil quickly, bringing sand to site only when necessary, covering and watering stockpiles, and covering soil and sand when carried on trucks;
- Increasing the workforce in sensitive areas to complete the work quickly;

- Providing wooden bridges for pedestrians and metal sheets for vehicles to allow access across open trenches where required (including access to houses);
- Using modern vehicles and machinery with standard adaptations to reduce noise and exhaust emissions, and ensuring they are maintained to manufacturers' specifications.

In addition the Executing Agency and Contractor should:

- Consult municipal authorities, custodians of important buildings, cultural and tourism authorities, and affected communities in advance of the work to identify and address key issues, and avoid working at sensitive times, such as religious and cultural festivals.

102. A different but no less significant impact is the effect on people and communities if water supplies are closed down for extended periods when work is conducted on the network. This would be inconvenient in the short term, and there could be health risks if the water supply was unavailable for several successive days or longer. It will therefore be important to take the necessary measures to avoid such a situation. This will require:

- Detailed planning of the construction program to keep the cessation of water supplies to the minimum possible (in both area and duration);
- Provision of alternative potable water to affected households and businesses for the duration of the shut-down;
- Liaison with affected persons to inform them of any cessation in advance, and to ensure that they are provided with an alternative supply.

103. 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.

104. An additional, particularly acute health risk presented by this work 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 encountered 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 are that:

- The DI ring-, carrier- and distribution-mains provided by this project will entirely replace the existing AC distribution network, from which there is heavy leakage at present;
- The AC network will be left in situ and there will be no deliberate excavation of AC pipes, and no need to join the new network to any AC pipes;
- The locations of the new network will be planned to avoid all locations of existing AC pipes so AC pipes should also not be encountered accidentally.

105. Given the dangerous nature of this material for both workers and citizens, one additional measure should be taken to protect the health of all parties in the event (however unlikely) that AC pipes are encountered. This is that, during design of the water supply system, the design consultant should develop a protocol to be applied in any instance that AC pipes are encountered, to ensure that appropriate action is taken. This should be based on the approach recommended by the United States Environmental Protection Agency (USEPA)[3], 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 recognise 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.

106. There could again be some short-term socio-economic benefits from the construction work if local people gain employment in the workforce. To ensure that these benefits are directed to communities that are affected by the work, as suggested in Section IV.B.5, the Contractor should be required to employ at least 50% of his labour force from communities in the vicinity of construction sites. Creating a workforce from mainly local people will bring additional benefits by avoiding problems that can occur if workers are imported, including social difficulties in the host community and issues of health and sanitation in poorly serviced temporary camps.

V. ENVIRONMENTAL IMPACTS AND MITIGATION: OPERATION AND MAINTENANCE

A. Screening out areas of no significant impact

107. Because a water supply system should operate without the need for major repair and maintenance (see below), there are several environmental sectors which should be unaffected once the system begins to function. These are identified in Table 5 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.

[3] 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

Table 5: Fields in which operation and maintenance of the completed water supply system is not expected to have significant impacts

Field	Rationale
Climate	Operation of water supply infrastructure should not affect climate
Topography and soils	Water will be used for domestic purposes not agriculture or irrigation
Fisheries & aquatic biology	No additional abstraction of water is planned in Tranche 1
Wildlife, forests, rare species, protected areas	There are none of these features in or outside the town
Coastal resources	Alwar is not located in a coastal area
Industries	The water supplied by the new system will not be for industrial use

B. Operation and maintenance of the improved water supply system

108. The main requirement for maintenance of the new infrastructure will be for the detection and repair of leaks. The generally flat topography and the usage of good quality DI pipes should mean that pipeline breaks are very rare, and that leaks are mainly limited to joints between pipes. The repair of household connections and the provision of new connections to increase the number of people supplied should greatly reduce the incidence of illegal connections, which are often a major source of leaks.

109. The bulk meters will allow monitoring of amounts of water flowing through individual parts of the network, which will pinpoint areas where there are leaks. A small Leak Detection Team will then visit these areas with audio devices to locate individual leaks, which will then be repaired in essentially the same way that the pipes were installed. Trenches will be dug to reveal the leaking area and the faulty connection will be re-fitted, or the pipe will be removed and replaced if necessary.

110. There will be some small scale maintenance required at the new OR sites, which will involve regular checking and recording of performance for signs of deterioration, servicing and replacement of parts, replenishment of chlorination cylinders, etc. Two or three men will be employed at each site for this purpose.

