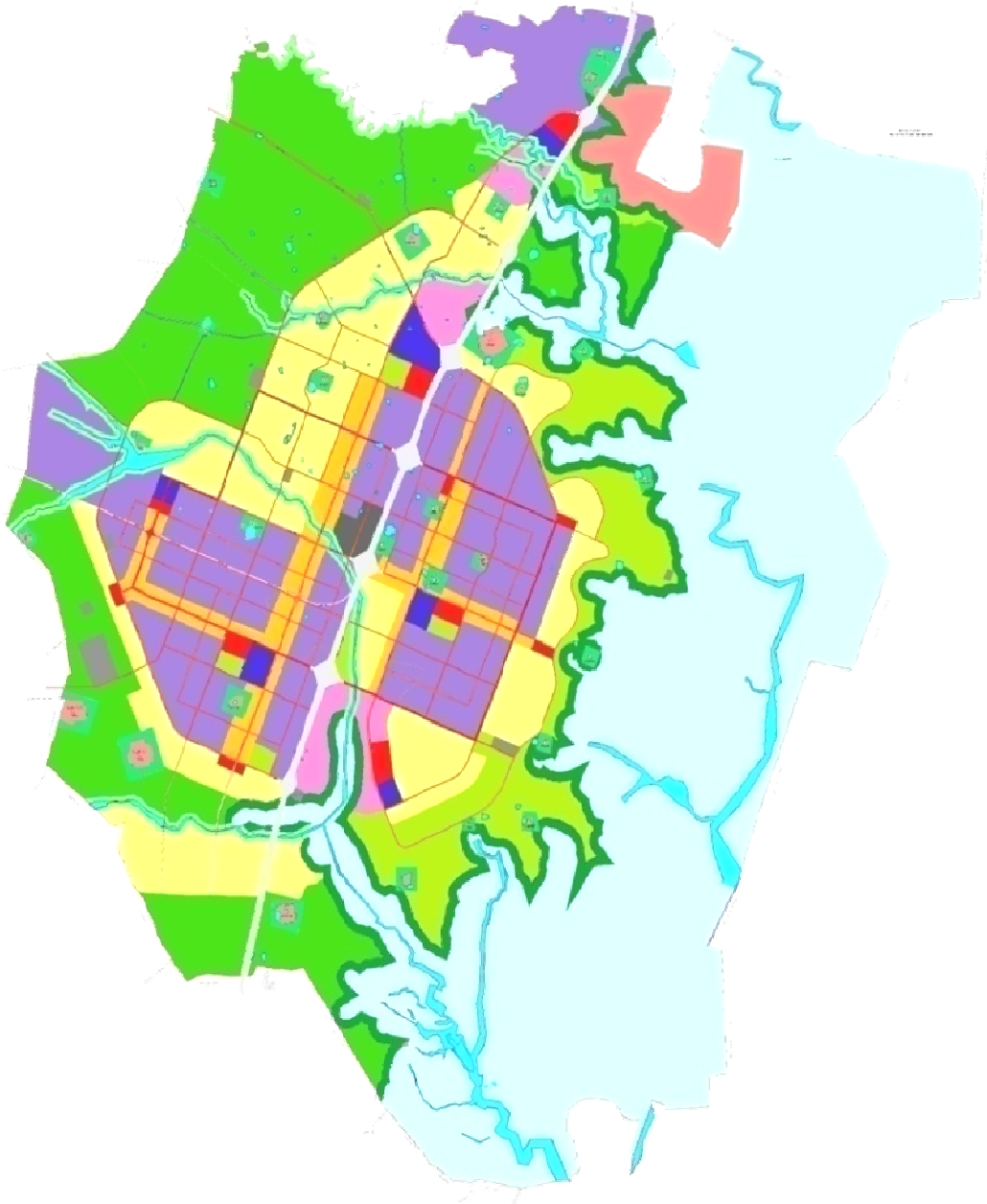
Dholera Special Investment Regional Development Authority

FINAL DEVELOPMENT PLAN – DSIRDA

REPORT - 1



SANCTIONED BY APEX AUTHORITY (GIDB) ON 10TH SEPTEMBER, 2012 AND

CAME INTO FORCE ON 10TH SEPTEMBER, 2012

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Abbreviations

DFC	Dedicated Freight Corridor
DMIC	Delhi-Mumbai Industrial Corridor
DSIRDA	Dholera Special Investment Region Development Authority
DSIR	Dholera Special Investment Region
CRZ	Coastal Regulation Zone
MoU	Memorandum of Understanding

State and Central Government Organisations

CPHEEO	Central Public Health and Environmental Engineering Organisation
CPCB	Central Pollution Control Board
GEB	Gujarat Electricity Board
GETCO	Gujarat Energy Transmission Company
GERC	Gujarat Electricity Regulatory Commission
GIDB	Gujarat Infrastructure Development Board
GPCB	Gujarat Pollution Control Board
GSRDC	Gujarat State Road Development Corporation
IRC	Indian Roads Congress
MoEF	Ministry of Environment and Forests
MNES	Ministry of Non-conventional Energy Sources
NEERI	National Environmental Engineering Research Institute
PCCF	Principal Chief Conservator of Forest

Utility Infrastructure Terms

CETP	Common Effluent Treatment Plant
DCS	Distribution Control System
ICT	Information Communication Technology
IWMF	Integrated Waste Management Facility
SCADA	Supervisory Control and Data Acquisition System
STP	Sewage Treatment Plant
SWM	Solid Waste Management
TSE	Treated Sewage Effluent

Financial and Economic Terms

CAPEX	Capital Expenditure
ERR	Economic Rate of Return
ENPV	Economic Net Present Value
OPEX	Operating Expenditure

Terms related to Environment, Sustainability and Green Buildings

EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
BREEAM	BRE Environmental Assessment Method
GRIHA	Green Rating for Integrated Habitat Assessment
LCC	Low Carbon City
LEED	Leadership in Energy and Environmental Design
IGBC	Indian Green Building Council

Terms Related to Transportation

LRT	Light Rail Transit
PHF	Peak Hour Factor
PCTR	Per Capita Trip Rate
TOD	Transit Oriented Development

Measurement Related Terms

BUA	Built Up Area
FSI	Floor Space Index
ha	Hectare
mn	million
Rs/sq.ft.	Rupees per Square Feet
sq.ft.	Square Feet
sq.km.	Square Kilometre
lpcd	Litres per Capita per Day
MLD	Million Litres per Day
MMSCMD	Million Metric Standard Cubic Meter per Day
MW	Mega Watt
MU	Mega Unit

Measurements

1 ha = 2.471 acres

1 acre = 43,560 sq.ft.

1 mn = 10 lakhs

1 sq.km. = 100 ha

CHAPTER 1

EXECUTIVE SUMMARY

1. Executive Summary

1.1. The Project

The Dholera Special Investment Region (DSIR) will be a major new industrial hub located on a Greenfield site about 100 km south of Ahmedabad and about 130 km from Gandhinagar. The project is the first investment region to be designated under the proposed Delhi - Mumbai Industrial Corridor project (DMIC), a joint Indian and Japanese Government initiative to create a linear zone of industrial development nodes along a Dedicated Freight Corridor (DFC) railway.

1.2. The Draft Development plan Report - 1

The purpose of the Draft Development Plan for the DSIR is to set out the framework for the long term growth of the area of the DSIR for a period of 30 years starting from 2010. It is intended to provide a broad development guide to all people with an interest in the future of the DSIR – including Central and State Governments, public and private bodies and corporations and the existing local inhabitants and landowners living within and adjoining the boundaries of the designated area.

Report 1, The Draft Development Plan; presents the background, overall vision and elements for the DSIR and is complemented by Report 2, which contains the General Development Control Guidelines (GDCR). The Plan provides the overall spatial allocations for the new City and sets out a 30 year, phasing strategy including land uses, transport and major infrastructures and utilities and services.

1.3. The Project Site

The DSIR covers a substantial area of land totalling to approximately 920 sq km and encompasses 19 villages of Dhandhuka Taluka and 3 villages of Barwala Taluka; total 22 villages of Ahmedabad District, making it the largest of the investment nodes proposed so far in the DMIC influence region. The site is strategically situated between the main industrial centres of Ahmedabad, Vadodara, Surat, Rajkot and Bhavnagar. It is linked to the major ports of Gujarat by State Highways but as yet has no direct rail connection. The nearest international airport is at Ahmedabad, although there is a current proposal to develop a new international airport to the north-east of the DSIR at Navagam Village.

The existing population within the study area is only about 37,000 (census 2001), inhabiting small settlements. Agriculture is the principal land use and activity within the area, although the land is generally of poor quality and saline, especially close to the sea, and farm output is not high. Land values are therefore relatively low.

1.4. Overall Vision and Objectives

The Draft Development Plan aims at the creation of an economically and socially balanced, new age City with world class infrastructure and high quality of life. Adoption of a sustainable approach across key components such as transportation, waste recycling, overall urban form and resource efficiency form the cornerstones of this Plan.

1.5. Plan Provision

A comprehensive assessment of the industrial and commercial potential was undertaken in order to determine the economic viability of the DSIR. The study, which included discussions with key stakeholders and detailed economic studies, concluded that the DSIR has the potential to attract a wide range of industrial uses, with particular strengths in the electronics and high tech industries, pharmaceuticals and biotechnology, heavy engineering and auto and general manufacturing sectors. Industrial employment, together with tourism and higher education will provide the economic foundations of the DSIR and generate about 343,000 ‘base’ jobs, which in turn would generate a further 483,630 jobs in support services. This is expected to create about 826,630 jobs in total over a 30 year time frame.

It is forecasted that the jobs created in the DSIR will support a total population of about 2.5 million. There is expected to be some commuting to the DSIR from neighbouring urban centres like Ahmedabad and

Bhavnagar, although a majority of the workforce would prefer to live in the new City. It is anticipated that housing will be required for a target resident population of about 2 million.

The average family size in the DSIR is expected to be about 4, in line with national trends in urban areas, so it is necessary to plan for the construction of about 500,000 dwellings.

1.6. The Land Use Allocations

The land use is allocated based upon twelve spatial planning principles:

- Creation of a compact city;
- Integration of land uses;
- Accessibility of industrial zones;
- Focus of the city internally away from the central expressway, which will only have limited access;
- Separation of industrial and city traffic;
- Provision for a high quality public transport system;
- Development of a poly-centric structure that has a number of commercial and community nodes;
- Integration of existing villages into the new city;
- Conservation of the better agricultural land;
- Protection of the CRZ;
- Development of a strong landscape strategy; and
- A phased development programme that allows optimised investment.

A summary of the land use allocations proposed in the DSIR is given in Fig. No.1-1

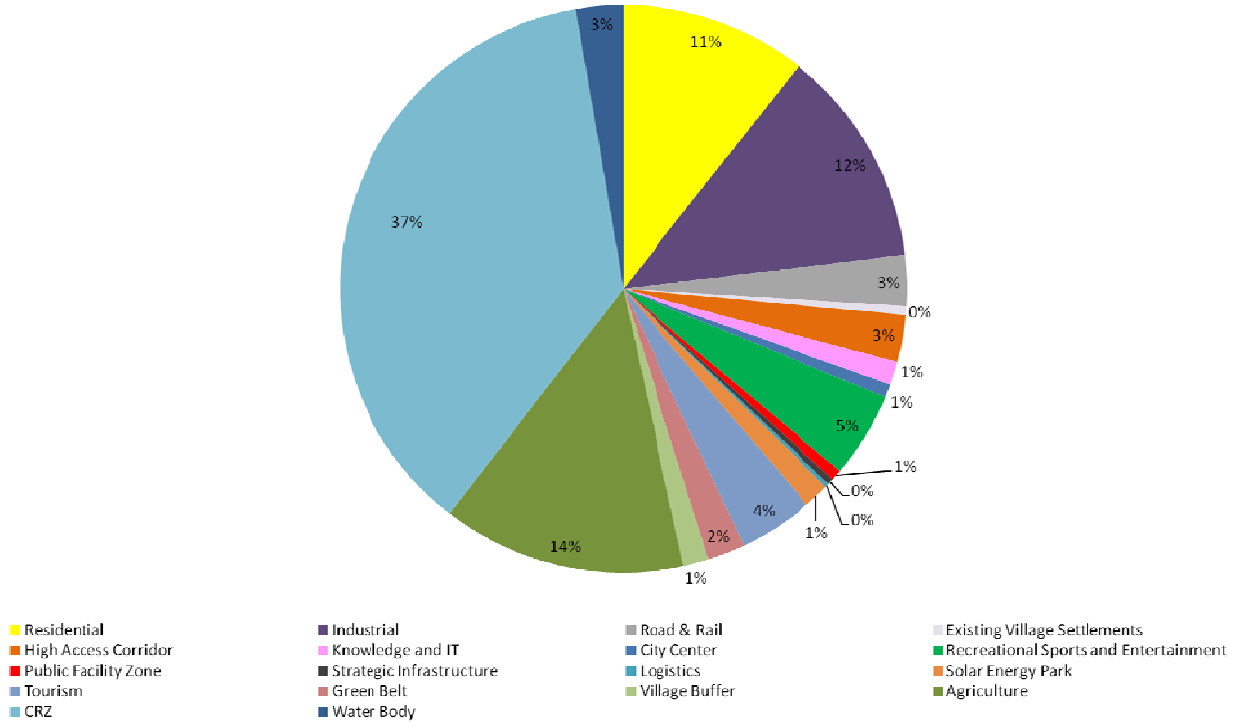


Figure 1-1: Overall Land Use Allocation - Percent Share

1.7. Industrial and Economic Zones

A total of about 11,661 ha land area is allocated for industrial and logistics use in a number of linked mega parks, all of which have excellent access to the road and rail networks.

In addition to the traditional industrial sectors, substantial additional land is allocated for knowledge based activities such as universities and research centres, bringing the total land area allocated for the economic sectors to over 12,891 ha. Additionally, about 12,000ha of agriculture land is allocated for future development.

1.8. Residential Areas

A wide range of housing types will be developed in the DSIR to meet the anticipated population of 2 million by 2030. A total of about 6,785 ha land area is allocated for housing, in addition to the 1,772 ha occupied by existing villages and their designated buffer zones. This provision is met through allocation for housing in various land use zones besides the Residential zone such as High Access Corridors, City Centre and Knowledge & IT.

About 20 percent of the residential land will be allocated for the development of housing for low income groups, another 57 percent is allocated for medium income groups and the remaining 13 percent of the housing land is planned for high income groups.

All residential areas will be mixed-incomes and housing will be developed with a comprehensive range of community facilities, including schools, medical facilities, neighbourhood retail and open space.

1.9. Government, Civic and Cultural Facilities

The DSIR will become a sizable city by 2030 and will therefore need to develop Government, civic and cultural services to match the requirements and expectations of the inhabitants and visitors. Major hospitals, colleges, Government offices and facilities such as post offices, fire stations, libraries, theatres and meeting halls, parks and sports venues and a range of religious buildings will be located in the central business district and the key commercial centres located in the different parts of the city.

1.10. Leisure and Tourism

Tourism is expected to play an important role in the economy of DSIR through traditional attractions such as religious sites and the Black Buck Sanctuary, as well as new ventures such as the proposed Film City, located in the Recreation Sports and Entertainment zone. A range of hotels will also be required to support the needs of business and industry, and these will be located within various zones such as City Centre, Knowledge & IT, High Access Corridors. Low development impact, Eco-resorts will be given special approval to be located in the Tourism & Resorts zone.

1.11. Green Spaces, Recreation and Agriculture

Spaces for recreation, open and green areas will make up more than 21 percent of the total DSIR and will ensure that the new city is an attractive and pleasant place to live and work with a high quality of life. A significant area of land will be allocated for agriculture in order to supply the new city with fresh farm produce. It will also act as a strategic land allotments should there be an additional demand for industrial land.

1.12. Phasing

For development in the DSIR to be efficient and cost effective, the distribution of land uses and infrastructure must be planned and provided in a phased and coordinated manner. The planning horizon of 30 years has been divided into 3 equal parts. The phasing strategy has been designed so as to optimise the use of available Government land in the initial phases and to build upon existing facilities and infrastructure. Development is then concentrated in one or two locations only so as to ensure that utility services can be provided economically.

The Phase 1 development will comprise about 34 percent, Phase 2 about 36 percent and Phase 3 about 30 percent of the land under urbanisable zones. Development of the DSIR is recommended to start from Ambli Village in the north side, close to the existing State Highway (SH – 6) and then proceed generally southward either side of the expressway to Bavariyari Village.

1.13. Transport

The DSIR will be integrated into the regional transportation network by greatly improved road infrastructure and the provision of a new rail connection with freight and passenger services. This will link Dholera with Ahmedabad, Bhavnagar and the key ports of Pipavav, Mundra and Kandla.

The proposed location of the new International Airport just to the north of Dholera at Navagam village will provide a major attraction for businesses in the DSIR.

The Central Expressway corridor (SH-6) will give direct access to the city through five grade separated interchanges. But to avoid congestion and the growth of the informal sector on this road, service roads are not provided along the expressway. Properties abutting the SH-6 will only access their plots through the internal road network.

A hierarchy of roads will distribute traffic in the city and there will be a high degree of separation between industrial and other traffic. The needs of pedestrians and cyclists will receive equal weight to that of motor traffic and there will be provision for a high quality public transport system, including street running trams.

1.14. Provision of Utilities

World-class facilities like power, water, telecommunications, gas and waste management facilities are proposed for the DSIR.

An estimated 947 MLD fresh water will be required to meet demand by 2030. Initially this will be provided by the Narmada Canal through the Vallabhipur and Dholka Branch or the Pariyej and Kanewal Reservoirs but other potential sources of water, such as the Kalpasar Dam and desalination may be required in the future.

A waste water management strategy will be formulated to manage, recycle and reuse industrial and domestic waste water and sewage treatment plants based upon aeration technology will be developed.

There will be a substantial power demand from the DSIR totalling 1,700 MW, of which an estimated 1,000 MW will serve the industrial sector. In the initial phase of development, demand will be met by tapping into the nearby electrical supply network. In addition to relying on State generated energy, the industrial parks offer a suitable location for the construction of a gas fired power plant. About 1346 ha of land has been allocated for the development of a solar energy park.

Gas and telecommunication networks have also been planned, as well as a strategy for solid waste management, including waste recycling.

1.15. Environment and Social Strategy

The environment strategy is based upon minimising potential impacts on important environmental areas and restricting development in the CRZ in order to protect future residents from flood hazards and to protect the local flora and fauna. Existing natural and man-made water bodies will be preserved and enhanced. New lakes and canals will be created through the widening and de-silting of existing rivers and watercourses and recreational areas and green spaces are established along their banks.

The development of the DSIR will not involve the displacement or resettlement of any local inhabitants. A comprehensive strategy for integration of villages recommends the creation of buffer zones around existing village settlements. The strategy is supported with a model village plan illustrating the ideal mix of activities and uses within a sample village buffer zone. It is recommended that the Dholera Welfare Society be created to function as a village assistance cell in order to ensure that the benefits of the development trickle down at the village level.

Villages will be provided with improved infrastructure and services, and their inhabitants provided with training programmes and support to enable them to participate fully in the employment opportunities that new development will bring about.

1.16. Cost of Infrastructure

The capital cost for infrastructure provisions to bring about the development of the DSIR is broadly estimated to be over 38,476 crores INR over the 30 year plan period. The cost of operating infrastructure elements is estimated to be over 304.60 crores INR in Phase 528.66 crores INR in Phase 2 and 251.04 crores INR in Phase 3.

1.17. Implementation Framework

Under the provisions of the Gujarat Special Investment Region Act, 2009; the DSIR will be governed by the Dholera Special Investment Development Authority (DSIRDA), with the Gujarat Infrastructure Development Board (GIDB) as its apex authority.

The Plan recommends adoption of a phased land management strategy in order to achieve speedy implementation at relatively low cost. This will involve, in the first instance, limited compulsory land acquisition for critical infrastructure elements in order to kick start the development. Thereafter the application of Town Planning Scheme can be applied, once the market for the resale of land is established and farmers are able to resell their land at a profit.

The framework sets the time line for review of the Draft Development plan on a regular basis. A review of provisions is recommended every five years and a more thorough review and revised atleast once in every ten years.

CHAPTER 2

INTRODUCTION

2. Introduction

2.1. Project Brief

The Dholera Special Investment Region (DSIR) is proposed as a major new industrial hub to be located about 100 kilometres (km) south of Ahmedabad and 130 km from Gandhinagar within the Saurashtra peninsula. The site covers an area of about 920 sq km of land bordering the Gulf of Khambhat.

The DSIR is the first investment region to be designated under the proposed Delhi – Mumbai Industrial Corridor project (DMIC), a joint Indian and Japanese initiative to create a linear zone of development along a Dedicated Freight Corridor (DFC) railway line. (See Figure 2.1)

Figure 2-1: DMIC Corridor and the National

Figure 2-2: The Vision for the DSIRDA

The Plan provides for the development of an integrated and largely self contained new city with the potential to grow up to and beyond a target population of 2 million (20 lakh). Figure 2.2 gives the vision adopted for this Draft Development Plan document.

2.2. Constitution of 'Authority' and 'Committee Members' of the Dholera Special Investment Regional Development Authority (DSIRDA) under the Gujarat Special Investment Region Act 2009

In exercise of the powers conferred by section 3 read with section 4 of the Gujarat Special Investment Region Act, 2009 (Guj. 2 of 2009), the Industries and Mines Dept. of Gujarat and the Government of Gujarat declared Dholera Special Investment Region (DSIR) vide Notification No. GHU-14/SIR/112009/253/(I)/(I**)** on 22nd May, 2009 published in Government Gazzete part IV-B on page number 40 and 41 on 4th June, 2009. Dholera Special Investment Region comprised of 19 villages of Dhandhuka Taluka and 3 villages of Barwala Taluka; total 22 villages of Ahmedabad District measuring about 879.3377 sq km.

In exercise of the powers conferred by sub-section (1) of sections 8, 9, 10 and 15 of the Gujarat Special Investment Region Act, 2009 (Guj. 2 of 2009), the Industries and Mines Dept. of Gujarat and the Government of Gujarat constituted Dholera Special Investment Regional Development Authority (DSIRDA) vide Notification No. HU/10/07/SIR/112010/81450/I on 16th February, 2010, published in Government Gazette Extraordinary part IV-B on page number 9-1 on 16th February, 2010.

DSIRDA shall consist of the following members, namely:-

(1)	Principal Secretary Industries & Mines Department,	Chairperson
(2)	Chief Executive Officer, Gujarat Infrastructure Development Board,	Member
(3)	Industries Commissioner,	Member
(4)	Collector, Ahmedabad,	Member
(5)	District Development Officer, Ahmedabad	Member
(6)	Director, School of Planning, Centre of Environmental Planning and Technology (CEPT), Ahmedabad,	Member
(7)	Shri U.S. Mehta (Retired Town Planner),	Member
(8)	President, Gujarat Chamber of Commerce and Industries	Member
(9)	Chief Executive Officer, Dholera Special Investment Regional Development Authority	Member Secretary

DSIRDA shall exercise all the powers and perform all the functions as specified in section 15 of the Gujarat Special Investment Region Act, 2009

DSIRDA will have its Head Quarter in Gandhinagar.

2.3. Powers and Functions of Dholera Special Investment Regional Development Authority U/S - 15

The powers and functions of the Dholera Special Investment Regional Development Authority will be according to section 15 of 'The Gujarat Special Investment Region Act, 2009. It is thus listed as below:

1) The Regional Development Authority shall secure planned development of the Special Investment Region and shall take steps for its effective regulation and efficient management so as to bring and enhance general welfare, convenience, productivity and excellence.

2) Without prejudice to the generality of foregoing provisions, the Regional Development Authority shall undertake the management of the Special Investment Region (SIR)

3) The Regional Development Authority shall, in particular, exercise the following powers and perform the following functions namely:-

   i. To classify and earmark the area of the Special Investment Region for various purposes and usages including economic activities, amenities and community services as it deems fit;

   ii. To prepare the Draft Development plan for whole or part of the area of the Special Investment Region;

   iii. To undertake preparation and executing of town planning scheme for whole or part of the Special Investment Region;

   iv. To regulate the development of the periphery area of the Special Investment Region,

   v. To acquire, hold and manage moveable or immoveable property as it may deem necessary subject to general or specific directions of the State Government in this regard;

vi. To acquire land in the Special Investment Region, by sale, lease, grant, allocation, donation, Town Planning Scheme, consent agreement or through proceedings under the Land Acquisition Act, 1894 for the purposes of this Act,

vii. To sale, lease, transfer or dispose of any land or building belonging to it subject to the regulations made by the Apex Authority;

viii. To carry out surveys in the Dholera Special Investment Region for the preparation of Draft Development Plans and Town Planning Schemes;

ix. To prepare, issue and implement the directions, the standards and the norms for building structures, infrastructure development and other construction activities in the Special Investment Region;

x. To enter into contracts, agreements or concession agreement with any person, entity, developer or organization as it may deem necessary for performing its functions;

xi. To execute, co-ordinate and supervise works in connection with infrastructure or provision of other services and amenities in the Special Investment Region;

xii. To provide for disaster management and mitigation in the Special Investment Region;

xiii. To levy and collect such fees, development charges, or user charges as may be ascertained and fixed by the Apex Authority under clause (vii) of sub-section (2) of section 6;

xiv. To remove encroachments and constructions not duly authorized or made in violation of the regulations, directions and norms laid down by the Regional Development Authority;

xv. To make arrangements for observance and promotion of safety, order, health and environmental safeguards within the Special Investment Region;

xvi. To guide, assist and co-ordinate with other authorities functioning in the Special Investment Region in matters pertaining to planning and use of land and development of the Special Investment Region;

xvii. To control the development activities in accordance with the Draft Development plan and to bring aesthetics, efficiency and economy in the process of development;

xviii. To ensure and make provisions for sufficient civic amenities and services including hospitals and medical services, schools, fire services, public parks, markets and shopping places, playgrounds, entertainment areas and disposal of waste and provisions of drainage;

xix. The make sustainable arrangements for providing and maintaining the highest standards in civic amenities and services particularly for cleanliness, aesthetics, health and hygiene;

xx. To make enquiry, inspection, examination or measurement of any land and building in any part of the Special Investment Region;

xxi. To exercise such other powers and discharge such other functions as may be prescribed by the rules or regulations.

xxii. (a) Notwithstanding anything contained in the relevant State Acts, rules or any existing instructions of the State Government, the Regional Development Authority my frame its own General Development Control Regulations (GDCR) and the same shall prevail for developments in the Special Investment Region.

b) Every person, unit or developer or any other stakeholder in Special Investment Region shall be required to get the plans of the building approved by the Regional Development Authority before commencing any construction and shall obtain the approval of the Regional Development Authority necessary and incidental thereto, after the completion and before the use of such premises.

c) For the purpose of this section and with any other requirement for proper planning, management and development of the Special Investment Region, the Regional Development Authority may issue such direction or instruction as it may consider necessary to any person, unit, entity, developer or any other stakeholder in the Special Investment Region and the person, unit, entity, developer or, as the case may be, the stakeholder shall be bound by such directions

2.4. Area under Jurisdiction of Dholera Special Investment Regional Development Authority

In exercise of the powers conferred by section 3 read with section 4 of the Gujarat Special Investment Region Act, 2009 (Guj. 2 of 2009), the Industries and Mines Dept. of Gujarat and the Government of Gujarat declared Dholera Special Investment Region (DSIR) vide Notification No. GHU-14/SIR/112009/253/(I)/(I**)** on 22nd May, 2009 published in Government Gazette part IV-B on page number 40 and 41 on 4th June, 2009. Dholera Special Investment Region comprised of 19 villages of Dhandhuka Taluka and 3 villages of Barwala Taluka; total 22 villages of Ahmedabad District measuring about 879.3377 sq km.

DSIRDA in exercise of the powers conferred by section 3 read with section 4 of the Gujarat Special Investment Region Act, 2009 (Guj. 2 of 2009), the Government of Gujarat hereby:-

i. Declares the areas specified in column 4 of the Schedule appended hereto to be the Special Invesment Region which shall be known as “Dholera Special Investment Region”; and
ii. Determines the areas within the boundaries of revenue villages specified in column 4 of the said Schedule to be the geographical area of the said Special Investment Region, measuring 879.3377 sq. kms in total.

SR. NO.	NAME OF DISTRICT	NAME OF TALUKA	NAME OF REVENUE VILLAGES			
1	2	3	4			
			Sr. No.	**Name of Village**	**Total survey nos.**	**Total Area of land in sq. km.**
1	Ahmedabad	1. Dhandhuka	1	Bavaliyari	1204	111.2724
			2	Bhadiyad	1908	49.7331
			3	Bhangadh	620	83.0777
			4	Bhimtalav	223	7.4042
			5	Dholera	969	45.8145
			6	Gorasu	1219	31.1763
			7	Kadipur	648	27.3509
			8	Khun	227	38.2968
			9	Mahadevpura	179	22.5431
			10	Mingalpur	261	33.0813
			11	Mundi	316	17.8054
			12	Otariya	801	18.0975
			13	Panchi	360	13.9638
			14	Rahatalav	336	63.4464

SR. NO.	NAME OF DISTRICT	NAME OF TALUKA	NAME OF REVENUE VILLAGES			
			15	Sandhida	517	18.6401
			16	Zankhi	389	22.0941
			17	Ambli	1084	55.2044
			18	Cher	464	16.2436
			19	Gogla	385	55.4426
		2. Barwala	1	Hebatpur	1086	72.6594
			2	Sangasar	790	35.4928
			3	Sodhi	588	40.4975
		Total			**14574**	**879.3377**

2.5. Purpose of the Draft Development plan

The purpose of the Draft Development plan is to set out the framework for the long term growth of the DSIR over a period of 30 years. It intends to provide a broad development guide to all people with an interest in the future of the DSIR – including Central and State Governments, districts and talukas, public and private bodies and corporations and the existing local inhabitants and landowners living within and adjoining the boundaries of the designated area.

The Draft Development plan comprises a spatial plan, showing land use and infrastructure proposals for the whole of the DSIR, together with regulations, guidance and recommendations for the implementation of the Plan and the proper control of development.

The Plan is essentially a strategic document, setting out a broad structure plan for the DSIR. More detailed physical plans will need to be prepared for each part of the DSIR in the form of Town Planning Schemes, conservation plans, and individual zone and village plans.

Subject plans for individual elements and components of the DSIR will also need to be prepared, for example, for public transport provision, housing provision, and open space and recreation sports and entertainment.

Although the Draft Development plan sets out the broad land use allocations for 30 years, it will need to be monitored, updated, and amended on a regular basis as circumstances change, if it is to remain valid. The review process will need to be continuous and it would be expected that the first revision for the Draft Development plan would be done in 5 years after the publication of the first Plan as per the provisions of the Act - 1976.

2.6. The Approach Adopted in the Preparation of the Draft Development Plan

The Plan has been prepared after extensive research into the likely market demand for industrial and other employment generating land uses and a thorough appraisal of physical and socio–economic constraints. Research has been conducted through surveys, interviews, site visits and literature reviews.

Research into the economic base of the DSIR has been conducted at international, National and State level, with particular focus on the planned role of the DMIC in fostering of Indo-Japanese economic cooperation, including foreign direct investment (FDI) and improving India's transport infrastructure. At a more regional scale the Plan recognises the objectives and aspirations for DSIRDA as stated by the Government of Gujarat and also takes into consideration the outline plans and objectives of a number of developers who have signed Memorandum of Understanding (MoUs) with the State Government.

The Plan takes full account of existing physical and socio–economic conditions and facilities found within the region and the immediate hinterland of the DSIR, notably transport and utility infrastructure, and also takes into account committed and programmed improvements in infrastructure and major development projects, including the proposal for the development of a new international airport north of the DSIR.

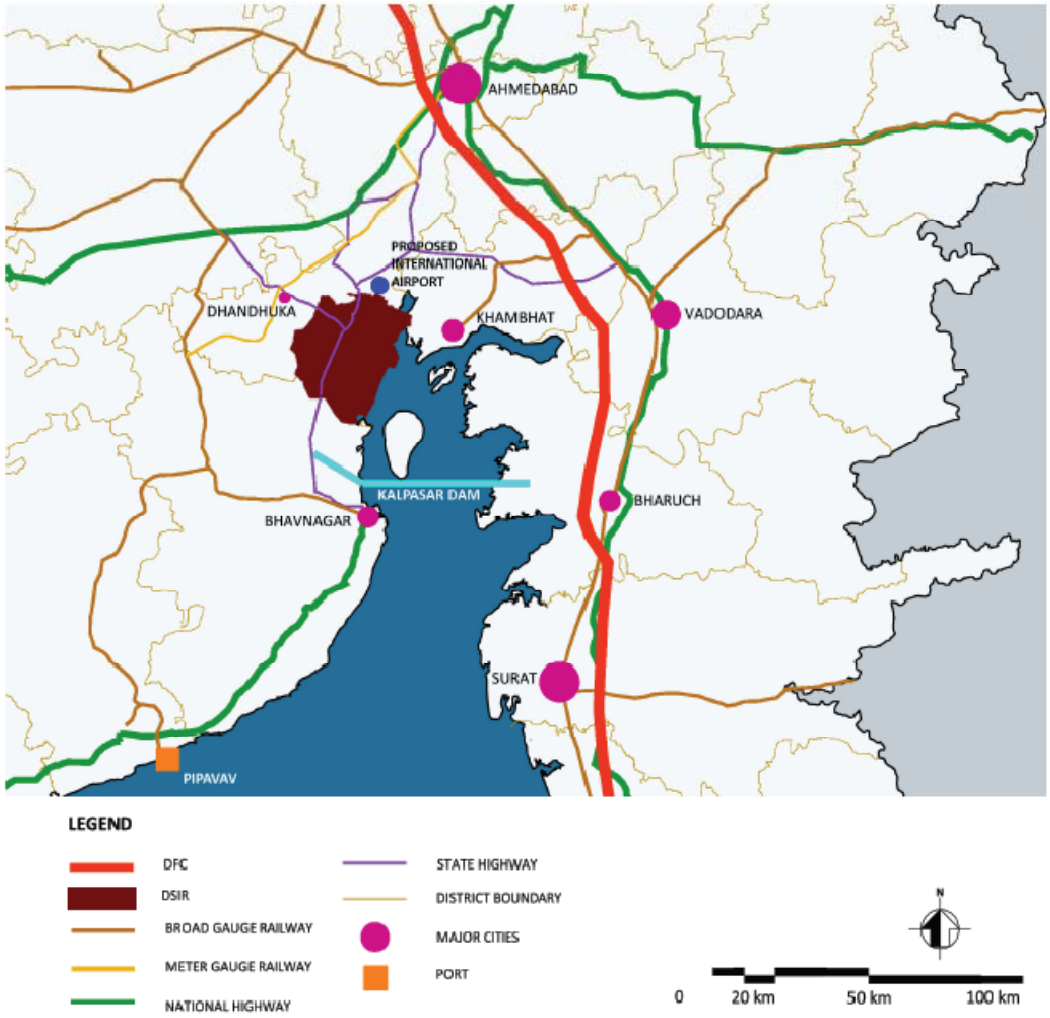


Figure 2-3: The Strategic Planning Determinants

The construction of the Kalpasar dam project would release a substantial area of land within the boundary of the DSIR for potential development. However the project has yet to receive funding or the necessary environmental clearances and there is no firm start or completion date. In view of this uncertainty, the Draft Development plan has been prepared on the basis of the current situation whereby the Coastal Regulation Zone (CRZ) precludes development to the east of the DSIR. Should the Kalpasar dam eventually become a fully funded and approved project, and then the Draft Development plan will need to be revised. An illustrative plan showing a possibility of how the Draft Development plan might be revised in the post Kalpasar dam scenario is given in Chapter 13.

The Development Plan report has been based on the following background studies and research data base prepared by Halcrow

- Report 1: Concept Master Plan;
- Report 2: Industrial Market Potential and Critical Gap Assessment;
- Report 3: Techno-economic Feasibility Study of the Industrial Mega Park;
- Report 4: Master Plan for the Greenfield Integrated Township;
- Report 5: Pre-Feasibility Studies;
- Report 6: Draft Development plan

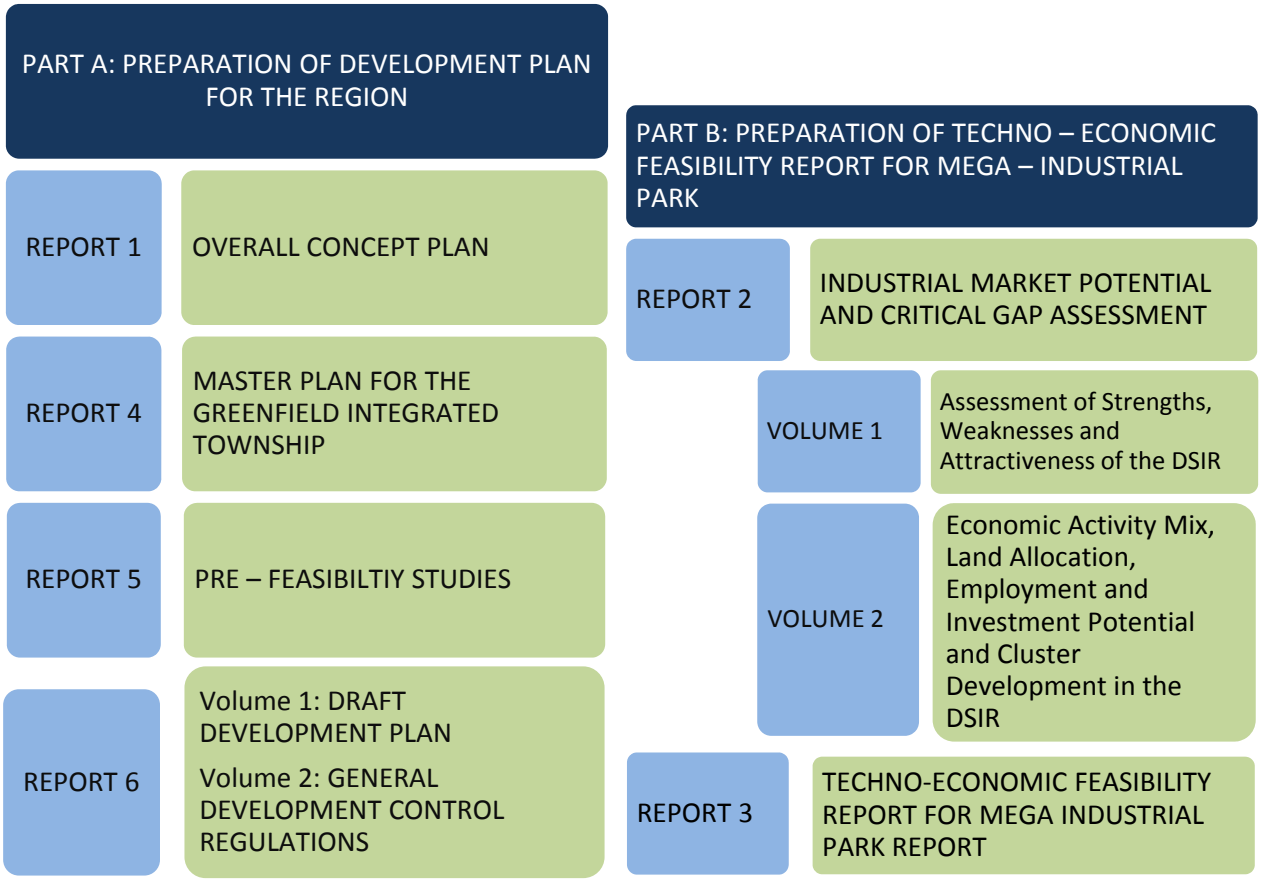


Figure 2-4: Reports referred to - prepared by Halcrow

CHAPTER 3

THE DEVELOPMENT STRATEGY

3. The Development Strategy

3.1. Plan Provision

The site for the development of the DSIR is a rural area of approximately 920 sq km, comprising 22 villages, which in 2001 had a combined population of about 37,000 people. The development of industries and other economic activities in the region will create about 0.8 million new jobs and support a very large population. It is anticipated that a high proportion of those employed in the DSIR will live in the new city and the Draft Development plan has been designed to house a target population of 2 million. Trends in household formation in Gujarat over the next 30 years suggest that the average household size in the DSIR will be 4 persons, so that an estimated total of 500,000 new dwellings will be required to house this future population.

The key employment and demographic provisions of the Plan are summarized in Table 3.1.

Table 3-1: Key Provisions in the DSIR

PARAMETER	PROVISION
Base Jobs	343,000
Support Jobs	483,630
Total Jobs	826,700
Total Population supported by DSIR	2,500,000
Population residing in the DSIR	2,000,000
Number of housing units	500,000

3.2. Plan Objectives

The overall objectives for the Draft Development plan are the:

- Development of an economically and socially balanced new city;
- Creation of a number of large scale, world class industrial parks capable of attracting a range of expanding industrial sectors;
- Allocation of a number of prime sites for the development of other economic sectors, in particular in knowledge, education and research, tourism and recreation sports & entertainment;
- Creation of an urban environment that will provide housing for all income groups, including community, commercial and other facilities that will encourage the growth of a socially integrated, attractive, sustainable and affordable city in which to live and work;
- Construction of good quality infrastructure in order to ensure that transport, energy, water and other utility services meet the needs of the industries, businesses and inhabitants;
- Protection of the environmentally sensitive areas within and adjoining the DSIR by the means of exclusion and buffer zones and the creation of new areas of parkland and areas of nature conservation;
- Adoption of a sustainable approach to development that forms the ground work to aid the evolution of a Low Carbon City (LCC), including planning for public transit and transit oriented development (TOD), encouraging the use of renewable energy, minimising the use of conventional energy buildings, optimizing the conservation and recycling of water, and the recovery and recycling of solid waste materials.

3.3. Spatial Themes and Planning Principles

The Draft Development plan is based upon the application of twelve spatial planning principles that will ensure a consistent and coherent urban structure and a plan that is robust, flexible and economical to develop.

The spatial planning principles are:

- Creation of a compact city;
- Integration of land uses;
- Accessibility of industrial zones;
- Focus of the city internally away from the central expressway, which will only have limited access;
- Separation of industrial and city traffic;
- Provision for a high quality public transport system;
- Development of a poly-centric structure that has a number of commercial and community nodes;
- Integration of existing villages into the new city;
- Conservation of the better agricultural land;
- Protection of the CRZ;
- Development of a strong landscape strategy; and
- A phased development programme that allows incremental growth.

3.3.1. A Compact city that makes efficient use of land

In order to minimise the use of scarce resources, the city is kept compact, so that travel distances are minimized and the lengths of utility networks are kept as short as possible, thus reducing capital and running costs. Overall housing densities are designed to be high enough to support frequent, good quality public transport and movement and circulation by cycle and foot.

3.3.2. Integration between different land uses

The Plan proposes that all industrial and employment areas are located relatively close to, and accessible from, housing areas, to minimise the home to work daily commute. The Plan generally provides that the average maximum distance of an industrial area is not more than 3 km from the nearest residential area.

3.3.3. Accessible industrial zones

The main industrial and logistics zones are all located centrally on either side of the expressway and railway line to provide good road and rail access. This allows transport to and from the industrial sites to bypass the main housing and commercial areas, speeding up the delivery of goods in step with the "just in time" philosophy of logistics and minimising any adverse impacts on residential areas.

3.3.4. Central transport corridor with a limited access expressway

The central transport corridor will contain a high capacity, limited access expressway, with grade separated interchanges at key locations and a parallel right of way for a twin track broad gauge (BG) rail line. Access from the expressway to the city will be through grade separated junctions that allow full turning movements or through slip roads that allow left-in-left-out traffic movement.

The northern end of the expressway will feature a grand entry into DSIR.

3.3.5. Provision of a road system that minimises conflict between industrial, residential and city traffic

Traffic from the expressway will be directed to use specific entry and exit points so that trucks only enter industrial zones and city traffic uses other access and egress points. This system is continued within the city, with a network of roads serving primarily truck traffic and another serving other traffic, including the main public transport routes.

3.3.6. Provision of dedicated public transport rights of way within key routes

The cross section of key roads in the city includes a reservation for bus only lanes, which will be upgraded in stages to a higher capacity system such as a tram or trolley bus system.

3.3.7. A Poly-centric spatial model

The Draft Development plan provides for a poly-centric spatial model, with 6 city centres dispersed around the city. The largest, main central business district is located close to the existing Dholera town. The 5 district centres will act as local nodes that serve the surrounding residential and industrial uses. Each of the district centres will achieve a degree of self sufficiency and viability on their own and also offer choice and flexibility to the industrial and real estate markets.

Movement patterns in a polycentric city

3.3.8. Integration of existing communities and villages into the city structure

DSIR includes 22 village settlements within its boundary and a buffer zone is drawn around each settlement in order to allow each village to expand naturally at its own pace. Those villages in the middle of the new city will inevitably lose their farmland and grazing lands to urban development over a period of time. Alternative sources of livelihood will need to be generated for the populations of these villages and appropriate job and skill training programmes for the existing local communities will have to be established. Some villages in the DSIR will not lose their farmland and can continue as primarily agricultural communities. The inhabitants of these villages will however also benefit from training programmes to be made available in the DSIR so that they can also access alternative employment in the DSIR. It is proposed that these villages will also receive increased support in the form of additional physical and social infrastructure and they will also benefit from their proximity to a growing market to sell locally grown fresh garden produce.

3.3.9. Conservation of the better agricultural land

The areas with better farmland on the Western and Southern edge of the city are allocated for continued agricultural use, both as a source of livelihood for many of the local villages and also as a potential source of fresh garden produce for the new city. Only if the supply of industrial land is genuinely exhausted should consideration be given to the release of these farmlands for alternative use.

3.3.10. Conservation of the natural floodplains and the Coastal Regulation Zone (CRZ)

The Coastal Regulation Zone (CRZ) is designed to protect coastal areas from the risk of flooding and natural hazards. The CRZ that falls within DSIR will not be developed but recreation will be permitted and the area enhanced through forest planting and landscaping. The continuing use of the area for agriculture or aquaculture will be encouraged.