C. Environmental impacts and benefits of the operating system

1. Physical Resources

111. Generally the main risk to the physical environment of operating an improved water supply system is that increased abstraction of surface or groundwater will deplete the water resource. However that will not be the case here, as in Tranche 1 there will be no additional abstraction of water. The increase in supply will be obtained from the provision of a new water distribution network (which will significantly reduce system losses from leakage), and the installation of a new metering system (which will improve leak detection and cost recovery). The subproject will also fund a detailed study of additional sources of surface- and ground-water, and an investigation into ways that these might be used sustainably to increase the supply of municipal water in the future. This will be integrated with other measures already planned or underway to protect the diminishing groundwater resource. These include:

- Legal measures to restrict agricultural water use through regulation and the relocation and re-zoning of agricultural land to outer areas of the town. This is already underway by AMC and it is expected that by 2011 there will be no farm land in the urban area;
- Gradual abandonment and limitation in the use of existing tube-wells (particularly those in the centre of the town that deplete the aquifer and deliver polluted water), as the municipal supply improves with the implementation of the subproject;
- Other resource conservation activities including rooftop rainwater harvesting, use of urban storm water for groundwater recharge, providing subsidies or incentives for the use of drip/sprinkler irrigation, and regulating all agricultural water use.

112. These and other measures will be considered for support via future tranches of funding, with the overall aim of developing an integrated resource conservation and management strategy to provide a sustainable and long-term solution to the water needs of Alwar town. In the short-term the improved infrastructure will provide more water at the existing rate of abstraction, which should protect the aquifer from further over-exploitation. Recovery of the aquifer in the longer term will depend on the successful development and implementation of an appropriate conservation strategy.

113. With no proposed increase in the abstraction of water in Tranche 1, the physical impacts of operating the improved infrastructure should be very minor indeed.

114. If trenches are dug to locate and repair leaks or remove and replace lengths of pipe, the work will follow the same procedure as occurred when the infrastructure was improved. In this case soil and backfilled sand will be removed to expose the leaking junction or pipe, and if necessary a new pipe will be brought to site and replaced. The trench will then be refilled and re-compacted. This work should be very infrequent, and will affect individual small locations for short periods only (an average of a few hours for most repairs). Physical impacts will therefore be negligible. Work will not be conducted during rainfall so there will be no effect on drainage, and the removed material will be replaced in the trench so there will be no waste. There should also be no need to cover excavated material to prevent dust as it will have been wetted by the leaking water.

2. Ecological Resources

115. As there are no significant ecological resources in or around the town, any repairs or maintenance work can be conducted without ecological impacts.

3. Economic Development

116. Although network repairs could result in shops losing some business if the work means that access is difficult for customers, any losses will be small and short-lived and will probably be at the level of normal business fluctuations. It should therefore not be necessary to compensate for such losses. Nevertheless simple steps should be taken to reduce the inconvenience of the works, including:

- Informing all residents and businesses about the nature and duration of any work well in advance so that they can make preparations if necessary;
- Requiring contractors employed to conduct these works to provide wooden walkways across trenches for pedestrians and metal sheets where vehicle access is required;

- Consulting the local police regarding any such work so that it can be planned to avoid traffic disruption as far as possible, and road diversions can be organised if necessary.

117. The provision of an improved water supply system is not expected to have direct economic benefits for business or industry, as connections will only be provided to domestic users. However businesses will almost certainly benefit economically from the expected improvement in the health and wellbeing of their workforce (see below) as this will result in fewer days lost through illness, and overall increased productivity.

4. Social and Cultural Resources

118. Although there is a high risk of excavation in the town discovering material of historical or archaeological importance, there will be no need to take precautions to protect such material when areas are excavated to repair leaks in the network, as all work will be conducted in trenches that have already been disturbed when the infrastructure was installed.

119. Repair work could cause some temporary disruption of activities at locations of social and cultural importance such as schools, hospitals, temples, tourist sites, etc, so the same kinds of precautions as employed during the construction period should be adopted. These include:

- Consulting town authorities to identify any buildings nearby that could be at risk from vibration damage and avoiding any use of pneumatic drills or heavy vehicles in the vicinity;
- Completing work in these areas quickly;
- Providing wooden bridges for pedestrians and metal sheets for vehicles to allow access across open trenches where required;
- Consulting municipal authorities, custodians of important buildings, cultural and tourism authorities and local communities to inform them of the work in advance, and avoid sensitive times, such as religious and cultural festivals.

120. The responsible authorities will employ local contractors to conduct repairs of the distribution network, and contractors should be required to operate the same kinds of Health and Safety procedures as used in the construction phase (see Section IV.C.5) to protect workers and the public. This should include application of the asbestos protocol if any AC pipes are encountered, and prohibition of the use of AC pipes for any repair or maintenance work.