3.3.11. Conservation of Forest Land

DSIR has about 9500 hectare of forest (as per data available from Forest Department) inside its boundary. One of the fundamentals of planning of the city is to preserve the existing natural elements and settlements, pertaining to this the city will be sensitive to the existing forest land. The forest area under the urbanizable city limits shall be conserved under the Development Plan and any development will be regulated through Forest Department and DSIRDA (as per data available from Forest Department). Please refer Appendix I on page 235

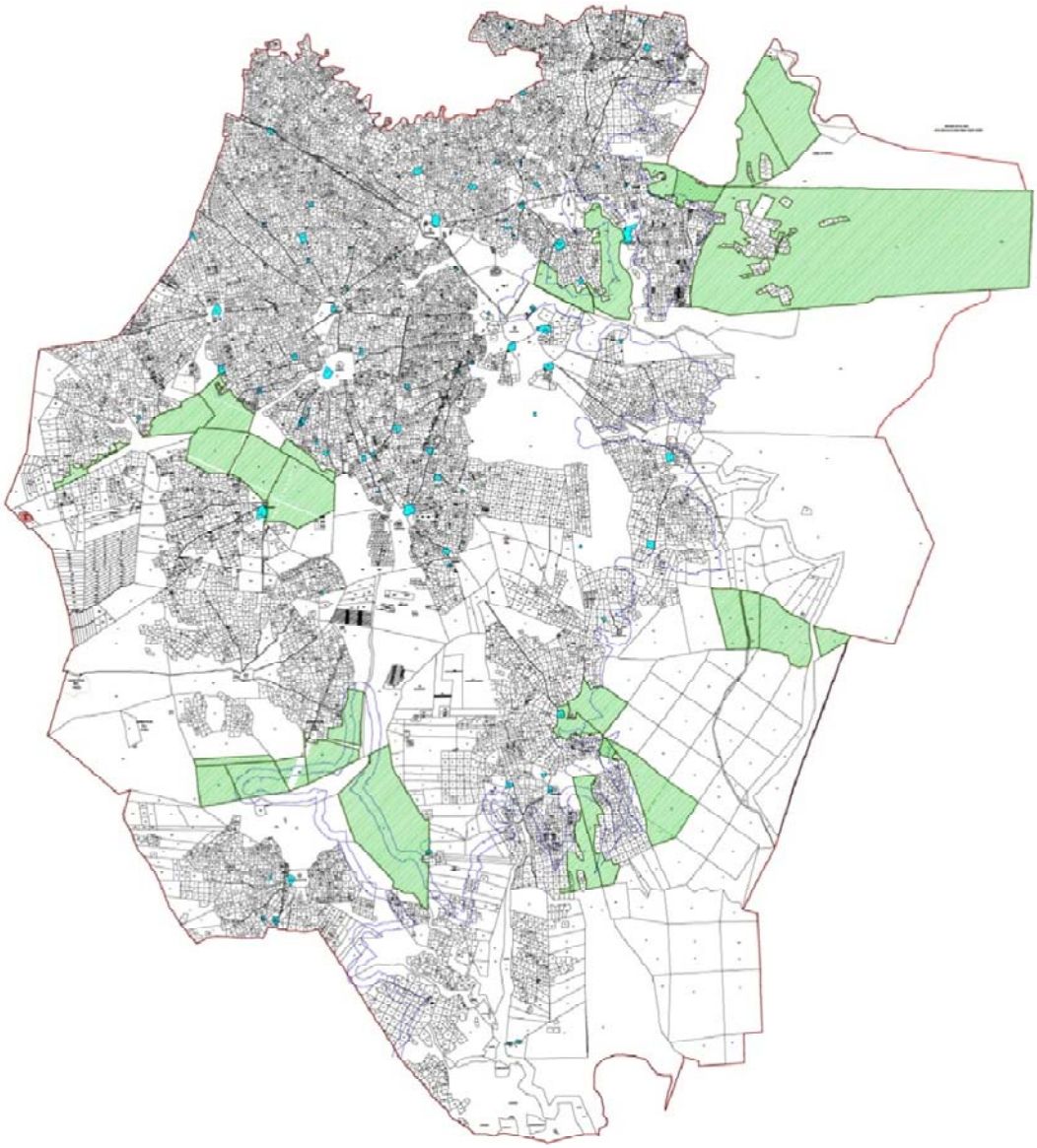


Figure 3-1: Forest Land within DSIR (only indicative)

3.3.12. A strong landscape strategy

The new city will be an attractive and well landscaped city. A strong urban design theme will be the development of the existing river courses into a series of attractive lakes and canals in order to create the potential for waterfront development along with parks and recreation facilities. This will be particularly attractive for hotel and hospitality uses, knowledge based & high end IT related developments and residential uses. The lakes would also serve a dual purpose as a source of fresh water for the city and be part of the city's flood management system. The extensive network of lakes and canals will be linked by a number of attractive urban parks and tree lined roads and small parks, so that the overall ambience of the new city is one of space and greenery.

3.3.13. A Phasing Plan that allows optimised investment and incremental growth

Development in the city will be programmed in a series of phases and each phase will contain a mix of uses necessary to ensure that at any point in time the new urban area city can function effectively as a "stand alone" development, being self contained in terms of infrastructure in the short term but planned so that it can be easily and cost effectively expanded as demand for land increases.

3.4. Overall Spatial Strategy

3.4.1. The Urban Structure

Transportation network is a key component of an urban structure. In case of the DSIR, it derives heavily from principles of mobility friendly circulation patterns, with priority to public transportation, pedestrians and cyclists. A basic grid that forms super blocks of size 4km x 4km is adopted as broad level street pattern for the DSIR.

Street grids are generally preferred as transport patterns the world over as they enhance connectivity and route flexibility, are efficient for public transit and create easy navigable and legible urban environs.

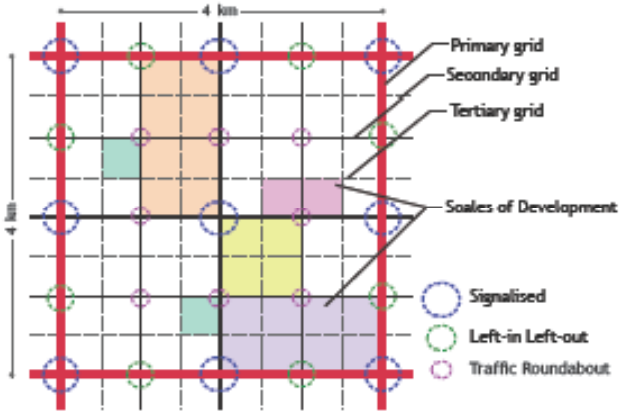


Figure 3-2: Broad Urban Structure - Street Grid

Connectivity and Walk-ability

The primary grid formed by the main streets (arterials and collectors) enable access at higher levels within the city. This primary grid allows for local streets interspersed at a distance between 250m to 750m, providing for a hierarchy of intersections and interconnected network that facilitates traffic movement and route choice. A degree of flexibility is allowed for distances between local streets within the primary grid, in order to impart variation in the character of different areas, while maintaining uniformity at the broader level.

The ideal distance between 2 major streets is considered to be twice the comfortable walking distance of about 400 to 500m. The grid adopted, allows everyone to be within walking distance of one east-west and one north-south connection. This network provides for closely spaced intersections that enable access and visibility, thus encouraging pedestrian trips and facilitating a walkable urban environment.

Efficiency for Public Transit Systems

Grid pattern of main streets also extends a structural advantage of allowing the city to evolve into a transit metropolis. Straight, continuous arterials mean mass transit systems such as the light rail are not subjected to frequent turns.

Development Flexibility

The wider primary grid also allows for greater development flexibility for need based large or small blocks. Each larger block can breakdown into the standard 750m/500m /250m urban blocks with a distinct road hierarchy.

3.4.2. A Case for Densities

Density describes the number of dwellings (households) or people that occupy an area of land. One of the governing principles for the DSIR that arises out of its goal to achieve sustainability is the adoption of a compact plan.

A primary indicator of compactness is an average housing density that is high enough to support public transportation. Higher residential densities provide a dense catchment of users thereby encouraging a mix of compatible land uses, in particular retail and community activities. Furthermore, variation in land uses within a neighbourhood entails shorter commuting distances that enable use of non-motorised transport, which is a critical aspect of sustainable urban development in the current age.

In DSIR, the gross city level density (including all roads and open spaces and excluding the CRZ zone) would be about 37 persons per hectare (pph), whereas the gross average 'urban' density (including all roads and open spaces only in the urbanisable area) would be about 65 pph.

In terms of net average housing density, (including land for purely residential purposes, excluding all roads, local open spaces and common amenities) would be about 393 pph or 98 dwellings per hectare (dph). Further discussion on net housing densities across various housing categories is presented in Chapter 5, Land Use Proposals.

3.4.3. Plan Provision

The plan is designed to meet the forecast land demand for base industrial employment, and support jobs, together with residential, community, commercial and other land uses necessary to sustain a modern city. Adequate land is provided to house a population of over 2 million inhabitants over a 30 year period.

3.4.4. Land Use Allocations

DSIR covers an area of about 920 (sq km). A large portion of this area is being covered by Coastal Zone Regulation (CRZ) restrictions. Land area outside the CRZ (read area that can be developed) is about 581 sq km, of which urban land uses cover about 339 sq km. The remainder of the land outside the CRZ is allocated for agricultural, forestry, nature reserves, recreation and the solar energy parks.

The land use plan is illustrated on Figure 3.3 and the land use budget is given in Table 3.2 (see page 21).

The main features of these land use allocations are:

- The areas of land set aside for industrial purposes are in accord with demand studies. An area of land is demarcated as a reserve, should additional industrial land be required;
- Land has also been designated for non-industrial employment uses such as education, IT and knowledge based activities;
- The balance between the allocation of industrial land and the areas allocated for residential uses is such that approximately 80% of the forecast demand for housing arising from employment opportunities in DSIR can be accommodated within the city. This will allow the new city to become a self contained settlement providing both jobs and homes in an integrated manner;
- Generous allocations have been made for commercial and community land uses;
- The city centre, district centres and high access corridor zones will provide lively and successful mixed use urban centres typical of historic Indian cities;
- Adequate but not over-generous provision has been made for road rights of way, with the emphasis on public transport provision and landscaped boulevards and pedestrian areas,
- A high proportion of the site is given over to open space and waterways so as to create an attractive and desirable living environment; and
- Surplus land not immediately required for urban development purposes is set aside for agricultural use. It is proposed that treated sewage effluent be directed to these areas for irrigation purposes, with the aim of raising the output of the farmland within DSIR.

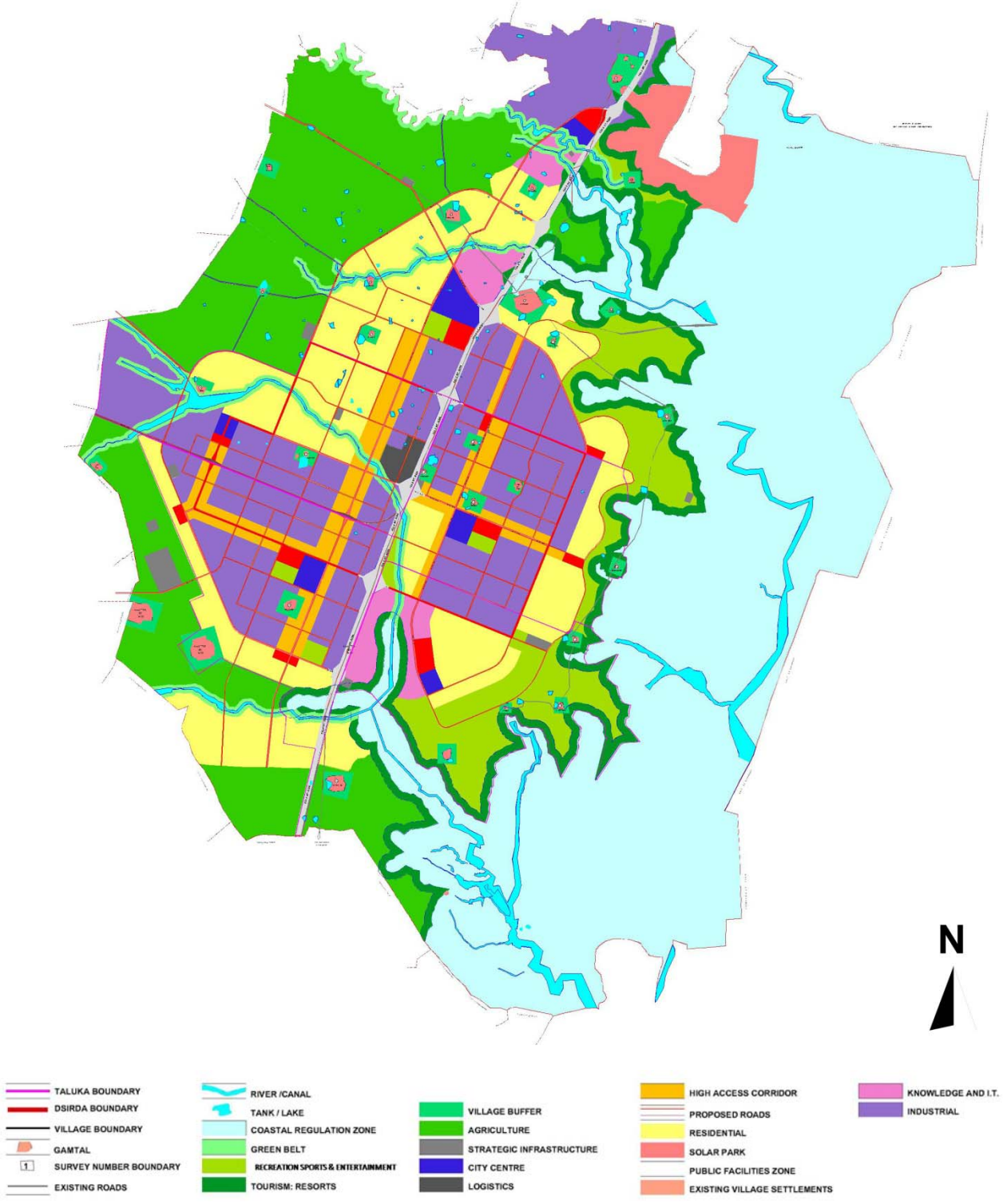


Figure 3-3: Spatial Development plan

Table 3-2: Land Use Budget

Sr. No.	BROAD LAND USE ZONES	AREA (HA)	PERCENT OF DEVELOPABLE AREA	PERCENT OF TOTAL AREA
1	Residential	9780.26	17%	10.6%
2	High Access Corridor	2465.11	4%	2.7%
3	City Centre	679.08	1%	0.7%
4	Industrial	11457.36	20%	12.5%
5	Logistics	203.64	0%	0.2%
6	Knowledge and IT	1229.97	2%	1.3%
7	Recreation Sports and Entertainment	4500.29	8%	4.9%
8	Roads	2644.51	5%	2.9%
9	Strategic Infrastructure	323.33	1%	0.4%
10	Public Facility Zone	562.11	1%	0.6%
A	**Subtotal - Urban (1 to 10)**	**33,846**	**60%**	**37%**
11	Tourism - Resorts (CRZ III)	3888.83	7%	4.2%
12	Green spaces	1960.12	3%	2.1%
13	Village Buffer	1325.37	2%	1.4%
14	Existing Village Settlements	446.92	1%	0.5%
15	Agriculture	12804.15	23%	13.9%
16	Rivers, Canals and Other Water bodies	2467.71	4%	2.7%
B	**Subtotal Non-urban (11 to 16)**	**22,893**	**40%**	**24.9%**
C	**Developable Area (A+B)**	**56,739**	**100%**	**61.7%**
17	Solar Energy Park	1345.92	-	1.5%
18	Land under CRZ I	33885.23	-	36.8%
D	**Subtotal Land under CRZ I (17 to 18)**	**35,231**	**-**	**38%**
E	**Total Site Area (C+D)**	**91,970**	**-**	**100%**

Notes:

1. *The total project area as per the site information provided by GIDB was about 878 sq km. However, as per the Halcrow GIS and CAD database prepared after validation with NRSS data, it is understood to be about 920 sq km.*
2. *'Public Amenities' is an overlay zone, which is subject to regulations applicable to the base Broad Land Use Zone. The area covered under Public Amenities is therefore included within the Broad Land Use Zones. Refer Table 3.3 for areas under community facilities in each zone, and Table 5.5 for type of facility and its area.*

With a view to create vibrant, activity oriented, walkable and sustainable communities, each of broad urban land use categories comprise a mix of uses.

The Table 3.3 presents this break-up of the 10 'urbanisable' broad land use zones into 12 development categories namely: residential high, medium and low density, commercial office/retail, leisure/hospitality, education, industry, light industry, community facilities, public open space, recreation sports & entertainment, utilities and local roads.

This break-up of the broad land use zones into further categories is a critical component of the spatial plan. It illustrates that any zone is not a monolithic swath of land allowing only a singular use, but a mix of character areas. It also sets out the desired development type in a zone that fits into the broader city level strategy. For example, break-up for the High Access Corridor zone reflects absence of residential low density, higher percentages of commercial and community facilities to cater to the induced higher densities and light service industry as an exclusive category. The percent share of land under local roads within the Industrial, Recreation & Sports and Entertainment zones is about 12 percent, as compared to a 22 percent share in the other zones.

Table 3-3: Break-up of the Urbanisable Area

BROAD LAND USE		RESIDENTIAL	HIGH ACCESS CORRIDOR	CITY CENTRE	INDUSTRIAL	LOGISTICS	KNOWLE-DGE	RECREATION SPORTS & ENTERTAIN-MENT	STRATEGIC INFRASTRUCT-URE	ROADS	PUBLIC FACILITY	TOTAL	
Area (ha)		9,780	2,465	679	11,457	204	1,230	4,500	323	2,645	562	33,846	
COMPONENTS OF THE BROAD LAND USE ZONES (AREA IN HA)													
Residential High Density	Area	782	345	109	0	0	0	0				1,236	Housing*
	%	*8%*	*14%*	*16%*	*0%*	*0%*	*0%*	*0.0%*					
Residential Medium Density	Area	3,032	592	102	0	0	184	-				3,910	
	%	*31%*	*24%*	*15%*	*0%*	*0%*	*15%*	*0.0%*					
Residential Low Density	Area	1,467	0	0	0	0	172	0				1639	
	%	*15%*	*0%*	*0%*	*0%*	*0%*	*14%*	*0.0%*					
Commercial Offices/Retail	Area	196	148	95	0	0	135	0				574	Commercial*
	%	*2%*	*6%*	*14%*	*0%*	*0%*	*11%*	*0.0%*					
Leisure/Hospitality	Area	98	74	20	0	0	49	1350				1591	
	%	*1%*	*3%*	*3%*	*0%*	*0%*	*4%*	*30.0%*					
Light Service Industry	Area	0	123	0	0	0	0	0				123	Industrial*
	%	*0%*	*5%*	*0%*	*0%*	*0%*	*0%*	*0.0%*					
Industry	Area	0	0	0	9051	163	0	0				9214	
	%	*0%*	*0%*	*0%*	*79%*	*80%*	*0%*	*0.0%*					
Education	Area	0	0	0	0	0	184	0			562	747	Public & Institutional*
	%	*0%*	*0%*	*0%*	*0%*	*0%*	*15%*	*0.0%*			*100%*		
Community Facilities	Area	978	370	75	344	4	135	0				1906	
	%	*10%*	*15%*	*11%*	*3%*	*2%*	*11%*	*0.0%*					
Local Public Open Space	Area	978	247	122	115	2	209	641				2314	
	%	*10.00%*	*10.00%*	*18.00%*	*1.00%*	*1.00%*	*17.00%*	*14.3%*					
Recreation Sports & Entertainment	Area	0	0	0	0	0	0	1946				1946	
	%	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*43.3%*					

BROAD LAND USE		RESIDENTIAL	HIGH ACCESS CORRIDOR	CITY CENTRE	INDUSTRIAL	LOGISTICS	KNOWLE-DGE	RECREATION SPORTS & ENTERTAIN-MENT	STRATEGIC INFRASTRUCT-URE	ROADS	PUBLIC FACILITY	TOTAL	
Local Roads	Area	2152	542	149	1375	24	148	540		2645		7575	Infrastructure*
	%	*22%*	*22%*	*22%*	*12%*	*12%*	*12%*	*12.0%*		*100%*			
Utilities	Area	98	25	7	573	10	12	23	323			1070	
	%	*1%*	*1%*	*1%*	*5%*	*5%*	*1%*	*0.5%*	*100%*				
Total Urban Area	**Area**	**9780**	**2465**	**679**	**11457**	**204**	**1230**	**4500**	**323**	**2645**	**562**	**33846**	
	%	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***		

For ease of understanding, the Tables 3.4 and 3.5 present a summary of the demand for key activities and a consolidated land use provision respectively. The quantification of development demand is discussed in detail in Chapter 5, Land Use Proposals.

Table 3-4: Summary of Land Demand

DEVELOPMENT DEMAND	AREA (ha)	SOURCE
Industrial land demand (excluding logistics)	8,000	Synovate Research
Commercial land demand (including formal tourism)	1,608	Knight Frank and Synovate Research
Housing land demand	5,087	Knight Frank and Halcrow Research

Table 3-5: Summary of Land Provision

Sr. No.	USE CATEGORY	SPECIFIC ACTIVITY/USE	AREA (ha)	PERCENT OF DEVELOPABLE AREA	PERCENT OF TOTAL AREA
1	Housing	Residential high, medium and low density	6,785	12%	7%
2	Commercial	Commercial office, retail, light service industry, leisure, formal tourism, hospitality	2,165	4%	2%
3	Industrial	Industrial and logistics	9,337	16%	10%
4	Public and Institutional	Education, community facilities, local public open space, recreation sports & entertainment	6,912	12%	8%
5	Infrastructure	Strategic roads and infrastructure, local roads, utilities	8,645	15%	9%
	Subtotal - Urbanisable Zones		33,846	60%	36.8%
6	Open and Green	Agriculture, Green spaces, Reserve for future industries and entertainment, Rivers/Streams, Existing Village Settlements and Village Buffers, and Tourism - Resorts (CRZ-III)	40%	25%	25%
	Subtotal Developable Area		56,754	100%	61.7%
7	No Development Zone	Solar Park within CRZ - I, and remaining land under CRZ - I	35,231	-	38%
	Total Site Area		**91,970**	**-**	**100%**

3.5. Key Spatial Plan Elements

In order to ensure that the urban structure of DSIR is compact and efficient, the Draft Development plan emphasises a mix of land uses where this is compatible with good environmental practice and safeguards. There will be an element of mixed-use in all parts of the city but it will be a pronounced feature of the city and district centres and the high access corridors. The concept behind the planning of these areas is summarised in this section.

Another key feature of the Plan is the approach for integration of the existing 22 villages into the economic life and urban fabric of the new city. The villages have been allocated buffer zones and within these zones,

special regulations and policies apply as discussed later. The concept of the village buffer zones, and their function is briefly discussed in this section, while a more detailed description and a model village plan is presented in Chapter 9, Social Assessment.

3.5.1. Main City Centre

The city centre is conceived as a vibrant, mixed-use area and focal point for the whole of DSIR. It will have a wide range of uses, with an emphasis on those that require a central, easily accessible location to function efficiently. The range of facilities proposed is as follows:

- Retail uses, that concentrate on serving regional demand and the highest level shopping facilities such as malls, and stores offering mostly comparison goods and also entertainment facilities;
- Commercial and Government offices which are frequented by members of the public or which require a central location so that workers can access them easily by public transport;
- Major community facilities that require good accessibility for the public, such as speciality hospitals, central library, concert halls, sports stadia, major religious buildings;
- A major central park or 'maidan' to act as the lungs and defining feature of the new city;
- A wide range of residential accommodation, including high quality apartments in prime locations overlooking the central park, and high and medium density apartments, some of which could be built over retail units.

Character of Main City Centre

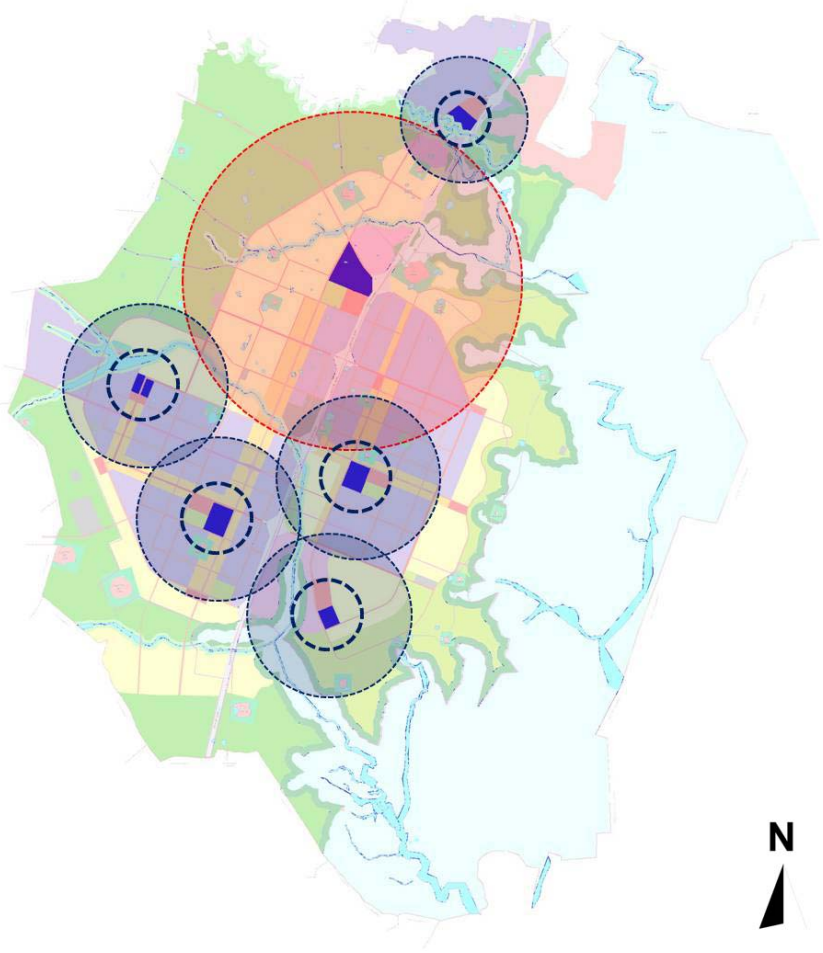
Character of District Centres

Figure 3-4: Character of City Centres

3.5.2. District Centres

The district centres will be smaller, scaled down versions of the city centre. They are intended to ensure that the city can develop as a poly-centric urban area, with facilities spread evenly around the city. The district centres would typically contain facilities required at a lower level in the hierarchy of provision. For example, the city will provide the highest level and specialist medical facilities but each district centre would be expected to have a smaller general hospital to serve a more local population. The range of facilities proposed is as follows:

- Retail shops, with both comparison and convenience goods such as food shopping;
- Commercial and Government offices serving the district;
- Community facilities that require good accessibility from the rest of the district;
- Residential accommodation, including high and medium density apartments, some of which could be built over retail units.



Illustrative view – possible development scenario in the core sector within the city centre

Figure 3-5: Poly-centric Development - Main City Centres and District Centres

3.5.3. High Access Corridors

High Access Corridors are allocated on a distance of about 250m to 750m (5 to 10 minutes walk) from the major public transit routes, as illustrated in the Figure 3.6. This zone will feature the character of 'transit-oriented developments', with higher FARs and residential densities than other residential areas and greater mix of activities. Apart from retail and service oriented activities for the surrounding populace, they will provide high density housing for workers in the industrial zones. These also provide for shops and services and community facilities for its residents and the day to day needs of the industrial areas. It is anticipated

that each corridor will become a major public transit route, in the first instance as a bus route but eventually as a tram or light rail transit (LRT) route when traffic levels are high enough. This zone is intended to contain the highest residential densities. Figure 3.6 illustrates a sample plotting of a sector within the High Access Corridor.

The breakdown of the different uses is broadly as follows:

- High density housing, including provision for High Income Group (HIG) & Low Income Group (LIG), and the economically weaker sections (EWS);
- Community facilities to meet the needs of the resident population and workers from the adjoining industrial areas, including parks and sports areas;
- Commercial facilities to serve the needs of residents and workers, such as retail shops, restaurants, hotel, banks, and other services;
- Institutional buildings serving the immediate needs of the locality.

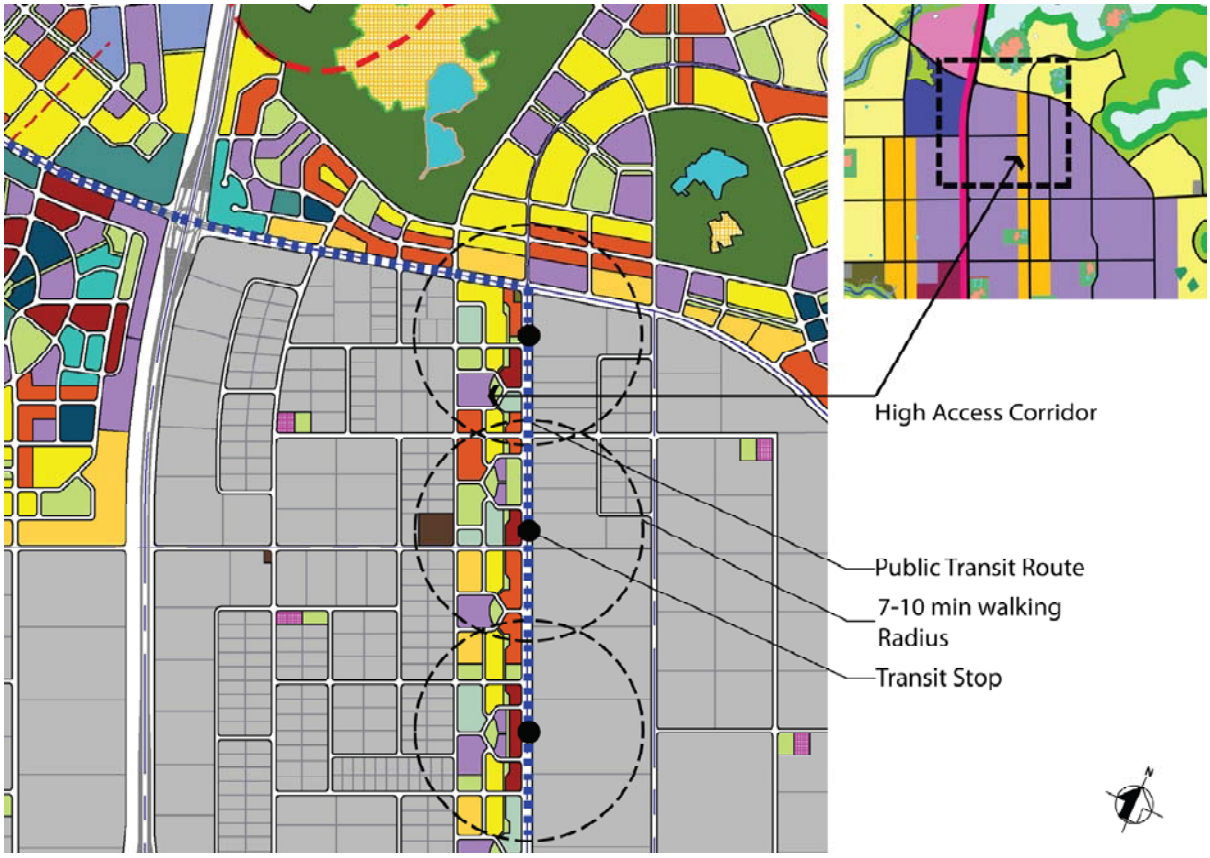


Figure 3-6: High Access Corridors as Transit Oriented Developments

3.6. Integration of Existing Village Settlements

In deriving heavily from the principles of inclusive growth, the Draft Development plan makes a provision for a comprehensive village integration strategy to accommodate the natural future growth in these settlements by constituting village buffer zones as a land use. The overall strategy, which is described in detail in Chapter 9 Social Assessment, includes the following as its components:

- Creation of Village Buffer Zones, as a separate land use category in the Draft Development plan;
- Zoning regulations to determine the land uses in the Village Buffer Zone;
- Sensitive upgrading of the existing village settlement fabric;
- Creation of the Dholera Welfare Society as a village assistance cell within DSIRDA.

The role of the buffer zone is to:

- Physically demarcate areas in the Draft Development plan for prioritizing continued agriculture based activities around villages settlements;
- Ease integration of the settlements with the surrounding urban land uses over time;
- Give a sense of ownership and control to the village residents on their immediate environs;
- Prevent uncontrolled development in the vicinity of the sensitive village fabric.

Figure 3.7 illustrates the locations of the existing village settlements, each surrounded by a Village Buffer Zone.

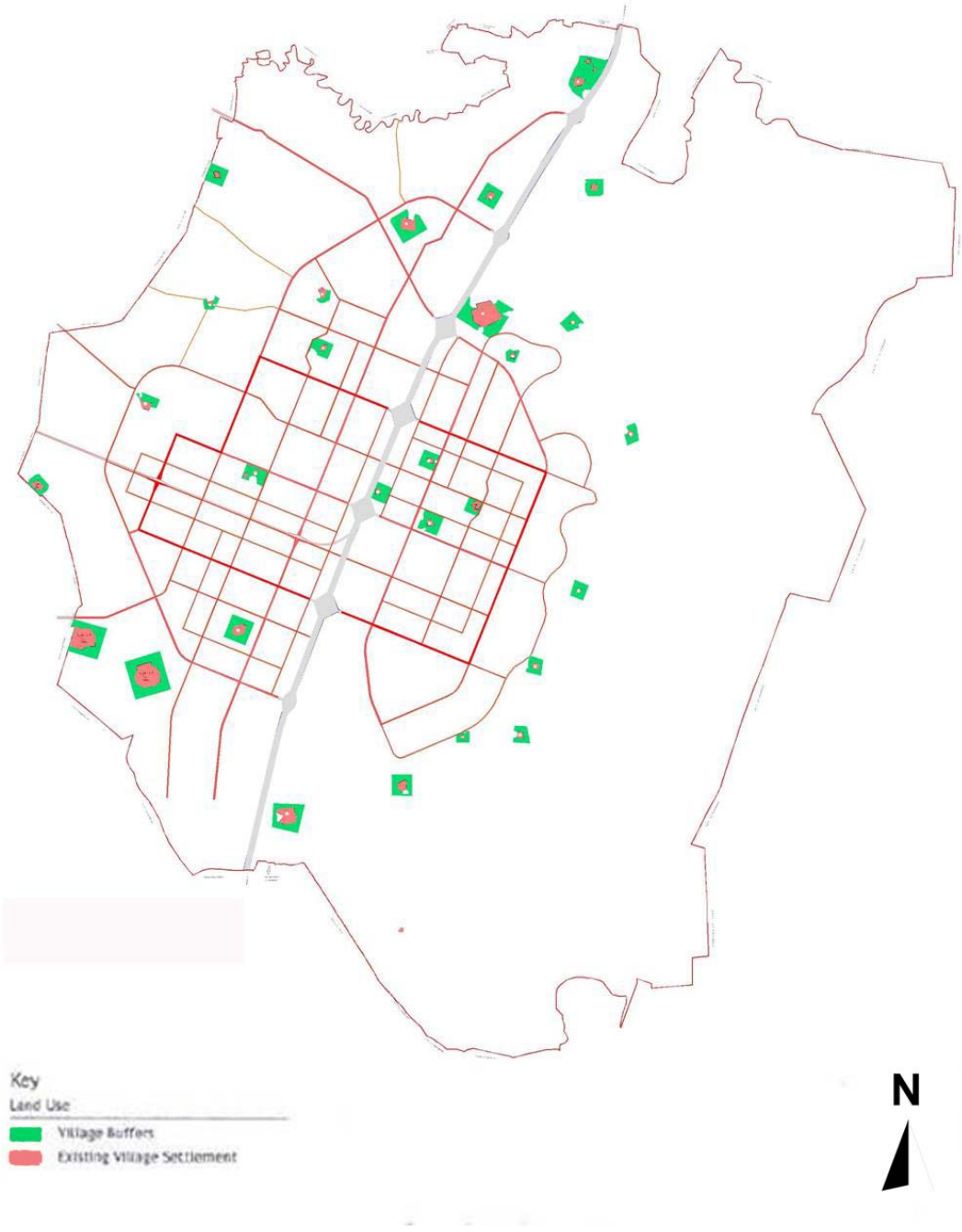


Figure 3-7: Village Buffer zones around Existing Village Settlements

3.7. Sustainability

The development that can achieve economic growth without depleting natural resources, harming the environment, or destroying communities is now widely known as sustainable development. The most commonly used definition is that of the *Brundtland Commission*, which describes sustainable development as:

"Development that meets the needs of the current generation without compromising the needs of future generations"

The concept of sustainable development has captured considerable widespread support throughout the world at National and local Government level, as well as with community groups and non-Governmental organisations. It is also becoming increasingly recognised by the private sector as a legitimate concern of developers and industrialists. It is the means by which environmental impacts are mitigated.

Sustainable development principles are increasingly viewed as an essential framework for urban planners, to help them address the potentially conflicting goals of economic development, environmental protection and social justice in development planning. It is finding expression in proposals for eco-cities and eco-towns in many parts of the world.

3.7.1. Sustainable Development in the DSIR

Sustainable development is usually defined in three dimensions: economic, environmental and social parameters measured throughout strategic and detailed planning processes and subject to evaluation and monitoring.

It is becoming increasingly common worldwide to identify those factors that are important to achieve sustainable development and to adopt policies to address them in plans and development control procedures through design guidelines, building codes and green rating systems.

The spatial planning of DSIR incorporates many planning policies and spatial proposals that incorporate environmental mitigation and sustainable urban design principles, notably:

- Adapting to climate change and planning for the risk of flooding;
- Treating land as a scarce resource;
- Provisions for renewable energy:
- Providing a land use access strategy that encourages walking, cycling and public transport;
- Provision for the recycling of waste;
- Avoiding pollution though the provision of adequate treatment facilities and environmental management;
- Protecting and enhancing biodiversity and the natural environment;
- Integrating local communities into the new city;
- Catering for all housing sectors.

The environment mitigation strategy for DSIR places sustainable development at the very heart of the planning and urban design of the new city. Sustainable design has a strategic component and a more detailed component that is addressed at the level of the plot and the building. Both levels of design need to be addressed if truly sustainable design is to be achieved. This section summarises the strategic policies and principles for Environmental Mitigation through Sustainable Development.

The application of green building codes and environmental rating systems, such as Leadership in *Energy and Environmental Design* (LEED), *BRE Environmental Assessment Method* (BREEAM), *Green Rating for Integrated Habitat Assessment* (GRIHA and the *Indian Green Building Council* (IGBC) Green Homes is rapidly becoming the norm in terms of improving the sustainability of buildings. The codes are all slightly different but in general cover issues such as the use and conservation of materials and resources such as energy and

water, the layout of plots, including landscaping, and building operations and maintenance. Development in the DSIR will be expected to set high standards of sustainable design as discussed in this section.

At a more detailed level, sustainability is addressed through the adoption of resource efficient buildings through green building codes. The application of green building codes in the DSIR is discussed in the General Development Control Regulations.

3.7.2. Strategic policies and principles for Sustainable Development

Adapting to climate change and planning for the risk of flooding

Flooding, from inundation by the sea and from seasonal monsoon rains, is currently a major problem in DSIR. This problem could be directly exacerbated by urbanisation and the resulting increase in the area of impervious surfaces and indirectly by global warming and consequent sea level rises.

A large part of the DSIR falls within the Coastal Regulatory Zone (CRZ) and this regulation is designed to protect people and property from the risk of flooding by preventing inappropriate development in areas subject to sea level rises and natural hazards. In the part of the DSIR falling beyond the High Tide Line (HTL) no development will be allowed. In the CRZ III, the following activities only will be allowed according to the Coastal Management Zone Notification dated 6th January, 2011 (details given in chapter 26 of GDCR report):

a. agriculture, horticulture, gardens, pasture, parks, play field, and forestry;
b. projects relating to Department of Atomic Energy;
c. mining of rare minerals;
d. salt manufacture from seawater;
e. Foreshore facilities for desalination plants and associated facilities;
f. weather radars;
g. construction of units or auxiliary thereto for domestic sewage, treatment and disposal with the prior approval of the concerned Pollution Control Board or Committee;
h. facilities required for local fishing communities such as fish drying yards, auction halls, net mending yards, traditional boat building yards, ice plant, ice crushing units, fish curing facilities and the like;
i. development of vacant plot in designated areas for construction of hotels or beach resorts for tourists or visitors subject to the conditions;
j. facilities for receipt and storage of petroleum products and liquefied natural gas;
k. facilities for regasification of liquefied natural gas subject;
l. storage of non-hazardous cargo such as, edible oil, fertilizers, food grain in notified ports;
m. facilities for generating power by non-conventional energy sources;
n. construction or reconstruction of dwelling units so long it is within the ambit of traditional rights and customary uses such as existing fishing villages and goathans;
o. Construction of public rain shelters, community toilets, water supply drainage, sewerage, roads and bridges by CZMA who may also permit construction of schools and dispensaries for local inhabitants of the area for those panchayats, the major part of which falls within CRZ if no other area is available for construction of such facilities;
p. reconstruction or alteration of existing authorized building

The Draft Development plan only allocates agriculture, aquaculture, green areas and development of basic infrastructure within the CRZ.

Outside the CRZ, the DSIR is divided into flood management zones as described in Chapter 7. Protection bunds will be constructed around each cell to prevent flooding destroying crops and property, whether flooding is from seasonal rains or from the sea. Rivers in the DSIR will be dredged and de-silted to ensure rapid dispersal of any flood waters.

Treating land as a scarce resource

The Draft Development plan is based upon a compact urban model in order to conserve land resources, averaging to medium or high residential densities and supported by a good quality urban transit system.

There is a general agreement that it is becoming increasingly important to reduce "food miles", that is, the distance that food has to travel before it is consumed. Producing food locally is very sustainable and so it is proposed that land will be retained in agricultural use in DSIR unless and until it is needed for more productive uses.

Farmland is generally better in the west of the DSIR than the land close to the Gulf of Khambhat and much of this area is allocated for agriculture unless urgently required for development. The plan thus allocates about 12,804 ha (14 percent of the total site) area under agriculture. A programme of soil improvement and enrichment is suggested and increased use of irrigation, (some by using treated sewage effluent) is recommended in order to increase productivity.

Provision of renewable energy

There will be a greatly increased requirement for electricity in the DSIR to support industrial, commercial and residential development. The Draft Development plan proposes a very large solar energy park, which will have the potential to service a significant proportion of the power demand in the DSIR.

Provision of solar hot water systems and photo voltaic cells to generate electricity on the roofs of buildings, as well energy reduction through the use of environmental building standards and features, and insulating materials will be encouraged via sustainable building codes discussed later.

Providing a land use access strategy that encourages walking, cycling and public transport

The Draft Development plan integrates land uses so that the majority of journeys can be made by foot, cycle or public transport, with the aim of reducing the need for private cars to an absolute minimum. This strategy is in accordance with best urban practice and is similar to those being implemented in some of the most prosperous and successful cities in the world.

Waste recycling

Many of the industries located in the DSIR will produce recyclable material and the strategy outlined in Chapter 7 provides facilities for the re-use and recycling of this material.

Avoiding pollution

All industries locating within the DSIR will be required to meet National and State environmental pollution regulations. The DSIR is intended for non polluting industries which can treat their own waste on site before safe discharge into the various waste disposal modes like the solid waste and common sewage system. Industries requiring more complex treatment process, such as petrochemical industries, will be required to locate elsewhere, for example in the Dahej PCPIR where more specialist regulation and common treatment facilities will be in place.

CHAPTER 4

THE PHASING STRATEGY

4. The Phasing Strategy

4.1. Introduction

The planning horizon for the DSIR is 30 years and it is therefore convenient to consider dividing the growth of the city into 3 equal development phases of 10 years. This will ensure that urban growth can be implemented in an efficient and cost effective manner over time and that land uses and infrastructure are planned and provided in a coordinated manner.

4.2. Land Demand

The forecast of demand for industrial land derived from the market assessment studies suggests that demand will build up slowly at first, then grow at a fast rate through the middle period and then level off as the city matures. The demand for residential, commercial and other land uses will follow a similar pattern. The Draft Development plan therefore ensures that sufficient land is available in each period to provide for all land uses in an integrated manner.

Table 4.1 indicates the broad plan requirement by phase in terms of the major economic activity and the corresponding housing to be accommodated. Table 4.2 (see page 34) presents the allocation of various land uses of the Draft Development plan over the three phases. The land use budget provides for areas commensurate with the demand for each phase.

Table 4-1: Key Demand and Provision by Phase

KEY REQUIREMENT/PROVISION	PHASE 1	PHASE 2	PHASE 3	TOTAL
Total jobs	204,850	402,470	219,310	826,630
Demand for net industrial land (Synovate)	2,230	3,780	1,970	7,980
Resident population (Halcrow, Knight Frank)	496,000	970,000	534,000	2,000,000
Demand for housing units (Knight Frank)	124,000	242,500	133,500	500,000
Net land demand for housing* (Halcrow)	1,262	2,467	1,358	5,087
Net land provision for housing	1,655	3,600	1,530	6,785

4.3. The Spatial Phasing Strategy

In determining the spatial phasing strategy, the Draft Development plan recognises that:

- Development is best started where the most comprehensive range of existing facilities and infrastructure is already available, particularly where they are close to existing centres of population;
- Concentrating early development on Government owned land will minimise the cost and potential delays in land procurement;
- Development should preferably be concentrated in one or two locations at any one time, rather than be spread thinly over the entire development area, so as to allow utility services such as water and waste water treatment to be supplied economically and with minimum delay;
- Each phase should be as self sustained as possible and should provide a well balanced mix of uses so that it can function effectively and not require development within subsequent phases to complete it;
- The early development phase should be largely completed before subsequent phases are brought on stream

Table 4-2: Summary of Land Provision

SR NO	LAND USE ZONE	PHASE 1	PHASE 2	PHASE 3	TOTAL
		AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)
1	Residential	2,187	4,268	3,326	9,780
2	High Access Corridor	690	1,177	598	2,465
3	City Centre	318	170	191	679
4	Industrial	4,554	4,044	2,859	11,457
5	Logistics	86	69	49	204
6	Knowledge & IT	585	-	645	1,230
7	Recreation Sports & Entertainment	1,959	1,216	1,324	4,500
8	Strategic Roads	845	859	790	2,494
9	Strategic Infrastructure	52	212	60	324
10	Public Facility Zone	221	94	247	562
(A)	**Subtotal - Urban**	**11,505**	**12,045**	**10,147**	**33,696**
11	Tourism - Resorts (CRZ III)	2,046	681	1,162	3,889
12	Solar Park (located in CRZ-I)	-	1,346	-	1,346
(B)	**Area subject to phased Development**				38,931
13	Green Spaces				1,960
14	Village Buffer				1,325
15	Existing Village Settlement				447
16	Agriculture				12,804
17	Rivers, Canal and Other Water bodies				2,468
(C)	**Subtotal Non-urban (11 to 12 + 14 to 17)**				**22,893**
	Developable Area (A+C)				**56,589***

*The difference between the developable area in table 3.2 is owing to the fact that some roads in the agriculture area to the West of the City connecting different villages will be developed as and when required

4.4. Phase 1

The early development of DSIR is located in the north of the site, close to Dholera, on either side of the existing SH-6. (See Figure 4.1). The northern part of the DSIR is currently more developed than the south and has better existing road connections to Ahmedabad, Vadodara and the nearest railhead at Dhandhuka. Being closest to the sources of fresh water and electrical power lines this area can be most easily provided with utilities.

The largest concentration of Government owned land is in the north-east portion of the DSIR and therefore adds considerable weight to the development of this part of the DSIR in Phase 1 of the plan. Government land ownership with respect to the Draft Development plan phasing is given in Appendix - E.

The major road traversing the DSIR, the SH-6, passes centrally through the site in a north–south direction. Since this provides the main access to the site from existing population centres and ports, proximity to this road for the early development phase is also important.

Phase I of the development can be considered in two sub-phases of five years each. The first five years would concentrate on enabling works and infrastructure and see little actual development.

The next five years will provide much more industrial and housing uses with supporting community infrastructure. Overall in Phase 1, the uptake of land for industry and housing is expected to reach about 33 percent of the total demand for urbanisable land over the 30 year development period.

The key infrastructure components required during Phase 1 are:

- The creation of strong connecting roads with the existing SH-6, including the construction of a new road crossing the SH-6 south of Dholera town to open up areas for development either side of the expressway. A decision as to whether this road needs to fly over SH-6 at the outset needs to be determined. Whilst traffic volumes may not justify such provision immediately, it may be more economical to construct this structure at the same time as the dualling of the road is carried out;
- Construction of a water treatment works and sewage treatment works;
- Water supply distribution system
- Commercial uses to be located in a new centre to the west of the SH-6;
- Development of a passenger rail station to serve the new railway line and link the new city to Ahmedabad and the surrounding towns. Adjacent to the station would be a bus station to ensure efficient public transport interchange;
- Development of a public transit system will be started with the key bus routes that would operate in the first phase. These bus routes will eventually be converted into street trams, in the second phase;
- The first phase of a freight logistics depot will be created on the edge of this zone, with access to the railway line close to a major junction on the SH-6;
- An extensive programme of dredging to deepen and widen existing rivers will be instigated in this phase in order to create areas of attractive waterfront and also to create artificial lakes and ponds for the storage of rain water.

In Phase 1, the total land area under urban zones, Tourism - Resorts is 13,551 ha, whereas area under only urban zones is 11,505 ha.

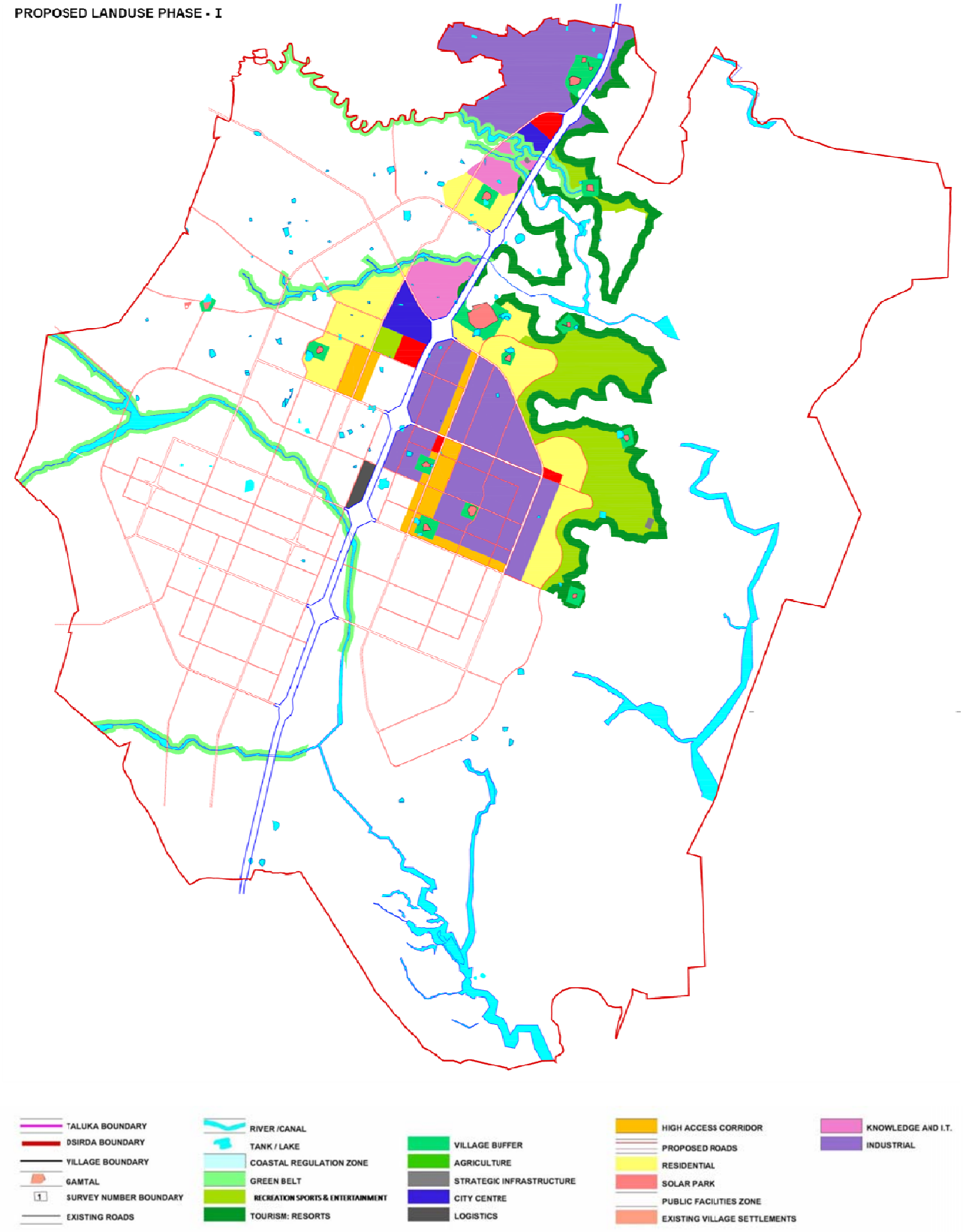


Figure 4-1: Phase 1 Development – Land Uses

***Note**: Roads are indicated for purpose of reference; Figure does not indicate phasing of major infrastructure; Village Settlements and Village Buffers are shown for indicative purposes only. These areas will not be subject to any market-led development.*

4.5. Phase 2

Construction of the second stage of the city's development would not commence until substantial progress has been made on the earlier stage. The intent is to make maximum use of already serviced land before new investment is made in opening up additional areas for further development.

Development of the second phase will be a logical extension of the Phase 1 development and will also include a mix of industrial and residential uses. This growth can be accomplished by extending the existing grid of roads outwards from the phase 1 area. This will be an economical and efficient way of creating new development opportunities. Less extensive expansion might also be considered to the north-west so as to make use of the good access this area has to the existing development.

The forecast up take of land for industry and housing in Phase 2 is expected to be significant, representing about 34 percent of the total demand for urbanisable land over the 30 year development period. This represents the strongest period of the city's growth.

There will be no requirement for any additional major strategic road connections during this phase, since SH-6 will still form the main road access to the DSIR. However by this phase, an additional traffic lane in both directions may be required. Building of the first section of the tram system should be started during this period. The section from the railway station south-east over the expressway is likely to be the most viable section in the short term.

Many other facilities provided in Phase 1 will only be reaching full capacity within this second phase but for geographical reasons it may be found necessary to develop additional sewage and water treatment facilities.

Development of further commercial zones in the new development areas will be according to market demand.

In Phase 2, the total land area under urban zones, Tourism & Resorts (area subject to development) is 12,725 ha, whereas area under only urban zones is 12,045 ha.

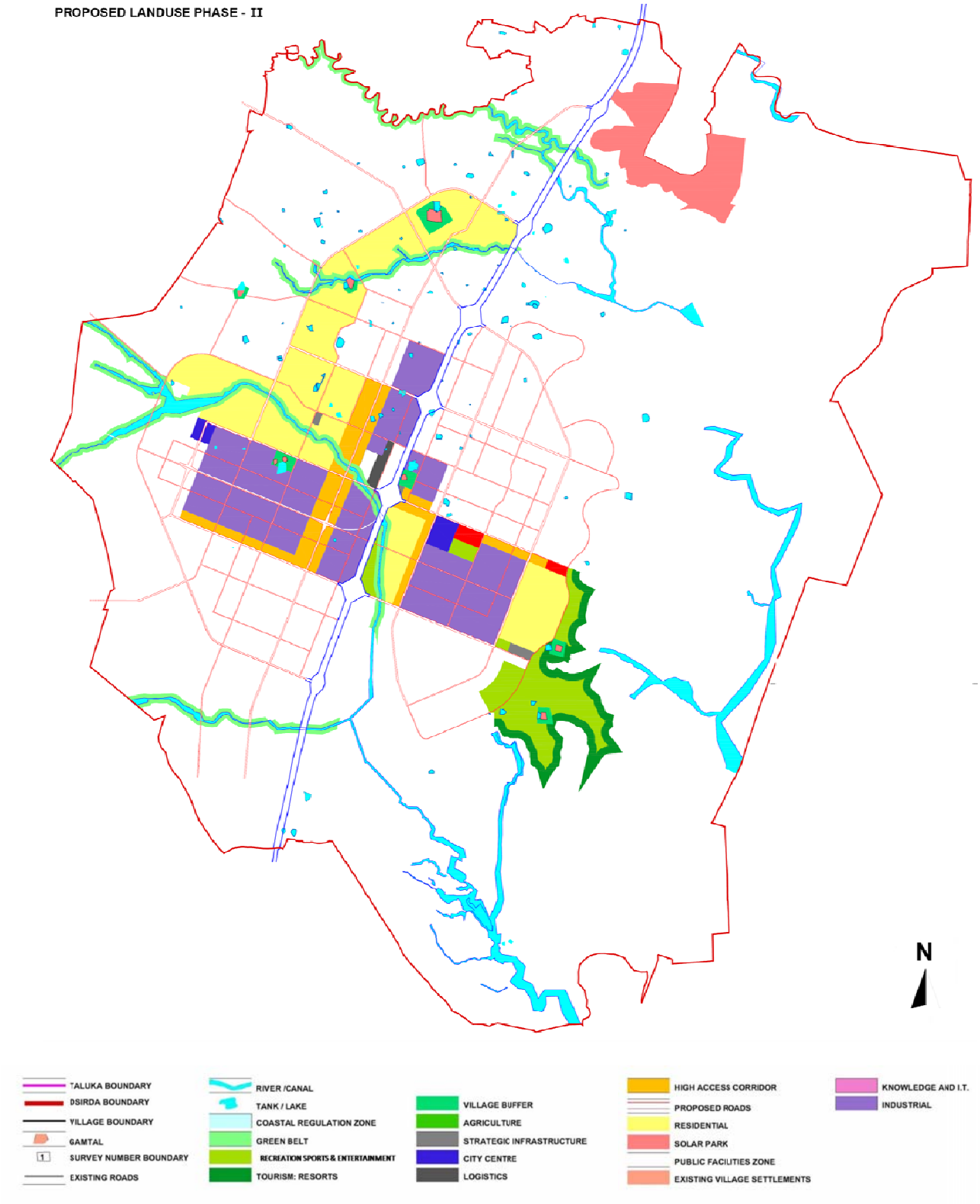


Figure 4-2: Phase 2 Development - Land Uses

***Note**: Roads are indicated for purpose of reference; Figure does not indicate phasing of major infrastructure; Village Settlements and Village Buffers are shown for indicative purposes only. These areas will not be subject to any market-led development.*

4.6. Phase 3

This phase sees the completion of development on the western and southern sides of the DSIR, again with a balanced mix of land uses.

In this phase of development the uptake of land for industry and housing is expected to slow down as the city matures, although this phase will still represent about 27 percent of the total demand for land over the 30 year development period.

As with the other phases, Phase 3 will provide a balance of industrial and housing uses, together with supporting community infrastructure and commercial centres. The key infrastructure components required to bring this about will include the further extension of the grid of city roads, construction of additional sewage treatment works to serve the south of the city and completion of the tram network comprising two interconnecting lines.

In Phase 3, the total land area under urban zones and Tourism is 11,309 ha, whereas area in only urban zones is 10,147 ha.

A summary of area developed under the three phases is indicated in Table 4.3

4.7. Retaining Flexibility

Expansion beyond the boundaries of the urban area beyond the planning horizon period would be relatively straightforward, as the grid of roads and the tram system is expandable and peripheral expansion in all directions is feasible without major redesign of the city. The agricultural land to the west of the city within the flood bund is allocated as the first urban extension, as and when required.

The city thus has capacity to develop well beyond the time frame of the existing plan.

Not all developers have the same site location requirements so it is recognised that perhaps not all of their requirements can necessarily be met at each stage of phased development. Furthermore, larger developers may well be of such a scale that they can proceed on their own in a self contained manner.

If the case arises that larger developers wish to proceed with their own development outside the normally allocated phased development area, it is assumed that they would be required to be self sufficient in terms of infrastructure. In this case, it is presumed that they would bear any additional infrastructure costs.

Table 4-3: Summary of Area under Phasing

PHASE	URBAN AREA UNDER PHASED DEVELOPMENT (ha)	PERCENT OF TOTAL URBANISABLE AREA
Phase 1	11,505	34%
Phase 2	12,045	36%
Phase 3	10,147	30%
Total	33,696	100%

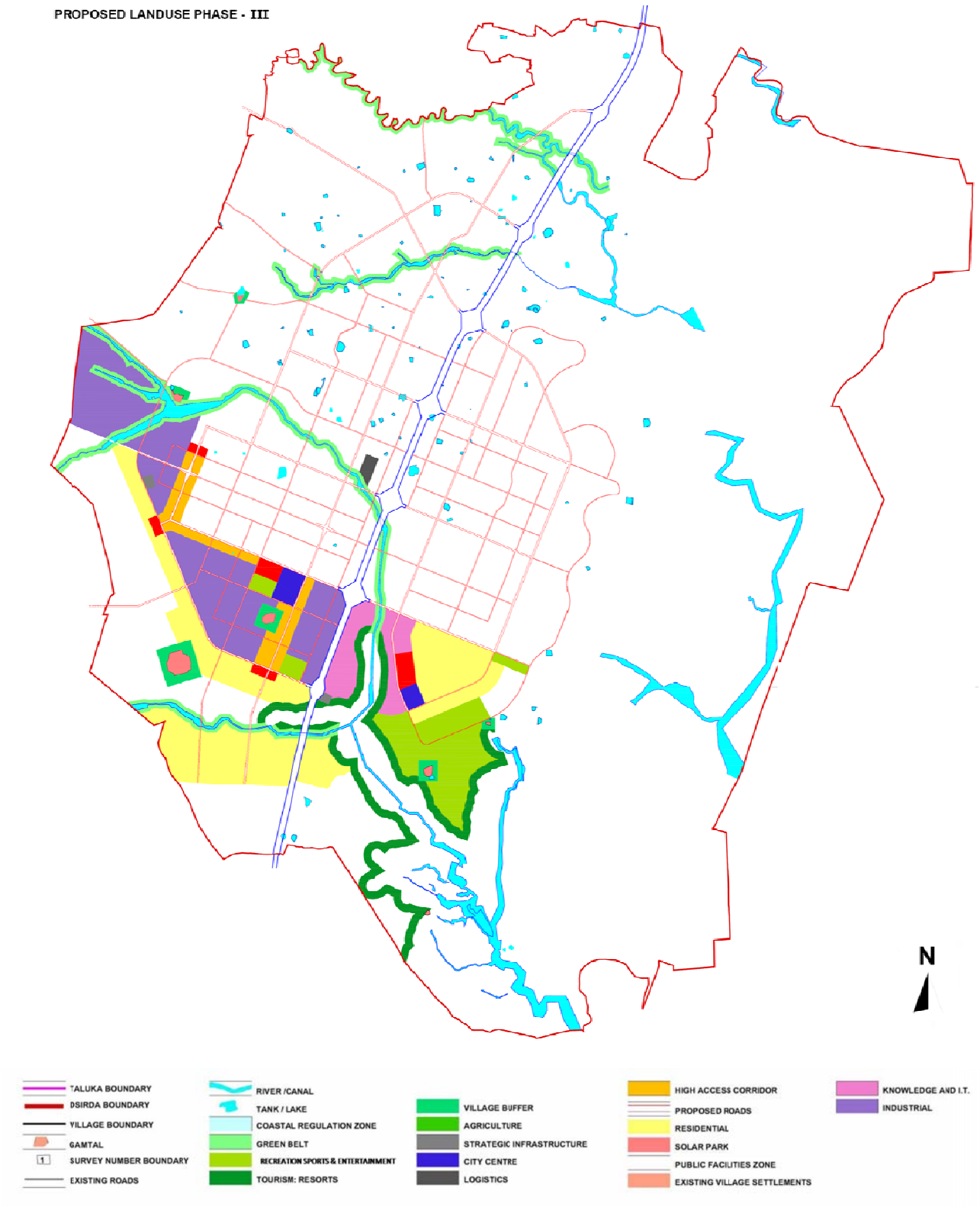


Figure 4-3: Phase 3 Development - Land Uses

***Note**: Roads are indicated for purpose of reference; Figure does not indicate phasing of major infrastructure; Village Settlements and Village Buffers are shown for indicative purposes only. These areas will not be subject to any market-led development.*

4.8. Phasing of Major Infrastructure Elements

An indicative time line for the critical enabling infrastructure elements, provision of which would underpin a systematic development in the DSIR is given in Table 4.4.

Table 4-4: Indicative Phasing of the Major Infrastructure Elements

INFRASTRUCTURE		PHASE 1		PHASE 2	PHASE 3
		PHASE 1A	PHASE 1B		
		2010-2015	2015-2020	2020-2030	2030-2040
Land under Urban Uses (ha) (Cumulative)		11,505		23,549	33,846
Population (Cumulative)		500,000		1,450,000	2,000,000
Dwellings (Cumulative)		125,000		362,500	500,000
Overall Urban Development		Industrial park, CBD, new housing areas in new township around Dholera	Continued urban development in the north of the DSIR	Urban development concentrated in the west and centre of the DSIR	Urban development in the south and on the western and eastern sides of the DSIR
Transport: *Agency: Gujarat State Road Transport Development Corporation (GSRDC)	Strategic Roads	Dualling of SH6		Strengthening road connectivity from the DSIR to the DFC	Construction of road connections on the Kalpasar Dam
		Toll road connecting DSIR with Pipavav Port			
	City Roads	Grade separated flyover of SH6 at Dholera Construction of primary road grid	Second grade separated flyover of SH6 Construction of local roads	Expansion of city roads in accordance with urban growth and traffic demand, including additional grade separated junctions with the SH6	
	Rail	Provision of BG rail link to Dholera and construction of a passenger rail station		Construction of rail line over Kalpasar dam and direct link to Bhavnagar Suburban Rail from	

INFRASTRUCTURE		PHASE 1		PHASE 2	PHASE 3
		PHASE 1A	PHASE 1B		
		2010-2015	2015-2020	2020-2030	2030-2040
				Ahmedabad to the DSIR (planned by the Government of Gujarat)	
	Inter-city Public Transport	Improved local bus services, central bus station	Dedicated bus lanes	Tram lines	LRT System
	Air	-	Development of a new international airport near Navagam Village		-
Utilities *Agency: Public Works Department					
	Water Supply Rising Main	55 km		75 km	10 km
	Water Supply Distribution Network	780 km		1240 km	730 km
	Water Treatment Works	Construction of Ottariya Stage 1 treatment works (Capacity: 258 MLD)		Construction of Hebatpur Stage 1 treatment works (Capacity: 450MLD)	Construction of Stage 2 treatment works at Ottariya & Hebatpur (Capacity: 238 MLD)
	Flood Management	De-silting and training of DSIR rivers and construction of flood protection bunds		-	-
	Waste Water Treatment	Construction of STP B,C,D and CETP 1,4: Total Capacity: 178 (MLD)		Construction of STP A,B,D and CETP 2,3,4 Total Capacity: 310 (MLD)	Construction of STP D and CETP 2,3,4 Total Capacity: 164 (MLD)
	Sewage Network and Intermediate Pumping Stations	780 km, 7 pumping stations		1240 km, 12 pumping stations	730 km, 8 pumping stations

INFRASTRUCTURE		PHASE 1		PHASE 2	PHASE 3
		PHASE 1A	PHASE 1B		
		2010-2015	2015-2020	2020-2030	2030-2040
	Power Supply *Agency: Uttar Gujarat Vij Company Limited	Building regulations requiring on site solar renewable generation (e.g. water heating & Photo voltaics)	Construction of a major renewable energy power station Construction of a conventional power station of 90MW X 1 number.	Construction of a conventional power station of 90MW X 1 number.	Construction of additional renewable energy power stations Construction of a conventional power station of 90MW X 1 number.
	Power Transmission *Agency: Gujarat Energy Transmission Company	Construction of a 132kv line from Dhandhuka to a 132kv sub-station at Dholera	Construction of a 400kv line to the eastern side of the DSIR and a 400kv main sub- station. Development of sub-transmission line of 132KV & associated substations of 132/33/11KV along with load growth.	Construction of a second 400kv line to the western side of the DSIR and a 400kv main sub- station. Development of sub-transmission line of 132KV & associated substations of 132/33/11KV along with load growth.	Development of sub-transmission line of 132KV & associated substations of 132/33/11KV along with load growth.
	Solid Waste	Development of waste collection and recycling facilities, including energy from waste plant			

CHAPTER 5

LAND USE PROPOSALS

5. Land Use Proposals

5.1. Housing Provision

The development of industry and other economic sectors in the DSIR will create a substantial need for housing. The housing strategy for the DSIR is to allocate sufficient land for residential purposes that will meet the needs of all income groups. For planning purposes it has been assumed that 80% of all household heads working in the DSIR will wish to live in the region with their families.

These dwellings will be matched to the needs of the new population in terms of affordability, size and typology. Particular attention will be paid to adequate housing provision for lower income groups (LIG) and economically weaker sections (EWS) in order to prevent the formation of slums. The release of land for housing will also be phased in order to ensure an orderly housing market and to prevent price speculation.

The demand for housing is derived from the detailed employment forecast and the analysis of the market for housing in the DSIR. This study examined the likely employment structure in the DSIR over a 30 year time horizon and the income levels of employees, both for those directly employed in the base industries of the industrial parks and in the knowledge, higher education and tourism sectors, and those in the support sectors such as banking, retail, construction and infrastructure services.

About 500,000 dwellings are required to meet the housing requirement of DSIR for the 30 year plan period. This number is based upon a target DSIR population of 2 million inhabitants living at an average household size of four persons sharing a single dwelling.

The analysis of income levels and affordability in the DSIR identified a requirement for three broad categories of housing;

- High income groups (annual income more than INR 500,000) - low to medium density housing
- Medium income groups (annual income within INR 150,000 to 500,000) – medium to high density housing
- Low income groups, including EWS (annual income less than INR 175,000) – high density housing.

Each housing category is essentially based upon densities and described in terms of average gross and net density. Gross density includes local roads, community facilities and open space, whereas net density includes plot areas or saleable land only, The description of each category of housing is as follows:

5.1.1. Low Density Housing

This will include detached bungalows and villas above 100sqm in carpet area on large plot areas. The average net density proposed for such housing is about net density of 25 dph (dwellings per hectare).

5.1.2. Medium Density Housing

This will typically be larger row houses and apartments with carpet areas of 50 sqm – 100 sqm. The average net density proposed for medium density housing is 75 dph.

5.1.3. High Density Housing

This will include group housing structures such as apartments, smaller row houses, dormitories and bachelor housing for migrant industrial workers and sites and services schemes. These units are likely to have carpet areas of less than $50m^2$. The average net density proposed for such housing is about 195 dph. The provision of dwelling units for each density category is indicated in Table 5.1.

Table 5-1: Target Number of Dwellings

HOUSING CATEGORY	DWELLING UNITS	PERCENT OF TOTAL HOUSING PROVISION
Low Density	34,000	7%
Medium Density	246,000	49%
High Density -	220,000	44%
Total	500,000	100%

Housing will be located in designated residential areas, in high access corridors, and commercial zones, including in the city centre and district commercial centres. Housing will also be allowed in higher education and knowledge industry campuses in the form of staff housing and student housing and in the village buffer zones.

The allocation of various housing densities is such that it encourages mixing of income groups in each of the land use zones that permit residential premises. Table 5.2 indicates the housing density mix across the Residential, High Access Corridor, City Centre and Knowledge & IT Zones.

All three density categories are included in the Residential Zone, whereas only high and medium densities are included in the City Centre and High Access Corridor Zones. The Knowledge and IT Zone accommodates only medium and low density dwelling units. The spatial distribution of housing is shown on Figure 5.1 (see page 47).

Table 5-2: Land for Housing Provision in Various Land Use Zones

LAND USE ZONE	AREA (ha)	PERCENT AREA UNDER HOUSING		
		High Density	Medium Density	Low Density
Residential	9,780	8	31	15
High Access Corridor	2,465	14	24	0
City Centre	679	16	15	0
Knowledge and IT	1,230	-	15	14

5.1.4. Housing for the Economically Weaker Section

Housing for population with annual income of less than INR 150,000 is allocated in high density housing areas. The overall housing requirement by income groups is based upon the total employment generated, which includes all support jobs. Thus, provision of housing for the Economically Weaker Section (EWS) is included within this allocation.

As an additional measure to ensure that the EWS receive their share of housing, it is proposed that about 4 percent of total housing provision of 500,000 units should be reserved as site and services plots (See Table 5.3). The EWS are assumed to be most appropriately located in the High Access Corridors, in close proximity to places of employment. 'Sites and Services' plots would be a good model to follow in the provision of housing for this sector, as trunk services and infrastructure will be readily available in this corridor.

Serviced plots could be achieved at relatively low cost by Government, NGOs or other bodies. The plan recommends that an annual review should be conducted for assessment of adequacy of this initial provision and appropriate additions be accommodated in the future revisions of this plan.

Table 5-3: Provision for EWS Housing

PROVISION	DWELLING UNITS	PERCENT OF TOTAL PROVISION UNITS
Total Housing Provision	500,000	1
Reservation for Site and Services Scheme for EWS, located in the high density housing areas	20,000	4

5.2. Community Facilities

An extensive range of community facilities will be developed to meet the needs of the inhabitants of the DSIR. The new city will be some distance from other urban centres and so will need to be largely self contained in terms of health, education, cultural, Government, sports and open space facilities.

Community facilities are provided on the basis of catchment area and hierarchy of provision, and an indication of percent of land provision in the land use zones that contain housing is given in Table 5.4. The provision norms are summarised in Table 5.5 (page 48), which indicates the type of facility, the population served, the area of the unit where applicable and an indicative site area.

The principle behind the location of community facilities is that they are situated in the centre of their respective catchment areas. So for facilities serving the whole city, the most appropriate location is within the main city centre. Facilities serving the districts are located within the district nodes and facilities serving smaller populations are embedded within the communities that they serve

Table 5-4: Summary Provision of Community Facilities

LAND USE ZONE	TOTAL LAND AREA	PERCENT LAND UNDER COMMUNITY FACILITIES	PERCENT LAND UNDER UTILITIES
Residential	9,780	10	1
High Access Corridor	2,465	15	1
City Centre	679	11	1
Knowledge & IT	1,230	11	1

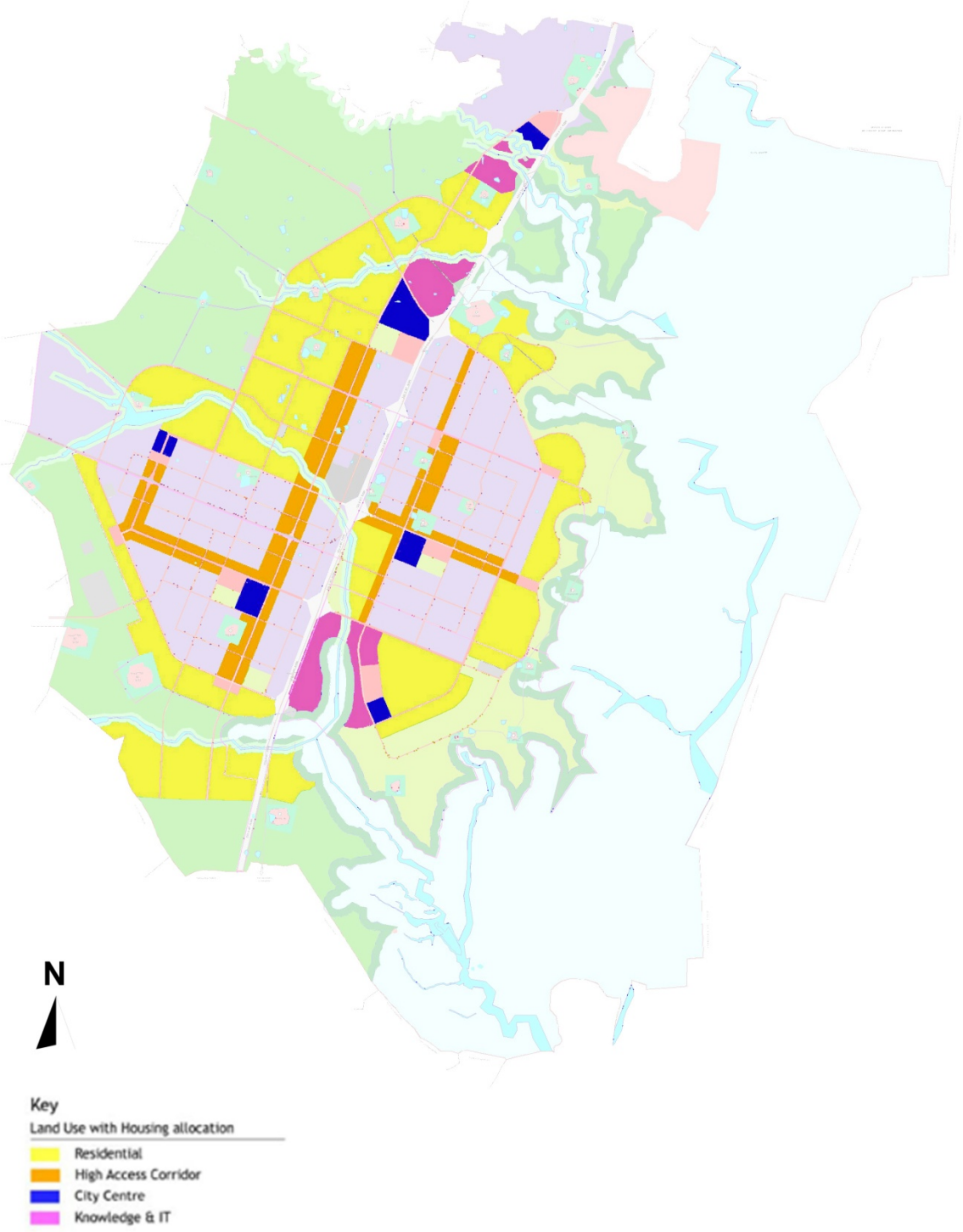


Figure 5-1: Land Uses with Housing Allocation

Table 5-5: Community Facilities

TOWNSHIP URBAN STRUCTURE UNIT	POPULATION	FACILITY	NO. OF UNITS	UNIT AREA (Ha)	TOTAL AREA (Ha)
Neighbourhood	**Education**				
Populations: 5,000	5,000	Nursery	1	0.2	0.2
	5,000	Primary School	1	1	1
	Shopping				
	5,000	Convenience shopping (Mixed)	included in mixed-uses		
		Other Community facilities	included in mixed-uses		
	5,000	Religious centre	2	0.2	0.4
	5,000	Aanganwari	2	0.02	0.04
	Recreational				
	5,000	Neighbourhood Park	1	0.8	0.8
	Utilities				
	5,000	Local level waste water treatment facility	1	0.05	0.05
	5,000	Three wheeler and taxi stand	1	0.02	0.02
Community/Sec-tor	**Education**				
Population: 20,000	20,000	Secondary school	1	2	2
	Shopping				
	20,000	Community Market	1	0.25	0.25
	20,000	Informal bazaar	1	0.1	0.1
	Other Community facilities				
	20,000	Banquet Hall	2	0.4	0.8
	20,000	Dispensary/Poly Clinic	2	0.02	0.04
	Recreational				
	20,000	Community Park	2	1	2
	Utilities				
	20,000	Underground Water storage & Water Tower	2	0.2	0.4
	20,000	Sewage Pumping station	2	0.05	0.1
	20,000	Electric sub-station (11 Kv)	2	0.008	0.016
Population: 100,000	**Community Facilities**				
	100,000	Hospital C (101 beds to 200 beds)	1	0.5-1.0	0.5-1.0
	100,000	Hospital D (Upto 100 beds),	1	0.2-0.5	0.2-0.5
	100,000	Family Welfare centre,	1	0.05	0.05
	100,000	Paediatric Centre,	1	0.02	0.02
	100,000	Geriatric centre	1	0.02	0.02

TOWNSHIP URBAN STRUCTURE UNIT	POPULATION	FACILITY	NO. OF UNITS	UNIT AREA (Ha)	TOTAL AREA (Ha)
	100,000	Diagnostic centre,	1	0.02	0.02
	100,000	Dispensary for pet animals	1	0.02	0.02
	100,000	Maternity home,	2	0.2	0.4
	100,000	Nursing Home/Poly clinic	2	0.2	0.4
	100,000	Socio cultural Centre	1	0.3	0.3
	100,000	Multipurpose community hall	1	0.3	0.3
	100,000	Cinema Hall (LIG)	1	0.2	0.3
	100,000	Police post	1	0.05	0.05
	Shopping				
	100,000	Zonal commercial Centre	1	4	4
	Recreational				
	100,000	Community sports centre	1	2	2
	100,000	Zonal Park	1	5	5
	Utilities				
	100,000	Water Works site (Storing treated water)	1	3	3
	100,000	Sewage Pumping station	1	0.2	0.2
	100,000	Electric sub-station (66 kv)	2	0.85	1.7
Population: 275,000 to 500,000	**Residential**				
	500,000	Old age home	1	0.3	0.3
	500,000	Care centre for physically/mentally challenged	1	0.3	0.3
	500,000	Working men- women hostel	1	0.3	0.3
	500,000	Orphanage/ Children's centre	1	0.3	0.3
	Education				
	275,000	Scientific Research Institute	2	2	4
	275,000	Adult education centre	1	0.1	0.1
	500,000	Vocational Training Centre (ITI/Polytechnic)	2	0.5	1
	500,000	General College	3	1.5	4.5
	500,000	Professional college	5	3	6
	Community Facilities				
	500,000	Hospital A (500 beds and above)	1	4	4
	275,000	Hospital B (201 beds to 500 beds)	1	2	2
	275,000	Veterinary hospital for pet animals	1	0.2	0.2

TOWNSHIP URBAN STRUCTURE UNIT	POPULATION	FACILITY	NO. OF UNITS	UNIT AREA (Ha)	TOTAL AREA (Ha)
	275,000	Fire station (5-7 km radius)	2	0.5	1
	275,000	Public Library	1	0.5	0.5
	500,000	Police station	1	0.5	0.5
	500,000	Auditorium	1	1	1
	500,000	Socio-cultural Centre	1	3	3
	500,000	Sports Centre	1	5	5
	500,000	Cremation ground	4	0.4	1.6
	Shopping				
	275,000	District Centre	1	4	4
	275,000	Service market	1	2	2
	Recreational				
	275,000	Playground/open space	1	3	3
	3 to 500000	City Centre Park	1	20	20
	Utilities				
	500,000	Electric sub-station (132 kv)	1	3	3
	275,000	Sewage Treatment Plant	1	10	10
City 2,000,000	**Education**				
	1,000,000	Technical Education Centre	1	2	2
	1,000,000	Medical (and paramedical) College	1	5	5
	1,000,000	School for mentally and physically challenged	1	0.2	0.2
	2,000,000	University	1	40	40
	Community Facilities				
	1,000,000	Telephone Exchange and (Remote Subscribe Unit)	1	0.25	0.25
	2,000,000	Agricultural Wholesale market	1	10	10
	1,000,000	Head Post Office and Administrative office	1	1	1
	1,000,000	City Museum	1	2	2
	1,000,000	Religious centre	2	1	2
	1,000,000	Exhibition cum fair ground	1	10	10
	1,000,000	Science Centre	1	10	10
	2,000,000	Super speciality hospital	1	5	5
	2,000,000	Jail	1	6	6
	2,000,000	Police Headquarters	1	3	3
	2,000,000	City Public Library	1	1	1
	2,000,000	International Conventional Centre	1	50	50
	2,000,000	City Administrative Complex	1	2	2

TOWNSHIP URBAN STRUCTURE UNIT	POPULATION	FACILITY	NO. OF UNITS	UNIT AREA (Ha)	TOTAL AREA (Ha)
	2,000,000	Court	1	3	3
	2,000,000	Passenger inter-modal transport facility	1	14	14
	Shopping				
	1,000,000	Regional Retail Centre/Market	1	10	10
	Recreational				
	1,000,000	City Park	1	100	100
	2,000,000	Divisional Sports Complex*	1	30	30
	Utilities				
	2,000,000	Water Treatment Plant	2	15	30

5.3. Commercial Uses and Formal Tourism

5.3.1. Strategy of Provision

A range of commercial uses including retail shops, offices and the hospitality industry, which includes hotels and entertainment venues will be allowed in DSIR. The amount of floor space for each activity has been determined in studies undertaken as part of the development of the Concept Plan as outlined in Concept Master Plan report prepared by Halcrow (refer pg. 25).

5.3.2. Retail Space

A model was developed to determine the quantum of retail space, based upon the population of the DSIR, the average size of household, forecast average expenditure and the ratios of branded to un-branded retail and the breakdown of formal and informal retailing sectors. This model provides an indication of the size of the market and the retail space and land requirement.

For the DSIR a total area of about 107 ha is expected to be required for retail space over the plan period, distributed according to a hierarchy. At the level of the neighbourhood provision will include kiosks, shops and community markets, at the district and area level there will be larger commercial centres and markets. The highest level of retail provision will be in the city centre.

The distribution of retail floor space will be as shown in Table 5.6.

Table 5-6: Demand for Commercial Retail Real Estate

LAND USE CALCULATIONS	NUMBER
Branded Retailing	
Branded Retail Market Size (Rs. mn)	19,770
Sales (Rs/Sq ft/Year)	9,500
Total Branded Retailing (mn.sq.ft)	2.08
Unbranded Retailing	
Unbranded Retail Market Size (Rs. mn)	4,612
Sales (Rs/Sq ft/Year)	6,500
Total Unbranded Retailing (mn.sq.ft)	7.1
FAR Assumptions	
Branded Retailing	1

LAND USE CALCULATIONS	NUMBER
Unbranded Retailing	0.75
Land Area Required (ha)	
Branded Retailing	19.33 ha
Unbranded Retailing	87.90 ha
Total Land Area Required	107 ha

5.3.3. Office Space

Offices will be required primarily for the indirect employment generated as a result of direct employment in the base industries and economic sectors. The following sectors will require office space:

- Transport and storage
- Construction and infrastructure
- Public administration
- Utility companies and institutional bodies
- Banking and financial services.

It is assumed that the wholesale and retail sectors will operate out of their own premises. The banking and financial sectors will operate out of what is referred to as Grade A space, that is high quality buildings in prestigious locations that will be located primarily in the main city centre. Non Grade A space would be to much lower specifications and would be more widely distributed in other city nodes and high access corridors or on less prominent sites within the city centre.

Based upon the floor space per employee of office space, which is higher in case of Grade A properties, a total requirement of about 247 ha is required, of which approximately 12% will be for Grade A space and 88% for non Grade A. Table 5.7 shows the demand for commercial office real estate.

Table 5-7: Demand for Commercial Office Real Estate

LAND USAGE CALCULATIONS	NUMBER
No. of People requiring office space	461,333
Average Area per person	
Grade A	100.0 sq.ft
Non Grade A	60.0 sq.ft
Category of Building	
Grade A	12%
Non Grade A	88%
Total Area Requirement (mn sq ft)	29.92
Grade A Building	5.6
Non Grade A Building	24.32
Average FAR Assumption	
Grade A Building	2.5
Non Grade A Building	1
Total Land Area Required (ha)	246.76 ha

5.3.4. Hospitality and Tourism

The key drivers for hospitality in DSIR will be business travellers connected with the industrial, economic and administrative functions of the new city and tourists visiting existing or new pilgrimage or leisure destinations.

Tourism Demand

Tourism growth rates in Gujarat have been very strong in recent years but these growth rates are likely to level off as visitor destinations in the area, such as Palitana, reach saturation point. Tourist numbers at the attractions nearest to the DSIR, notably Dholera, Valabhipur, and Velavadar attract relatively few visitors. The most significant growth in number of tourists is therefore likely to come from new attractions. The basis for assessing demand for hotels catering to the leisure segment is given in Table 5.8. The major attractions proposed in the DSIR are shown in Table 5.9.

Business Hotels

The hospitality demand from business is related to the size of the economic sector in the local economy and has been calculated on the basis of 0.5 room nights per employee as described in Concept Master Plan. This demand is broken up by category of hotel, adjusted to reflect company owned facilities and occupancy rates. The basis for assessing demand for business hotels is given in Table 5.10.

The number of bed spaces to meet the forecast demand from tourism is also broken up by category of hotel, adjusted to reflect company owned facilities and occupancy rates.

Table 5-8: Demand Assessment for Hospitality - Leisure

HOSPITALITY DEMAND ASSESSMENT - LEISURE	NUMERICAL DETAILS	BASIS
Total Tourists arrivals within catchment of DSIR	2,341,944	Tourist arrivals in the catchment region (Knight Frank research)
Total Target Tourists for hotels within DSIR (Current)	70,258	Room Night demand @ 3% total tourist arrivals
CAGR	3%	
Target Tourists to DSIR (2040)	180,921	Target tourist to DSIR
Average Duration of stay (nights)	1.8	Room night demand of tourist arrivals in DSIR: room night demand of 1.8 as per hospitality trends in the DSIR influence zone
Total Room nights	325,658	
Average Occupancy	70%	KF Research & Analysis
% Room Break-up - starred and budget		
Star Category	50%	KF Research & Analysis
Budget	50%	KF Research & Analysis
Break-up of Rooms across Hotel Categories		
Star Category	3,246	
Budget	3,246	
Total Leisure Hotel Room Demand (all categories) DSIR + Input for economic mix under tourism industry	6,492	" Leisure Room Night demand @ 70% occupancy and input from Industrial market assessment of 5217 rooms for tourism "

Table 5-9: Tourism Destinations in the DSIR

PROPOSED ACTIVITY	NUMBER OF FACILITIES	AREA / FACILITY (Ha)	TOTAL AREA (Ha)
Theme Park	1	200	200
Large Aquarium	1	5	5
Night Safari	1	45	45
Exhibition Grounds	1	100	100
Golf Course	2	70	140
Handicrafts	4	2	8
Film City	1	680	680
Religious Place	1	40	40
Museum	1	2	2
Total Area (rounded)			**1,220**

Table 5-10: Demand Assessment for Hospitality- Business

CATEGORY	NUMERICAL DETAILS	BASIS
Total Employee Population (Number)	824,663	Industrial market research, Synovate and KF research
Room Night Demand per Employee	0.5	KF Research & Analysis
Total Room Night Demand (Number)	412,332	
Hotel Room Night Demand (Number)	329,865	Discounting @ 20% for room night demand met by company owned facilities
% Room Breakup within categories		
5 Star / 5 Star D	10%	KF Research & Analysis
4 Star	10%	
3 Star	33%	
Budget	45%	
Serviced Apartments	2%	
Occupancy (%)		
5 Star / 5 Star D	70%	KF Research & Analysis
4 Star	65%	
3 Star	70%	
Budget Hotel	75%	
Serviced Apartments	60%	
Break-up of Room Night Demand across Hotel Categories		
5 Star / 5 Star D	32,987	5 Star / 5 Star Deluxe demand at 10% of total room night demand
4 Star	32,987	4 Star demand at 10% of total room night demand
3 Star	108,856	3 Star demand at 33% of total room night demand
Budget Hotel	148,439	Budget Hotel demand at 45% of total room night demand

CATEGORY	NUMERICAL DETAILS	BASIS
Service Apartment	6,597	Service Apartment demand at 2% of total room night demand
Total Room Night demand (Number)	329,865	
Break-up of Rooms across Hotel Categories		
5 Star / 5 Star D	129	Number of 5 Star Rooms at 70% occupancy
4 Star	139	Number of 4 Star Rooms at 65% occupancy
3 Star	426	Number of Budget Hotel Rooms at 70% occupancy
Budget Hotel	542	Number of Budget Hotel Rooms at 75% occupancy
Serviced Apartment	30	Number of Serviced Apartment Rooms at 60% occupancy
Total Business Hotel Room Demand	1,267	rooms

Table 5-11: Total Business and Tourist Hotel Rooms Demand Summary

HOTEL CATEGORY	BUA PER ROOM	NO OF ROOMS	BUILT UP AREA (Sq Ft)
BUSINESS			
5 Star / 5 Star D	1,200	129	154,800
4 Star	575	139	79,925
3 Star	400	426	170,400
Budget Hotel	350	542	189,700
Service Apartment	500	30	15,000
LEISURE			
Star Category	750	3246	2,424,500
Budget/Service Apartments	450	3246	1,460,700
Total Built-up Area	4,505,094		4,495,025
Average FAR	1.2		1.2
Total Land Area for Hospitality Development (ha)	**34.88**		**37.45**

The total number of rooms and real estate demand across hotel and tourist categories are given in Table 5.11. A summary of the total number of rooms and bed spaces by category for business and leisure are given in Table 5.12.