121. The use of local contractors will provide economic benefits to the companies and the workers they employ. There is however little prospect of directing these benefits to persons affected by any maintenance or repair works as contractors will utilise their existing workforce. To provide at least some economic benefits to affected communities, persons employed to maintain the pump stations and OR sites should be residents of the neighbouring area.

122. The citizens of the town will be the major beneficiaries of the improved water supply, as they will be provided with a constant supply of better quality water, piped into their homes. This should improve the social capital of the city, and individual and community health and well-being. Diseases of poor sanitation, such as diarrhoea and dysentery, should be reduced, so people should spend less on healthcare and lose fewer working days due to illness, so their economic status should also improve, as well as their overall health.

VI. ENVIRONMENTAL IMPACTS AND MITIGATION: LOCATION AND DESIGN

123. 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 IV and V above and no other impacts are expected.

124. 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 groundwater resource was depleted by excessive abstraction this would be an impact of both the location and design, because groundwater may not be depleted if the design had used surface water to augment the supply, and the specific aquifer would not have been depleted if the wellfield was located elsewhere.

125. 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 is relatively small in scale 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 is invasive, involving trenching and other ground disturbance. However the routine nature of the impacts means that most can be easily mitigated;
- In the one field in which there could be significant impacts (archaeology), those impacts are clearly a result of the construction process rather than the project design or location, as they would not occur if this did not involve trenching or other ground disturbance.

VII. INSTITUTIONAL REQUIREMENTS AND ENVIRONMENTAL MONITORING PLAN

A. Summary of environmental impacts and mitigation measures

126. Table 6 lists the potential adverse impacts of the Alwar water supply 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 +).

Table 6: Environmental impacts and mitigation for the Alwar Water Supply Subproject (Black = continuous activity; Grey = intermittent)

Potential Negative Impacts	Sig	Dur	Mitigation Activities and Method	Respon sibility	Location	07	2008				2009			
Construction: Supply Augmentation Works						D	1	2	3	4	1	2	Op	[4]
Excavation will produce relatively small amounts of waste that can be dumped at the municipal landfill	NS	P	Schedule excavation to take place after the new landfill has been provided under the Solid Waste Subproject	DSC	Gazuki R & OR sites									0
Dust produced by excavation at OR sites could affect residents and workers in the vicinity	M	T	Remove waste soil for disposal as soon as it is excavated	Contractor	OR sites									0
			Cover soil with tarpaulins when carried on trucks											0
			Cover or spray soil to reduce dust in windy weather											0
Ground disturbance could damage archaeological and historical remains	S	P	Request state and local archaeological authorities to assess archaeological potential of all work sites	DSC	All sites									0
			Select alternatives if sites have medium-high potential	DSC										0
			Include state and town historical authorities as project stakeholders to benefit from their expertise	LSGD										0
			Develop and apply protocol to protect chance finds (excavation observed by archaeologist; stop work if finds are suspected; state authority to plan appropriate action)	DSC and Contractor										+
Economic benefits if local people are employed in Contractor's workforce	M	T	Contractor should employ at least 50% of workforce from communities in vicinity of work sites	Contractor	All sites									+
Construction: Network Improvements														
Excavation of pipeline trenches will produce large amounts of waste soil	M	P	Find beneficial uses for waste soil in construction, land raising and infilling of excavated areas	Contractor	Network sites									+
Waste soil (and sand for trench infilling) could create dust	M	T	As above: remove waste soil as soon as it is excavated	Contractor	Network sites									0
			Plan work to only bring sand to site when needed											0
			As above: cover or spray stockpiled soil and sand in wind											0
			As above: cover soil and sand when carried on trucks											0
Roadside trees may be removed along pipeline route	M	P	Only remove trees if it cannot be avoided	Contractor	Network sites									0
			Plant and maintain two trees for every one removed											0
Some land may need to be acquired where route of pumping main diverges from alongside main road	M	P	*Purchase land as described in Resettlement Framework	LSGD	Where necessary									0
			*Avoid taking >10% of the land of any occupant	DSC										0
			* Compensate farmers in cash for loss of crops and trees	LSGD										0
Shops and other businesses may lose income if customers' access is impeded	M	T	*Compensate businesses for lost income	LSGD	Network sites									0
			Leave spaces for access between mounds of soil	Contractor										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
[4] 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