Table 5-12: Summary of Provision - Commercial Retail, Office and Hospitality

LAND USE ZONE	TOTAL AREA (HA)	PERCENT AREA UNDER COMMERCIAL USE		
		OFFICES/ RETAIL	LEISURE/ HOSPITALITY	LIGHT SERVICE INDUSTRY
Residential	9,780	2%	1%	0%
High Access Corridor	2,465	6%	3%	5%
City Centre	679	14%	3%	0%
Knowledge and IT	1,230	3%	4%	0%
Recreational, Sports and Entertainment	4,500	0%	60%	0%

5.3.5. Spatial Strategy

Commercial land uses are distributed around the new city as shown in Figure 5.2. The facilities are broadly categorised as follows:

Retail Space

The prime retail space represented by malls and high quality shopping space will be in the city centre and the district centres. Other local centres and markets located in residential areas and the high access corridors will accommodate the more day to day needs of consumers, particularly food shopping and convenience goods.

Office Space

The higher quality office space (Grade A) will be located primarily in the city centre. Other offices will be located in the district centres or along high access corridors.

Hotels

Business hotels should be located within the city centre or district centres. Lower quality hotels should be located in the high access corridors close to the main industrial and employment centres. Tourist hotels will be located close to each of the tourist attractions.

Developments related to Tourism

Large scale tourist developments such as a film city or other theme park are located on the northern edge of DSIR, with an adjoining CBD and direct access off a grade separated access road from the expressway. This location is also in close proximity to the proposed international airport.

Resort development is located on the eastern edge of the site adjoining the CRZ on the Gulf of Khambat. These developments will be low-intensity land uses that will respect the sensitive natural ecology of the CRZ.

Additionally, a reserve area is allocated for further future expansion of tourism, entertainment and sports related uses on the southern edge of DSIR. This land will remain agriculture use until required.

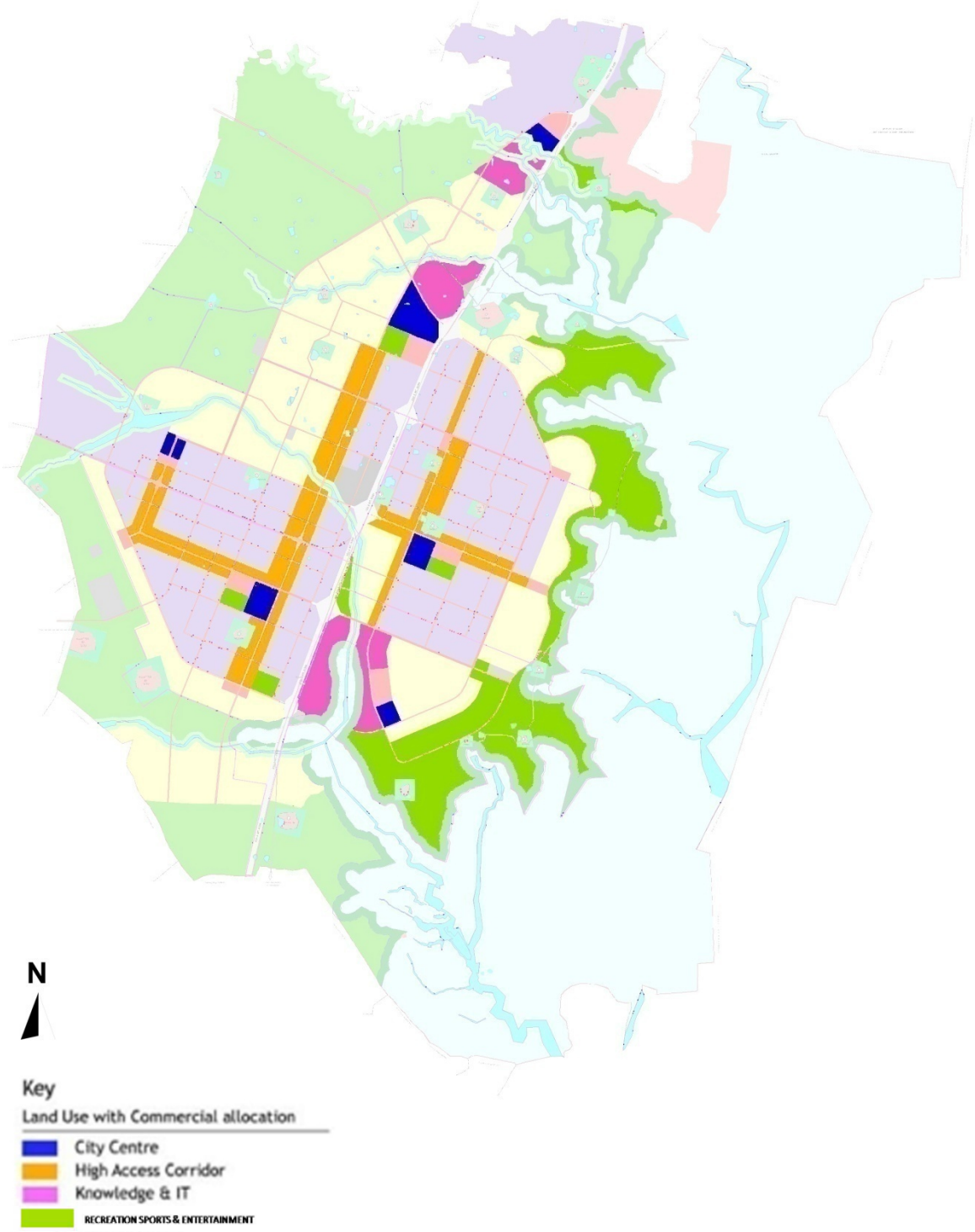


Figure 5-2: Land Uses with Commercial Allocations

5.4. Industry

5.4.1. Industrial Land Provision

The strategy for the development of industry and other economic sectors in DSIR is based upon detailed studies undertaken in the preparation of the Development Plan and described in Report for Industrial Market Potential and Critical Gap Assessment, prepared by Halcrow (refer page 12).

The proposed mix of industrial activities is based upon a focus on those sectors that meet the following criteria:

- Where DSIR offers a comparative economic advantage;
- Where DSIR provides the benefit by its location;
- Industries that can be located in DSIR without an adverse affect upon the local environment;
- Where the same sectors are not already being targeted for development elsewhere in Gujarat.

The following industrial and economic sectors are being targeted for development in DSIR, given in order of importance according to the generation of employment:

- Electronics, High Tech and Emerging Technologies
- Pharmaceuticals and Biotechnology
- Heavy Engineering
- Automobile and Auto Ancillary Industries
- General Manufacturing
- Tourism
- Agro and Food Processing
- Metals and Metallurgical Products
- IT/ITES
- Education

In addition, small, light and cottage industries will be expected to develop in response to the requirements of the main industrial sectors and the growing urban population.

The land requirements of the main economic sectors, employment potential within the region are given in Table 5.13.

5.4.2. Spatial Strategy

The distribution of the main industrial zones is shown on Figure 5.3. The strategy allocates the land for industrial uses in a number of large, linked blocks of industrial zones or ‘mega-parks’. The detailed strategy for the Industrial Mega Park is given in the report on Techno-economic Feasibility for the Mega Industrial Park.

The industrial mega parks are all accessed from the arterial roads originating from the central expressway and are well connected with each other by a network of main roads. The logistics zone is centrally located so that it can serve all industrial activities equally well and is connected to both the rail and main road networks.

Smaller areas are also required to be set aside for the development of small workshops and businesses. These can be located either on the edge of the main industrial areas or within the mixed use zones.

Table 5-13: Land Allocation for Industry, Knowledge and IT

INDUSTRY SECTOR	AREA REQUIRED (HA)	EMPLOYMENT DENSITY (PER HECTARE)
General Manufacturing	440	96
IT/ITES	20	365
Electronics, Hi-tech & Emerging Technologies/Value Adding Industries	1,360	64
Automobile & Auto Ancillary	1,990	22
Agro & Food Processing	340	81
Heavy Engineering	2,250	20
Metals & Metallurgical Products	480	24
Pharmaceuticals & Biotechnology	1,120	44
Logistics	200	-
Subtotal land required for Industry and Logistics	8,200	NA
Total Provision for Industry and Logistics	11,661	NA
Total Provision for Knowledge and IT	1,230	NA

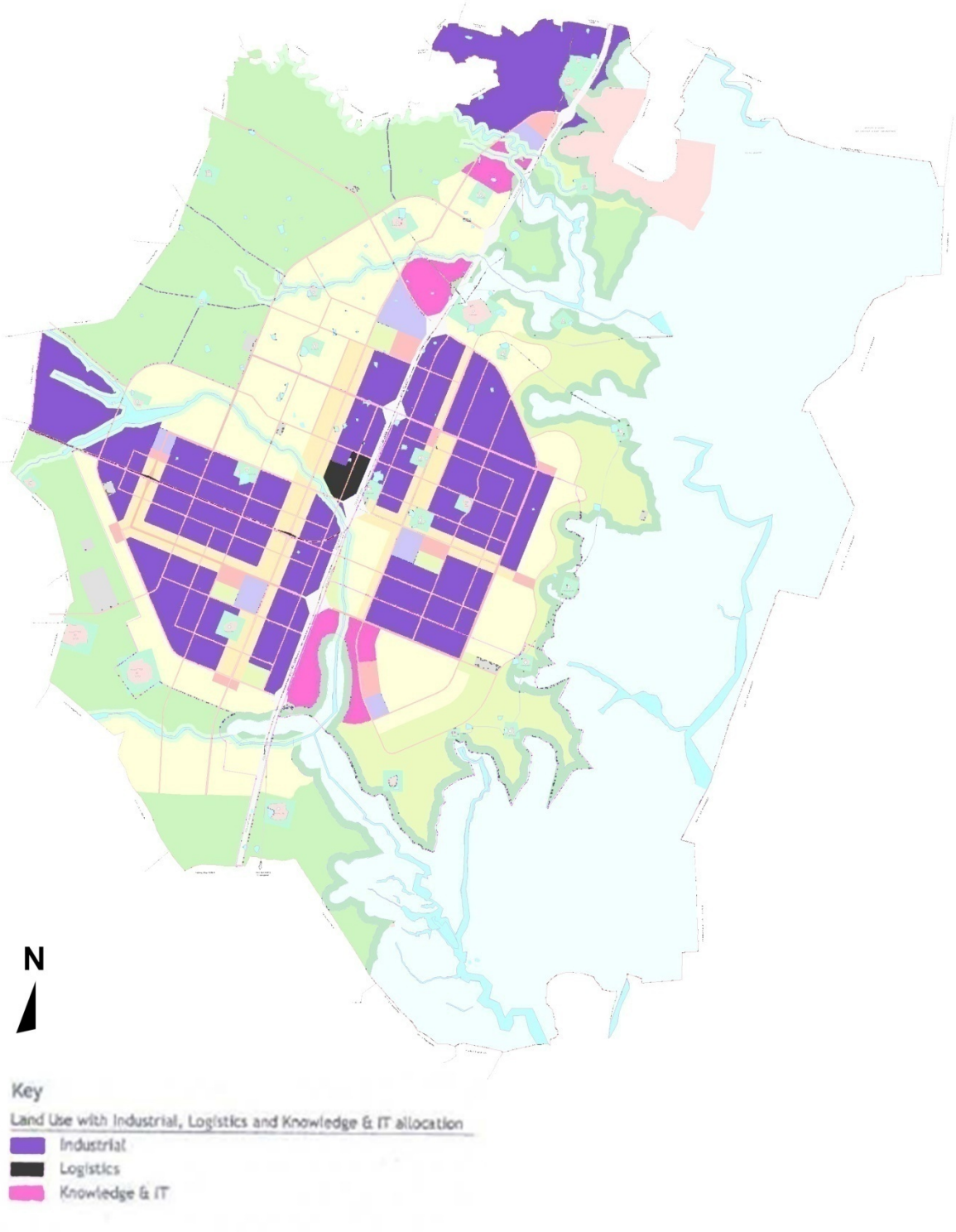


Figure 5-3: Industrial. Logistics and Knowledge Zones

5.5. Open space and Recreation

5.5.1. Provision

In order to ensure that the city is an attractive and desirable place to live, a high proportion of the city is planned as public parks, open spaces and landscaped roads and corridors.

Figure 5.4 (page 63) shows the major areas of green and open space proposed but there will be smaller areas of recreational space in all residential and industrial areas. Table 5.14 indicates percent provision of local open space within land use zone which exhibit housing. Open space will comprise lakes and canals, formal parks and sports grounds and pitches, informal open space and landscaped areas alongside roads.

Table 5-14: Summary of Local Open Space Provision

LAND USE ZONE	PERCENT OF LAND UNDER LOCAL OPEN SPACE
Residential	10
High Access Corridor	10
City Centre	18
Knowledge & Logistics	17

5.5.2. Waterfront Development

A unifying theme of the new city is the creation of a number of attractive lakes and canals in order to create the potential for waterfront development. This will be achieved by deepening and widening existing river courses and floodplains, which will not only provide storage areas for flood waters but provide a strong landscape feature that will have value for recreation. If deep enough, the lakes may have potential to store fresh water for the city, as in the case of the city of Udaipur.

Cherry Blossom Festival along the Potomac River waterfront in Washington DC

Perhaps equally important, the lakes and canals will also have significant visual appeal, increasing the marketability of housing along the waterfront. The proposed network of lakes and canals will be linked by a number of attractive urban parks and tree lined roads and small parks, so that the overall appearance of the new city is one of space and greenery, unlike most industrial townships.

Commercial Theme Park and Food Street along Waterfront

The plan provides opportunities for development of waterfronts with varying character in multiple locations within the City:

- Eco-sensitive tourism development in the Resorts zone, along the CRZ boundary;
- Series of interconnected neighbourhood parks and gardens within the Residential Zone, in areas adjacent to the Green Space and Canals;
- Commercial food streets, retail courts and public

Retail and Street-side Cafeterias along a Residential Area in Copenhagen

activity arenas in the City Centre Zone, in areas adjacent to the Green Space and Canals;

- Creation of artificial lakefront by bunding portion of the CRZ zone adjacent to the Knowledge and IT Zone.

Conservation of Natural Waterfront within an environmentally sensitive area

Waterfront Development Precedents for the DSIR

5.6. Agriculture Zones and Reserve Land

Approximately 14 percent of the total site area, totalling over 12,804 ha will be retained as farmland for the short term. This land is not required for development until the city grows beyond a population of about 2 million inhabitants. Of this, about 6,835 ha are allocated for expansion of industrial and tourism related uses, however these reserves will be opened for development only after the current land allocation under these uses are exhausted (See Figure 5.4 on next page)

Figure 5-4: Open Spaces

CHAPTER 6

TRANSPORT

6. Transport

6.1. Introduction

A principle element for the success of the DSIR will be improved connectivity to the rest of the State, to the DFC and other regions in the DMIC influence area. Along with improved regional connectivity, an efficient public transportation system at a city level will ensure a sustainable city.

6.2. Estimated Traffic Demand

The patronage of public and private transport has been assumed as 70% and 30 % respectively and the mode share for vehicles is as given in Table 6.1 and 6.2. This assumption is based on the Study on Traffic and Transportation Policies and Strategies in Urban Areas in India by the Ministry of Urban Development; May 2008, also supplemented by the past experience of the Consultants in Indian cities similar to DSIR in terms of size.

The peak hour factor (PHF) has been assumed as 0.1 and peak directional factor has been assumed as 0.55; Even though the PHF for external linkages is 5.5% to 7.5%; the PHF for DSIR roads is assumed as 10% because for external roads, traffic is distributed throughout the day while for urban roads traffic has peak hour characteristics.

Vehicular trips for the passenger vehicles is estimated by taking population as the base and applying the adopted per capita trip rate, modal shares and occupancy factors. The Per Capita Trip Rate (PCTR) was assumed to be 0.04 for internal-external-internal and 1.8 for external-internal-external.

The adopted occupancies for passenger and freight vehicles and traffic studies undertaken for demand assessment are enlisted in the Appendix F.

The travel demand is estimated for three categories, namely trips generated from the DSIR to the surrounding cities/region, trips generated from the surrounding cities/regions to the DSIR and the trips within the DSIR. The Table 6.3 shows estimated trips per day for all the three types of movement.

Based on these trips, strengthening of external linkages is recommended (See Table 6.4). Trips from the DSIR to outside are expected to be relatively low because most people will work and reside within the DSIR.

The internal road hierarchy and widths are based upon the trip forecasts. The forecasts suggest that about half of all traffic will be from the north; that is from Ahmedabad, Vadodara and the site of the proposed airport. An equal share of traffic will be from the south and east, notably from Bhavnagar and Pipavav port.

Table 6-1: Public-Private Patronage and Mode Share for External-Internal Trips

PRIVATE					PUBLIC	
70%					**30%**	
2W	**Car**	**Taxi/ Other**	**Sharing Jeep**	**Cycle**	**Bus**	**Train**
30%	20%	10%	20%	20%	15%	85%

Table 6-2: Public-Private Patronage and Mode Share for Internal Trips

PRIVATE					PUBLIC	
45%					**55%**	
2W	**Car**	**IPT**	**Walk**	**Cycle**	**Bus**	**Train**
22%	13%	4%	33%	27%	15%	85%

Table 6-3: Preliminary Per-day Traffic Estimates

MODE	INTERNAL –EXTERNAL TRIPS			EXTERNAL-INTERNAL TRIPS			INTERNAL-INTERNAL TRIPS		
	PHASE-I	PHASE-II	PHASE-III	PHASE-I	PHASE-II	PHASE-III	PHASE-I	PHASE-II	PHASE-III
Private Transport									
2W	4500	9000	4500	5200	10000	5400	61400	133500	72700
Car	3000	6000	3000	3500	6800	360	36800	80100	43600
IPT	4500	9000	4500	5200	10100	5400	12300	26700	14500
Cycles	3000	6000	3000	3500	6700	3600	73600	160200	87200
Public Transport									
Bus	5250	10500	5250	6000	11800	6200	92000	200300	109100
Train	29750	59500	29750	34500	67000	35500	337600	734200	399800
Total Trips									
Private	15000	30000	15000	17400	33800	17900	184100	400500	218100
Public	35000	70000	35000	40600	78800	41700	429700	934500	508900
Total	50000	100000	50000	58000	112600	59600	613800	1335000	727000

6.3. Development Strategy – External links

6.3.1. Ports

DSIR will not generate sufficient traffic by itself to justify the development of a new port, which in any case cannot be located within the DSIR because of the potential Kalpasar dam project. The industries that will be attracted to the DSIR will undoubtedly generate port traffic in the form of import and export containers. However there will be no bulk cargo flows of, coal, cement clinker, or LNG for example, for which a captive jetty would be required.

The choice of port by businesses in DSIR depends to a large extent on the overall supply chain logistic cost and it is not necessarily the case that the traffic will leave or arrive at DSIR through the closest port. Port choice might be driven by destination constraints for export cargo where, for example, that destination is only serviced by an Indian port that is not the closest one to DSIR.

The strategy adopted in the Draft Development Plan is to recommend the upgrading of connections to existing container terminals in the area at Pipavav, Mundra and the container terminals in Mumbai. The connectivity provided by the existing container terminals is attractive to shippers since the ports have established shipping services and port related infrastructure. These improvements will be to both road and rail connections.

6.3.2. Rail

Regional freight and passenger rail services will play an important role in connecting the DSIR with the rest of the country and the DFC.

High Priority Projects

Indian Railways is intending to convert the existing metre gauge (MG) rail line from Ahmedabad to Botad, in to broad gauge (BG). The implementation of this project is critical to the development of DSIR. Although the line is not within the DSIR, it is the nearest railway line, the closest stations being located at Dhanduka to the north-west and Bhimnath to the west.

It is proposed that a BG loop line be constructed from this existing line to Dholera, so as to provide a direct link from DSIR to the rest of the Indian Railway system, including a direct connection Ahmedabad.

Subject to the assessment of the route, it is anticipated that the loop line would leave the existing railway line south of Dholka and travel via the new international airport site at Navagam and then route westwards to rejoin the exiting railway line at Bhimnath. It is proposed that the loop would have a link eastwards from the Vataman area to join the existing rail lines at Petlad, so providing rail connections to Anand and Vadodra and to the DFC as shown on Figure 6.1.

To ensure that the new lines are of adequate capacity to accommodate both freight and passenger services and can operate fast and frequent services, it is proposed that the right of way (ROW) of the converted and new BG lines should all be wide enough to accommodate double tracks. At the outset, bridges would be provided with ROW for double track but only one track will be constructed in the Phase 1 development.

Ahmedabad has plans to develop a metro system from the metropolitan area and there are also schemes to connect the proposed new airport near Navagam, Pachcham and Valinda to Ahmedabad by rail. The proposed BG line to DSIR could be routed via the airport site if that is found feasible.

Related Projects

Indian Railways are doubling the existing BG line from Pipavav port northwards, which will increase rail capacity from there to Dholera and thus increase the speed and reliability of freight services to the DSIR and thus strengthen its attractiveness as an industrial location.

6.3.3. Road Connectivity

The Government recognises the importance of connectivity and therefore has initiated plans to develop a 6 lane dual carriageway highway (with provision for up gradation to 10 lanes) between DSIR and Ahmedabad and Bhavnagar and upgrade the existing National Highways and rail routes to Pipavav Port.

Based upon the traffic flows forecast in the traffic studies, improvement to the key State Highways linking DSIR to the wider region is recommended, as given in Table 6.4.

Table 6-4: Recommended Strengthening of the Regional Road Network

PERIOD	SH-6 (SOUTH)	SH-20 (LIMBDI)	SH-6 (NORTH)	SH – 8 (WATAMAN)
Phase 1	2L Paved Shoulders	2L Paved Shoulders	4	4
Phase 2	4	4	6	6
Phase 3	4	4	6	6

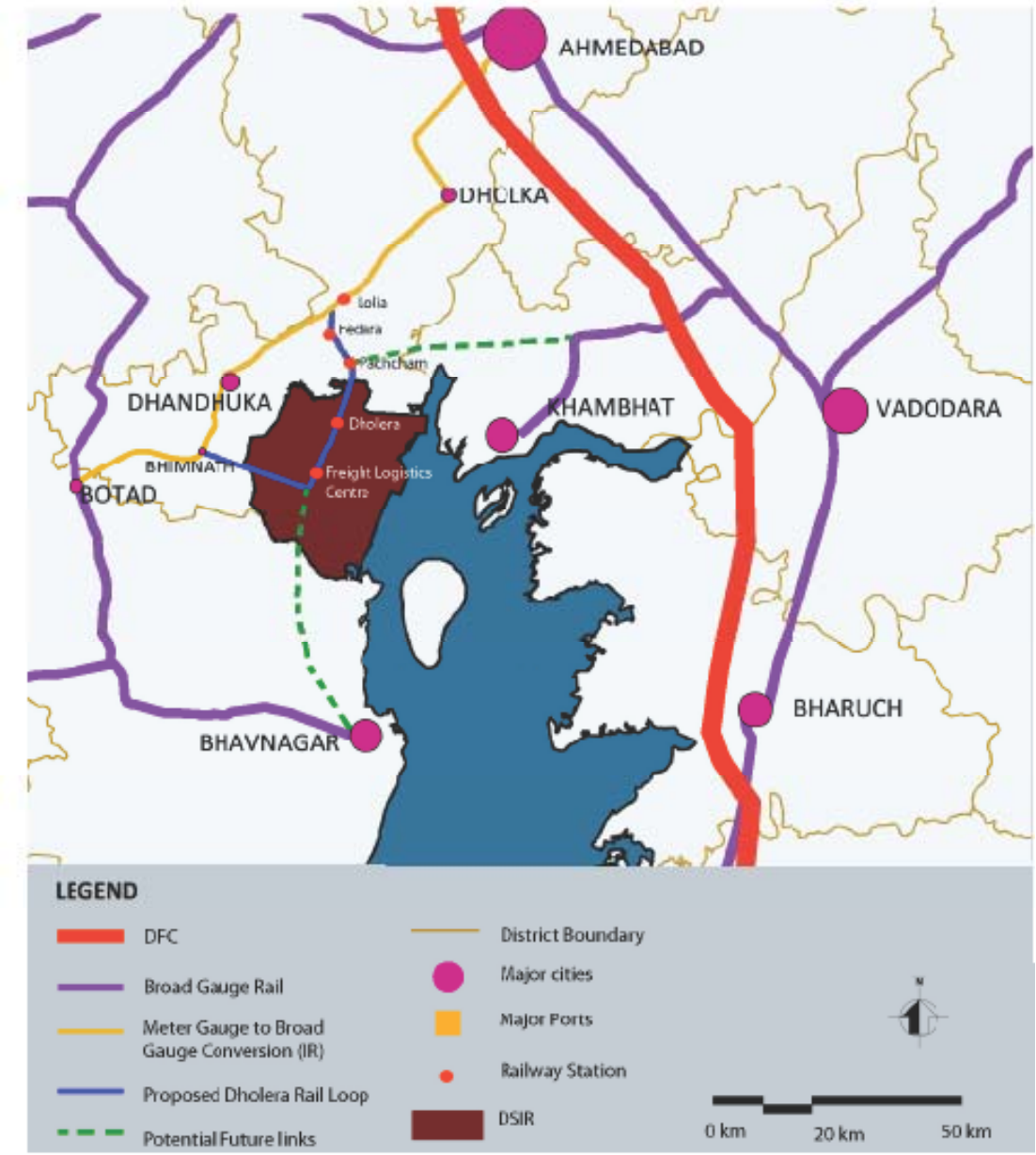


Figure 6-1: Proposed Rail Network

6.4. An Integrated Transport Strategy for the City

A multi-modal transport strategy for DSIR is proposed covering both public and private transport. This requires a good system of roads, footpaths and cycle-tracks, and a range of public transport systems that are matched to the level of demands.

6.4.1. The Road System

All planned roads in DSIR are classified in order that the network will work efficiently. Classification is based on the avoidance of conflict, by separating roads serving different purposes from each other and from non road uses. This consideration is not only to do with the functional efficiency of traffic flow, but also to ensure the safety, amenity and environmental quality of urban areas. The adoption of a hierarchy allows consistent decisions to be taken about the design and management of a road or street along its length. The classification is based on priority of the different modes and purposes such as freight movement, daily commuting for workers, leisure trips and so on. The division of function can boost efficiency of the system along with ensuring safety for all users involved.

Arterial roads are planned to be associated with strategic routes, heavier traffic flows, higher design speeds, with limited access to minor roads with frontage access. Collector and local roads are planned to be associated with more lightly trafficked, local routes, with lower design speeds and more frequent access points and with access to building frontages.

The spatial Draft Development plan is based upon a grid iron pattern and the transport network has been planned such that the roads form a perpendicular junction giving each sector ease of access as well as division into streets and areas. The internal road hierarchy and widths are based upon the trip forecasts.

6.4.2. Road Hierarchy

Categories and hierarchy of roads with their key design features is indicated in the Table 6.5 (See page 70). The system comprises five classes of roads, as illustrated in Figure 6.2:

- Expressway;
- Industrial Priority Arterial roads;
- Arterial roads;
- Collector roads;
- Priority Truck Collector Roads and
- Local roads.

The road right-of-way for each category is described below with illustrative views and cross-sections. These have been designed in line with the international best practices for major planned developments elsewhere throughout the world.

Figure 6.3 (see page 71) illustrates a sample sector, with its internal local roads and their connectivity with the strategic roads.

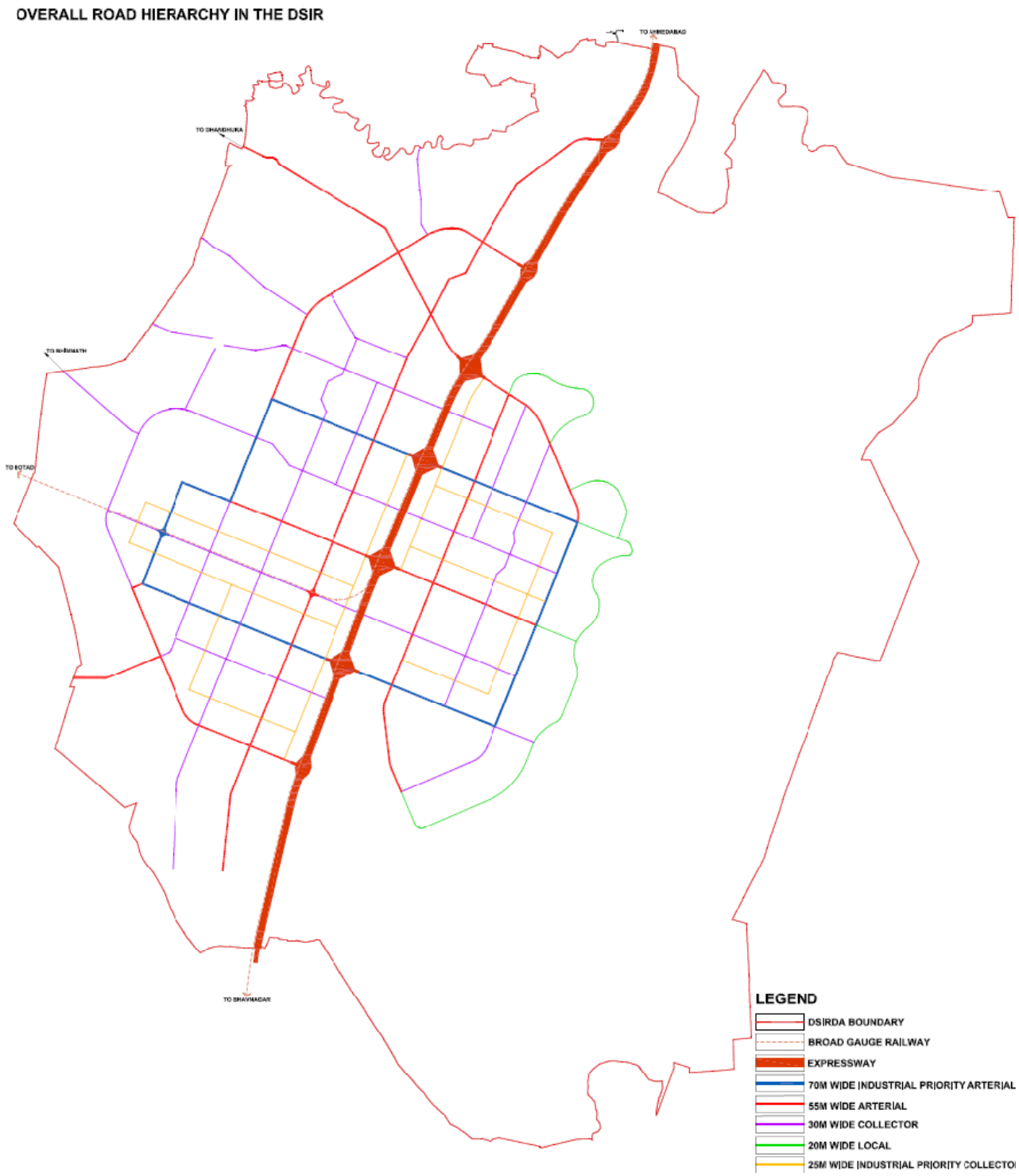


Figure 6-2: Overall Road Hierarchy in the DSIR

Table 6-5: Proposed Road Categories and Key Design Features

ROAD CATEGORY	RIGHT OF WAY	DESIGN SPEED	DESIGN CAPACITY (PCU/PEAK HOUR)	NUMBER OF LANES	LANE WIDTH	CARRIAGE-WAY	LEVEL OF VEHICULAR ACCESS	LENGTH OF ROADS (IN KM)
Expressway Corridor	250m (100m road)	120	6000	6	3.75	2 way, divided	No frontage access, cross traffic only through grade separated interchanges, no standing vehicles	36.182km
Industrial Priority Arterial roads	70m	80	5400	6	3.75	2 way, divided	Limited frontage access, no standing vehicles, minimum cross traffic	43.717 km
Arterial roads	55m	80	5400	6	3.5	2 way, divided	Limited frontage access, no standing vehicles, minimum cross traffic	99.660 km
Collector Roads	30m	50	2900	4	3.5	2 way, divided	Free frontage access, no parked vehicles for type 1, parked vehicles for type 2, heavy cross traffic	116.01 km
Priority Truck Collector Roads	25m	40	1800	4	3.5	2 way, divided	Free frontage access, parked vehicles, heavy cross traffic	65.475 km
Local Roads**	20m	30	1800	4	3.5	2 way, un-divided	Free frontage access, parked vehicles, light cross traffic	29.574 km

**Sub-arterial category has not been assigned to any road in the current plan. Based upon need, it they may be assigned in future.*
***Additional local roads can be designed as per need during the detailed planning stage for individual areas*

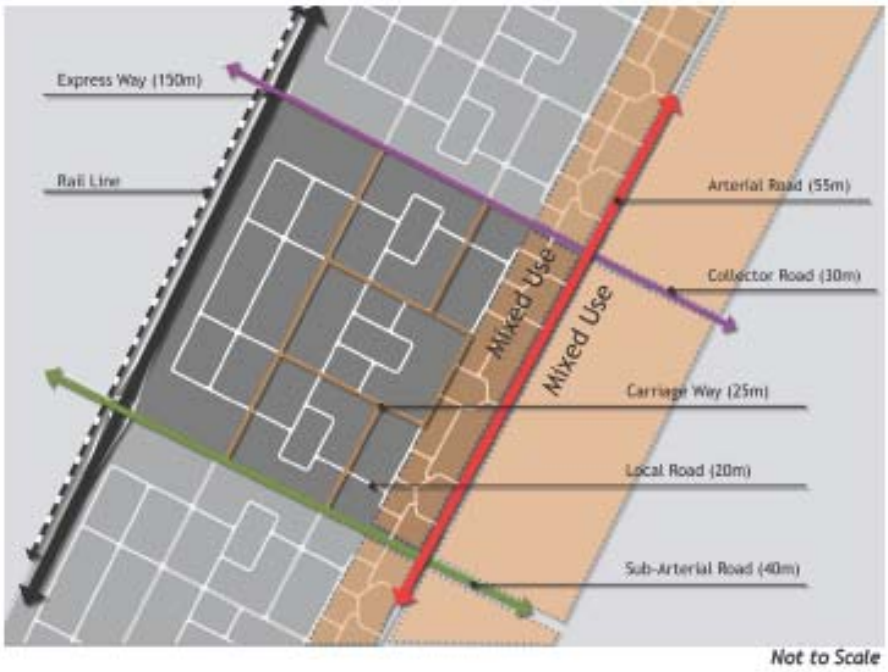


Figure 6-3: Internal Roads within Sectors and the Connectivity with the Strategic Roads

6.5. Description of Road Categories

6.5.1. Expressway

Expressways are the highest class of roads and have full control of access onto them. They are used for long distance travel at a high speed. DSIR sits astride the main highway route linking the DMIC via Ahmedabad and Vadodara to Bhavnagar and Pipavav port. This road is planned to be upgraded to expressway standard as part of the DSIR project. Access to and from the Ahmedabad–Pipavav expressway is to be provided only through grade-separated interchanges or left on, left off, slip roads. Access to land uses to the east of the expressway is not allowed for the entire length of DSIR in order to ensure that there is no conflict between through and local traffic. A service road is not provided because it is intended that all plots adjoining the expressway from the east will have their access through the network of industrial roads in the city. A right of way for a railway line separates the expressway from the plots to the west, so there will be no access to these plots from the expressway on this side as well. The expressway through DSIR will therefore be similar in character to the existing Ahmedabad – Vadodara expressway. By not providing service roads, the width of the right of way containing the expressway will be significantly reduced, thus saving bridging costs.

The proposed road cross-section of the expressway is for a dual carriageway highway with an overall RoW of 250m. This will be capable of accommodating a maximum of ten lanes, if such provision were ever to be required. The initial configuration will be two lanes in each direction, each lane width being 3.75m with a hard shoulder of 2.5m on either side. One additional lane in either direction would be provided at a later stage by reducing the width of the central median from 6m to 2m. If required, additional lanes in either direction could be achieved by converting the hard shoulder into additional carriageways. A design speed of 120 km/hr is proposed for the expressway.

A RoW of 50m is reserved next to expressway for a twin track broad gauge railway line. The rail line and expressway would thus share a combined right of way as the 'Central Transport Corridor' of 250m ROW.

Seven junctions are proposed on the portion of the expressway within the DSIR, each being about 4 kms apart. The inner four junctions will be four way junctions, with slips roads leaving the main road and over-bridges being provided to take traffic into special investment region. The outer northern junction and the outer southern junction will be more limited, with left in and left out movements.

Figure 6-4: Illustrative View - Central Transport Corridor

The first junction to be constructed will be at Dholera, so as to act as a gateway to DSIR. This junction will allow traffic from Dhanduka to cross over the expressway and enter that part of the new city to the east of the expressway. In addition, two grade separated junctions may be required on the junction of rail and arterial roads to the west of the expressway when traffic levels justify their provision.

Figures 6.4 and 6.5 illustrate a view and cross section of the Central Transport Corridor respectively

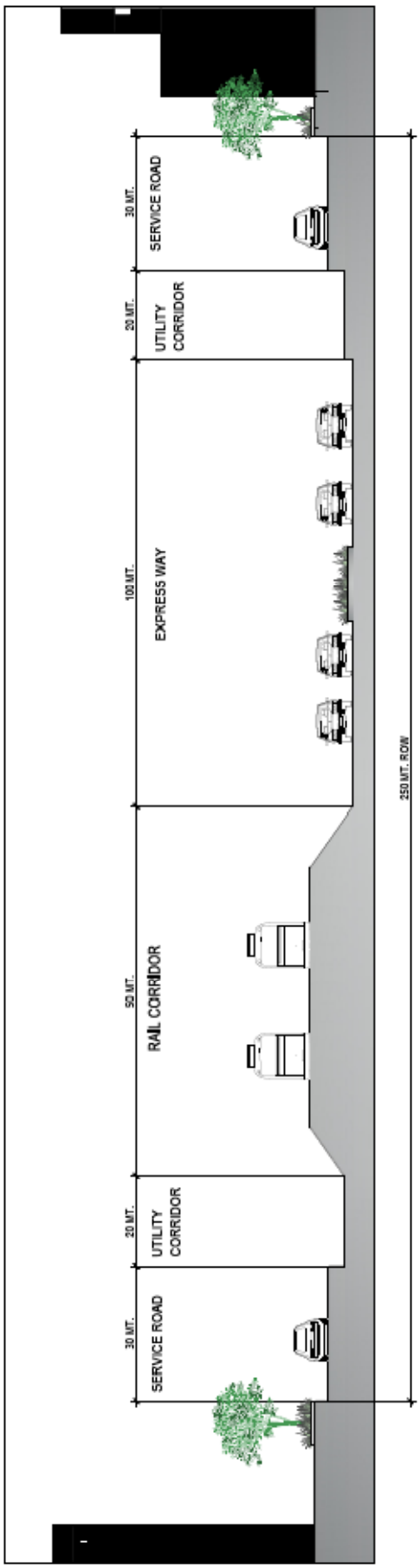


Figure 6-5: Road Cross Section - Central Transport Corridor

6.5.2. Industrial Priority Arterial Roads

Industry Priority Arterial roads are provided for the efficient movement of industrial traffic from industrial zones to the expressway. They are dual carriage-way roads that will facilitate the movement of high truck traffic volumes to the expressway. The 70m wide corridor allows for a provision of a transit lane within the RoW. This would aid the movement of industrial workers to their job locations.

Figure 6.6 shows a view and 6.7 illustrates a cross section of the Industry Priority Arterial. A portion of the planting strip on either side of the road may be utilised as an additional lane if expansion of this corridor is required in the future.

Figure 6-6: Illustrative View - Industrial Priority Arterial Road

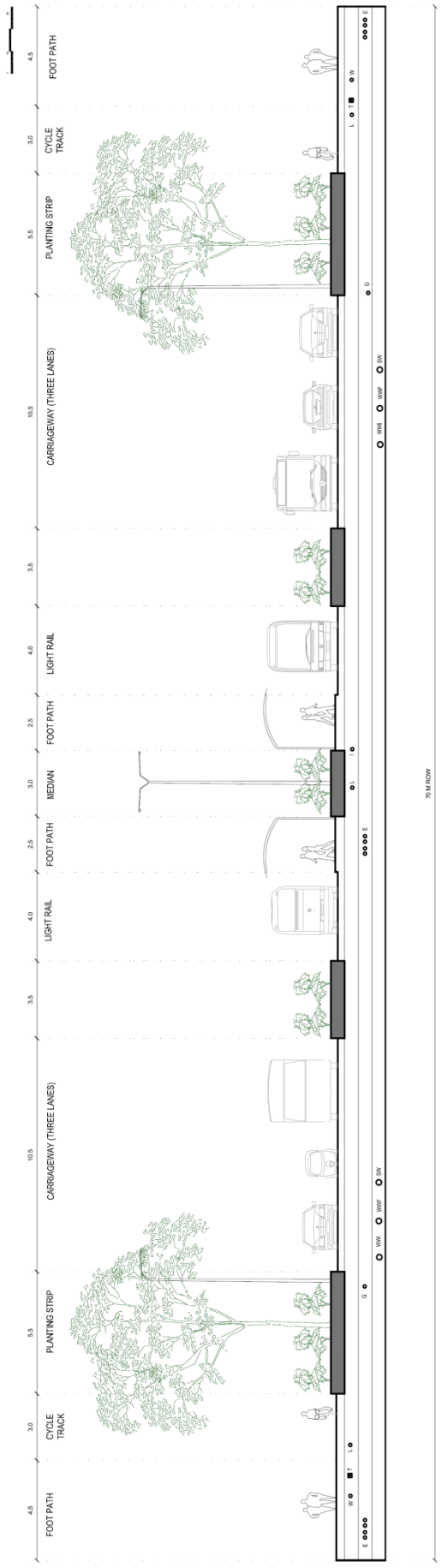


Figure 6-7: Road Cross Section - Industrial Priority Arterial Road

6.5.3. Arterial Roads

Arterial roads are provided for the efficient movement of traffic within the city and have a right of way of 55m. They are dual carriageway roads that will facilitate the movement of high traffic volumes and provide links between different districts within the city. Traffic signals or roundabout will be provided at the intersections of these roads with collector roads.

Access to land uses on one or both sides of the arterial roads can be provided through a service road in order to separate the low-speed local traffic from the higher speed traffic. On certain arterial roads there will also be provision for public transport. This would normally be on the same side of the road as the mixed commercial/residential areas. Where the arterial road is provided with a street tram, there will be no service road on that side of the street – the tram will in effect, run on the space reserved for the service road.

Figure 6-8: Illustrative View - Arterial Road

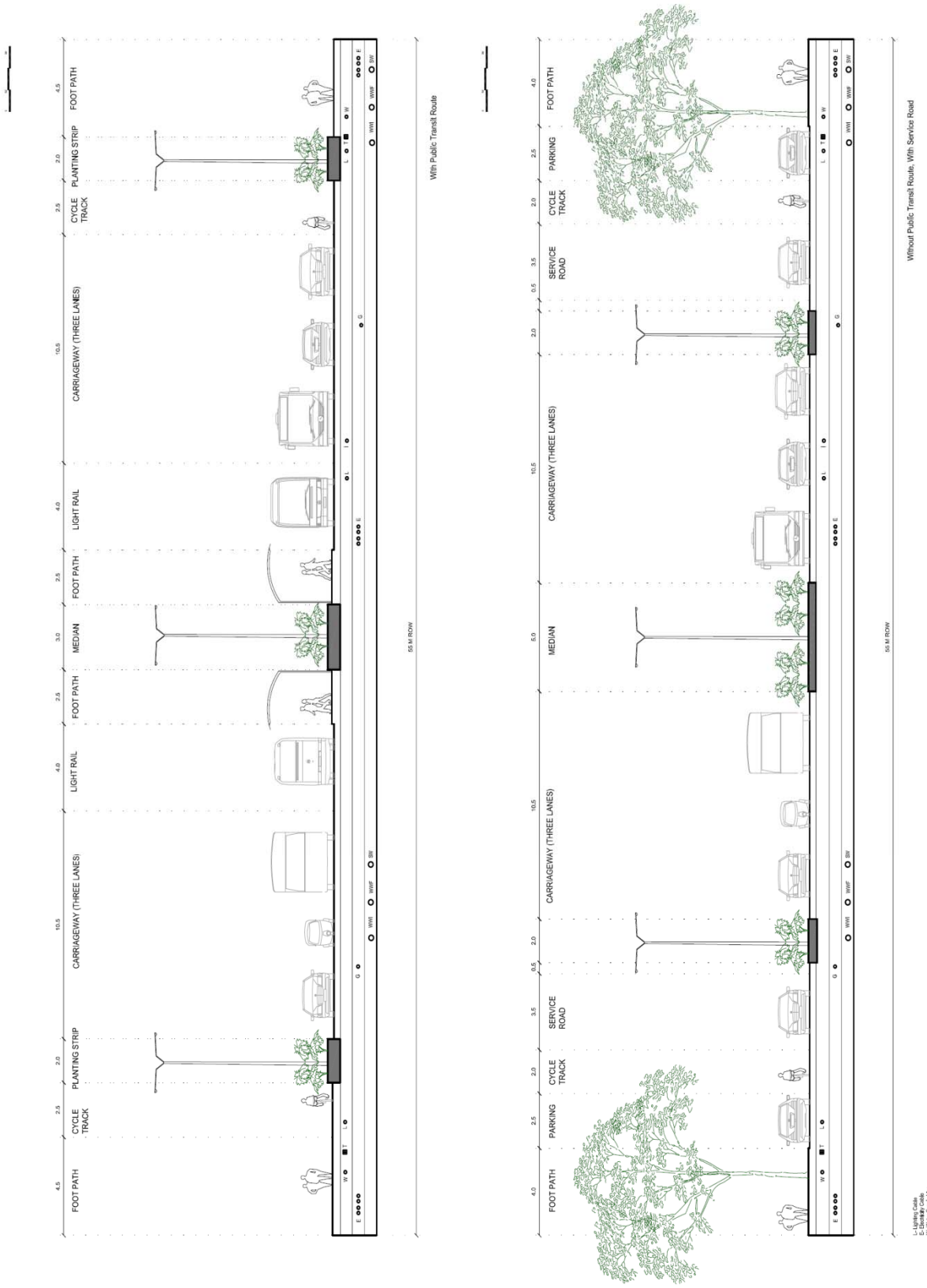


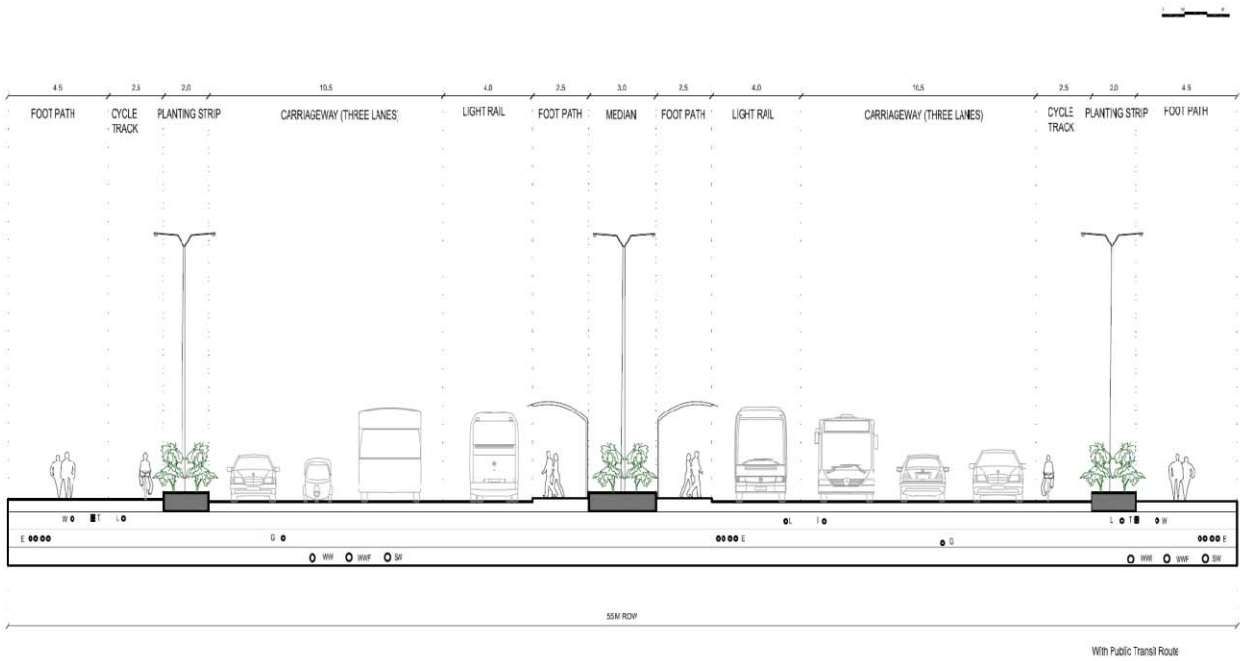
Figure 6-9: Road Cross Section - Arterial Road

6.5.4. Collector Roads

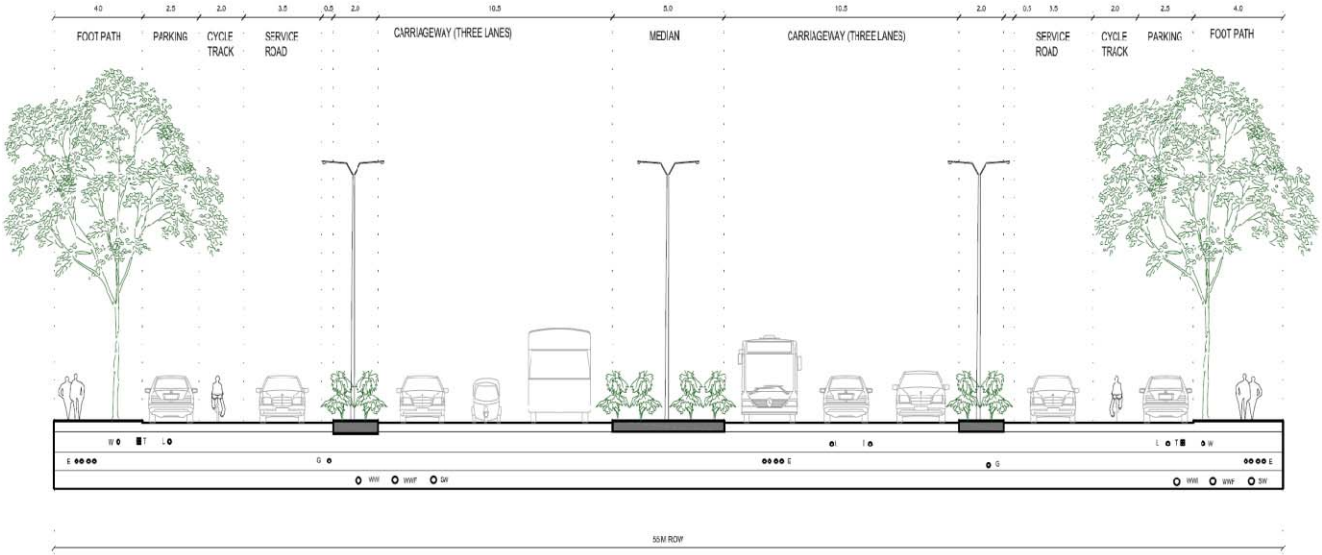
The collector road network intercepts traffic from inside the city districts and feed it into the arterial roads. All these roads are non-continuous since their primary function is the service of districts and their design is to connect with local roads.

The proposed cross section of these collector roads requires a right-of-way of 30m, which comprises a divided dual 2-lane carriageway with a lane width of 3.5m and separate cycle-tracks and pedestrian footpaths and a narrow median.

Figure 6-10: Illustrative View - Collector Road



With Public Transit Route



Without Public Transit Route, With Service Road

Figure 6-11: Road Cross Section – Collector Roads

6.5.5. Truck Priority Collector Roads

Within the Industrial Zone, the 25m wide collector roads would be truck priority routes. These routes originate from the Expressway and are designed to prioritise heavy truck traffic with larger and heavier loads. Feeding into the truck priority routes are the 20m wide local roads which have been planned in the form of loops so as to restrict the movement of the trucks within the Industrial Park extents.

Roads with restricted truck access indicate priority routes for all light traffic (with a limited access for the service trucks during non-peak hours of the day). These routes are intended to provide safe access of the passenger traffic to the mixed use residential areas and also the village settlements.

This Figure 6.12 illustrates a view of Collector Road and Figure 6.13 illustrates the cross-section for the Truck Priority Collector roads. Local roads within the industrial park are also designed with heavy traffic in mind and cul-de-sacs have been avoided in the network.

Figure 6-12: Illustrative View - Internal Collector Road

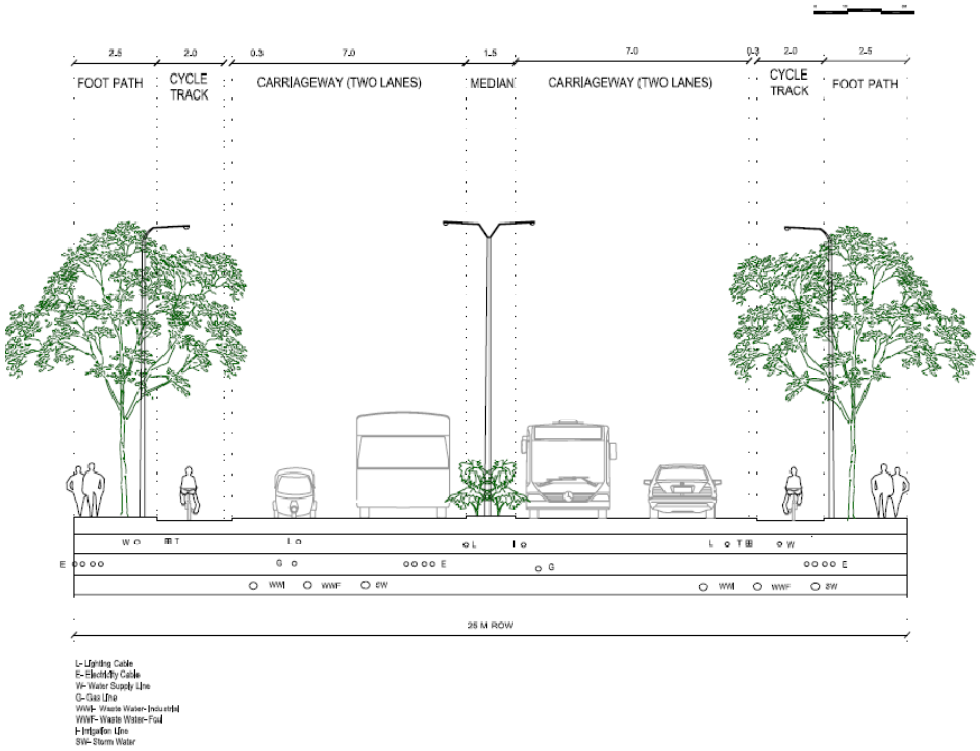


Figure 6-13: Cross Section - Internal Collector Road

6.5.6. Local Roads

Local roads provide services at the destination of the vehicular trips. They are the lowest classification of the city road hierarchy and will have low traffic volumes. The proposed right-of-way is 20m. Local roads are a single 2-lane carriageway with a lane width 3.65m, provided with parallel on-street parking on each side of the road.

Figure 6.14 illustrates the view and Figure 6.15 illustrates the cross section of a local road.

Figure 6-14: Illustrative View - Local Road

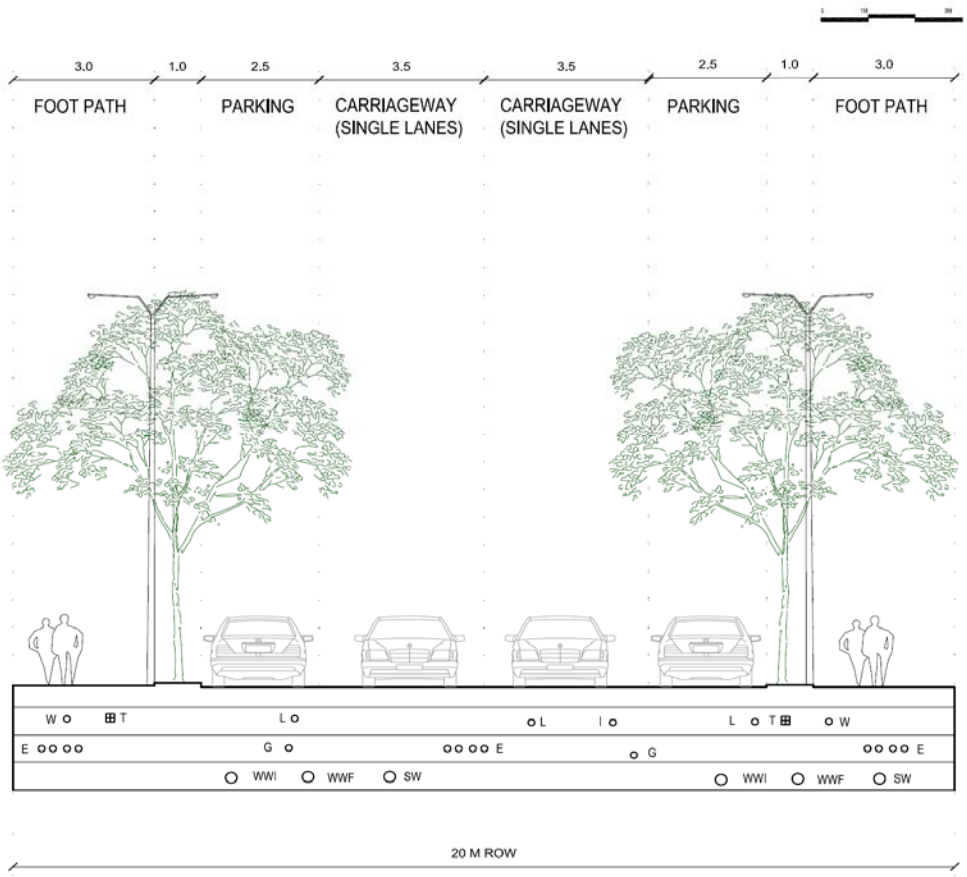


Figure 6-15: Road Cross Section - Local Road

6.6. Road Junctions

Road junctions in Dholera SIR are planned in such a way that vehicular traffic going in different directions can proceed in a controlled manner to minimize accidents. In some cases, vehicles can change between different routes or directions of travel.

Mainly two kinds of junctions are planned in DSIR:

- Intersections which do not use grade separation (they are at-grade) and roads are crossing directly. Forms of these junction types include roundabouts and traffic circles, priority junctions, and junctions controlled by traffic lights or signals;
- Grade separated interchanges, where roads pass above or below one another, preventing a single point of conflict by utilising grade separation and slip roads. The term Expressway Interchange is typically referred to this layout in case of DSIR.

The traffic at most of the junctions will be controlled by either using grade separators or traffic signals. The main four central junctions on the expressway and two junctions close to the railway in the west will be grade-separated (See Figure 6.16).

The signalized intersections are planned on arterial and sub arterial roads where the traffic volume (above approximately 100 to 1200 vehicles per hour) will warrant traffic signal to ensure the safe crossing of vehicles and pedestrians. Figure 6.16 indicates locations of junctions within the road network and Figures 6.17 to 6.19 illustrate the broad circulation concept of major junction types.

6.6.1. Junction Capacities

Adequate roadway capacity at any junction is desirable. Widening of both the highway and intersecting roadway may be warranted to reduce the delays caused by intersections controlled by traffic signals. Widening of intersecting roadway is often beneficial to operation of main highway because it reduces the signal time that must be assigned to side street traffic. In urban areas the effect of widening can be achieved by elimination of parking at intersectional approaches. It is desirable to have at least two lanes for moving traffic on each approach to a signalised intersection. Additional width may be necessary on the leaving side of the intersection as well as on the approach side, in order to clear traffic through the intersection effectively. A traffic signal will need to be provided if warranted by minimum vehicular volume or interruption of continuous traffic or minimum pedestrian volume. Minimum vehicles of 800 per hour in case of major streets and 1200 vehicles per hour for interruption of continuous traffic are the warrants for provision of traffic signals (Source: IRC 106:1990).

The capacity of interchanges is increased with proper planning of all the components of interchange. It starts with speed change lanes, tapers and islands. Free flow type ramp terminals are planned in DSIR for the Expressway where ramp traffic merges with entrance terminal or diverges from exit terminal.

6.6.2. Minimising Traffic Conflict

Conflicts between different modes of transport will be minimised mainly by the road hierarchy. The local roads will provide access to adjoining properties and most of the trips originate or terminate from these roads. These local roads will allow unrestricted parking and pedestrian movements. The collector roads will collect traffic from the local roads and feed to sub-arterial or arterial roads.

The sub-arterial roads are located in residential neighbourhoods, business or industrial areas. The arterial roads will carry mainly through traffic. Significant intra-urban traffic such as between the city centres and commercial nodes will be served by arterial roads. Arterial roads will also provide the only connection with the expressway and will collect and distribute through traffic and minimise conflict from sub-arterial and collector roads.

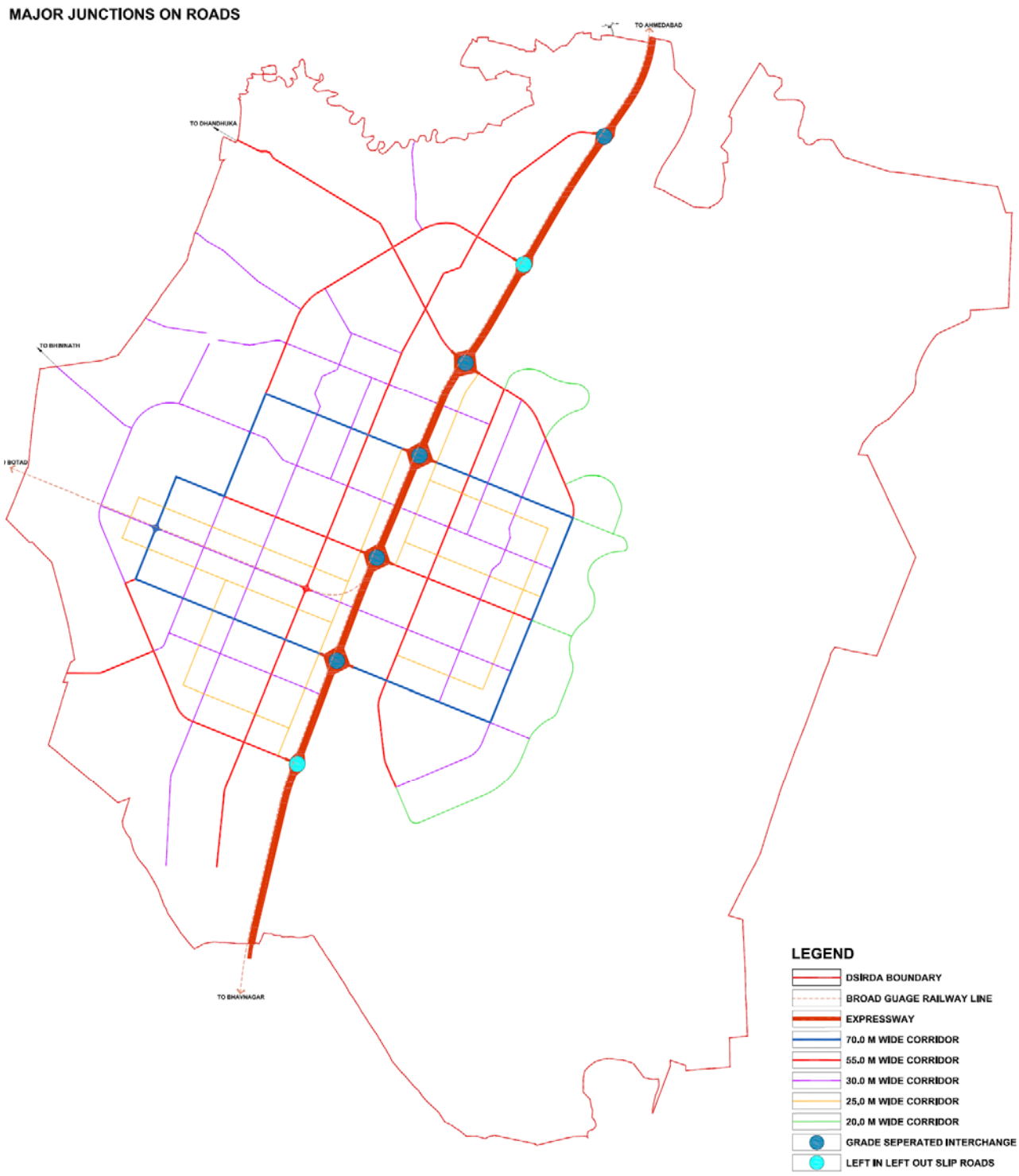


Figure 6-16: Major Junctions on Roads

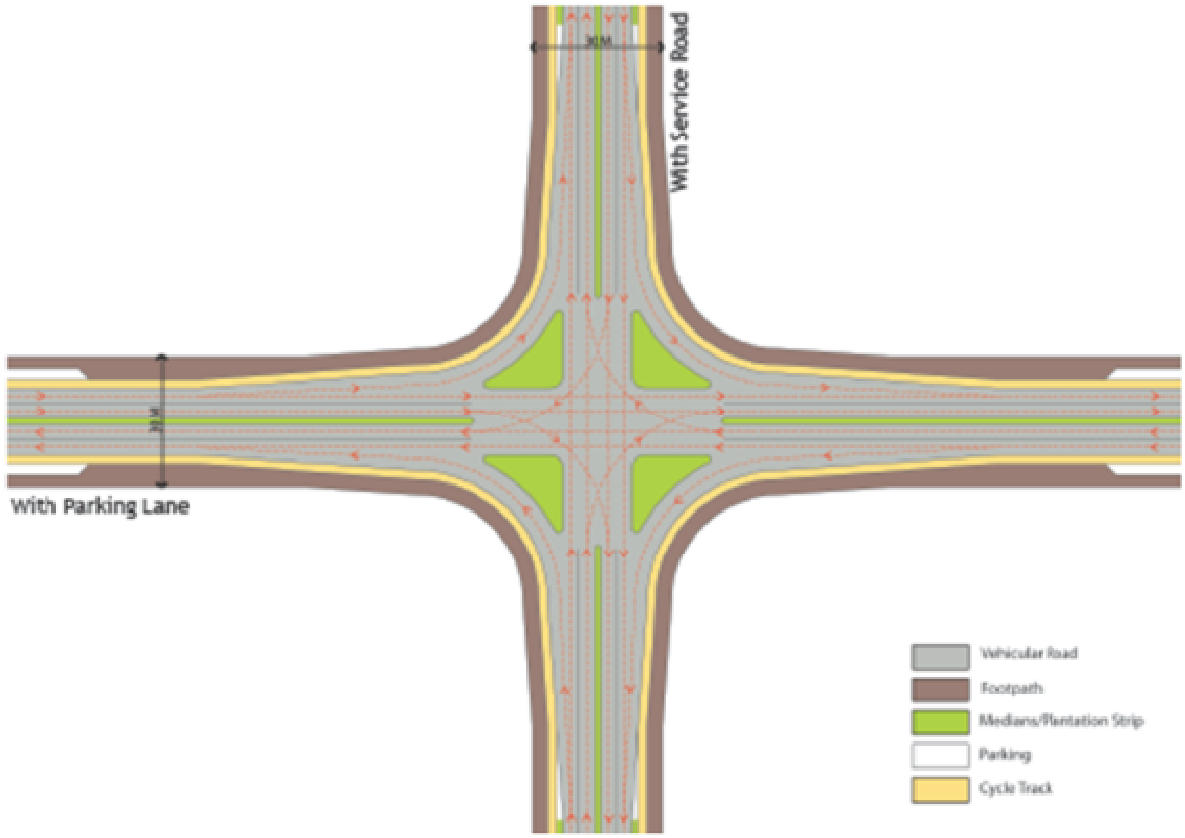


Figure 6-17: Junction on 30m Wide Collector Road

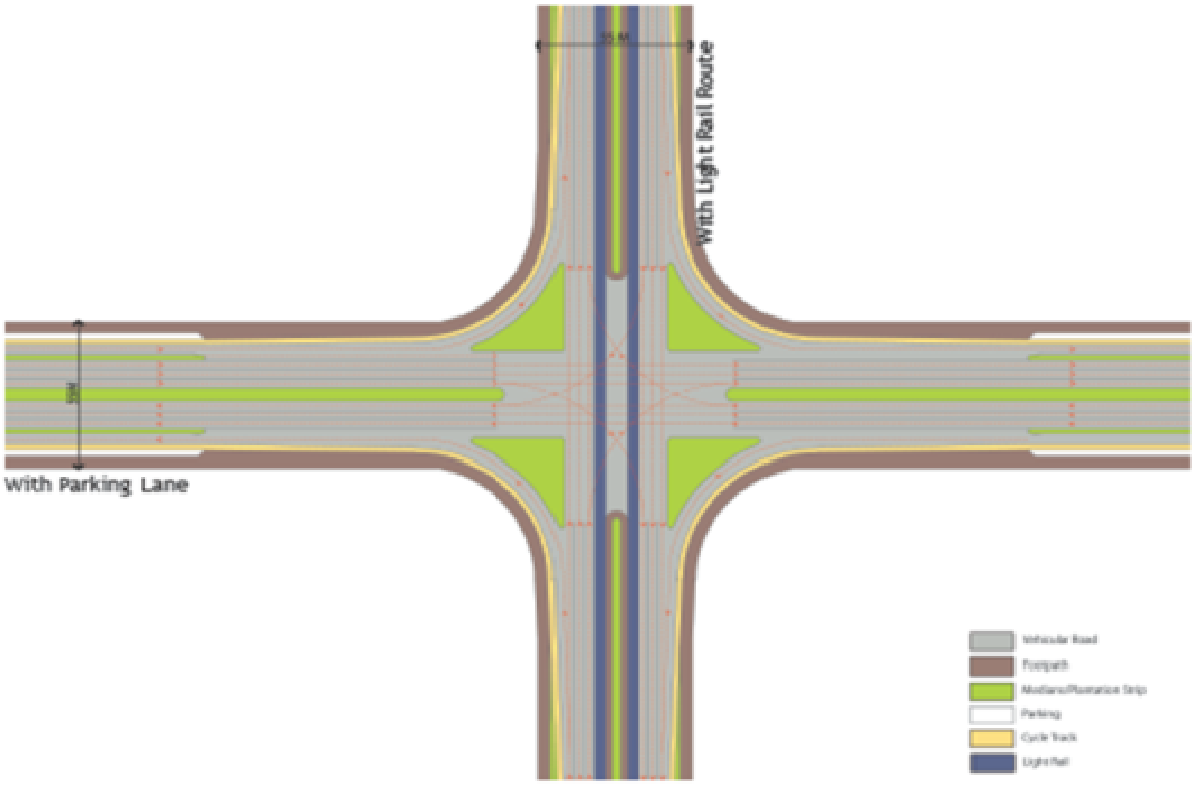


Figure 6-18: Junction on 55m Wide Arterial Road

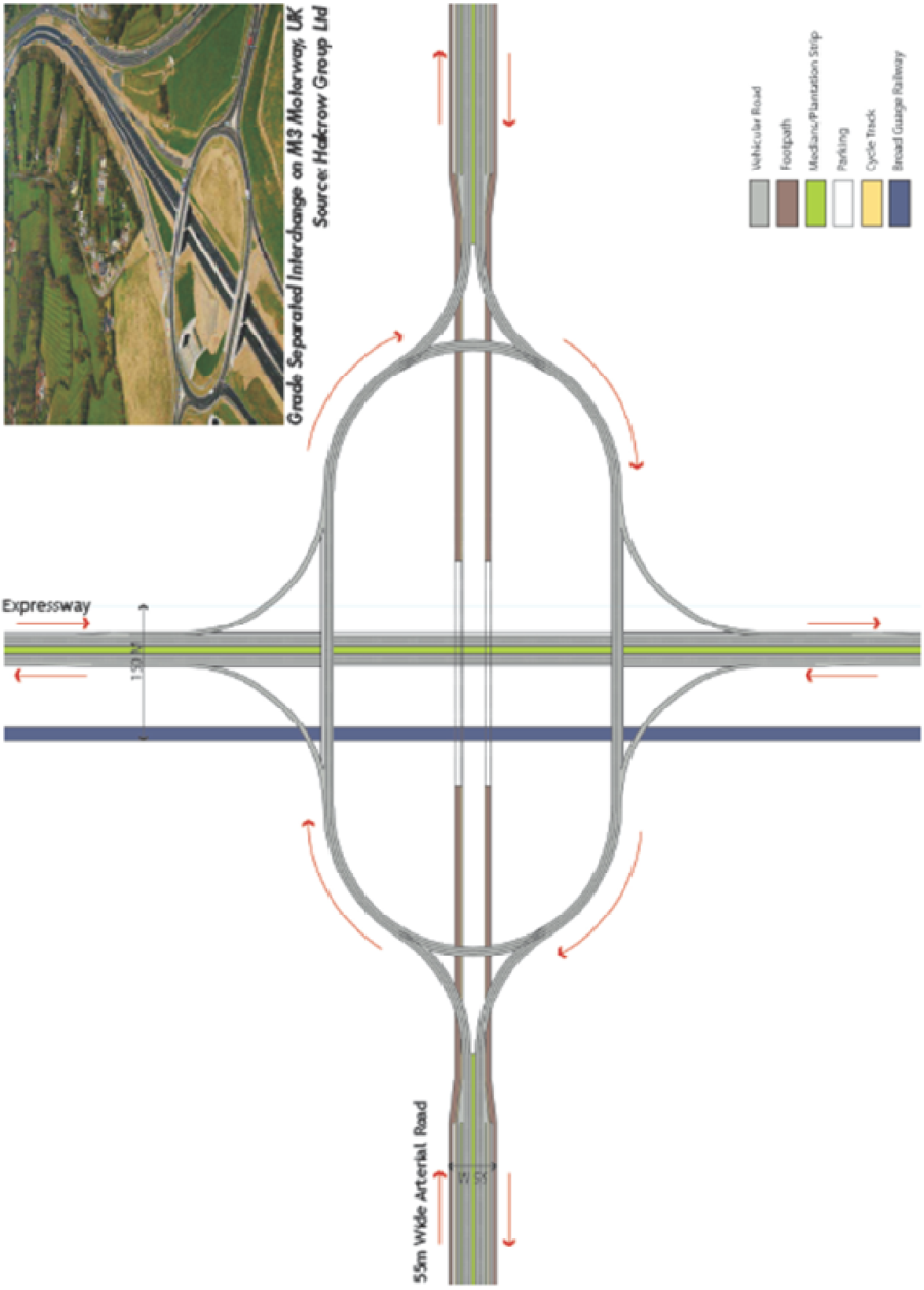


Figure 6-19: Grade Separated Junction on the 250 m Wide Central Transport Corridor (Expressway Corridor)

6.7. The Public Transport Strategy

The public transport for DSIR has been planned based on the estimated demand, matched to the most efficient way of meeting that demand. Demand is based upon estimates of peak hour passenger trips and passenger per hour peak direction, based on the population and employment forecasts as given in Table 6.6.

The mass transport systems will play a crucial role in connecting the DSIR to the surrounding region and urban centres from the initial stages of development. An integrated multi-modal system will be evolved with a mass transport system on arterial routes supplemented by feeder systems of buses on other routes.

Table 6-6: Trip Forecast

PHASE	PASSENGER PEAK HOUR PER DIRECTION (PPHPD)
Phase-I	9874
Phase-II	31353
Phase-III	43056

6.7.1. Transit Modes for Low Demand Corridors

Bus Mixed with other Road Traffic

Although buses, whether petrol, diesel or CNG driven, when mixed with other traffic tend to slow, they provide a very flexible public transport system that can be quickly introduced in any corridor without the need for significant investment in infrastructure. Buses will cater for low levels of demand up to about 2000 Peak Hour Peak Direction Traffic (PHPDT), which equates to 40 buses per hour, assuming a capacity of 50 persons per bus.

Bus Lanes

On corridors where the demand level exceeds the capacity of the buses operating in mixed traffic conditions, bus lanes will be introduced. Roads in these corridors have adequate width to accommodate these lanes. This will improve the travel speed and thus the carrying capacity of buses and the quality of service. The main requirement is a share in the road space marked exclusively for buses, together with preferential signalling at the road intersections. Depending upon the level of exclusivity provided, the capacity can be increased up to 10,000 PHPDT.

Buses and bus lanes are expected to remain as an important component of developing the mass transport system in DSIR before a higher capacity system is introduced. Even after this point, buses and bus lanes will act as a feeder system to the Light Rail Transit system.

6.7.2. Proposed Transit Modes for Medium Demand Corridors

The choice here is either a road based trolley bus system or a rail based tram or light rail transit (LRT). The capacity of all of these systems can be gradually increased as the demand grows by increasing the portions of the exclusive right of way and the length of the unit.

A trolley bus system is the least cost but lowest capacity option and the light rail transit the most costly but offers the highest capacity. At grade, a tram requires the equivalent width of 2 lanes while a bus-way requires 3 to 4 lanes of roadway. The capacity of a LRT is double to that of a standard bus and the life of the vehicle three times that of a bus.

The technology and operation of all of these modes is well developed so that reliable services can be provided for any of the three options.

6.7.3. Transit Modes for high demand level routes

Rapid Rail/Metro is preferred on a corridor only when the demand is expected to be beyond 25,000 PHPDT. To derive the full benefit from the high capacity metro rail, it is necessary to provide mass transport services on other corridors in the area to feed into the metro rail.

Rapid rail systems are usually based on the heavy-rail technology. These can be integrated with the inter-city rail network to provide a commuter rail option. Metros on the other hand, are lighter systems with smaller profiles and shorter coaches.

6.8. Choice of Mass Transport Mode for DSIR

In the first phase of development, a well run bus system will provide the lead time required to formulate and implement a higher capacity system. In the longer run, a trolley bus or rail based tram system are the alternative choices to complement the existing bus system in order to provide higher carrying capacity, faster, smoother and safer travel, as well as offering non-polluting and energy efficient systems. Choice of a street running tram would also be the preferred system over a metro because it is less costly but offers good capacity and convenience and a good public image. A trolley bus system would offer a less costly alternative to the tram.

The capacity of either system can be gradually increased as the demand grows by increasing the length and frequency of the trams or trolley buses.

The alignments of the main public transport corridors have a geometry that will involve right angled deflections which will necessitate the introduction of sharp curves with a radius of the order of 50m. A standard or metre gauge tram system commonly used overseas can easily cope with such curves. The system will function as a captive railway with no direct inter-connectivity with the proposed Indian Railways BG line other than a stop and transfer at the multi-modal passenger station located in the main city centre.

6.8.1. Description of Tram Routes

Any public transit system will be successful and commercially viable only if tied closely to the land use patterns. The high capacity tram network in DSIR is proposed to link the main residential parts of the city to each other, the commercial centres, and the main employment areas. The delineation of the transit route was conceived in tandem to the High Access Corridor land use category, which is planned as a high density residential and commercial service zone.

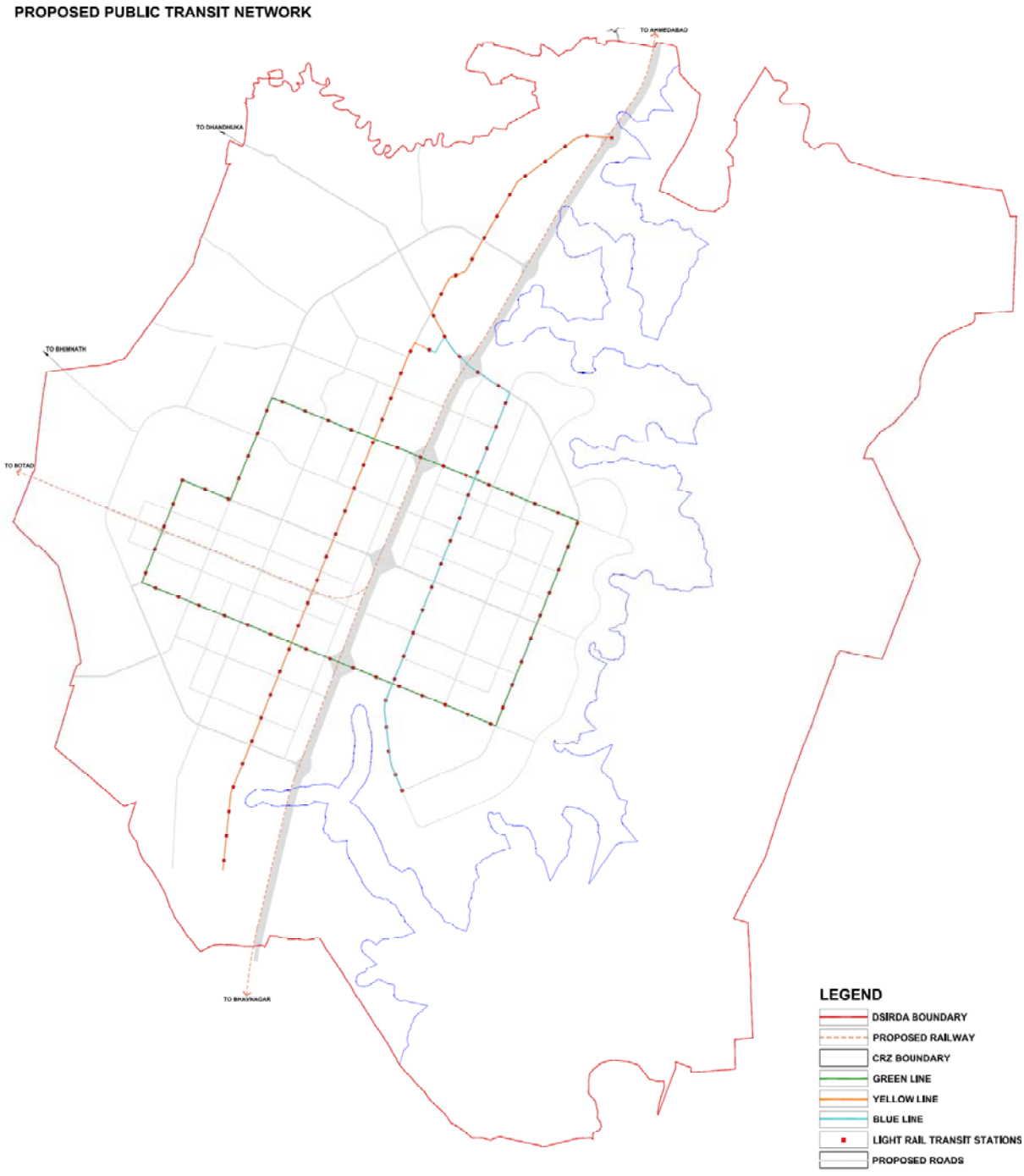
Once demand approaches viable levels in the city, three potential tram routes are proposed for study as follows:

- Blue Line: 20 km in length (22 stations)
- Green Line: 43 km in length (47 stations)
- Yellow: 32 km in length (36 stations)

The Green Line forms a loop along the proposed industrial and mixed land use areas and connects the west of the city to the east over the expressway. The Yellow Line will run on the western side of the DSIR north - south via the main CBD and railway and bus stations at Dholera. The Blue Line will start at the main CBD and rail and bus stations and run southwards through the industrial and residential areas of the DSIR on the eastern side of the expressway. All three LRT lines will interconnect with each other, thus providing a network of street running trams as shown in Figure 6.20.

The total length of the tram route is about 95 km with 105 stations on all three lines, with a few common stations at important junctions. The proposed tram routes are planned to maximise the number of potential passengers using the service and to ensure that the majority of the inhabitants of the new city will not have to walk far to access the rapid transit system. The average distance between the stations would be about 0.9 km.

Tram frequency will be based on the predicted passenger demand. Two car trams will have a total passenger carrying capacity of approximately 100-120 passengers. Passenger demands or usage generally fluctuate during the day and at weekends, so that services will be more intensive during peak periods and be reduced during off peak periods.



Note: Location of Transit stations are indicative

Figure 6-20: Proposed Public Transit Network

6.9. Integrated Multi-modal Transport System

One of the key features of the overall transport strategy is planning for non-motorised transport such as pedestrians and bicycles in order to provide options other than motorised private vehicles for the city residents.

Provision of a robust non-motorised transport network that is connected to the public transit stations would be critical for the overall success in promoting sustainable transportation options. All road categories therefore have designated sidewalks and bicycle tracks. On local roads and other minor roads, bicycles would ply in mixed traffic conditions. Figure 6.21 indicates the pedestrian and bicycle network, transit stations and open spaces.

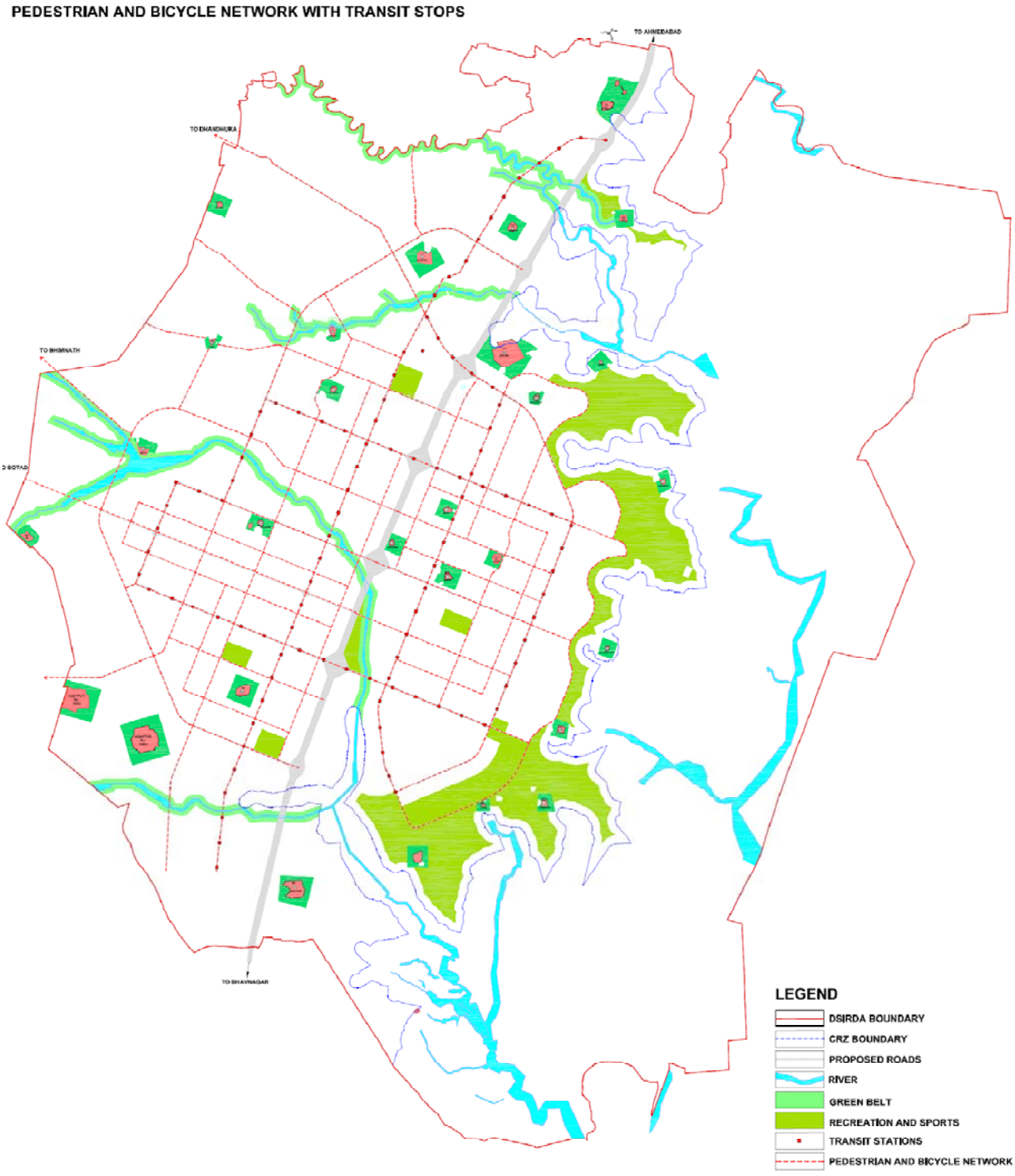


Figure 6-21: Pedestrian and Bicycle Network with Transit Stops

CHAPTER 7

UTILITIES

7. Utilities

7.1. Introduction

Industrialisation of the region and transition of lifestyles from rural to urban will require a massive expansion in the quantity and quality of utility services. At the same time, substantial efforts will need to be made to conserve resources such as water and recycle waste materials. These aspects have all been addressed in the conceptual planning of the infrastructure for DSIR and are described in this section under the following headings:

- Water supply source and distribution system;
- Wastewater system;
- Surface drainage system;
- Solid waste management system;
- Power supply transmission and distribution system;
- Telecommunication and
- Gas grid

7.2. Water Supply

7.2.1. Water Supply Options

Studies undertaken to evaluate options for the supply of water to the DSIR considered:

- The Narmada Canal;
- Pariyej Reservoir and Kaneval Reservoir;
- Development of reservoirs in and around the project area;
- Desalination of sea water;
- Ground Water and;
- The Kalpasar sweet water lake.

A summary of this evaluation study is given in Appendix G. The study concluded that tapping of the Narmada Canal should be considered as the prime source of water for DSIR. Development of water reservoirs in DSIR could also help supplement the supply of raw water but since the rivers are not perennial and remain dry for about 9 months of the year, it will always be necessary to connect and augment the water reservoirs from the tributary of the Narmada Canal.

The options of using the Pariyej Reservoir and Kaneval Reservoir was not considered viable on account of the waters already being allocated for other users. In case the same is made available by the Government it will be a very valuable source of potable water. Desalination may not be a viable long term option because of the high cost, especially since the DSIR is at a considerable distance from the open sea at low tide. However with new development in desalination technology and many creeks available in the area DSIR will be also explore the option. The use of ground water was also rejected on cost and also because of the likely poor quality of ground water.

In the longer term, if and when the Kalpasar dam is constructed, it would provide an alternative water supply for DSIRDA.

Since water is scarce in the area, it is proposed to recycle the treated sewage through biological treatment. This water will be used for the irrigation of land and gardens, parks and farmland in order to reduce pure water demand.

7.2.2. Estimated Water Demand

Development within the project area will be commensurate with the standards laid down for the Gujarat water supply system and the Manual on Water Supply and Treatment by Ministry of Urban Development,

New Delhi, the Manual on Sewerage and Sewage treatment by Ministry of Urban Development, New Delhi, the National Building Code (NBC), 1983 and the Handbook on water supply and drainage SP: 35 (S&T) -1987 by the Bureau of Indian Standards.

Based on proposed land uses, water demand has been assessed and is summarised in Table 7.1, based upon the following assumptions:

- 150 litres per capita per day (lpcd) for low and medium density housing:
- 140 lpcd for high density housing and villages;
- 40 lpcd for the commercial population;
- 45 lpcd for the floating population;
- 45 kilo litres per ha for Industrial use;
- 67 kilo litres per ha for irrigation use (to be met from treated sewage water);
- Losses - 15%, fire demand as 1% of water demand

The quality of treated water shall meet the standard set out in the manual on "Water Supply and Treatment" based on the Central Public Health and Environmental Engineering Organisation (CPHEEO).

Table 7-1: Estimated Total Water Demand for DSIR

CATEGORY	WATER DEMAND			
	PHASE 1	PHASE 2	PHASE 3	TOTAL
Residential (Target residents: 2 million)	74	145	79	298
Floating Population	2	4	2	8
Existing Village Settlements and Village Buffers	3	1	0.4	4
Industrial and Logistics	140	231	120	491
Leisure and Entertainment	4	7	4	15
Total Potable Water Demand	223	388	205	816
Fire demand @1%	2	4	2	8
Fresh Water Demand	225	391	207	824
Losses @ 15%	34	59	31	123
Gross Demand	259	450	238	947

7.2.3. Proposed Water Supply Schemes

The water supply scheme for DSIR has been planned on 60% availability. Two treatment plants will be provided at two different locations. Their location is determined by the topography of the DSIR in order to exploit the available natural slope, the availability of water and the proposed phasing plan.

One treatment plant will be located near Ottariya village for Phase 1 and Phase 2 development and the other treatment plant is proposed near Hebatpur village for Phase 2 and Phase 3 developments. The treatment plants will be constructed in a modular manner to meet the proposed phasing pattern. The treated water in the treatment plant shall be stored in clear water storage tanks near the treatment plants.

The total land requirement for the two treatment plants will be about 30 ha, including 1.5 days capacity of treated water storage tanks. 24 water works sites are planned at the sector levels, Land requirement for

each of the 24 water works site planned at the sector level will be 0.50 ha. Figure 7.1 illustrates the location of these strategic water supply infrastructure facilities in the DSIR.