			Provide walkways and metal sheets to maintain access across trenches for people & vehicles where required	Contractor										0
			Increase workforce in these areas to finish work quickly	Contractor										0
			Consult businesspeople: inform them of work in advance	LSGD										0
Excavation could damage existing infrastructure	S	P	Confirm location of infrastructure and avoid these sites	DSC	Network sites									0
			Locate different infrastructure on opposite sides of road											0
Roads/people may be disturbed by repeated excavation	M	T	Integrate subprojects to conduct excavation at same time	DSC/LGD	Network									0
Traffic may be disrupted by soil, vehicles and machinery on road	M	T	Plan work with town authority: conduct when traffic is light	Contractor	Network sites									0
			Ensure police provide signs and diversions when needed											0
			As above: increase workforce to finish this work quickly											0
Traffic, people and activities could be disrupted by trucks carrying waste soil or delivering sand or other materials	M	T	Plan routes to avoid narrow streets, congested roads, important/fragile buildings, key religious and tourism sites	Contractor	Network sites									0
			Plan work to avoid peak traffic and main tourism season											0
Major risk that ground disturbance in town could damage archaeological and historical remains	S	P	As above: ask authorities to assess potential of all sites	DSC	All sites									0
			As above: alternative sites where risk is high/medium	DSC										0
			As above: include state/local authorities as stakeholders	LSGD										0
			As above: apply protocol to protect chance finds	DSC/CC										+
Sites of social/cultural importance (schools, hospitals, temples, tourism) may be disturbed by noise, dust, vibration and impeded access	M	T	Identify buildings at risk from vibration damage. Plan work to avoid using pneumatic drills & heavy vehicles nearby	Contractor	Network sites									0
			As above: remove waste quickly, cover/spray stockpiles, import sand only when needed, cover soil/sand on trucks											0
			As above: increase workforce to finish work quickly											0
			As above: use bridges to allow access (people/vehicles)											0
			Use modern vehicles/machinery & maintain as specified	Contractor	All sites									0
			Consult relevant authorities, custodians of buildings, local people to address issues & avoid work at sensitive times	Contractor	Network sites									0
People will be inconvenienced and their health may be at risk if water supply system is shut down for long periods	M	T	Plan work carefully to keep shutdown to minimum	DSC	Network sites									0
			Provide alternative water to affected residents	LSGD										0
			Inform communities of any shutdown well in advance	LSGD										0
Workers and the public are at risk from accidents on site	M	T	Prepare and implement a site Health and Safety Plan that includes measures to:	Contractor	All sites									0
			- Exclude the public from all construction sites;											0
			- Ensure that workers use Personal Protective Equipment											0
			- Provide Health & Safety Training for all personnel;											0
			- Follow documented procedures for all site activities;											0
			- Keep accident reports and records.											0

Existing water supply system uses AC pipes, a material that can be carcinogenic if inhaled as dust particles	S	T	Design infrastructure to avoid known locations of AC pipes	DSC	Network sites									0
			Train construction personnel in dangers of asbestos and how to recognise AC pipes in situ	Contractor	All sites									0
			Develop & apply protocol to protect workers and public if AC pipes are encountered. This should include:	DSC and Contractor	Network sites									0
			- immediate reporting of any occurrence to management	Contractor										0
			- removal of all persons to a safe distance											0
			- use of appropriate breathing apparatus and protective suits by workers delegated to deal with AC material											0
			- safe removal and long-term disposal of AC material											+
Economic benefits for people employed in workforce	M	T	As above: 50% of workforce from affected communities	Contractor	All sites									+
Operation and Maintenance														
Shops may lose small amounts of income if customers' access is impeded by network repair works	NS	T	As before: inform shopkeepers of work in advance	GA	Network sites									0
			As before: provide walkways and bridges for vehicles	OMC										0
			As before: request police to divert traffic if necessary	OMC										0
Sites of social/cultural importance may be disturbed by noise, dust, vibration, impeded access for short time during network repairs	NS	T	As before: avoid using drills/trucks near fragile buildings	OMC	Network sites									0
			As before: complete work quickly in sensitive areas	OMC										0
			As before: provide walkways/bridges for people/vehicles	OMC										0
			As before: consult authorities and communities, inform them of work in advance, avoid sensitive periods	GA										0
Health and safety of workers & the public could be at risk from repair work and AC pipes of old water supply system	M	T	Prepare and operate H&S Plan with same measures as used in construction phase	OMC	All sites									0
			Apply previously-developed protocol to protect all persons if AC pipes are encountered											0
Local people will benefit if employed by project	M	P	Workers employed to maintain TW, pump stations and ORs should be residents of neighbouring communities	GA	All sites									+

B. Institutional arrangements for project implementation

127. 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.

128. 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.

129. Environmental issues will be coordinated centrally by an Environmental Specialist within the IPMU, 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

130. Table 6 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.

131. 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 operate[5].

132. Table 6 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.

133. Table 7 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 6 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.