In case of recycled water being supplied by DSIR, a separate network will be constructed for the same.

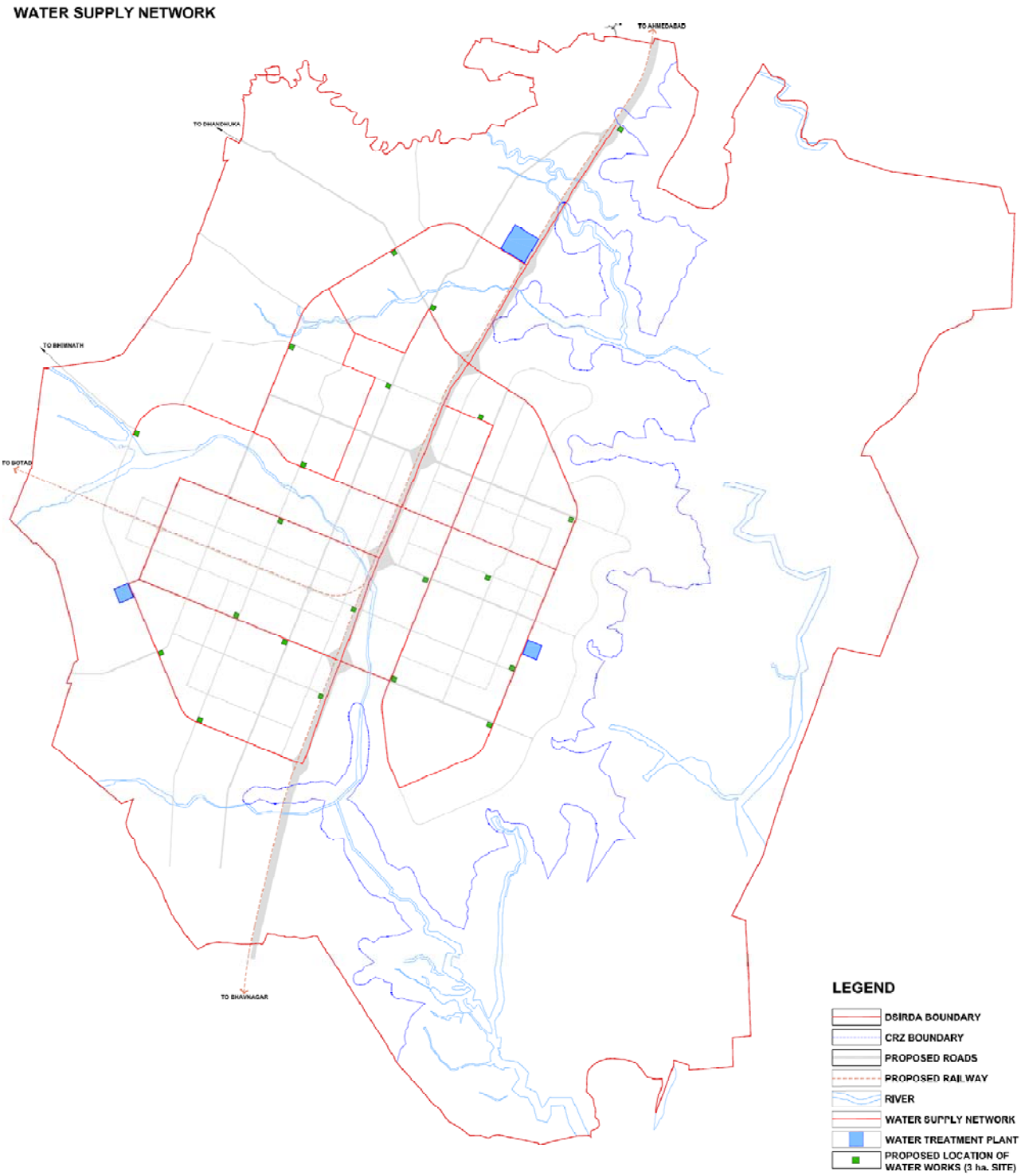


Figure 7-1: Water Supply Network

7.3. Waste Water Management System

Wastewater generated in the DSIR will be treated at sewage treatment plants (STPs) and common effluent treatment plant (CETPs) to a standard that enables it to be recycled for the irrigation of agricultural land, parks and gardens, green spaces, forests and industrial use. The balance treated water would be transported and then disposed off in to the natural stream or water bodies.

The sewerage network is planned to collect the waste water from the farthest areas and transport it to the treatment plants either by gravity or by pumping. The sewage flow has been based upon a 80% return factor of the water supply. The DSIR has been divided in to a number of sewerage zones as shown in Figure 7.2 (page 95), based on the best utilisation of topography, natural boundaries and highways, economics of operation and maintenance.

The sewerage system comprises the following components:

A main collection system at parcel level to receive wastewater at the outlet point of parcels of land. An internal system of the land parcel will be planned and executed by the developer or owner;

1) Trunk sewers collecting sewage from several areas and conveying it to the STPs/CETP;
2) Sewage pumping stations to transport sewage to trunk mains or treatment plants;
3) Sewage and common effluent treatment plant (STP/CETPs);
4) Irrigation network to reuse the treated waste water for irrigation or industrial purposes
5) Outfall drains to transport treated effluent to the final disposal point;

The total waste water to be generated in the DSIR is presented in Table 7.2.

Table 7-2: Waste Water generation in SIR

CATEGORY	PHASE 1 (MLD)	PHASE 2 (MLD)	PHASE 3 (MLD)	TOTAL
Residential Population (Target residents: 2 million)	59	116	63	238
Floating Population	1	3	2	6
Existing villages within site with buffers	2	1	0.3	3
Industrial and Logistics	112	185	96	393
Leisure and Entertainment	3	6	3	12
Total Waste Water Generation	177	311	164.3	652
Residential Population (Target residents: 2 million)	59	116	63	238

7.3.1. Sewerage Treatment Scheme

Four STPs and four CETPs have been planned at different locations of the DSIR to treat waste water generated from the different user groups at decentralized locations so as to best utilise the treated effluent. Since DSIR is to be developed in three stages, collection and treatment system can be designed in modules to assure its effective utilisation.

Extended aeration technology for waste water treatment is a popular conventional technology in India and provides for a good quality treatment and this is proposed as the most suitable method for DSIR.

The catchment areas for each STP and CETP are shown in Figure 7.2. Proposed locations of treatment plants & pumping stations with the sewerage network is shown in the Figure 7.3. The capacity of the treatment plants and the land area required for their construction has been shown in the Table 7.3.

A number of intermediate sewage pumping stations will be required to boost the wastewater flows because of the topography of the area and the high water table. Each intermediate pumping station would require about 0.5 ha of land.

Table 7-3: Capacity of Treatment Plants and Land Requirement

TREATMENT PLANT	TOTAL CAPACITY (MLD)	CAPACITY			LAND REQUIREMENT (HA)
		PHASE- 1	PHASE-2	PHASE-3	
STP-A	15	-	15	-	3
STP-B	71	10	61	-	13
STP-C	60	60	-	-	10
STP-D	71	10	51	10	13
CETP-1	82	82	-	-	14
CETP-2	114	-	64	50	20
CETP-3	95	-	40	55	16
CETP-4	144	45	70	29	25
Total	652	207	301	144	114

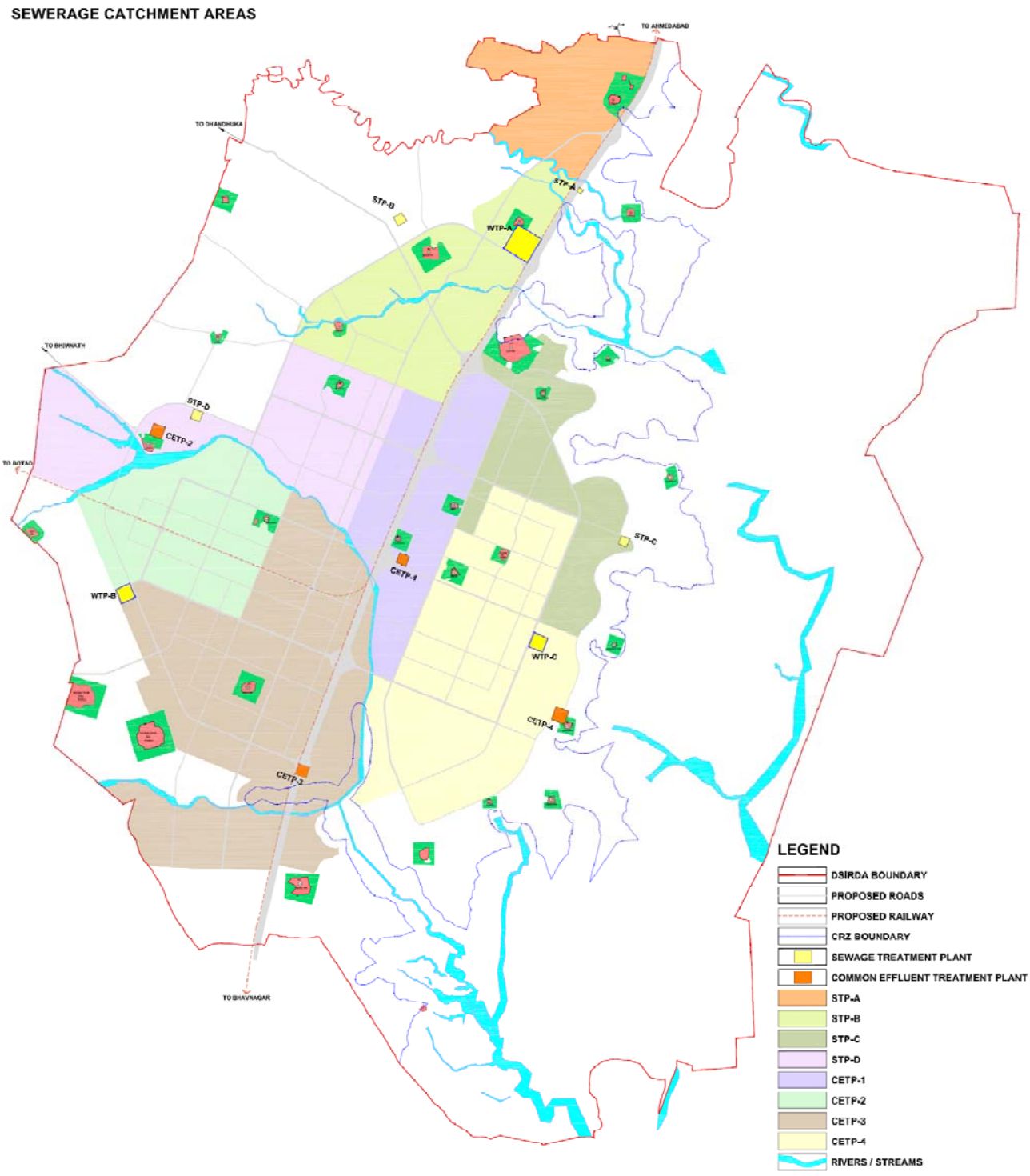


Figure 7-2: Sewerage Catchment Area

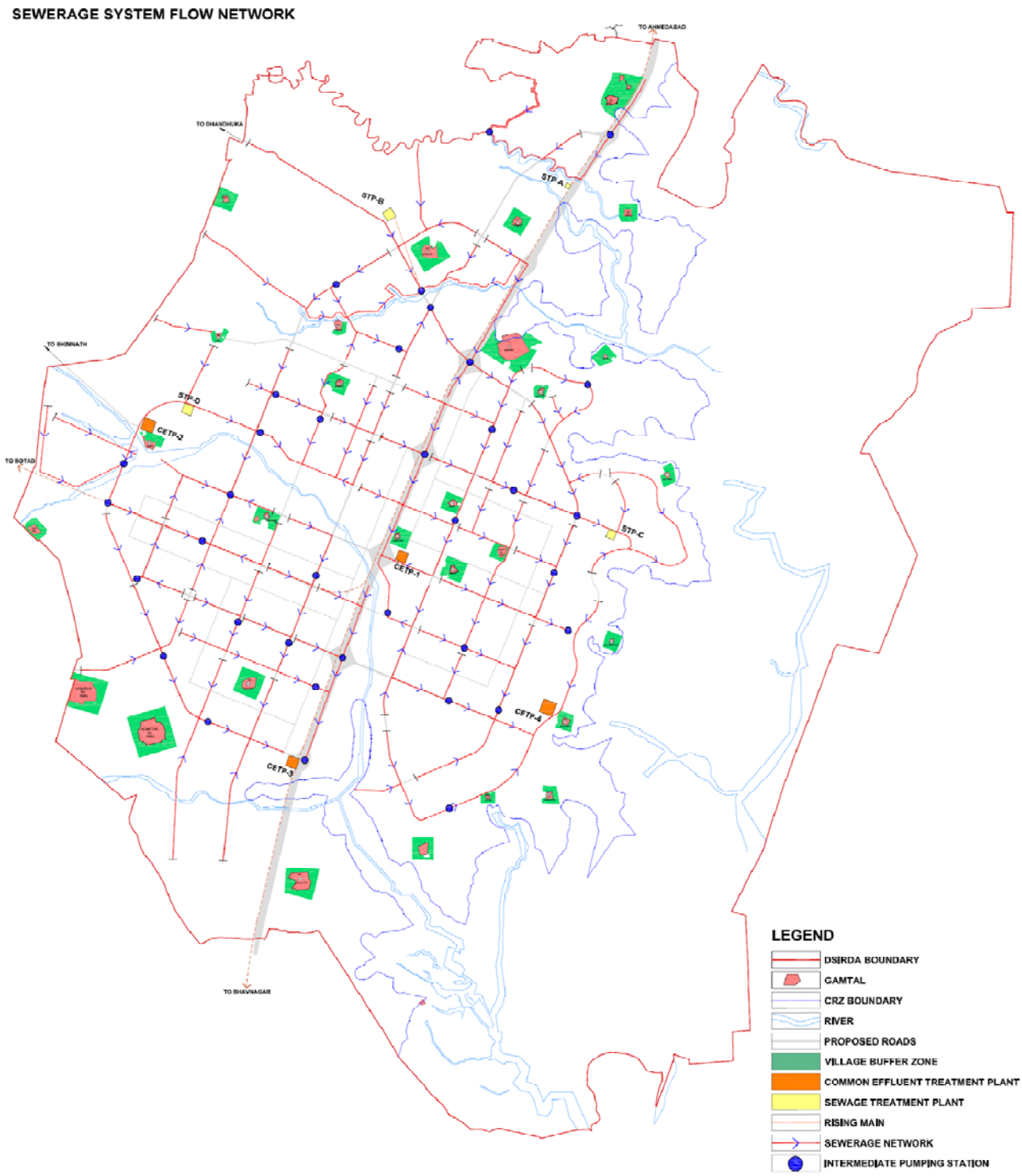


Figure 7-3: Sewage System Flow Network

Influent Quality

It is proposed that effluent discharged to the sewage system will meet strict standards. Pre treatment on site may be required by certain processes or industries before they are permitted to discharge to the main sewerage system to transport it to the treatment plant/proposed CETPs. The characteristics of the common effluent can be expected to be as indicated in Table 7.4 after pre-treatment by the individual Industries. However the quality of the effluent indicated is a general guide only and may vary and the CETP should be designed to cope with variations.

Final Effluent Quality

The final effluent from the treatment plants should have the characteristics indicated in Table 7.5 in line with the provision of IS: 2490.

Recycling of Treated Effluent

It is proposed to re-cycle the treated waste water and use for irrigation of land and gardens, parks and agricultural fields and industrial uses. Irrigation water demand for the DSIR is given in Table 7.6.

The total generation of waste water in the DSIR will be 652 MLD. Total irrigation demand of the DSIR would exceed this if all of the agricultural land within the DSIR is irrigated with treated sewage effluent (TSE). The distribution of TSE will therefore need to be determined on a priority basis according to demand. The recycling of treated effluent will require a separate distribution system from the waste water collection and treatment system, to be developed on a PPP basis, with and revenue generated by selling the treated wastewater to different user groups.

Table 7-4: Assumed Pre-treated Common Effluent Characteristics

CHARACTERISTIC	ASSUME VALUE
pH	7.0 to 7.5
Colour	200 - 300
T.S.S	150 mg/l
BOD(5)	250 mg/l
COD	450 mg/l
Oil & Grease	50 mg/l

Table 7-5: Standards of Recycled Water

USE	PH	BOD 5	TSS	FAECAL COLIFORMS
Disposal in to the river	5.5 - 9.0	30 mg/l	100 mg/l	1,000 MPN1
On land for irrigation purposes	5.5 - 9.0	100 mg/l	200 mg/l	1,000 MPN1
Industrial use	Depending upon the type of use			

Characteristics of Recycled Water

The characteristics of treated effluent for recycling purposes depend upon the type of use, and standards for the different uses have been summarised in Table 7.5. Water demand for irrigation is indicated in Table 7.6.

Table 7-6: Water Demand for Irrigation

SR NO.	OPEN SPACE WITH LAND USE	AREA (ha)	IRRIGATION DEMAND (MLD)
1	Agriculture within the DSIR	12804	165
2	Green Spaces, lakes within the DSIR (30% area has been considered for irrigation)	5848	110
3	Green Recreation and Sports	2010	135
Total Irrigation Demand			**410**

Final Disposal of Treated Effluent

Irrigation demand will not be throughout the year and in the rainy season much of the effluent may be needed to be disposed off safely into a water body or natural stream. Open channels will need to be constructed to receive excess treated effluent from all the proposed treatment plants and transport it to the Gulf of Khambhat downstream of the proposed location of Kalpasar. Until the Kalpasar dam is constructed, treated effluent could be discharged into the nearby rivers. The characteristics of the treated effluent that will be discharged are shown in Table 7.7.

Table 7-7: Assumed Characteristics of Ultimate Effluent to be discharged

CHARACTERISTIC	ASSUMED VALUE
pH	6.0 to 8.0
Temperature	Ambient
Oil & grease	< 10mg/l
Colour (PCS)	< 100 unit
B.O.D5	< 30 mg/l
C.O.D	< 250 mg/l
Total suspended solids	< 100 mg/l
Outlet coliform	<10000 counts/100ml

7.3.2. Broad Summary of Wastewater Recycling and Re-use

The Table 7.8 presents a summary of the induced fresh water demand, in a scenario where about 31 percent supply is met by re-use of water that is recycled from the waste water. Change in quantity of water losses compared to Table 7.1 (page 91), from 123 MLD to 110 MLD is accounted to reduce losses during transportation of water from source as 269 MLD out of 824 MLD is sourced from water recycled on site.

On account of reuse of recycled water, the demand for fresh water thus reduces from 934 MLD to 639 MLD.

Table 7-8: Summary of Waste Water Recycling and Reuse

SR. NO.	DESCRIPTION	WATER DEMAND (MLD)	WASTE WATER GENERATION (MLD)	RE USE POTENTIAL (MLD)	FRESH WATER DEMAND (MLD)
1	Resident Population (target population: 2 million)	298	238.4	22.2	275.8
2	Industrial and Logistics	491	392.8	245.5	245.5
3	Leisure and Entertainment	15	12	1	14
4	Existing villages with buffer for the future development	4	0	0	4
5	Floating Population	8	6	0	8
	Sub-Total	**816**	**650**	**269**	**547**
6	Fire demand @1%	8	0	0	8
7	Irrigation demand for green spaces and parks	0	0	0	0
	Sub-Total	824	650	269	555
8	Water losses @15% on fresh water and 10% on reuse water*	110	-	27	83

SR. NO.	DESCRIPTION	WATER DEMAND (MLD)	WASTE WATER GENERATION (MLD)	RE USE POTENTIAL (MLD)	FRESH WATER DEMAND (MLD)
	Sub Total	**934**	**650**	**296**	**639**
9	Irrigation demand for green space and parks	109		109	
	Total	**1043**	**650**	**405**	**639**

7.4. Storm-water Drainage System

7.4.1. Planning Objectives

The main objectives of storm water drainage planning are to drain the storm run- off from the DSIR during rainfall and manage the storm water entering into the region from other areas. This is required to avoid the loss of people's life and property, to minimize flooding and water logging, to provide flexibility for development in phases and to provide fully gravitational storm water drainage whenever possible by utilizing the natural topography of the area taking into account the high flood level of the receiving water body.

Another key objective is to manage the quantity of surface storm-water drained into the system on account of urbanisation, and monitor its quality to reduce downstream environmental impacts.

The proposed drainage strategy takes into account the size of the DSIR catchment area, drainage behaviour, rainfall and flood patterns, natural streams and channels available in the DSIR and the volume of water entering in to the project area. The strategy will include:

- Flood control measures such as the formation of small check dams at desired locations based on contours;
- Augmentation and maintenance of natural streams and rivers by de-silting, increasing the depth or width based on the volume of water flow;
- Formation of embankments and guide bunds for flood control with the available soil and embankment pitching with stones and boulders;
- Canalizing smaller streams towards main streams and connecting with the main streams;
- Development of green spaces along the entire course of stream to provide recreational space and flood storage areas;
- Proposing water reservoirs to store the upstream water to avoid flooding of the DSIR during periods of high tide and heavy rain fall. Water retained in the channels may be utilized as part of the city water supply after appropriate treatment;
- Provision of weirs across the rivers to act as barriers to stop sea ingress and the entry of silt and to raise the water level in the rivers for recreational and aesthetic purposes.

Table 7.9 indicates the freeboard for drains and Table 7.10 indicates surface run-off assumptions.

Table 7-9: Proposed Freeboard for Drains

DEPTH OF FLOW (cm)	FREE BOARD FOR DRAINS
> 100 cm	50 cm
50 - 100 cm	30 cm
<50 cm	15 cm

Table 7-10: Surface Runoff Assumptions

TYPE OF LAND USE	PERCENTAGE OF IMPERVIOUSNESS	PERCENTAGE ADOPTED
Commercial & Industrial Area	70 to 90	80%
High density	60 to 75	70%
Low density	35 to 60	45%
Parks & Open Spaces/Undeveloped Area	10 to 20	15%

The proposed storm water drainage system is conceptualized to cater for surface runoff within the project area by gravity flow as shown in Figure 7.4. Trunk storm water drains are proposed on both the sides of the roads and lateral and main drains are proposed on one side of the roads for reasons of economy.

The surface runoff collected from the catchment areas would be discharged by major outfalls into the natural streams, rivers and creeks and open land lying in the CRZ along the DSIRDA boundary. This approach will help to minimize the length of drains and to reduce the depth of the water channels. Since the topography of the DSIR is regular, gently sloping from the north-west to the south-east and towards the rivers, drains should be planned in such a way that the depth of drains is minimised and they can dispose off the storm water from DSIR without raising the level of the surrounding area.

The outlets of the drains may remain submerged during high tide and heavy rain fall conditions. To avoid flooding in the area, sluice gates and boosting system will be provided at the outlets of the drains. When the natural streams and nallahs are full and cannot flow by gravity from drains, the water may need to be pumped out. Outfalls lying in the CRZ area shall be planned and designed such that water discharging from the drain does not erode the land and spread in the form of sheet flooding.

In order to determine the hydraulic grade line due to backwater impact under high tide conditions coinciding with downpours, the invert levels for outfalls should be kept such that the DSIR should not be submerged during high tides coinciding with heavy monsoon rainfall. The high tide line reaches the 5.5m contour and in extreme conditions reaches the 6.9m contour. The formation level of the DSIR will be planned such that it can be protected from any kind of flooding or submergence.

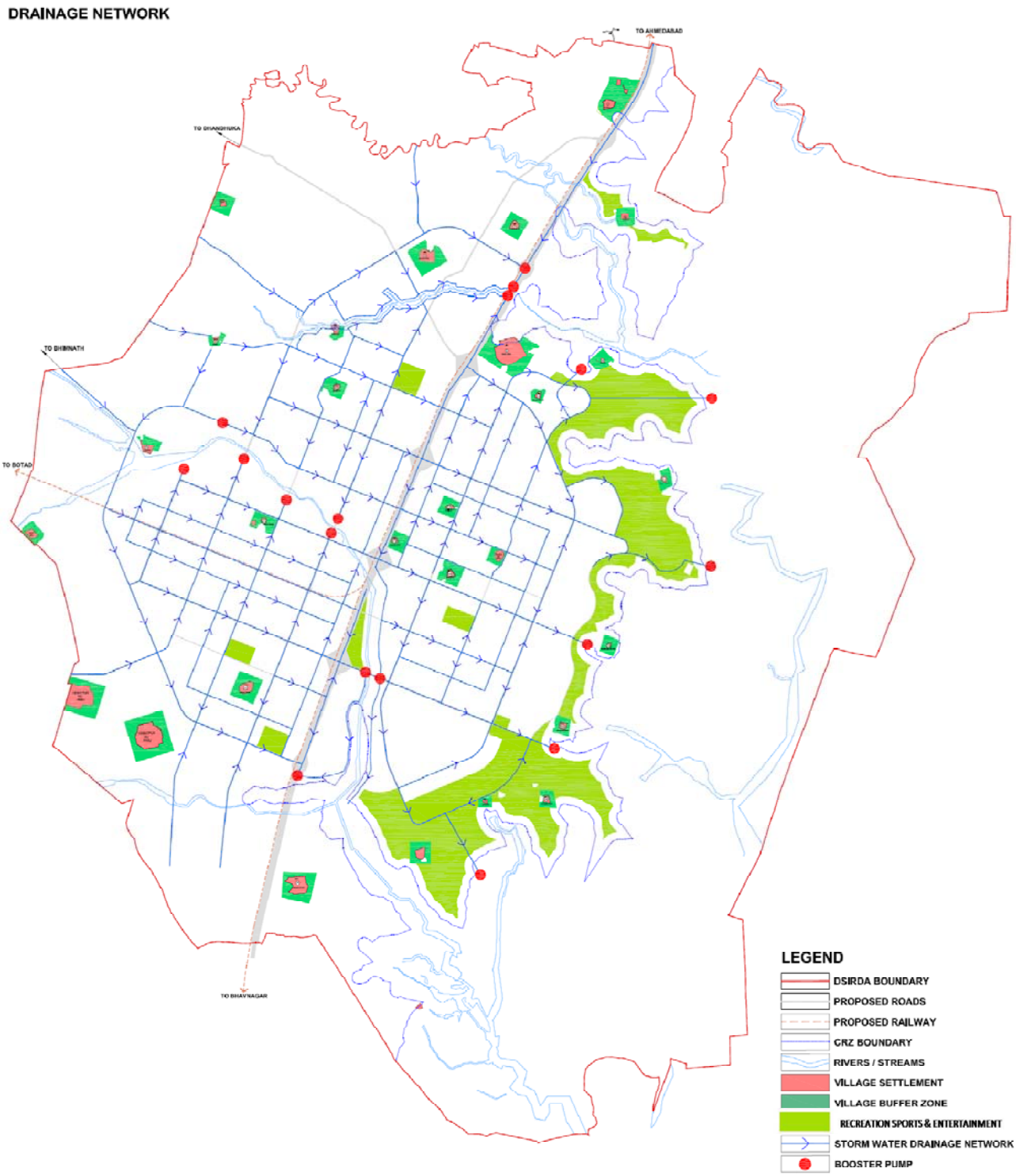


Figure 7-4: Drainage Network

7.5. River Management and Strategic Flood Control

The rivers to the west of the site are well defined in their channels as the land slopes from west to east. However around 6km from the western boundary of the site the rivers lose their definition and start to spread out to form many minor channels and sheet flow across the land. This situation has several implications for the flood protection to the DSIR site; effectively the land to be developed will have to be poldered or separated off from the rest of the land via a bund, on the west of the DSIRDA and along the rivers as shown in Figure 7.5.

All the bunds are likely to be around 2m high at their seaward end but then rising at a minimum slope of around 0.0002 in order that the water can develop a slope to make it flow towards the sea.

The topography of the area is regular, with gentle slopes from west to east and toward the rivers, whose depth is very shallow. As the upstream water passes from the DSIR it spreads in the form of sheet and submerges more areas. Rivers entering into the DSIR would be trained and guided to flow such that they cannot submerge the area beyond the river course when there is heavy rain and rivers are at peak discharge. Past records of the rivers behaviour show that major parts of the project area get submerged during high tide and high flood condition. To prevent the DSIR flooding, existing rivers courses will need to be modified to suit the hydraulics of the flow and banks will need to be raised to guide the flow to avoid spreading the river water in the form of a sheet. The height of the banks may vary from 2m at the seaward side to 4m at the western boundary. River banks would be lined and protected from erosion and the beds dredged to reduce the width of the rivers. Given that the CRZ line is about 500m away from the high tide line and the land along the CRZ slopes west to east, there should be no need to build a bund along the eastern side of the site. However construction of a small bund to ensure that extreme high tides do not flood the site might be advisable.

The flood estimation shall be worked out by flood frequency method for 1 in 25 years return period.

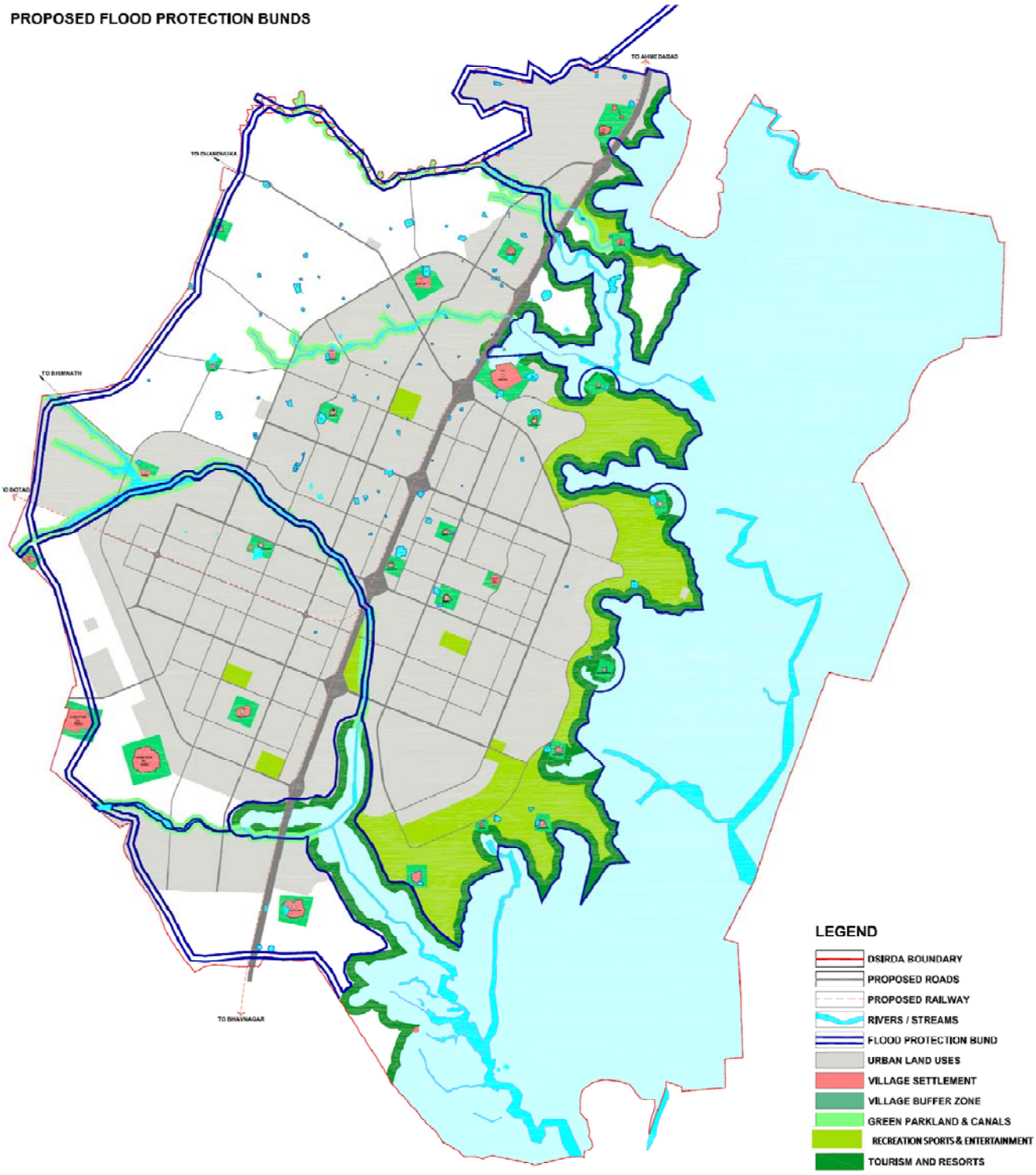


Figure 7-5: Proposed Flood Protection Bunds

7.6. Solid Waste Management System

Solid Waste Management will be one of the essential services necessary for maintaining the quality of life and for ensuring better standards of health and sanitation in the DSIR. For maximizing efficiency and effectiveness of this service, it is necessary to tackle this problem systematically by going into all aspects of the 'Solid Waste Management' (SWM) and devise cost effective and self managed system which may ensure adequate level of SWM services in the region, through collection, transportation, treatment and disposal of waste in an environmentally acceptable manner, following the Supreme Court Committee's recommendations as well as Municipal Solid Waste (Management & Handling) Rules 2000.

7.6.1. Policy and Legal Mandate

Gujarat Special Investment Region Act, 2009; gives emphasis on "collection-treatment-discharge and disposal of industrial, institutional and township waste" as one of the amenities to be provided in the DSIR.

Municipal Solid Waste (Management & Handling) Rules, 2000; apply to the collection, segregation, storage, transportation and disposal of solid waste management. As per rule 7, of the rules, the municipal authority (in this case DSIRDA) is responsible for managing the solid waste generated within the city or town and to set up a waste processing and disposal facility. The Industrial Policy, 2009; of State Government lays emphasis on inculcating systematic approach among the industries for holistic development that includes environment management as infrastructure.

Under Municipal Solid waste management rules, 2000; the urban local bodies have to ensure that no hazardous waste is mixed or collected along with municipal solid waste. Hazardous waste has to be segregated from municipal solid waste and treated separately in accordance with the Hazardous Waste (Management and Handling) Rules, 2000

As per Bio-Medical Waste (Management & Handling) Rules, 1998; Bio-medical waste is the waste generated during diagnosis, treatment and immunization of human beings or animals and in research activities. This waste should not be mixed with municipal solid waste and hence a separate system for its management has been specified.

7.6.2. Solid Waste Generation

The solid waste management of the DSIR will primarily revolve around the quantity and quality of solid wastes. The quantity will decide the magnitudes of the problems of storage, transportation and disposal operations which have to be undertaken for disposal or any such other purposes whereas the quality will hint at the precautions to be carried out in any such operations. The solid waste that will be generated in DSIR can be broadly divided into seven major categories:

- Residential / Domestic Waste;
- Commercial Waste;
- Institutional Waste;
- Industrial Waste;
- Construction and Demolition Waste;
- Street sweeping and Dead animals;
- Sewage Waste.

7.6.3. Composition and Characteristics of Waste

The composition and characteristics of municipal solid wastes (MSW) vary throughout the world and in the same country from place to place as it depends on number of factors such as social customs, standard of living, geographical location and climate. MSW is heterogeneous in nature and consists of a number of different materials derived from various types of activities. The National Environmental Engineering Research Institute (NEERI) has carried out extensive studies on characterization of solid waste from 43 cities during 1970-1994. The average characteristics have been presented in Table 7.11.

7.6.4. Quantification of Solid Waste Generation

Forecasting waste quantities is as difficult as predicting changes of waste composition and the factors promoting change in waste composition are equally relevant to changes in waste generation. Table 7.12 indicates quantities of municipal solid waste generation in Indian urban centres. Waste generation rates in an urban area suggested by the Central Public Health and Environmental Engineering Organization (CPHEEO), are given in Table 7.13.

Residential/Domestic Waste in the DSIR

Based upon a population of 2 million inhabitants and an Indian urban lifestyle, an average waste generation of 0.6 Kg per person per day would generate approximately 1190 metric ton per day. This is broken down on a phased basis in Table 7.14.

Table 7-11: Physical Characteristics of Municipal Solid Waste in Indian Cities

POPULATION RANGE IN MILLION	NUMBER OF CITIES SURVEYED	PAPER	RUBBER, LEATHER AND SYNTHETICS	GLASS	METALS	TOTAL COMBUSTIBLE MATTER	INERT
0.1 to 0.5	12	2.91	0.78	0.56	0.33	44.57	43.59
0.5 to 1.0	15	2.95	0.73	0.35	0.32	40.04	48.38
1.0 to 2.0	9	4.71	0.71	0.46	0.49	38.95	44.73
2.0 to 5.0	3	3.18	0.48	0.48	0.59	56.67	49.07
> 5	4	6.43	0.28	0.94	0.8	30.84	53.9

Note: All values in the table are in percentage, and are calculated on net weight basis

Table 7-12: Quantity of Solid Waste Generation in Indian Urban Centres

POPULATION RANGE IN MILLION	NUMBER OF URBAN CENTRES SAMPLED	TOTAL POPULATION (MILLION)	AVERAGE PER CAPITA VALUE (Kg/Capita/Day)	QUANTITY (Tonnes/Day)
< 0.1	328	68.3	0.21	14343
0.1 – 0.5	255	56.914	0.21	11952
0.5 – 1.0	31	21.729	0.25	5432
1.0 – 2.0	14	17.184	0.27	4640
2.0 – 5.0	6	20.597	0.35	7209
> 5.0	3	26.306	0.50*	13153
< 0.1	328	68.3	0.21	14343

** 0.6 kg/capita/day generation of MSW observed in metro cities*

Table 7-13: Generation Rate

WASTE CATEGORY	GENERATION RATE
Residential refuse	0.3 to 0.6 kg/cap/day
Commercial refuse	0.1 to 0.2 kg/cap/day
Street sweepings	0.05 to 0.2 kg/cap/day
Institutional refuse	0.05 to 0.2 kg/cap/day

Table 7-14: Municipal Solid Waste Generation in the DSIR

CATEGORY	PHASE 1 (TON/DAY)	PHASE 2 (TON/DAY)	PHASE 3 (TON/DAY)	TOTAL (TON/DAY)
Population Residing (Number)	500,000	1,000,000	500,000	2,000,000
Residential Refuse	295	579.6	315.8	1190.3
Commercial Refuse	98.3	193.2	105.3	396.8
Institutional Refuse	49.2	96.6	52.6	198.4
Street Sweepings	24.6	48.3	26.3	99.2
Industrial Worker Population (Number)	84500	166900	91000	342400
Industrial Refuse	12.7	25	13.7	51.4

Other Municipal Waste Generation in DSIR

Solid waste generation in the DSIR from other sources is estimated 0.2kg per person per day for commercial establishments, 0.1kg per person per day from Institutions and 0.05kg per person per day from street sweepings.

The per capita waste generation from street sweepings is assumed to be lower than observed values in Indian Cities, with the assumption that the region will set a global standard in terms of planning and service delivery as well as positive public participation. The total quantity of waste that will be generated per day in the region from these three sources is about 695 metric tons per day.

In the industrial area, average per capita domestic waste generation from the worker population has been assumed as 0.15 kg /day per person as shown in Table 7.14, giving a total waste generation from this source of about 51 metric tons per day.

Industrial Process Waste in the DSIR

Industrial process waste production will depend on different manufacturing processes of industries and related activities, which vary widely in quality and quantity across different types of industries, depending upon the production process, material management and existence of pollution control equipment, the type of raw material, its use and housekeeping.

In India, management of hazardous wastes is carried out at the State and regional level and its responsibility lies with the respective State pollution control board. It is estimated that total quantity of generated hazardous wastes in India is 4.44 million tons (year 2000) out of which 38 percent recyclable, 4.3 per cent was incinerable and remaining 57 per cent was disposable in secure landfills.

7.6.5. Hierarchy of Waste Management Options

The hierarchy of waste management that will be adopted in the region is shown in the Figure 7.6.

Reduction at source is first in the hierarchy because it is the most effective way to reduce the quantity of waste, the cost associated with its handling, and its environmental impacts.

Recycling will involve:

- Separation and sorting of waste materials;
- Preparation of these materials for reuse or reprocessing; and
- Re-use and reprocessing of these materials.

Waste processing will involve alteration of wastes to recover conversion products (e.g., compost) and energy. The processing of waste materials usually results in the reduced use of landfill capacity. Transformation of waste, without recovery of products or energy, may have to be undertaken to reduce waste volume (e.g. shredding and baling) or to reduce toxicity. Land filling will involve the controlled disposal of wastes on or in the earth's mantle. It is by far the most common method of ultimate disposal for

waste residuals. Land filling is the lowest rank in the hierarchy because it represents the least desirable means of dealing with society's wastes.

Figure 7-6: Hierarchy of Waste Management

7.6.6. Proposed Waste Management Activities

The activities associated with the management of all this waste in the DSIR can be grouped into six functional elements namely:

- Waste Generation;
- Storage: Storage of waste at source is the first essential step in Solid Waste Management. Every household, shop and establishment generates solid waste on day to day basis. The waste will normally be stored at the source of waste generation till collected for its disposal;
- Collection: DSIRDA will arrange for the primary collection of waste stored at various sources of waste generation by doorstep collection through containerized handcarts/tricycles, motorized vehicles or through community bins;
- Transportation: Transportation of the waste stored at waste storage depots at regular intervals is essential to ensure that garbage bins and containers do not overflow and waste is not littered on streets. The transportation system has to be so designed that it is efficient, yet cost effective and will be synchronized with the system of the waste storage depot.
- Segregation & Processing: Segregation of waste at source as well as at the common facility will be done based on the usefulness of the waste and suitability of treatment and disposal technology. Waste processing techniques that can be implemented based on the composition of the waste include: Composting / vermi-composting; Energy recovery; Biogas generation and Green coal and refuse derived fuel and eco bricks.

Waste not found suitable for waste processing, pre-processing and post-processing rejects from waste processing sites and non-hazardous waste not being processed or recycled.

Land filling of hazardous waste stream in the DSIR will be done at a hazardous waste landfill site. DSIRDA can however dispose the hazardous waste in a special hazardous waste cell in the MSW landfill designed according to Ministry of Environment and Forests (MoEF) guidelines for hazardous waste disposal.

Land filling of construction and demolition waste will be done in a separate landfill where the waste can be stored and mined for future use in earthwork or road projects. Construction and demolition waste can also be used as a daily cover at the MSW landfill.

7.6.7. The Proposed Integrated Waste Management Concept

An integrated approach will be adopted in the DSIR to efficiently manage the solid waste generated in the region. The waste that will be generated in the DSIR can be broadly categorised as municipal waste and industrial waste. However, based on composition and characteristics they are further categorised as hazardous waste, bio-medical waste, wet organic waste, dry organic waste, electronic- waste, recyclable waste and inert material.

The flowchart illustrated on Figure 7.7 describes the integrated approach that will be adopted in the DSIR to manage the waste generated from different sources in an efficient and environmentally accepted manner. It is important to note that special care will be taken while managing hazardous waste and biomedical waste. Some important components of the integrated approach are discussed below.

Approach to Municipal Waste

Municipal waste will be collected and transported to the integrated waste management facility (IWMF). If it has not already been sorted at source, it will be segregated into five components namely 1) Wet Organic waste 2) Dry Organic waste 3) Recyclable waste 4) Inert Materials and 5) electronic- Waste.

- Wet waste will comprise about 20 % to 30 % of total waste. This will be converted into organic compost through proper treatment;
- Dry waste will form 30% to 40 % of waste which can be utilized for making green coal or fluff. After segregation, recyclable waste like rubber, metal, plastic which has economic importance, will be sold;
- Segregated E-waste will be sent for processing along with hazardous industrial process waste;

At the last stage of the process, inert materials can be partly used for making bricks by mixing it with fly ash. Finally the residue from this process which is as little as 15% to 20%, will be sent for landfill in the sanitary landfill site.

Approach to Electronic- Waste

E-waste comprises of wastes generated from used electronic devices and household appliances which are not fit for their original intended use and are destined for recovery, recycling or disposal. Such wastes encompass a wide range of electrical and electronic devices such as computers, hand held cellular phones, personal stereos, including large household appliances such as refrigerators, and air conditioners.

E-wastes are considered dangerous, as certain components of some electronic products contain materials that are hazardous, depending on their condition and density. Some of the components of e-waste contain materials such as lead, cadmium, mercury, and polychlorinated bi-phenyls (PCBs), which are hazardous in nature. Therefore e-waste should be handled in an environment-friendly manner to prevent this hazardous material polluting the environment.

Currently there are no specific legislations pertaining to e-waste management. However, it is covered under Hazardous Waste (Management & Handling) Rules, 2003. Therefore, anyone who collects e-waste must comply with this regulation. Following are the steps involved in e-waste handling:

- Sorting;
- Identify Usefulness;
- Identify hazardousness;
- Dismantling;
- Segregation; and
- Treatment / Disposal.