134. Given the scale of the investment in providing the infrastructure, LSGD will also wish to conduct monitoring during the operational period to confirm the long-term benefits of the scheme. Table 7 shows that this will cover two elements, which will monitor:

- The chemical and bacteriological quality of water provided by the municipal system;
- The health of the population and the prevalence of diseases of poor sanitation.

[5] 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)

Table 7: Environmental Monitoring Plan

Mitigation Activities and Method	Location	Responsible for Mitigation	Monitoring Method	Monitoring Frequency	Responsible for Monitoring
CONSTRUCTION					
Excavate river barrier and OR sites after new landfill is available	Gazuki R, ORs	DSC	Site observation; design reports	As needed	EMS
Find beneficial uses for waste soil (construction, land raising, infill)	Network sites	Contractor	Site observations; CC records	Monthly	EMS
Remove waste soil for disposal as soon as it is excavated	All sites	Contractor	Site observations	Weekly	EMS
Use tarpaulins to cover dry soil and sand when carried on trucks	All sites	Contractor	Observations on and off site	Weekly	EMS
Cover or damp down soil and sand stockpiled on site	Network sites	Contractor	Site observations	Weekly	EMS
Only bring sand (for backfill) to site when needed	Network sites	Contractor	Site observations; CC records	Weekly	EMS
Leave spaces for access between mounds of soil	Network sites	Contractor	Site observations	Weekly	EMS
Only remove trees if it cannot be avoided	Network sites	Contractor	Site observations	Weekly	EMS
Plant and maintain two trees for every one removed	Network sites	Contractor	Observations on/off site; CC records	Monthly	EMS
*Acquire land as described in Resettlement Framework	Where required	LSGD	Landowner surveys; LSGD records	As needed	IMA[6]
*Avoid taking >10% of the land of any occupant	Where required	DSC	Owner/tenant surveys; LSGD records	As needed	IMA
* Compensate farmers in cash for loss of crops and trees	Where required	LSGD	Farmer surveys; LSGD records	As needed	IMA
*Compensate businesses for lost income	Where required	LSGD	Shopkeeper survey; LSGD record	As needed	IMA
Provide bridges to allow people & vehicles to cross trenches	Network sites	Contractor	Site observation; resident survey	Weekly	EMS
Increase workforce in sensitive areas to finish work quickly	Network sites	Contractor	Site observations; CC records	Monthly	EMS
Inform businesspeople and residents of work in advance	Network sites	LSGD	Resident surveys; CC records	Monthly	EMS
Consult town authority and avoid existing infrastructure	Network sites	DSC	Site observation; design reports	Monthly	EMS
Locate water and sewer pipes on opposite sides of roads	Network sites	DSC	Site observation; design reports	Monthly	EMS
Integrate subprojects to conduct trenching at same time	Network sites	DSC/LSGD	Site observation; design reports	Monthly	EMS
Plan work with town authorities – work when traffic is light	Network sites	Contractor	Site observations; CC records	Monthly	EMS
Ensure police provide traffic diversions when necessary	Network sites	Contractor	Site observations; CC records	Monthly	EMS
Plan transport routes to avoid narrow streets, important or fragile buildings, religious and tourism sites	Network sites	Contractor	Observations off site: CC record	Weekly	EMS