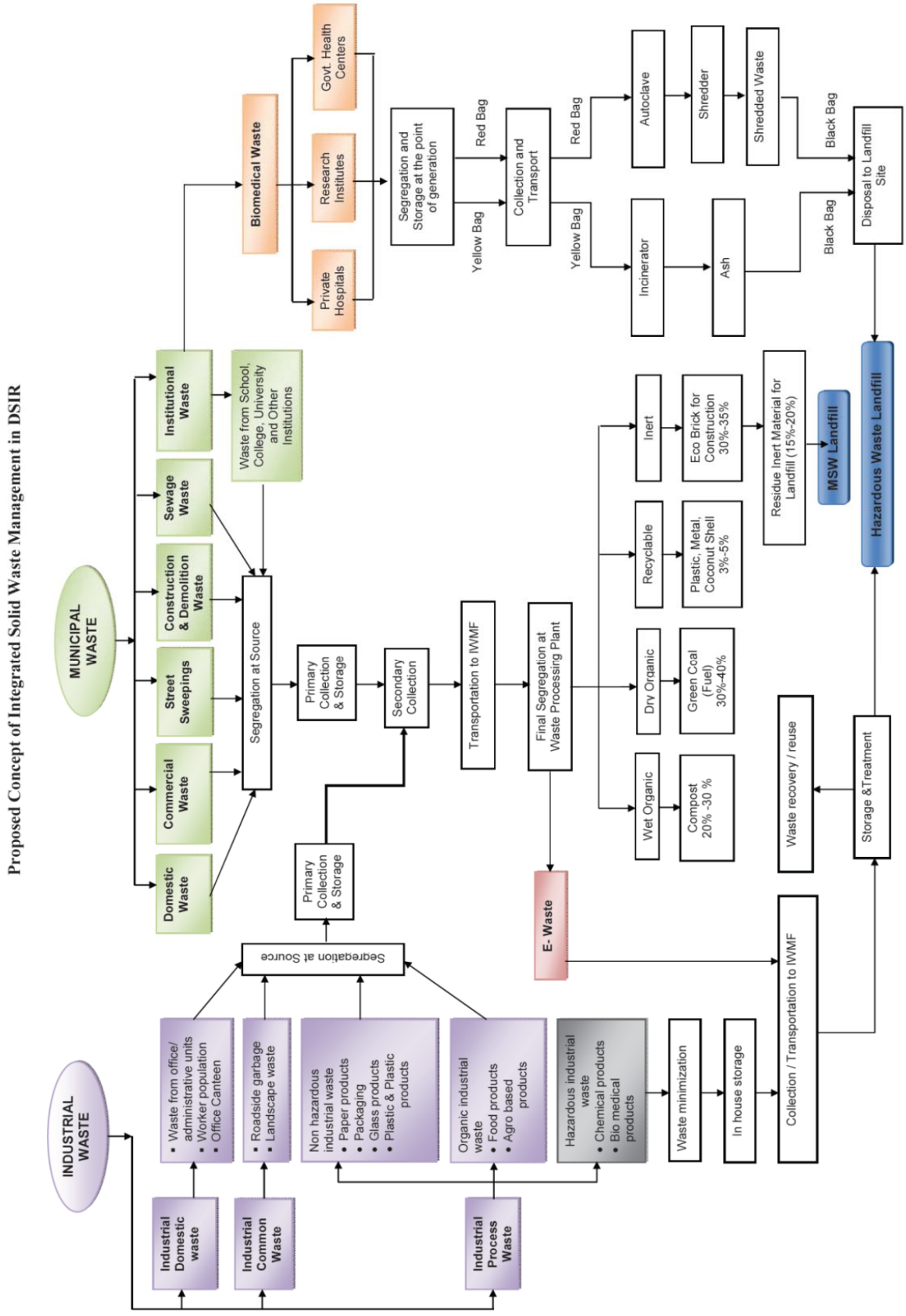


Figure 7-7: Integrated Waste Management Process Flowchart

Approach to Bio-medical Waste

'Bio-medical waste' means any solid and/or liquid-waste including its container and any intermediate product, which is generated during the diagnosis, treatment or immunisation of human beings or animals. The physio-chemical and biological nature of these components, their toxicity and potential hazard are different, necessitating different methods for their treatment and disposal. Therefore its treatment and disposal has been proposed following the Bio-medical Waste (Management and Handling) Rules, 1998.

Approach to Hazardous Waste

Hazardous waste is defined, as a "waste containing highly persistent elements, chemicals and compounds with some chronic and/or acute impacts on human health and environment". The hazardous wastes may take the form of solid, liquid or sludge. Different sources of hazardous wastes generation include industrial, commercial, agricultural and even domestic activities. However major source of hazardous wastes is the industrial activities.

Under Municipal Solid waste management rules, 2000, the DSIRDA will have to ensure that no hazardous waste is mixed or collected along with municipal solid waste. Hazardous waste will be segregated from municipal solid waste and treated separately in accordance with the Hazardous Waste (Management and Handling) Rules, 2000.

7.6.8. Components of Hazardous Waste Management

Various components of hazardous wastes management plan will involve waste minimization, reuse / recovery, in house storage, transport, secondary storage, treatment and final disposal.

Waste minimization

Waste minimization process involves source reduction, which means any activity that reduces or eliminates the generation of wastes within a process. Waste reduction will be carried out through changes in the industrial process, which will result in to reduction of total volume / quantity or toxic characteristics of wastes. Change in the industrial process will be carried out through input material alteration, technology alteration or procedural / institutional changes. This is called "Cleaner Production Concept".

Waste Recovery/Reuse

Certain wastes like non-ferrous metal wastes, zinc brass, used lead batteries, copper oxide mill scale, and used lubricating oil, can be recycled in an environmentally sound method which canbe techno-economically feasible as well. Facilities for such activities will be provided.

In house storage

For day to day storing of wastes, a separate space needs to be provided at within the generator premises. Waste is stored in bags, containers as directed by the regulatory authority. However, it should not be stored for more than 90 days as per rules, if the waste is to be recycled.

Transportation

Wastes collected from industrial premises will be transported through trucks. The vehicles for transportation will be approved by the regulatory authority and will follow the manifest system. Proper care will be taken during transportation to avoid any spillage, accidents or potential risk to the community and environment.

Treatment

Treatment will be given on the basis of waste characteristics. Widely used treatment includes stabilization, solidification and incineration.

Disposal

Disposal of hazardous wastes is the least preferable solution and at the same time a key component in whole hazardous waste management scenario. There are various methods of waste disposal; including land

disposal, underground disposal, incineration, solidification and stabilization, ocean disposal. The choice of method depends on evaluation of economics and potential pollution risks.

7.6.9. Siting of the Integrated Solid Waste Management Facility

Based on broad thumb rule calculations, an area of about 200 ha has been identified for the Integrated Waste Management Facility (IWMF) to be provided in the DSIR to deal with all wastes. Essentially the IWMF will include:

- Waste Collection and Storage Facility;
- Waste Processing Facility (Segregation, Reuse, recycle, recovery of valuables etc.):
- Waste Treatment and Disposal Facility (Waste to energy, creating compost, incineration and landfill).

Landfill is the most environmentally sensitive of these activities and therefore siting of such facility is subjected to guideline provided by the (CPHEEO), 2000; Schedule III of Municipal Solid Wastes (Management and Handling) Rules, 2000, as provided by Ministry of Environment and Forests, Hazardous Waste (Management and Handling) Rules 1989, and its amendment in 2001 and 2003; the Gujarat Pollution Control Board (GPCB), Gujarat.

According to the guidelines, it is essential that municipal solid waste landfill sites and hazardous waste landfill sites shall not be located within a certain distance of the natural features such as lakes, ponds, rivers, wetlands, flood plains, highways, habitation, critical habitat area, water supply wells, airports, coastal zone. Following these guidelines, a suitable site of about 200 ha that meets all of these criteria has been identified on the west side of DSIR as shown in the Figure 7.3 (page 96).

7.7. Power

7.7.1. Introduction

The Gujarat Electricity Board (GEB) is responsible for the development of power infrastructure, including supply and transmission in the DSIR. As part of the Power Reform Process, the Central Government has passed the Electricity Act, 2003, and Gujarat Electricity Industry (Re-organization & Regulation) Act, 2003, with an aim to improve efficiency in the management and delivery of services to consumers. Under the provisions of the Acts, the Government of Gujarat has framed the Gujarat Electricity Industry Re-organization & Comprehensive Transfer Scheme, 2003.

The Gujarat Electricity Board (GEB) was reorganized effective from 1st April, 2005 into seven companies with functional responsibilities of trading, generation, transmission and distribution. However with the present power reform process and with the development of the PPP model on power generation, transmission and distribution, many private players have entered the market. For example, in Surat and in Ahmedabad and Gandhinagar, power distribution is now being undertaken by Torrent Power.

For the DSIR it is proposed that a SUV (Special Utility Vehicle) be created by collaborating with any major private operator such as Torrent Power, Reliance Energy, Tata Power, or Kalpataru. This SUV should obtain the distribution license being a co-developer of the DSIRDA from GoG with the right to buy bulk power from any national grid provider in Gujarat, such as GETCO and UGVCL or even traded power from, for example, Adani or Lanco at competitive prices. Alternatively the SUV could sign a long term power purchase agreement with any independent power producer in India and import the power to the DSIRDA using the GETCO network by paying a transmission charge. This will enable a very reliable & good quality of power to be provided to the DSIRDA at an economical rate. The Dane SEZ and the Mundra SEZ are successfully developing such partnership schemes with Torrent Energy and Adani respectively and this is proving attractive to investors in these SEZs. The SUV should be created according to the norms of and guidelines of GERC (Gujarat Electricity Regulatory Commission) and the Electricity Act 2003 and a license for distribution obtained from GERC (The State authority).

7.7.2. Estimation of Power Demand

Power demand has been estimated based on load, taking into account a suitable diversity factor. In the view of the high degree of uncertainty with regard to the type, profile and phasing of manufacturing industries in the DSIR, the load estimation can only be an approximation at this stage. The targets may need to be revised depending on the sectors that will develop in the DSIR, their scale and phasing and Government policies in the future.

Broadly, three different categories of power load are anticipated in the DSIR:

- Industrial loads, covering heavy, medium, light and small scale industries;
- Social Infrastructure loads, including hotels, residential, institutional and commercial;
- Mixed loads: utility centres, substations, street lighting, transport.

Power demand will increase along with development in the DSIR over three phases and a total power demand of approximately 1700 MW is forecast as shown on Table 7.15.

The industrial load will be the main power consumer, taking approximately 63% of total demand, with social infrastructure constituting about 27% and the remaining 11% being accounted for by mixed loads.

Table 7-15: Estimated Phase Wise Power Demand

LOAD TYPE	TOTAL (MW)	PHASE 1 (MW)	PHASE 2 (MW)	PHASE 3 (MW)
Industries	1000	250	450	300
Public Buildings (including commercial)	600	125	300	175
Mixed Load	100	25	50	25
Total	1700	400	800	500

7.7.3. Power Supply to DSIR in Phase I:

Power demand in the initial phase of development will be low, of the order of 20-30 MW and it will gradually increase with the generation of construction jobs. Presently, there is one 11kv feeder from the Dhandhuka 132 kV Gujarat Energy Transmission Company (GETCO) substation which has a feeder capacity of approximately 4 MW. This extra capacity of 11 kV feeders can be utilised for the power requirement for the first two years of development. It is proposed that one 132 kV substation be constructed at Dholera, which will obtain feed from the 132 kv Dhandhuka switch-yard, by laying a 132 kV Overhead Transmission line of about 27 kms.

The flowcharts on power supply in the initial stage of Phase 1 (Phase 1a) and the later phases (Phase 1b, Phase 2 and Phase 3) are shown in Figure 7.8 and 7.9 (page 114) respectively. It is recommended that the SUV should be created in DSIRDA for power distribution as the first step and application made to the GERC for obtaining a Distribution License. This procedure typically takes about 3 to 4 months. It is also recommended that in the initial phase, a power purchase agreement be made with GETCO under the provisions of the GUVNL. Formation of a secondary license or franchisee is not deemed necessary as this option would be uneconomical.

7.7.4. Design and Planning of Electrical Power Network

The power distribution network in the DSIR is designed to be flexible enough to accommodate not only the estimated load of 1700 MW, but also the variations in amount and time of the incoming load. The overall design shall consider wide variations in load values and shall be planned to be modular and flexible. The plan will be able to cater to these variations, while implementation has to be based on actual demand. The main receiving voltage will be 400 KV. The bulk power transmission voltage level inside the DSIR will be 132KV and the sub-distribution voltage will be 33 KV. The lower voltage levels will reduce transformation losses and equipment costs.

All equipment proposed to be used will be suitable for a highly humid, saline and dusty environment. High flood and tide data, high wind velocity & cyclone susceptibility and earth quake intensity shall be considered when designing structures and foundations. The conducting characteristics of the soil in the area are very poor and extra care will need to be taken while designing the earthing system.

The main objectives of the power system are:

- To ensure 60% availability of equipment meant for power distribution;
- Redundancy and reliability;
- Voltage drop within permissible limit;
- AT & C losses are within permissible limit; and
- To ensure Zero % theft.

Captive power is only considered to take care of highly critical loads like utilities in the case of the loss of connectivity of DSIR to the grid. A 60 percent captive power is not considered for the DSIR because power generation is unlikely to be a prime business of DSIR since fuel in terms of coal or gas is not available in bulk quantities.

System Capacity

The total load demand of DSIR is estimated to be 1700 MW by the end of the plan period, while the MVA demand will be around 1800 MVA.

The required capacity design for the 400KV transmission line taking into account the peak load and future or sudden requirement for power is therefore 2000MVA. The transformation capacity at 400KV to sub-distribution voltage level will be around 2600 MVA. At sub-distribution voltage level, the required capacity of feeders will be of at least 5000 MVA with transformation capacity of around 5000 MVA.

It is assumed that losses will be between four and ten percent, depending on load factor, which compares to an industry average of around 20% due to theft and overhead line losses.

Main Receiving Stations & Primary Substations

The main power supply shall be available from a 400 KV grid at 400 KV. It is proposed to build two EHT MRS (Main Receiving Stations) in Phase 1 and Phase 2. The voltage will be stepped down to sub-distribution voltage level at these receiving stations through power transformers. To distribute the power to end user, 132 kv, 66 kv, 33 kv, 11 kv and 11/0.433 kv substations of various capacities are proposed at sector and sub sector levels. At sub distribution level from 33kv substation the power distribution proposed will be underground with RMU'S and unitised substation and feeder panels at strategic locations as required.

Substations will have intelligent numerical relays for control, supervision and protection. These Relays shall be linked to a Supervisory Control and Data Acquisition System (SCADA) by soft serial linkage. The substations will be unmanned and all the supervision will be by a 24-hour manned SCADA room.

Taking into account power requirement, aesthetics and electrical infrastructure development requirements, it is proposed that the proposed 400 KV MRSS and 132 KV Substations are located in industrial areas. It is also proposed that the overhead transmission lines should not cross the main expressway so as not to restrict the utilisation of this major transportation corridor.

The land required for proposed substations is as follows:

- 400 KV MRSS – 6 ha (250m x 400 m);
- 132 KV Substation – 3 ha (160m x 200m);
- 66 KV Substation – 1 ha (16m x 90m);
- 33 KV Substation – 0.4 ha (70m x 50m).

The proposed location of the sub-stations and transmission lines for DSIR is shown in the Figure 7.10.

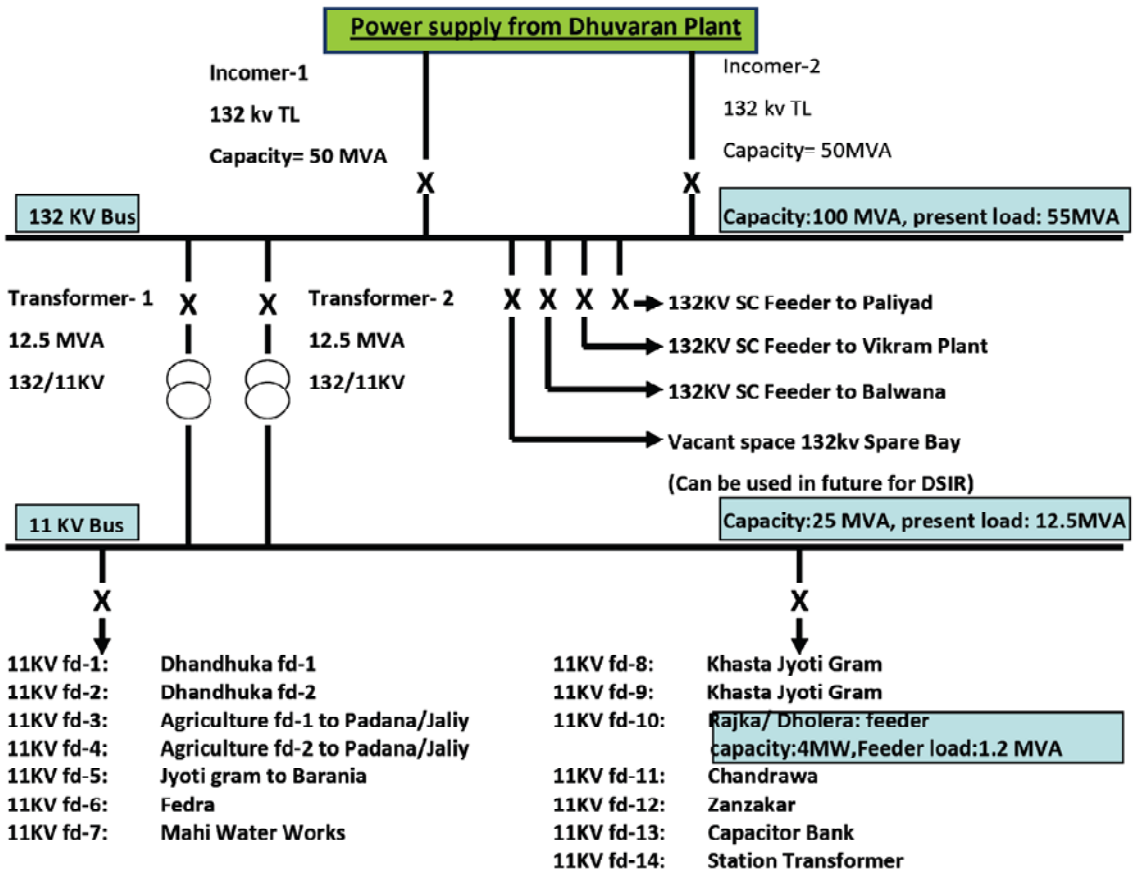


Figure 7-8: Power Supply Initial Phase

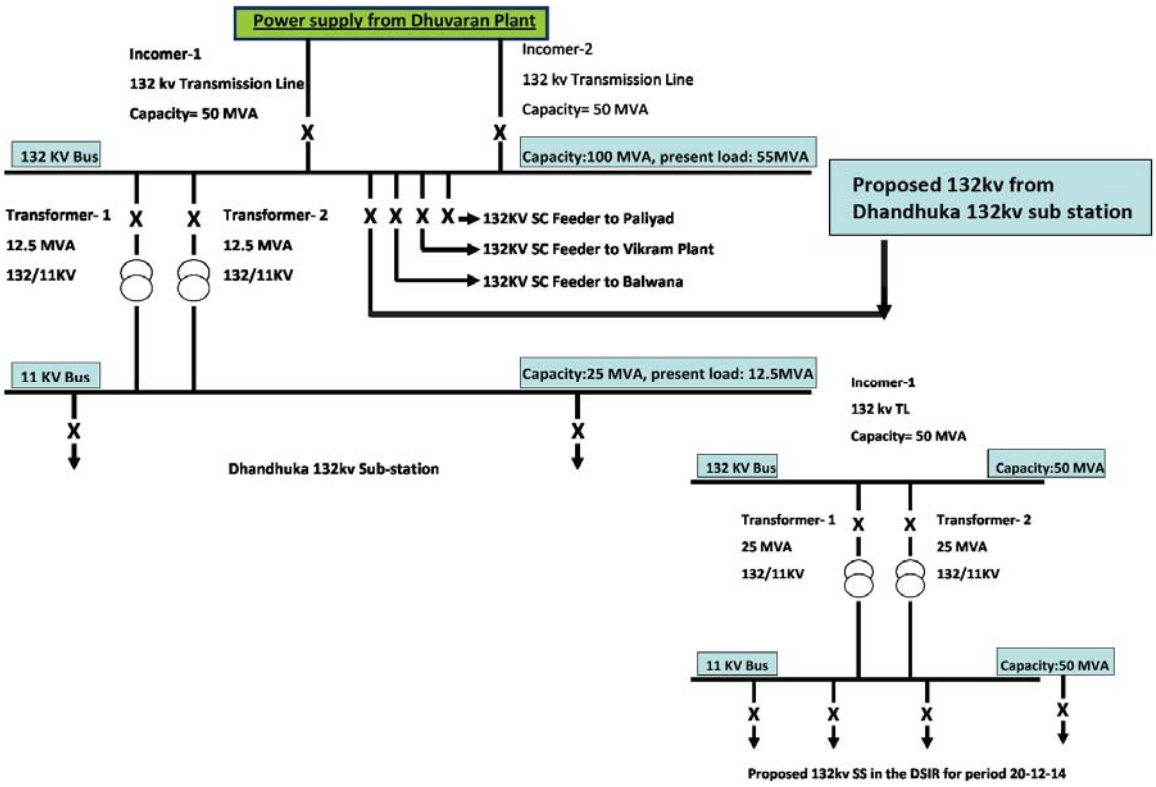


Figure 7-9: Power Supply in Later Phases

7.7.5. Power Sources

Conventional Power

It is proposed to build up a captive gas power plant of 270MW with the capacity configuration of 3 X 90MW units. This captive power plant will run in synchronisation with the State and National grid and in the case of total blackout of the grid or electrical isolation, will provide for the critical loads in DSIR such as public utilities, water supply, fire stations, lighting, emergency service and hospitals. The power plant will be located adjoining the western 400KV MRS, and can be brought on stream in three phases: Phase 1b, Phase 2 and Phase 3.

Renewable Energy Sources

The Central Electrical Authority (CEA) has recently revealed that India is facing a chronic power shortage of around 70,000 MW. CEA projects the shortage to be about 9% with a peak demand shortage of 18% in 2008-09. The power position becomes more chronic in the Western region in which DSIR falls, with a likely peak demand deficit of about 27% according to the latest CEA data.

Fortunately India has vast renewable energy resources and has one the largest programs in the world for deploying renewable energy products and systems. Indeed, it is the only country in the world to have an exclusive ministry for renewable energy development, the Ministry of Non Conventional Energy Sources (MNES). Since, its formation, the ministry has launched one of the world's largest and most ambitious programs for renewable energy. The projected output from renewable energy by 2012 is 6,000 MW, from an estimated potential capacity of 152,000 MW. Interestingly this potential is broadly equivalent to the current total installed energy generating capacity of India today.

Fossil fuels in India are limited, with coal deposits forecast to last only for the next 4 decades and oil & gas reserves similarly limited. Today, the renewable energy industry has reached maturity and commercial viability. Although solar power is not yet fully competitive with conventional power, the cost of conventional energy is increasing rapidly and the gap is likely to close. Furthermore, renewable electric technologies offer the possibility of distributed generation at or near the point of use, which will reduce peaking loads and save on the cost of up-grading and maintenance of transmission & distribution networks.

While the capital cost of renewable energy is close or lower in many cases than that of conventional power, the greatest advantage lies in its short gestation period. It is proposed that for DSIR, renewable energy should be harnessed to constitute at least 20% of the total demand for power.

A number of renewable energy sources have been considered for application in DSIR, the most promising being solar power and energy from waste. Wind power would also be ideal from an economic and land use point of view because of the availability of under-used land in the CRZ. However wind power is dependent upon the DSIR having sufficient wind resources to make the technology viable and studies on behalf of GIDB are currently ongoing to determine the feasibility of wind power in DSIR.

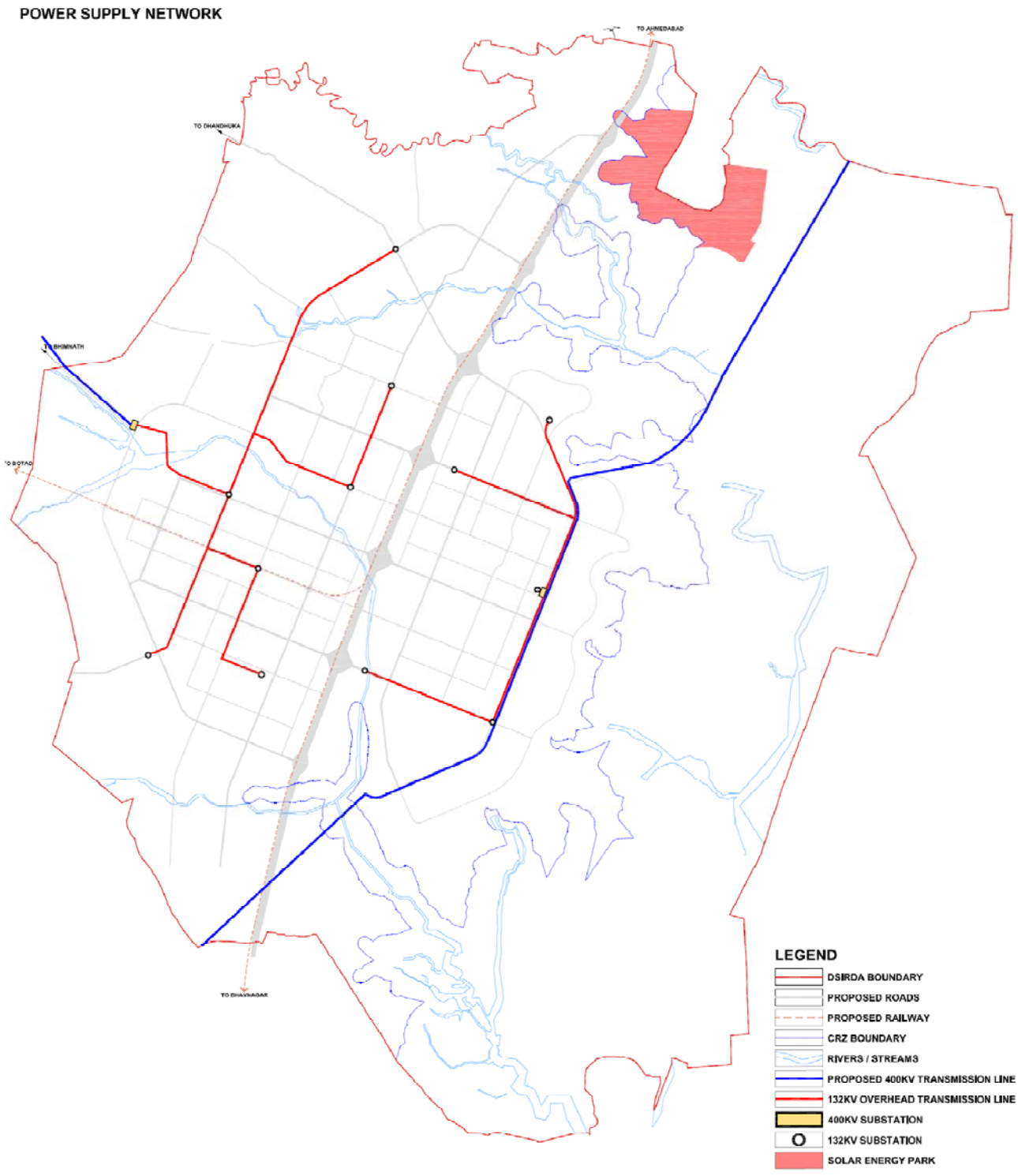


Figure 7-10: Power Supply Network

Solar Power

At the current rates, the estimated capital cost of setting up a solar power plant is in the range of INR 130 – 180 million (13-18 crores) per MW. Based on the technology and system efficiency, the cost of generation is about INR 9-13 per unit. With the latest initiatives from Government of Gujarat and innovation in the technologies involved, it is hoped that solar power generation will become cost effective in the near future.

DSIR region enjoys the advantage of an average of 300 sunny days in a year. The vast barren land mass will also work for the benefit of installation of such a land intensive facility. The land use plan sets aside an area

of about 1290 ha for the generation of solar energy either by concentrated solar power or photo voltaic arrays in the north-east of the DSIR. With this, it is estimated that the solar power generation capacity from the solar park will be about 1161 MU (See Table 7.16).

Renewable energy experts have forecasted that solar power generation will be more competitive than thermal power generation by around 2017. Thus the development Phases 2 and 3 are likely to be more suitable for the establishment of the solar power plant. However, it should be acknowledged that setting up the solar power plant as early as possible in the initial development stages will be extremely advantageous to the project as a whole. While providing a unique identity to the project at a global scale, it will benefit the new city by reducing the dependence on conventional power sources. It is therefore recommended that the establishment of the solar power plant be started in Phase 1.

Wind Power

Wind power is proposed as a potential subsidiary for support power generation and in particular to meet peak power demand. DSIR falls under a moderate wind zone making it potentially feasible for power generation by smaller units. Small generators of around 850 KW capacity may be viable. The wind velocity in the DSIR is more dominant in the evening time, when there will a steep hike of power demand of around 20 percent of average demand. It is therefore proposed to install wind turbines in phases to help meet this peak demand of power. Studies are currently underway to assess the location suitability for installation of wind turbines, but on a broad basis, it is proposed that the CRZ zone be utilized for the purpose.

The Pre-feasibility Study on Renewable Energy Scheme for the DSIR has estimated a power generation potential of about 313 MU from small installations to harness wind power on roof-tops (See Table 7.16).

Energy from Municipal Solid Waste

A small proportion of the energy requirements for the DSIR will be met from the re-use of waste materials. This will include biomass from agricultural processes and the incineration of materials from industrial, commercial and household sources that cannot otherwise be recycled easily or economically. Creating energy from biomass is a well know practice in India and large scale waste to energy plants using modern, clean technology are well proven and popular in developed Nations.

Power Generation Potential from Renewable Energy Sources

A Pre-feasibility study has been undertaken by the consultants to assess generation of power through various renewable energy sources in the DSIR. A summary of the findings of this study is given in Table 7.16.

Table 7-16: Power Generation Potential from Renewable Energy Sources in DSIR

SOURCES	RESIDENTIAL	COMMERCIAL	MUNICIPAL SERVICES*	TOURISM	INDUSTRIAL	SOLAR PARK
Photo Voltaic (MU)	77.6	84.5	2.5	0.46	0	1161
SHW (Solar Thermal)	596.4	0	0	0.09	0	0
Wind (MU)	116.24	197.3	0	0	0	0
Municipal Solid Waste (MW)	0	0	6.5	0	0	0
Biomass (MW)	0	0	0	1	0	0
Process Heat-Solar Thermal (MW)	0	0	0	0	100	0
Power Generation Potential (MU)	790.1	281.8	11	1.745	125	1161

**Municipal Services include solid waste management, water supply, street lighting and traffic signal operations. It is proposed to substitute the usage of electricity for water supply, street lighting and traffic lights from the conventional energy to solar power.*

Energy Minimization

Development and investment in conventional and renewable power is wasted unless efforts are also made to minimize the use of energy. Building Guidelines developed elsewhere in this Plan propose the introduction of the GRIHA National Rating System developed by TERI/LEED India or the equivalent IGBC green building code. The concept of green building focuses on increasing the efficiency of resource use (energy, water, and materials), while reducing buildings impacts on human health and the environment during the building's life-cycle, through better sitting, design, construction, operation, maintenance and removal. Measures to reduce energy use will include high targets for solar water heating, natural ventilation and solar lighting.

Smart Grid Technology

Smart Grid is a new age concept for the efficient use of power transmission and distribution network. Smart Grids would deliver accessibility and reliability. In order to be applicable as per the phasing for the DSIR, the solution needs to be modular in nature and highly reliable. In general, Smart Grid refers to a change from the traditional 'static' electricity network to a 'dynamic' one, and one of the keys to the success of such a network will be extensive use of advanced information based technology (ICT network) to increase the network efficiency, reliability and flexibility.

The DSIR would satisfy its power demand from various sources such as a gas-fired power captive power plant, solar park, possibly wind turbines and other renewable power systems. The application of the Smart Grid philosophy and technologies would be important to assist with the integration of various power generation systems and successful implementation of the management on the demand side.

The Smart Grid Philosophy for Dholera

The distribution network within Dholera development would consist of a series of semi-independent grids or micro-grids. The micro-grids would align closely with the different development phases of DSIR. Smart Grid system cannot be successfully implemented without extensive use of advanced information-based technology such as Distribution Control System (DCS) and SCADA. It also requires Smart Metering, which provides data on the net import/export of energy in the control zone, extending to a more complex arrangement whereby detailed energy usage information and control associated with each load/generation source within the control zone would be provided. To maximize the energy efficiency with the Smart Grid philosophy, the more complex arrangement of deep penetration of Smart Metering within the individual premises would be necessary.

The Smart Grid Control Philosophy

The DCS (Distributed Control System) will need to be able to set the reconfiguration and load management that builds on the functionality of a network analysis system.

The Smart Grids Control System functionality will allow:

- Optimal network utilization
- Details of real time load flow
- Optimal Feeder Reconfiguration
- Power balance
- Short Circuit Analysis
- Loss Minimizations
- Load Switching
- View and Analyze Network Conditions

7.8. Information Communication Technology (ICT) /Telecommunication Network

7.8.1. Introduction

Over the plan period it is likely that development of the ICT/Telecommunication system will continue to evolve as rapidly as in recent years and that the demand for basic telephony, cellular services and broadband services will likewise increase.

In the present scenario, the telecommunication sector enjoys substantial encouragement and support from Government policies and it is reasonable to assume that sustainable and economical fibre optics network in the project area can be developed. The 'Fibre-To-Home concept' is proposed, which will carry all the signals for telephone (landline), broadband internet, video-on-demand, entertainment channel, and so on.

Service providers such as BSNL, Airtel, Reliance, Tata Indicom, Vodafone and Idea are all present in the local market and it is anticipated that multiple carrier services can be made available to consumers by Government agencies or private operators.

7.8.2. Plan Provision

In order to cater to the ICT demand of a state of the art global industrial City by 2040, the following assumptions are considered:

- Fibre-to-Home Connection: One each for each building/plot belonging to all land uses
- Cellular Phone: 100 percent tele-density

The Development Plan provides ducting for carrying ICT/Telecommunication network on major roads, as shown in the road cross sections in Chapter 6. Broadly, the following independent networks would be reticulated:

- 9 numbers of 100mm ducts along the expressway,
- 4 numbers of 100mm ducts along both sides of arterial and collector roads and
- 4 numbers of 100mm ducts along one side of local roads.

Thus, provision of 1.5m corridor has been made for the ICT network.

During detail design, it is recommended that ICT network be developed with following considerations:

- Provision and development of telephone exchanges, telecom cabinets and control rooms at multiple locations depending on the number of users;
- Down-stream cables with localized cabinets of connection capacity depending upon the required pair of lines;
- Infrastructure cables within the development run through underground PVC ducts and pipe of required sizes with inspection chambers at suitable intervals for installation and maintenance along the road side in the cable corridor;
- Optical fibre cables should be used for ICT/ telecommunication system with electronic console, to be laid by the service provider; and facilities for telecommunications infrastructure should be allocated in the new city as when required.
- Any developer will need to define a strategy for the proposed levels of service (i.e. facilities) to be provided in this respect, e.g. including security matters (CCTV) for which additional ducting would be required.

7.8.3. Further Considerations in Future

The developer or facilities manager should consider the following, which may have some limited impact on spatial requirements:

- Telecommunication provider to be defined and engaged into the design process;
- Decisions regarding dedicated or combined telecoms / site management (iBMS, CCTV etc) systems to be made;
- Location of centralised monitoring points to be defined;
- Requirements for GSM (Mobile Network) to be ascertained (repeaters on towers or dedicated masts – parcel allowances within the master plan).

Security

A security policy needs to be developed to determine the level of CCTV and access control required throughout the development. All CCTV and access control systems will be able to be transmitted across the development on the communications network to a central control room.

SCADA

To effectively manage the services across the development, it is recommended that a certain level of monitoring of plant is made available to the Facilities Management team. This would involve transmitting information from the various plant buildings (for water, sewerage, power etc.) to a central point (Maintenance Hanger) where alarms can be monitored, access controlled, and if required, a level of plant control provided.

To achieve this level of monitoring and control, it is important that the individual systems within the various plant buildings are able to transmit their data over the network, and a network is installed – typically, underground fibre optic cabling in ducting is used.

One possible system is a SCADA (Supervisory Control and Data Accusation) protocol is the equivalent of a computer language that can be understood by the various control elements. The syntax rules of some protocols have been made freely available for use by the manufacturer. This is an 'open protocol'. This syntax is not available for all protocols (these are 'closed protocols') although some systems integrators are able to work with them.

7.8.4. Gas Supply

A gas supply line passes close to the DSIR between Anand and Rajkot. The Government of Gujarat has identified the route between Darod and Bhavnagar for a new Gas Grid system for which the off take point is Darod Village. The proposed network would be the nearest gas supply point to the DSIR. The possible off-take points from this proposed network is indicated in the Table 7.17 and illustrated in Figure 7.11.

The viability of connecting the DSIR to the proposed gas network is likely to depend upon demand, which would be largely from the industrial sector. The location of the intake gas station should be strategically planned to be close to the industrial areas to make the distribution network viable. The gas distribution network could be developed for DSIR on a PPP basis.

Table 7-17: Possible Off- Take points for Gas Supply

DIRECTION	LOCATION	DISTANCE FROM SOURCE
North-West	Near Bhadiyad Village	15.06 kms
South-West	Near Hebatpur Village	10.43 kms

7.9. Provision for Integrated Utility Network along Roads

Provision for utility service corridors is made under roads for the following:

- Potable water (transmission & distribution)
- Telecommunication ducts
- Power cables (street lighting/low tension cable / high tension cable)
- Sewer lines
- Storm water drainage
- Recycled water (Irrigation)
- Gas pipe

7.9.1. Aspects considered for allocation of utility corridor

The following aspects are considered for allocation of utility corridors under the road RoW:

- Provision has been made for storm water drainage on all roads;
- Space for storm water drain and sewers is made under the carriage-way or in the median. These services are positioned at least 0.5m below the potable water pipes;
- Separate provision has been made for sewerage (foul water) and effluent from industries;
- Space for electrical services is made under sidewalk, adjacent to the plot boundary;
- Telecommunication ducts, potable water lines and Irrigation water lines are located under the sidewalks, parking lane or the bicycle lane;
- Recycled water (for irrigation) pipes are located in the median for the most part, however they may be located under the carriage way in case of space constraint;
- Potable water pipes may be located under the carriage-way in case of space constraint;
- Gas pipes are located below potable water pipe or telecommunications duct.

It is recommended that the utility pipes/ducts must be installed as per the manufacturer's instructions, and additional protection as required be provided at the road cross sections.

Table 7.18 indicates the minimum service cover required for the provision of each utility. The road cross sections illustrated in Chapter 6, Transport indicate the provision for utilities.

7.9.2. Provision for Fire Fighting

It is recommended that provision for installation for fire hydrants be made on the sidewalks of all roads, at an interval of about 200m, approximately. Water connection for the hydrants would be given through the potable water distribution pipe network provided below the road RoW.

Table 7-18: Minimum Service Cover for Utilities

SR. NO.	UTILITY	MINIMUM SERVICE COVER (m)
1	Potable water pipe (distribution)	0.65
2	Potable water pipe (transmission)	1.2
3	Telecommunications ducts	0.8
4	Power cables (low voltage)	0.65
5	Power cables (high voltage)	1.2
6	Sewage pipes	2
7	Storm water drainage pipe	1.2
8	Recycled (irrigation) water (distribution)	0.65
9	Recycled (irrigation) water (transmission)	1.2
10	Gas pipe	2

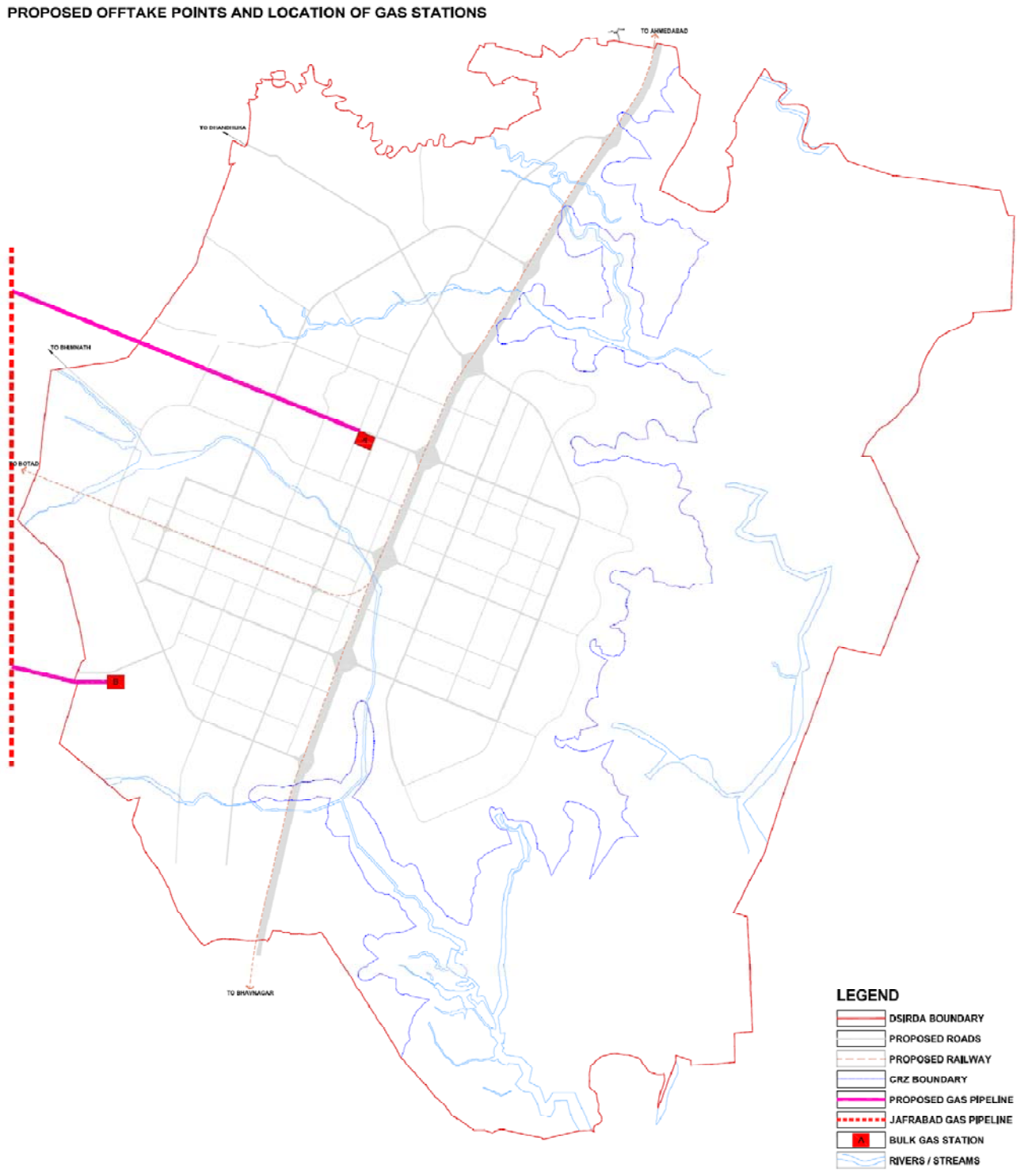


Figure 7-11: Proposed Off-take Points and Locations of Gas Stations

7.10. Smart Metering

The Smart Metering will enable for remote monitoring of power load, total usage and analysis of grid as mentioned in the section above. It is recommended that the metering facilities should come with the protection and control system at the building incoming level for the purposes of monitoring and controlling the generation and demand by the DCS.

Smart Metering would also assist in billing and demand profiling. The collected data will feed into the Network Management System to facilitate billing and demand management through the use of ICT network at the consumer level.

It is recommended that a Smart Metering system be used for the electricity, water supply and district cooling (if installed) at the consumer level and will be connected through ICT network.

7.11. Ubiquitous Urban Infrastructure

7.11.1. Introduction

Information and communication technologies (ICTs) play an increasingly important role in the planning, management and the use of urban physical infrastructure in the areas of transport systems, power supply, sewerage and waste treatment and water supply and management. Already, some ICT-based systems (for example, intelligent transportation systems and underground facilities management systems) have been installed separately to address environmental, transport and other urban problems in countries like Korea and Japan. But such isolated operations make organizational and prompt responses to emergencies difficult as well as render urban management unsystematic and dispersed.

U-City, based on integrated city operation centres, overcomes such problems through integrated services and higher management efficiency.

U-infrastructure uses sensors and sensor networks to continually communicate with wired and/or wireless computer devices embedded in personal devices (mobile phones, personal digital devices), buildings, infrastructure, and any feature or object of the urban space. This allows ubiquitous communication of person-to-person, person-to-object, and object-to-object even though computers or devices are invisible to users.

The ‘ubiquitous urban infrastructure’ (U-infrastructure) also provides everyone with an opportunity to access to urban services using any information technology devices, regardless of time and location. It can make the management of urban facilities more efficient and provision of services less expensive. For instance, people can access information without searching for information via the internet and objects share data with other objects without inputting data from people.

In the most advanced countries like the United States, Japan and in Europe, ubiquitous networking technology is fast emerging as a new paradigm for National informatization. In the Republic of Korea and Japan, policy makers and planners have developed and applied ‘ubiquitous computing systems’ in urban infrastructure planning and development.

7.11.2. Classification of the U-City services

The u-City services can be classified into two core services as follows:

Common Core Service

Common core service refers to the facility management, transportation, crime & disaster prevention, administration and environment related services.

Specialized Service

Specialized service is a service which corresponds to the new-city concept, such as waterfront, culture and tourism, leisure, etc.

Given below are some examples of the two main core services:

U-Administration

A service which aims to improve citizens' quality of life and the overall city management by providing information and monitoring services for the public administration.

U-Facility Management

Builds integrated & remote operation service system for the city infrastructure and provides prompt correspondence system through real-time disaster and safety accident detection, while linking such system with the concerned organization.

U-Transportation Service

The most advanced transportation environment service which converges the existing road, vehicle, traffic signs, etc. with IT, telecommunication, electronics, control and other ubiquitous technology, allowing efficient traffic facility and eases traffic congestion, as well as reducing traffic accidents.

U-Environment Service

Manages the environment efficiently for a more pleasant living environment for the citizens. It also provides an environment experiencing area to promote citizens' environmental awareness, and supports environmental improvement activities such as air purification, energy generation using forces of nature.

U-Waterfront

A service which provides diverse visual presentations such as waterscreen or advanced streetlight, creating a fascinating night view at harbors, waterfront restaurants and theme-bridge, etc.

Provides cultural performance information, tourist information and virtual experience services through mobile phones.

7.11.3. Technologies of Ubiquitous Infrastructure

ICT-based ubiquitous technologies are vital for the development of a U-infrastructure system that provides a wide range of services to the public. 'Telematics', for instance, allows users to send, receive and store traffic information via telecommunication devices, so far mostly by using global positioning system technology integrated with computers and mobile communications technology. Transport telematics applications are able to do more than this, such as contributing to safer, cleaner and more efficient transport by helping travellers, freight distributors and transport operators avoid delays, congestion and unnecessary trips; e.g. diverting traffic from overcrowded roads to alternative modes. These functions cover rail, sea and inland waterways and can reduce accidents, increase productivity, gain extra capacity from existing infrastructure, encourage integrated transport, reducing energy use and pollution, which increases the quality of life within the cities.

A number of other technologies like Broadband Convergence Network (BcN), High Speed Downlink Packet Access (HSDPA), Wireless Broadband (WiBro), Ubiquitous Sensor Network (USN) are also required for the successful development of U-infrastructures. Wireless local area network (WLAN), Radio Frequency Identification (RFID) wideband code division multiple access (WCDMA) and fibre to the home network (FTTH) are among the most sophisticated technologies that are used.