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

Plan work to avoid peak traffic and main tourism season	Network sites	Contractor	Site observations; CC records	Monthly	EMS
Request archaeological authorities to assess potential of all sites	All sites	DSC	DSC records; design reports	As needed	EMS
Select alternatives if sites have medium or high potential	All sites	DSC	DSC records; design reports	As needed	EMS
Include state and town historical authorities as stakeholders	All sites	LSGD	CC records; observations at meetings	As needed	EMS
Develop and apply archaeological protocol to protect chance finds	All sites	DSC and CC	DSC and CC records; site observations	Weekly	EMS
Avoid using pneumatic drills near buildings at risk from vibration	Network sites	Contractor	Site observations; CC records	Weekly	EMS
Use modern vehicles and machinery and maintain as specified	All sites	Contractor	Site observations; CC records	Monthly	EMS
Consult authorities, custodians of buildings, communities: address key issues, avoid working at sensitive times	Network sites	Contractor	Site observations; CC records; resident surveys	Monthly	EMS
Plan work to minimise shutdown of water supply system	All sites	DSC	Design reports; resident surveys	Monthly	EMS
Provide alternative water to affected residents	All sites	LSGD	Site observation; resident survey	Weekly	EMS
Inform communities of any shutdown in advance	All sites	LSGD	Site observation; resident survey	Weekly	EMS
Prepare and implement a site H&S Plan (safety of workers/public)	All sites	Contractor	Site observations; CC records	Monthly	EMS
Exclude public from the site	All sites	Contractor	Site observations; CC records	Monthly	EMS
Ensure that workers wear Personal Protective Equipment	All sites	Contractor	Site observations; CC records	Monthly	EMS
Provide Health and Safety training for all personnel	All sites	Contractor	CC records; worker interviews	Monthly	EMS
Follow documented procedures for all site activities	All sites	Contractor	Site observations; CC records	Monthly	EMS
Keep accident reports and records	All sites	Contractor	CC records	Monthly	EMS
Design infrastructure to avoid known locations of AC pipes	Network sites	DSC	DSC records; design reports	As needed	EMS
Train all personnel in dangers and recognition of AC pipes	All sites	Contractor	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	Contractor	Site observations; CC records	Weekly	EMS
Remove all persons to safe distance	All sites	Contractor	Site observations; CC records	Weekly	EMS
Workers handling AC: wear breathing apparatus; protective suits	All sites	Contractor	Site observations; CC records	Weekly	EMS
All AC material must be removed and disposed of safely	All sites	Contractor	Observations on and off site; CC records	As needed	EMS
Employ at least 50% of workforce from communities near sites	All sites	Contractor	CC records; worker interviews	Monthly	EMS
OPERATION AND MAINTENANCE					
Inform shopkeepers and residents of work in advance	Network sites	GA	Resident surveys	Monthly	
Provide walkways and bridges for vehicles	Network sites	OM Contractor	Site observation; resident survey	Monthly	

Request police to divert traffic if necessary	Network sites	OM Contractor	Site observations	Monthly	
Avoid using drills or trucks near fragile buildings	Network sites	OM Contractor	Site observations	Monthly	
Complete work quickly in sensitive areas	Network sites	OM Contractor	Site observations; OMC records	Monthly	
Provide walkways for people and bridges for vehicles	Network sites	OM Contractor	Site observation; resident survey	Monthly	
Consult and inform authorities & people, avoid sensitive periods	Network sites	GA	Site observation; resident survey	Monthly	
Prepare and operate H&S plan to protect workers and citizens	All sites	OM Contractor	Site observations; OMC records	Monthly	
Apply AC protocol to protect all persons if AC pipes encountered	All sites	OM Contractor	Site observations; OMC records	Monthly	
Employ people who live nearby to maintain TW, OR, pump station	All sites	GA	Employer record; worker survey	Monthly	
LONG-TERM SURVEYS					
Survey of chemical and bacteriological quality of municipal water	Source and Domestic sites	LSGD	Water quality sampling and analysis	Annual for 5 years	Consulting laboratory
Survey of public health and incidence of water borne disease	Alwar Town	LSGD	Hospital records; resident surveys	Annual for 5 years	Social studies consultant

135. An accredited laboratory will be appointed to monitor the quality of water at the existing wellfield and at the point of supply to consumers (in houses and slums), and a domestic social studies consultant will be appointed to monitor public health and the incidence of disease. These surveys will be conducted annually over the first five years of operation of the system, and require the initial collection of baseline data on pre-project conditions, during the construction period.

D. Environmental management and monitoring costs

136. Most of the mitigation measures require the contractors 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 contractors (those employed to construct the infrastructure or the local companies employed to conduct O&M when the system is operating) 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 shopkeepers for loss of business income during the construction period (Table 6) are calculated separately in the budgets for the Resettlement Framework and Resettlement Plans so are also excluded from this analysis.

137. The remaining actions in the Environmental Management Plan are:

- the environmental monitoring during construction, conducted by the EMS; and
- the long-term post-construction surveys that will be commissioned by LSGD.

These have not been budgeted elsewhere, and their costs are shown in Table 8, with details of the calculations shown in footnotes beneath the table. The figures show that the total cost of environmental management and monitoring for the subproject as a whole (covering design, 1 ½ years of construction and the first five years of operation) is INR 1.8 million, ie US$ 40,000.

Table 8: 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	100,000[7]	300,000	
Survey Expenses	Sum	100,000	100,000	400,000
2. Survey of municipal water quality (6 years)				
Domestic Consultant	6 x ½ month	100,000	300,000	
Sample Analysis	6 x 20	3,000[8]	360,000	
Other Expenses	Sum	200,000	200,000	860,000
3. Survey of public health (6 years)				
Domestic Consultant	6 x ½ month	100,000	300,000	
Other Expenses	Sum	200,000	200,000	500,000
TOTAL				1,760,000

[7] Unit cost of domestic consultants include fee, travel, accommodation and subsistence
[8] Cost of a standard suite of drinking water quality parameters (pH, turbidity, chlorinity, alkalinity, conductivity, TDS, DO, total and faecal coliforms, and selected metals) is $65 (INR 3,000) per sample

VIII. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

A. Project stakeholders

138. Most of the main stakeholders have already been identified and consulted during preparation of this IEE, and any others 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 of facilities that will be improved or built (OR, TW);
- Owners and users of any land that is acquired along the pumping main route;
- Custodians and users of socially and culturally important buildings in the same areas;
- State and local authorities responsible for the protection and conservation of archaeological relics and historical sites and artefacts;
- State and local tourism authorities.

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

139. Two forms of public consultation have been used during preparation of the IEE, to discuss the project and involve the community in planning the mitigation measures and develop the Environmental Monitoring Plan. These are:

- A public meeting was held in Alwar Town in March 2007, to which representatives of primary and secondary stakeholders were invited. Attendees were informed about the aim of the various subprojects and the benefits they would bring, together with their likely impacts and the ways in which they would be mitigated. Participants were invited to discuss their views and concerns, which were then incorporated into the IEE. Appendix 1 contains a summary of the meeting;
- *Ad hoc* discussions were also held on site with people and communities who could be affected by the subprojects, so that views could be expressed in a less formal setting. These were also considered in preparing the IEE.

140. This IEE will be disclosed to the public by making it available on the ADB website, together with the IEEs prepared for the other subprojects and the summary IEE (SIEE) describing the impacts and mitigation of all subprojects.

C. Future consultation and disclosure

141. 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 program 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 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

142. The process described in this document has assessed the environmental impacts of all elements of the infrastructure proposed under the Alwar Water Supply 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 main pipelines and branches of the distribution network 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;
- Designing the infrastructure so that the new DI distribution network will replace the existing AC network, which will be left in situ undisturbed.

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

143. Changes have also been made to the location of elements of the project to further reduce impacts. These include:

- Locating all new facilities (ORs) on government-owned land to avoid the need for land acquisition and relocation of people;
- Locating the 8 km pumping main in the ROW alongside the main road, to avoid acquiring agricultural land and affecting the livelihoods of farmers and farm workers.

144. 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 infrastructure is built and when it is operating. This is mainly because of the invasive nature of trenching work; because the distribution network is located in a town, some parts of which are densely populated; and because Rajasthan is an area with a rich history, in which there is a high risk that ground disturbance may uncover important remains. Because of these factors the most significant impacts are on the physical environment, the human environment, and the cultural heritage.

145. During the construction phase, impacts mainly arise from the need to dispose of large quantities of waste soil and import a similar amount of sand to support the pipes in the trenches; and from the disturbance of residents, businesses, traffic and important buildings by the construction work. These are common impacts of construction in urban areas, and there are well developed methods for their mitigation. These include:

- Finding beneficial uses for waste material;
- Covering soil and sand during transportation and when stored on site;
- Planning work to minimise disruption of traffic and communities;
- Providing temporary structures to maintain access across trenches where required.

146. There could also be a need to acquire small amounts of farm land along the route of the pumping main, where it is impracticable for the pipeline to follow bends in the road. 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 GoI 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 standing crops and productive trees.

147. 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 all proposed construction sites, and selecting alternative locations to avoid any areas 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.

148. The use of AC pipes in the existing water distribution network presents a particular problem, as workers and the public will need to be protected from inhalation of asbestos dust, which can be carcinogenic. This will be addressed by a number of measures, including:

- Provision of a new DI distribution network to entirely replace the old AC system, which will be left in situ undisturbed;
- Training staff and workers to raise awareness of the dangers of AC and enable early recognition of such pipes if encountered accidentally;
- Development of a protocol based on USEPA guidelines, 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).

149. 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 construction sites to provide them with a short-term economic gain;
- Ensure that people employed in the longer term to maintain and operate the new facilities are residents of nearby communities.

150. These and the other mitigation and enhancement measures are summarised in Table 6, which also shows the location of the impact, the body responsible for the mitigation, and the programme for its implementation.

151. Once the system is operating, most facilities (TW, OR, pump stations, chlorination) will operate with routine maintenance, which should not affect the environment. Leaks in the network will need to be repaired from time to time, but environmental impacts will be much less than those of the construction period as the work will be infrequent, affecting small areas only. It will also be conducted in areas that have already been excavated, so there will be no need to protect archaeological material.

152. The new system will protect the over-exploited groundwater resource in the short-term by satisfying the increase in water demand from system improvements (reduction in leakage and unaccounted-for water), rather than by increasing abstraction. Other water conservation measures will be introduced, including a study to assess whether alternative water sources may be used sustainably. These and other measures will ultimately form an integrated resource

conservation and management strategy, which could have more longer term benefits on the recovery of the aquifer if implemented successfully.

153. The main beneficiaries of the improved system will be the citizens of the town, who will be provided with a constant supply of better quality water, which serves a greater proportion of the population, including slum-dwellers. This will improve the quality of life of people as well as raising standards of both individual and public health as the improvements in hygiene should reduce the incidence of disease associated with poor sanitation. This should lead to economic gains as people will be away from work less and will spend less on healthcare, so their incomes should increase.

154. Table 6 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).

155. Mitigation will be assured by a program 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. There will also be longer-term surveys to monitor the expected improvements in the quality of domestic water and the health of the population.

156. Finally, stakeholders were involved in developing the IEE through both face-to-face discussions on site and a large public meeting held in the town, after which views expressed were incorporated into the IEE and the planning and development of the project. The IEE will be made available at public locations in the town and will be disclosed to a wider audience via the ADB website. The consultation process will be continued and expanded during project implementation, when a nationally-recognised NGO will be appointed to handle this key element to ensure that stakeholders are fully engaged in the project and have the opportunity to participate in its development and implementation.

B. Recommendations

157. 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 6) 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 VI.C of this report and the internal and external monitoring proposed in the Resettlement Framework are also implemented in full.

X. CONCLUSIONS

158. The environmental impacts of the proposed improvements in water supply and distribution infrastructure in Alwar Town have been assessed by the Initial Environmental Examination reported in this document, conducted according to ADB guidelines. 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. These measures were integrated into the IEE and are summarised in this report.

159. The overall conclusion of both processes is that providing 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.

160. There are no uncertainties in the analysis, and no additional work is required to comply with ADB procedure or national law. There is thus no need for further study or Environmental Assessment.

Photo 1: Overhead Reservoir in Alwar

Photo 4: Household water meter

Photo 2: Ductile Iron water pipes

Photo 5: Polluted lake south of Alwar

Photo 3: Above ground water supply pipes

Photo 6: Agricultural land outside Alwar

Photo 7: MIA Industrial Area (background)

Photo 9a: Roadside drains in Alwar

Photo 8a: Shop in Alwar town

Photo 9b: Roadside drains in Alwar

Photo 8b: Shops in Alwar town

Photo 10a: Road in the outskirts of Alwar

Photo 10b: Road in the outskirts of Alwar

Photo 13: Alwar City Palace

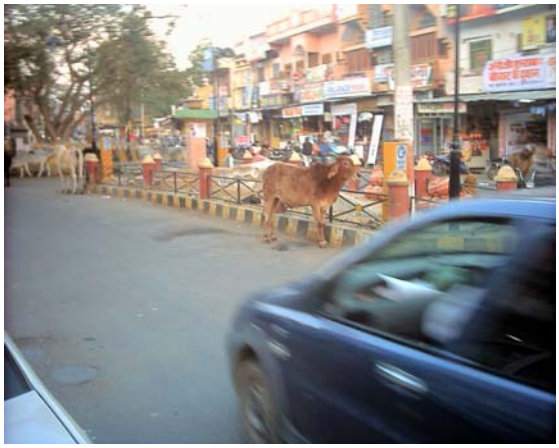


Photo 11: Road near the centre of Alwar

Photo 14: Siliserh Dam and lake

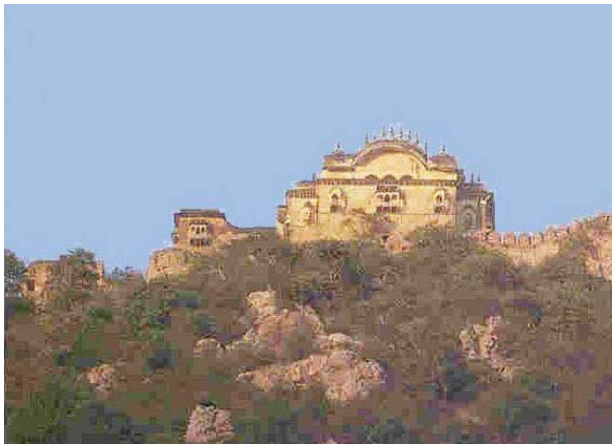


Photo 12: Alwar Fort

Photo 15: Irrigation canal from Siliserh lake

Photo 16: Jaisamandh Dam

Photo 19: Digging a trench by hand

Photo 17: Rig used to drill tubewells

Photo 20: Encroachments into ROW

Photo 18: Backhoe digger constructing a trench

Photo 21: Communal water collection point