7.11.4. Strategies for DSIR

In the later phases of development, DSIR can make the use of the ICT infrastructure as a major engine to propel its future development and focus on developing its U-City capabilities including early localization of core technologies such as integrated platforms and mapping out comprehensive measures to support the industry.

This would require the preparation of a comprehensive U-city plan outlining the policy vision, basic direction and key tasks for further developmental phases, with the aim of establishing high-tech urban spaces and intelligent city management systems by integrating U-City technologies into urban

infrastructure facilities and improving the quality of life through U-City-based urban services including finely customized services for residents.

To achieve these goals, the following implementation strategies are suggested. The strategies relate to preparation of institutions, development of core technology, support for industry growth and creation of sensible service

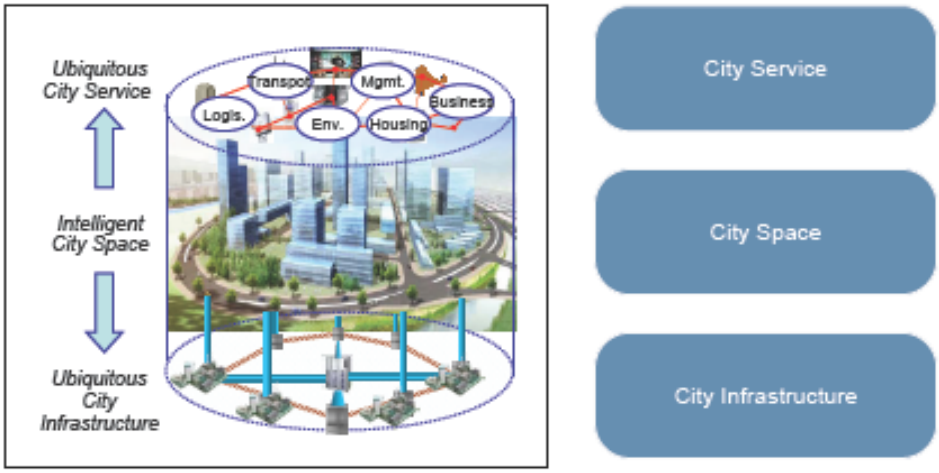


Figure 7-12: Ubiquitous Infrastructure Concept

and key tasks for further developmental phases, with the aim of establishing high-tech urban spaces and intelligent city management systems by integrating U-City technologies into urban infrastructure facilities and improving the quality of life through U-City-based urban services including finely customized services for residents.

To achieve these goals, the following implementation strategies are suggested. The strategies relate to preparation of institutions, development of core technology, support for industry growth and creation of sensible service.

Preparation of Institutions

The Government would have to promptly consolidate a comprehensive institutional basis for the industry related to planning, construction and management. This would require various guidelines for effective planning and management as well as effective measures to protect private information and prevent disasters, damages and infiltrations. For information connections and compatibility, which are key to U-City technologies, clear standards for information, core technologies and individual services will have to be set up. Another important task in this area would be promoting the use of U-City information among private sectors, thus raising the information utilization rate.

Development of Core Technology

The Government will have to provide R&D supports early to localize and foster core source technologies.

Support for industry growth

The Government's important task will be to produce a professional workforce. It will have to nurture high-quality researchers and skilled workers in the sector and train local Government officials with U-City capabilities.

Creation of Sensible Service

In order to find out diverse, creative services and disseminate them among local entities, the Government will also have to encourage active private-sector engagement in U-City planning and operations.

Conclusion

The U-City concept aims to overcome the limitations of the conventional urban planning and management practices. However, as the Korean examples reveal, moving towards a ubiquitous city is costly and requires much time and considerable public educational and skill development. Therefore, rather than solely observing its development in Korea and Japan it might be wiser that for DSIR we develop our own initiatives in intelligent infrastructure systems provision while researching on how to best benefit from these technologies to provide improved quality of life and sustainable urban development.

Figure 7-13: Cities with Ubiquitous Infrastructure

CHAPTER 8

ENVIRONMENTAL ASSESSMENT

8. Environmental Assessment

8.1. Introduction

This section presents the environmental assessment of the DSIR described in the preceding chapters of this report. It covers the following aspects:

- the existing baseline environment of the DSIR;
- environmental legislation applicable to the development;
- the requirements for environmental clearances;
- environmental impacts likely to be encountered during the life cycle of the project;
- proposed mitigation measures to address any potential adverse environmental impacts;
- a broad environmental management plan (EMP);
- Sustainable Design

The existing baseline environment of the DSIR has been described in the Appendix B.

8.1.1. Method of Assessment

A reconnaissance survey of the DSIR was undertaken in the preparation of this environmental assessment. Baseline data in respect of meteorology, ambient air quality, water quality, soil quality and noise levels was collected from the secondary and published sources. This data was analysed and project impacts were assessed on the various components of the environment. An environmental management plan and a sustainable development strategy have been prepared to mitigate the adverse environmental impacts.

8.2. Key Environmental Parameters

8.2.1. Ambient Air Quality

The ambient air quality data available in the Environmental Impact Assessment (EIA) study of the Gujarat State Road Development Corporation (GSRDC) for SH-6 (Sarkhej – Bhavnagar Road) that passes through the project area has been used as the data source. In addition, data published by the GPCB for Bhavnagar industrial area has also been used in this section.

With reference to the air quality standards set by Central Pollution Control Board (CPCB) provided in Appendix B, data in Table 8.1 indicates that the ambient air quality near the project area (Adhelai Village) is well within the stipulated limits. Since there is no pollution generation activity in the project area the ambient air quality at Adhelai village can be considered as representative of the Project region.

Table 8-1: Ambient Air Quality Monitoring

LOCATION	CONCENTRATION (Mg/M^3)				
	SPM	RPM	SO_2	NOx	CO
Adhelai Village	185	58	10.5	12	198
GIDC Chitra, Bhavnagar	240	131	12.6	17	NA
Alang Shipbuilding Yard	205	111	11.2	15.1	NA
Sosiya Ship Breaking Yard	189	103	10.5	14.4	NA
CPCB Standards	200	100	80	80	2000

8.2.2. Water Quality

The water quality can be expressed in terms of physical and chemical characteristics of water. The results of surface and ground water data for the DSIR are given in Table 8.2.

With reference to the water quality standards mentioned in Appendix B, it is observed that the surface water and ground water quality of the project area is saline and are not suitable for drinking.

Table 8-2: Surface and Ground Water Quality

CONCENTRATION IN MG/L EXCEPT PH	SURFACE WATER	GROUND WATER
Source	**Creek**	**Bore-well**
pH	7.66	7.17
TDS	27940	5664
TSS	2444	16
Sulphate	1782	468
Phosphate	0.83	0.32
Chloride	13596	2444
Turbidity (NTU)	416	0.9
Alkalinity	240	260
Iron	0.9	Nil
Hardness	5700	1100

8.2.3. Noise

Ambient noise data for the site is not available in published sources. The project area does not have commercial and industrial activity; therefore, ambient noise levels are expected to be well within the limits specified by the CPCB for rural and residential areas. The noise level standards are described in Appendix B.

8.2.4. Biological Resources

Vegetation

The Project site and its surroundings exhibit sparse vegetation of shrubs and thorny bushes and trees such as the Australian Babul, Neem, Pilu and Bore are encountered occasionally. The area adjoining the Gulf of Khambat has practically no vegetation except for mangroves at some locations.

Fauna

The Velavadar Black Buck Sanctuary, famous as one of the few Black Buck habitats in the sub-continent, is situated just to the south of DSIR boundary covering an area of nearly 35 sq km of flat grasslands, the Sanctuary is characterized by a unique grassland eco-system that has attracted fame for the successful conservation of the Blackbuck, the wolf and the lesser known Florican.

The Ministry of Environment and Forests (MoEF) has prescribed an eco sensivte zone in and aournd Velavadar. The DSIR area does not fall within this eco sensitive zone. The eco-sensitive zone is as show in figure 8.1

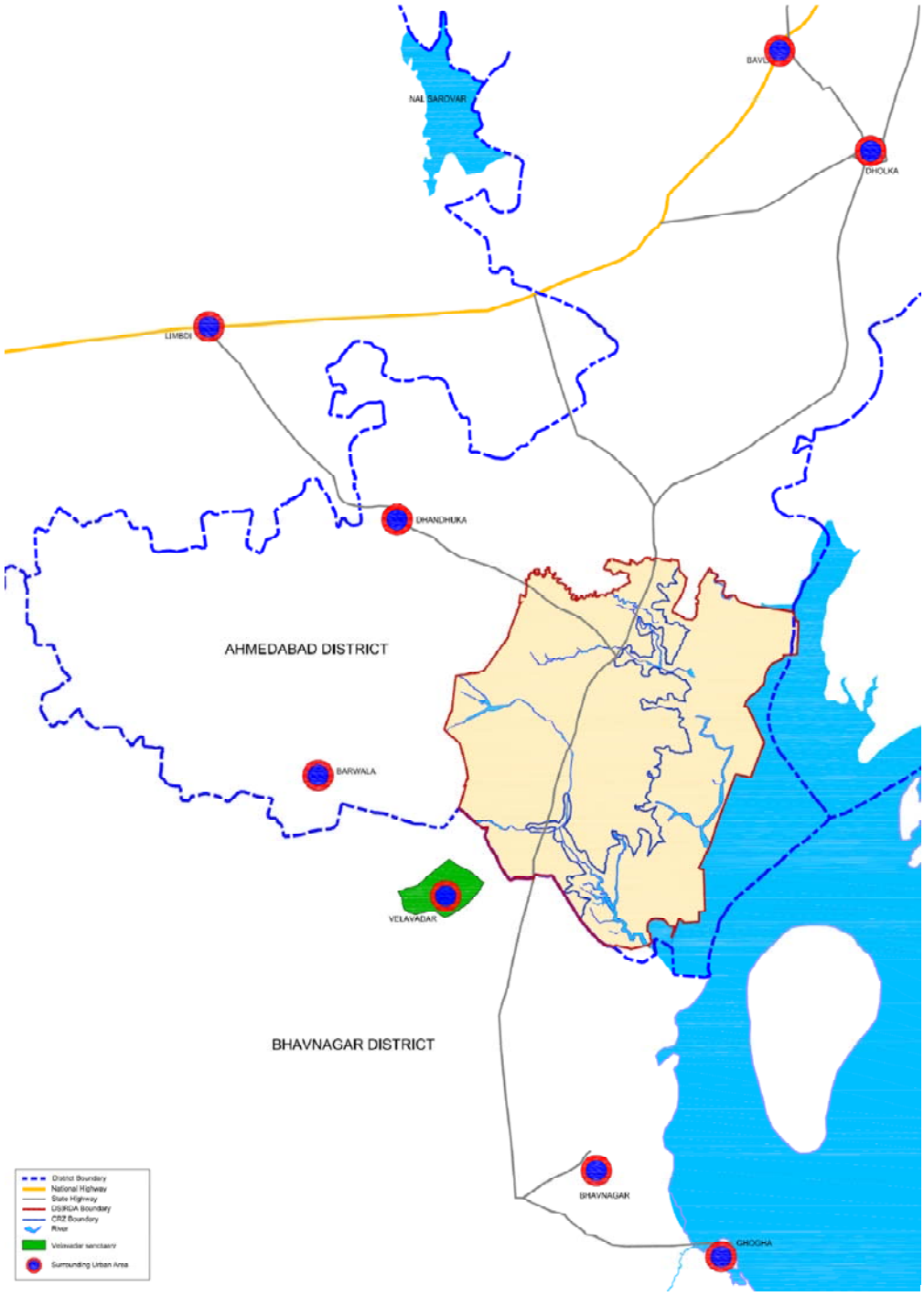


Figure 8-1: Natural Habitats in Proximity of the DSIRDA

8.3. Requirements of Environmental Related Clearances

Environmental Policies and the Legal Framework for the Industrial Mega Park 1

a. Article 48A and 51A of the Indian Constitution:

As a sequel to the UN Conference on the Human Environment (1772), Indian Parliament in 1776 amended the Constitution of India by introducing articles 48A and 51A. These articles incorporated environmental concerns into the Directive Principles of the State Policy and Preservation and thus, protection of the environment was postulated as one of the fundamental duties of all citizens.

b. Government of India – Environmental Legislations:

Acts and Rules relevant to environment protection prevail and will be applicable during pre-development, and project preparation stage as indicated in Table 8.3.

Environmental Administration

The MOEF is responsible for setting policy and standards for the protection of the environment along with the CPCB. This includes air, noise and water quality standards and the requirements for the preparation of EIA statements for developmental projects. Table 8.4 indicates clearances required for the development of the DSIR from various agencies, whereas Table 8.5 indicates applicability of various environment related acts and rules.

Table 8-3: Applicable Environmental Acts and Rules

ENVIRONMENTAL ACT / RULES	YEAR OF NOTIFICATION
The Environment Protection Act	1986
The Environmental Assessment Notification	2006
The Forest Conservation Act	1980
The Water (Pollution Prevention and Control) Act	1974, amended in 1988
The Air (Pollution Prevention and Control) Act	1981, amended in 1987
The Noise Pollution (Regulation and control Rules)	2000
The Motor Vehicles Act	1988
Central Motor Vehicles Rules (Rules 129 through 137)	1989
Fly Ash Notification	2003
Manufacture Storage and Import of Hazardous Chemical Rules	1989
Hazardous waste (Management and Handling) Rules.	1989

Table 8-4: Environmental Clearances Required for the DSIR

CLEARANCE REQUIRED	DESCRIPTION
Government of India	
MOEF Clearance	The DSIR will be classified as category 'A' development and will require clearance from MoEF, New Delhi.
CRZ Clearance	The Project area includes existence of creeks and part of the site is under CRZ I and III, therefore CRZ clearance will be needed for the project from MoEF.
State Government	
Wild Life Clearance	The Black Buck National Park is located at about 4.0 km from the site boundary, so clearance is not required. However consent of Principal Chief Conservator of Forest (Wild Life) must to be sought for approval of the buffer within the DSIR for Velavadar Black Buck Sanctuary.
Forest Diversion & Tree Cutting	In 1986, when the MoEF enacted the Environmental Protection Act, linear stretches of roadside plantation along many of the Highways were declared as Protected Forest. Thus, removal of trees from Protected Forests including roadside trees given a protected Status shall require clearance from the MoEF.

Table 8-5: Responsible Agencies, Policies and Regulations

AGENCY	STATUTE/ POLICY	RELEVANT OBJECTIVES
Ministry of Environment & Forests, GOI	The Environment (Protection) Act 1986	To protect and improve the quality of the environment and to prevent, control and abate environmental pollution
	The Forest (Conservation) Act, 1927 The Forest (Conservation) Act, 1980 as amended in 1998 The Forest Conservation Rules, 1981	To restrict deforestation by restricting clearing of forested areas
	Environment Protection Rules, 1986 The Environmental Impact Assessment Notification 2006	To ensure that appropriate measures are taken to conserve and protect the environment before commencement of operations
Pollution Control Board (State)	The Water (Prevention and Control of Pollution) Act 1974 as amended in 1988	To provide for the prevention and control of water pollution and the maintaining or restoring wholesomeness of water
	The Air (Prevention and Control of Pollution) Act 1981 as amended in 1987	To provide for the prevention, control and abatement of air pollution and for the establishment of Boards to carry out these purposes.
Environment & Forest Department	The 1972 Wildlife (Protection Act),	To protect wild animals and birds through the creation of National Parks and Sanctuaries
Department of Transport and Department of Police	The Motor Vehicles Act, 1988 The Motor Vehicle Rules, 1989 Rules of Road Regulations, 1989	To control vehicular air and noise pollution To regulate transport sector development
Archaeological Survey of India, Directorate of Archaeology	To regulate construction activities near the monuments and sites protected by the Government Ancient Monuments and Archaeological sites and Remains Act, 1958	To protect and conserve cultural and historical remains
Revenue Department	The Land Acquisition Act, 1894	To set out rules for acquisition of land by the Government departments and agencies

8.4. Development Proposed

This Plan provides details of the development proposed within the DSIR over the next 30 years. It includes the development of about 33,846 ha land outside the CRZ, (excluding area under open spaces, and agriculture) comprising industrial, residential and other urban uses together with supporting infrastructure including roads, railways, waste water & treatment facilities, solid waste disposal, drainage channels, power generation & supply infrastructure, and all services required to support a target population of about 2 million inhabitants.

8.5. Potential Impact and Mitigation Measures

This section assesses the environmental impacts of the proposed urban development in the construction and operational phases. The project is generally expected to bring in positive social impact in terms of employment for locals. In addition to employment, the infrastructure facilities in the project area and

surroundings will improve significantly. However, in the absence of due care, development of the DSIR may induce negative impacts, during the construction and operational phases.

Based on the baseline data collected from secondary and published sources, and field visits to the DSIR and study of the project activities following the design, construction and operation phases; the environmental impacts that have been identified are discussed below:

8.5.1. Climate

Limitations

This assessment does not address the wider issue of climate change and greenhouse gas (GHG) emissions. GHGs arise from many industrial processes and also from agriculture. Although GHGs are widely thought to be contributors to climate change, there are currently no emissions targets agreed for India at international or National level. Agreements such as the Kyoto Protocol and any successor treaties such as may emerge from the United Nations Climate Change Conference in Copenhagen 2007 may nevertheless agree international targets for controlling emissions.

Therefore in the future, the Government may set limits upon the emissions of GHGs from industrial users in the DSIR. However at present, GHG emissions from the DSIR are not subject to control and have therefore not been considered in this assessment.

Impacts during Pre-construction and Construction

Local Climate:

The proposed construction activities during the development of infrastructure and during the establishment of Industries will likely give rise to dust but this will be localized within the DSIR and will be of somewhat short duration.

No impact on the local climate is anticipated during the operational stage of the project, subject to the limitation already stated.

Landscape:

The existing landscape is undistinguished and is of little scenic value. It comprises of small trees and crops. This vegetation will be removed for construction work but will be replaced by landscape planting along roads and green buffer zones on the edges of the industrial plots.

Impacts during Operation

During operation there will be positive impact on climate as planned parks and open spaces within the DSIR will grow. There will be no impact on topography.

No impact on climate and topography is anticipated during the operation phase of the project, subject to the limitations noted earlier.

Mitigation Measures during Pre-construction and Construction

The removal of trees and vegetation will be minimized during the construction phase to minimize impacts on landscape and climate. Since rural villages and their surroundings are surrounded by a buffer zone, therefore the current landscape of villages will not change.

Mitigation Measures during Operation

Landscape planting along roads and buffers along industrial plots will account for natural vegetation lost during construction works.

8.5.2. Rural Services within the DSIR

Impacts during Pre-construction and Construction

During the construction phase there can be some minor impacts in the form of inconvenience to the general public living in rural areas due to movement of construction vehicles and machinery and material handling.

Impacts during Operation

During the operation phase there will be no impacts on the services of the rural population. There will be a positive impact on services to local people as the project will provide improved connectivity, water supply, and electricity to local villages within the DSIR.

Proper mitigation measures will be able to reduce the traffic disturbances. In a particular stretch, where construction activities are being initiated, local people should be made aware of the construction schedule so that they co-operate with the construction activities. The contractor will provide safe and convenient passage for vehicles and pedestrians. The contractor will not disturb the existing access for any construction activity without providing adequate alternate provisions.

Mitigation Measures during Pre-construction and Construction

The existing utility lines (water supply, electricity, telephone) will not be disturbed until the alternative supply source is constructed.

Mitigation Measures during Operation

Since no impacts have been identified on rural services during operation phase, therefore, no mitigation measure is warranted.

8.5.3. Air Quality

Impacts during Pre-Construction and Construction

During the development of the DSIR (Roads, drainage, water supply, sewage network and power supply) suspended particulate matter (SPM) and respirable suspended particulate matter (RSPM) level may rise due to dust generation, fugitive emissions from the vehicles, construction equipment and machinery. The dust generation will take place due to material handling at road and drainage work construction sites, excavation of trenches for laying of pipelines for sewage, water supply and underground cables for electric supply. The impacts will be localized, temporary and reversible. These will be limited to construction duration.

Impacts during Operation

During the operation phase impacts on ambient air quality will be due to vehicular emissions from the vehicles, diesel generator sets in the event of power failure. The industries have been planned by and large non-polluting hence there are no chances of process emissions from the industries.

Mitigation Measures during Pre-Construction and Construction

In order to control the dust emissions there will be regular water spray at the construction sites. All the construction vehicles and machinery will conform to latest Central Pollution Control Board (CPCB) regulations. The contractor will submit 'Pollution under Control Certificates' to the Project Management Consultants (PMC). There will be regular environmental monitoring at construction site to check the pollution levels during the construction. The environmental monitoring frequency has been specified in the monitoring plan. This monitoring plan has been given in the subsequent sections.

Mitigation Measures during Operation

During the operation phase the individual units will install air pollution control equipment, if required, as per 'Consent to Operate' conditions of Gujarat Pollution Control Board. In the project area and surroundings there will be regular ambient air quality monitoring according to the environmental monitoring plan.

8.5.4. Noise

Impacts during Pre Construction and Construction

Noise levels may increase during construction due to construction activities, movement of vehicles, construction machinery and equipment, which will be temporary, localized and reversible.

During Operation

During the operation phase increased noise levels in the DSIR will be felt due to movement of vehicles, and due to operation of plant and machineries within the individual industries.

Mitigation Measures during Pre Construction and Construction

No construction activity will be permitted near the settlements during night hours. All construction equipment, machineries, vehicles be fitted with noise controlling equipment and will adhere to CPCB norms.

Workers in the vicinity of high noise levels will be provided ear plugs, helmets and shall be engaged in diversified activities to prevent prolonged exposure to noise levels. At no instance noise levels at construction site will exceed the limit of 70 dB (A) in an 8 hours limit recommended in the Factories Act 1756.

Mitigation Measures during Operation Phase

Vehicular noise within the DSIR will be mitigated due to the planting of shrubs and trees in the medians and along roads. The applicable ambient noise levels as per Ambient Noise Level Standards will be 75 dB (A) for 'Day' time (0600 – 2100 hours) and 70 dB (A) for 'Night' time (2200-0500 hours). Within the boundary of industrial area noise levels will be controlled as per requirements of the Factories Act.

All diesel generating sets to be procured by the individual entrepreneurs will be with acoustic enclosures according to the requirements of CPCB regulations. The nature of industries in the DSIR is such that industries will not generate extensive noise as noise generating sources such as compressors, cooling towers, and boilers are not expected to be installed at individual industrial units.

8.5.5. Water Quality

Impacts during Pre-construction and Construction

- Surface Water Quality

  Perennial surface water sources do not exist at the project site. River Lilka carries some storm water during the monsoon.

  The other surface water sources in the project area are village ponds. These ponds are not likely to be impacted as in the project planning buffer area around villages has been left untouched. The other impact is likely during construction in the event of contractors using the pond water for the construction purposes.

- Ground Water Quality

  The ground water in the project area is saline in nature. There are no ground water sources having sweet water in the project area. Hence no impact on ground water potential is anticipated as project will not utilize ground water during construction or operation.

Impacts during Operation Phase

Impacts will be felt on ground water quality and soil of the region if domestic sewage and industrial water generation are not treated properly and discharged on open ground.

Mitigation Measures during Pre Construction and Construction Phase

During the construction phase, all waste water generated at construction camp and construction workers camp will be diverted to septic tanks. The contractor will provide proper temporary drains at construction sites during monsoon to avoid accumulation of storm water. The borrow areas for road construction will not be operated near villages so that these do not act as stagnant pools for mosquito breeding.

Mitigation Measures during Operation Phase

All waste water generated (industrial effluent and domestic waste water) from the DSIR will be treated in the Sewage Treatment Plants (STPs) and the Common Effluent Treatment Plants (CETPs). The treated waste water will be discharged through newly constructed lined drains. The existing drains will not be used for the discharge of waste water.

8.5.6. Flora and Fauna

Impacts during Pre-construction and Construction

The project area has common flora and fauna. There will be removal of shrubs from the RoW of planned roads and utilities network. The impact on flora will be temporary in nature because it will re-grow after completion of the construction works. There is no wild life in the project area except domesticated fauna; therefore, no impact is anticipated.

Impacts during Operation

During the operation phase there will be a positive impact on flora as shrubs and tree plantation will be taken up along the roads and in the vacant space in the project area. No impact on fauna of project area and surroundings is anticipated in the operation phase of the project.

Mitigation Measures during Pre-construction and Construction

During the construction phase only vegetation and trees marked will be cut. The workers of construction camps will be trained not to hunt the local wild animals and not to cut the trees for cooking. The contractor will provide cooking fuel (Kerosene/LPG) to the workers. This will be part of the contract document.

Mitigation Measures during Operation

During the operation phase to compensate the tree cutting, there will be compensatory tree plantation. This compensatory tree plantation will be taken in the ratio of 1:3 i.e.: three trees will be planted for every tree to be cut.

8.5.7. Solid Waste Generation

Impacts during Pre-construction and Construction

Solid waste will be generated through the dismantling of pavement, bituminous road during the up gradation of the existing routes, disposal of sub-standard construction material, excess soil generation due to excavation, and waste generated from construction camps.

The contractor will need to submit a waste reduction, re-use and construction activity waste disposal plan. This will include a previously identified site for disposal of construction waste and debris, or arrangement with construction waste haulers to dispose the waste to the authorised dumping ground.

Impacts during Operation

During operation phase two types of solid wastes will be generated from the Mega Industrial Park. The type of these wastes will be as follows:

a) Conventional Solid Waste – This waste will be generated from the household activities
b) The other main solid waste generated at Mega Industrial Park will be from industrial operations at individual industrial units. The sludge from CETPs will also be generated in significant quantities. This waste will be hazardous in nature. The estimation of this waste is difficult at present as exact numbers of industries likely to come up are not known.

The above wastes are to be disposed off properly to avoid ground contamination and adverse impacts.

Mitigation Measures during Pre Construction and Construction

Debris / solid waste generated will be reused during the construction. Waste generated from the construction camps will be disposed off as per law and to the extent of satisfaction of Engineer appointed by DSIRDA

The clean-up and restoration operations will be implemented by the contractor prior to demobilization. The contractor will clear all temporary structures; dispose off all garbage and night soils waste as desired by the engineer. All construction zones used by the project will be left clean and tidy, at the contractor's expense and to the extent of satisfaction of engineer.

Mitigation Measures during Operation

The conventional solid waste will be disposed off as per provisions of Municipal Solid Waste (Management and Handling) Rules- 2000. A municipal solid waste disposal site will be developed in the DSIR.

The hazardous waste generated will be disposed off as per provisions of 'Hazardous Waste (Management, Handling and Transboundary) Rules, 2008 and non hazardous waste will be disposed off along with municipal solid waste generated at site.

Impacts and Mitigations for Construction Workers' Camp

The Contractors to be engaged for different construction jobs are likely to engage local labour for various construction activities. However, in case of engaging migrated labour for the purpose, the contractor has to establish properly designed labour camps with all basic amenities such as proper water supply and sanitation facilities. The EMP envisages mitigation measures for likely adverse impacts associated with the labour camps.

8.5.8. Interference with the Local Water Supply

During Pre-construction and Construction

The water demand for construction activity will be significant, but contractors will arrange their own supply of water for the construction works, therefore, interference with the local water supply is not anticipated.

During Operation

During operation phase there will be separate lines for water supply to Mega Industrial Park and there will be no interference with the local supply.

8.5.9. Accidents and Risks

Impacts during Pre-construction and Construction

As the proposed work involves use of heavy machinery and work force has at times to work in accident and risk prone conditions. If the contractor does not take reasonable precautions to prevent danger to the workers and the public from accidents, the impacts will be severe.

Impacts during Operation

During operation phase there will be accidental risks due to vehicle collisions on roads of the Industrial zone.

Mitigation Measures during Pre-construction and Construction

The excavated area shall be delineated properly with proper fencing and reflective markings to avoid accidental fall of human beings or animals. All other precautionary measures shall be taken to prevent accidents and risks from electrical equipment, and other hazardous activities. Provision of first aid and emergency response system to deal with accidents shall be maintained at the construction sites.

Mitigation Measures during Operation

During operation phase all roads will be delineated with reflective markings and road signages and gantry will be provided as per stipulations of IRC.

The accidental risks at industries will be controlled through in-house safety audits and through installation of safety devices per requirements of the Factories Act.

8.5.10. Socio-economic Conditions

Impacts during Pre-construction and Construction

The implementation of the project does not involve involuntary resettlement of people. However, there may be limited acquisition of land from private owners for having some of the critical trunk infrastructure in place.

Positive impact is anticipated in terms of employment opportunity as many skilled, semi skilled and un-skilled personnel will get direct and indirect employment during the construction phase.

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

Impacts during Operation

During the operation phase there will be positive social impact as there will be huge generation of employment to the locals. The quality of life of the people living in local villages in the project area and surroundings will improve significantly. Social assessment has been presented in the following Chapter 9.

Mitigation Measures during Pre-construction and Construction

It is recommended that a Grievance Redressal Mechanism be put in place to alleviate grievances of the existing village communities and land owners caused during this stage.

Mitigation Measures during Operation

It is recommended that social welfare measures be taken up by DSIRDA. The details of these will be worked out during project implementation.

8.6. Environmental Management Plan (EMP)

The project will be implemented as per provisions of 'The SIR Act -2009'. As per this act there will be formation of Regional Development Authority (RDA), here DSIRDA.

To ensure the effective implementation of mitigation measures and environmental management plan, during construction and operation phase of the sub-project, it is essential that an effective Environmental Monitoring Plan is implemented.

Ambient Air Quality (AAQ) Monitoring

RSPM, SPM, SO2 and NOx are to be monitored at two appropriate locations from the commencement of construction activities. These locations will be identified by DSIRDA. These locations will change during construction phase as intensity of construction will change during the construction. Monitoring should be done near construction sites during construction phase in accordance to National Ambient Air Quantity Standards.

The measurements of noise levels at two appropriate locations (locations same as that of ambient air quality) should be carried out near construction sites during construction phase in accordance to the ambient noise standards formulated by Ministry of Environment and Forests (MoEF).

PH, DO, BOD, COD, TDS, TSS, Turbidity, Temperature, and conductivity (as per the requirement) are to be monitored at surface water bodies (village ponds). Maximum two locations will be selected.

Table 8.6 indicates the institutional framework for environmental monitoring of the project while Table 8.7 gives the recurring costs. Table 8.8 gives the Environmental Monitoring Plan for DSIR.

Table 8-6: Institutional Framework for Environmental Monitoring

COMPONENT	PROJECT STAGE	PARAMETER	STANDARDS	LOCATION	DUCATION FREQUENCY	INSTITUTIONAL RESPONSIBILTIES	
						IMPLEMENTATION	SUPERVISION
Water	Construction stage	pH, DO, BOD, COD, TDS, TSS, Turbidity, Temperature, and conductivity	Water quality standards	Two Locations to be identified by DSIRDA	Once in 3 months	Contractor through approved monitoring agency	DSIRDA
Air	Construction stage	RSPM, SPM, NOX, SOX	National Ambient Air Quality Standards	Two Locations to be identified by DSIRDA	Once in 3 months	Contractor through approved monitoring agency	DSIRDA
Noise	Construction stage	Ambient noise level	As per National Noise Standards	Two Locations to be identified by DSIRDA	Once in 3 months	Contractor through approved monitoring agency	DSIRDA
Operation Phase							
Air	Operation stage	RSPM, SPM, NOX, SOX	National Ambient Air Quality Standards	At two locations. Locations to be identified in consultation with GPCB	Once in 3 months for first 5 years	DSIRDA through approved monitoring agency	Approved Monitoring Agency
Water	Operation Stage	pH, DO, BOD, COD, TDS, TSS, Turbidity, Temperature, and conductivity	Water quality standards	At two locations. Locations to be identified in consultation with GPCB	Once in 3 months for first five years	DSIRDA through approved monitoring agency	Approved Monitoring Agency

Table 8-7: Recurring Cost

ITEM	FREQUENCY	UNIT COST (RUPEES)	TOTAL COST (RUPEES)
Construction Phase			
Air Quality Monitoring	Once in 3 months excluding monsoon season at 2 locations (Total 3 samples in Construction phase at each location in each year total 18 samples in 3 years)	6000	1,08,000
Noise Level Monitoring	Once in 3 months excluding monsoon season at 2 location ((Total 3 samples in Construction phase at each location; total 18 samples)	1500	27,000
Water Quality Monitoring	Once in 3 months excluding monsoon season at 2 location (Total 3 samples in Construction phase at each location; total 18 samples)	6000	1,08,000
Total cost for 36 months			Rs. 2,43,000 Say Rs. 2,50,000
Operation Phase			
Air Quality Monitoring	Once in 3 months at 2 locations (Total 30 samples in 60 months)	6000	1,80,000
Water Quality Monitoring	Once in 3 months at 2 locations (Total 30 samples in 60 months)	6000	1,80,000
Noise Level Monitoring	Once in 3 months at 2 location (Total 30 samples in 60 months)	1500	90,000
Total Cost			4,50,000
Grand Total (Rs.)			**7,00,000**

Table 8-8: Environmental Management Plan

	ENVIRONMENTAL ISSUE/ COMPONENT	REMEDIAL MEASURES	APPROXIMATE LOCATION	TIMEFRAME	INSTITUTIONAL RESPONSIBILITY	
					IMPLEMENTATION	SUPERVISION
	A. Pre Construction and Construction Phase					
1	Uncertainties concerning land and other asset acquisition	The compensation will be paid to the Project Affected Persons (PAPs) as per Rehabilitation and Resettlement Policy of Government of India	DSIR	During pre construction and construction	Government of Gujarat	DSIRDA
2	Existing water supply and other utility lines	During design, it will be ensured that water supply and other utilities may not get affected. If any kinds of public utilities are required to be shifted, then this shifting shall be done before start of construction phase and in minimum time duration.	DSIR	During Pre Construction and Construction phase	Government of Gujarat	DSIRDA
	B. Construction Phase					
3	Construction waste generation and disposal	During the construction phase the silt and solid waste generated, shall be disposed off at the site approved by the Engineer appointed by DSIRDA The operations related to the cleaning, removal, storage and transportation of the waste materials shall be performed in strict adherence to the central & Gujarat Pollution Control Board norms.	Construction sites	During construction phase	Contractors	DSIRDA
4	Use of water for construction	The contractor will make arrangements for water required for construction in such a way that water availability and supply to nearby communities remain unaffected. For construction purpose water will be taken from existing surface bodies i.e. village ponds	Construction sites	During construction phase	Contractors	DSIRDA
5	Rural Services	Construction wastes should be collected and disposed off in an environmentally sound manner as soon as construction is over at a particular stretch. In a particular stretch, where construction activities are being initiated, local people should be made aware about the construction schedule so that they co-operate with the construction activities. For construction purpose, local water resources shall not be used as villagers are dependent on these and project area suffers from salinity ingression from the sea.	Construction sites	During construction phase	Contractors	DSIRDA
6	Surface water quality	Sewage water from construction camp and construction workers camp will not be discharged with storm water and will be disposed off in septic tank.	Construction Camp and sites	During construction phase	Contractors	DSIRDA

	ENVIRONMENTAL ISSUE/ COMPONENT	REMEDIAL MEASURES	APPROXIMATE LOCATION	TIMEFRAME	INSTITUTIONAL RESPONSIBILITY	
					IMPLEMENTATION	SUPERVISION
7	Air pollution and dust emissions from construction activities	Vehicles transporting construction waste, loose and fine materials, like sand and fine aggregates should be fitted with tail boards to reduce spills. Water sprinkling to suppress dust shall be carried out at the construction sites (if required). The contractor will take every precaution to reduce the level of dust from construction activities and machineries either by sprinkling of water or encapsulation of dust source and by erection of screen/barriers/curtains. Regular maintenance of machinery, vehicles and equipment will be carried out. All vehicles, plants and equipment used in construction will conform to the MoEF/GPCB air quality standards. Ambient air quality monitoring should be carried to ensure the effectiveness of mitigation measures.	Construction sites	During construction phase	Contractor	DSIRDA
8	Noise Levels	Protection devices (ear plugs or ear muffs) shall be provided to the workers operating in the vicinity of high noise generating machines. Construction equipment and machinery should be maintained properly. Operation of construction machines will be scheduled to coincide with period when people would least likely be affected. The unloading of materials at construction sites in/close to settlements will be restricted to daytime only. Noise levels should be monitored during construction phase and suitable control measures should be taken, if noise levels are found to be above the prescribed standards.	Construction Sites	During construction phase	Contractors	DSIRDA

	ENVIRONMENTAL ISSUE/ COMPONENT	REMEDIAL MEASURES	APPROXIMATE LOCATION	TIMEFRAME	INSTITUTIONAL RESPONSIBILITY	
					IMPLEMENTATION	SUPERVISION
9	Sanitation and waste disposal in construction camps/workers' camp (Based on requirement of camp)	The construction camps will be located away from the habitation. Supply of sufficient quantity of potable water in every work place/labour campsite at suitable and easily accessible places and regular maintenance of such facilities is to be ensured. The contractor will provide garbage bins in the camps and ensure that these are regularly emptied and disposed off in a hygienic manner. Unless otherwise arranged by local sanitary authority, arrangements for disposal of night soils (human excreta) will have to be provided by the contractor. Contractor will keep the sewage system for the camp area in such a fashion that no health hazard occurs. Separate toilets/bathrooms, wherever required, screened from those from men (marked in vernacular) are to be provided for women. Adequate water supply is to be provided in all toilets and urinals. Temporary medical facilities to be provided by the contractor to the workers.	At Construction camp locations, wherever located in the project area	During construction phase	Contractors	DSIRDA
10	Drainage and run-off	Contractor will ensure that construction materials like earth, stone or appendage are disposed off in a way not to block the flow of water of any water course. In addition to the design requirements, the contractor will take all required measures as directed by the Engineer appointed by the DSIRDA to prevent temporary or permanent flooding of the site or any adjacent area.	Entire DSIR area	During construction phase	Contractors	DSIRDA
11	Accessibility	The contractor will provide safe and convenient passage for vehicles and pedestrians. The contractor will not disturb the existing access to the villages in the SIR area for any construction activity without providing adequate alternate provisions.	Entire DSIR area	During construction phase	Contractor	DSIRDA
12	Flora and Fauna	The contractor will take reasonable precautions to prevent his workmen or any other persons from removing and damaging any flora (plant/vegetation) and fauna (animal/bird). The unloading/dumping of construction and waste materials should be done away from the existing trees.	Workers' camps	During construction phase	Contractors	DSIRDA

	ENVIRONMENTAL ISSUE/ COMPONENT	REMEDIAL MEASURES	APPROXIMATE LOCATION	TIMEFRAME	INSTITUTIONAL RESPONSIBILITY	
					IMPLEMENTATION	SUPERVISION
13	Safety near construction activities	To ensure safe construction, temporary accesses during construction, lighting devices and safety signal devices will be installed. First aid facilities to be provided by the contractor at the construction sites The contractors will take all necessary measures for the safety of traffic and people during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as required by the Engineer for the information and protection of traffic approaching or passing through the construction areas. The contractors will comply with all the precautions as required for ensuring the safety of the workmen as per the International Labour Organization (ILO) Convention No. 62 as far as those are applicable to this contract. The contractors will not employ any person below the age of 14 years for any work and no woman will be employed on the work of painting with products containing lead in any form.	Entire DSIR area	During construction phase	Contractors	DSIRDA
14	Contamination of soil from fuel and lubricants	Construction vehicles and equipment will be maintained and refueled in such a fashion that oil/diesel spillage does not contaminate the soil.	Entire DSIR area	During construction phase	Contractors	DSIRDA
15	Contamination of soil from construction wastes	Construction wastes, generated, will be dumped by contractor in consultation with Engineer at suitable site.	Entire DSIR area	During construction phase	Contractors	DSIRDA
	C. Contractors' Demobilization					
16	Clean-up Operations, Restoration and Rehabilitation	The clean-up and restoration operations are to be implemented by the contractor prior to demobilization. The contractors will clear all temporary structures; dispose all garbage and night soils waste as desired by the Engineer appointed by DSIRDA. All construction zones used/affected by the project will be left clean and tidy, at the contractor's expense, to the entire satisfaction to the Engineer.	Entire DSIR area	At the end of construction Phase	Contractors	DSIRDA

	ENVIRONMENTAL ISSUE/ COMPONENT	REMEDIAL MEASURES	APPROXIMATE LOCATION	TIMEFRAME	INSTITUTIONAL RESPONSIBILITY	
					IMPLEMENTATION	SUPERVISION
	D. Operation Phase					
17	Environmental Monitoring in respect of Ambient Air Quality, Water Quality, Soil Quality, and Noise Levels	The environmental monitoring in respect of ambient air quality, water quality, soil quality and noise levels will be carried out as per monitoring plan	At identified locations	Operation phase initial five years	DSIRDA	Approved Agency
18	Environmental Monitoring in respect of Ambient Air Quality, Water Quality, Soil Quality, and Noise Levels	The environmental monitoring in respect of ambient air quality, water quality, soil quality and noise levels will be carried out as per monitoring plan	At identified locations	Operation phase initial five years	DSIRDA	Approved Agency
19	Maintenance of plantation, drains and proper disposal of solid wastes	The plantation will be maintained properly. Minimum survival rate of plantation in initial 5 years be maintained as 75%. The drains should be maintained properly and these should be cleaned in pre-monsoon season so that there is no accumulation of storm water in the Mega industrial Park. The solid waste disposal to be carried out as per provisions of Municipal Solid Waste (Management and Handling) Rules 2000 and Hazardous Waste (Management, Handling and Transboundary) Rules, 2008. In no case wastes should be disposed off near Rural areas, Gulf of Khambat, and CRZ area.	Entire DSIR area	Entire Project life	Contracting Agency hired by DSIRDA	DSIRDA
		The common effluent treatment plant, sewage treatment plant will be properly operated and monitoring report of treated effluents shall be submitted to GPCB at regular intervals as specified in Consent to operate conditions of GPCB.	CETPs and STPs	During operation phase	Contracting Agency hired by DSIRDA	DSIRDA

CHAPTER 9

SOCIAL ASSESSMENT

9. Social Assessment

9.1. Scope

This social assessment is based upon the following primary data sources:

- 2001 Census;
- GIS database developed from high resolution satellite imagery;
- site visits to the area;
- research into the land acquisition in India and
- discussions with the GIDB officials.

The output of this assessment is:

- background data on the socio-economic conditions in the DSIR, including population, sex ratio, livelihoods, literacy, land ownership and land farm size, and access to community facilities;
- assessment of likely socio-economic impacts;
- mitigation measures with specific attention on training;
- recommendation on land procurement that protects the interest of the local farmers.

9.2. Existing Socio-economic Conditions

9.2.1. Population

The DSIR contains 22 villages and houses a population of less than 40,000 according to the 2001 Census. A summary of the existing demographic characteristics is given in the Table 9.1.

9.2.2. Work Force and Employment

The population gains its livelihood predominantly from farms as shown in the Table 9.2, Occupation Pattern of Villages.

Table 9-1: Demographic Characteristics of the Village Settlements

VILLAGES	POPULATION 2001	SEX RATION	LITERACY RATE
Bavaliyari	2325	909	49
Bhadiyad	2630	741	72
Bhangadh	1734	942	37
Bhimtalav	141	932	61
Dholera	2637	908	76
Gorasu	2484	911	72
Zankhi	526	977	38
Kadipur	923	850	67
Khun	1628	913	52
Mahadevpura	1211	895	23
Mingalpur	2133	986	25
Mundi	705	986	53
Ottariya	1950	791	83
Panchi	891	908	60
Rahatalav	1395	865	37
Sandhida	989	913	67

VILLAGES	POPULATION 2001	SEX RATION	LITERACY RATE
Sangasar	1609	911	70
Hebatpur	5236	953	54
Ambli	1972	930	51
Gogla	1245	878	43
Cher	342	911	69
Sodhi	3007	934	61
Total	**37713**	**906 (Average)**	**55 (Average)**

The Table 9.2 (next page) reveals that the vast majority of the existing population depends upon farming for their livelihood, with very few people involved in industry.

A variety of crops are grown in the DSIR, the main ones being wheat, cotton and jowar, although gram and jeera are also grown. There is some double cropping with the aid of irrigation but generally the soil is poor and the area is not a highly productive. Salinity is a major problem, especially on the eastern side of the area. In some villages the proportion of the land under cultivation is very high, for example at Panchi it is 97% but in other villages on the eastern boundary of the site, farming land can be a very low proportion of the village land area.

Cultivators are the majority of the workforce and the proportion of marginal farm workers is fairly high, at about 35%. The proportion of main to marginal workers varies greatly between settlements, reflecting the different land ownership characteristics of each settlement, including the quality of land and size of the settlement.

Comparing the results of the 2001 Census with that of the 1991 Census reveals that there has been a marginal net loss of the total rural workforce (percentage of total workers to total population) in Dhandhuka Taluka in the intervening period. The loss has been greatest in the category of main workers at nearly 6 percent and the proportion of main workers to total worker has decreased, so that the proportion of marginal workers has gone up. The marginalization of the workforce manifests itself in migration and joblessness in much of the study area.

Table 9-2: Occupational Pattern by Village

VILLAGE	TOTAL POPULATION	TOTAL WORKERS	% TOTAL WORKERS	TOTAL MAIN WORKERS	% MAIN WORKERS	% TOTAL MAIN CULTIVATORS	% TOTAL MAIN AGRI-CULTURAL LABOURER	TOTAL MAIN OTHER WORKERS	% TOTAL MAIN OTHER WORKERS	TOTAL MARGINAL WORKERS	% TOTAL MARGINAL WORKERS
Bavaliyari	2325	1190	51	618	52	19	56	149	24	572	48
Bhadiyad	2630	1274	48	1107	87	20	32	525	47	167	13
Bhangadh	1734	685	40	374	55	28	37	126	34	311	45
Bhimtalav	141	63	45	16	25	38	6	9	56	47	75
Dholera	2637	810	31	799	99	7	34	455	57	11	1
Gorasu	2484	1429	58	1178	82	35	36	319	27	251	18
Zankhi	526	176	33	131	74	6	2	117	89	45	26
Kadipur	923	463	50	324	70	46	27	57	18	139	30
Khun	1628	740	45	740	100	14	59	193	26	0	0
Mahadevpura	1211	520	43	115	22	48	0	60	52	405	78
Mingalpur	2133	743	35	724	97	29	3	495	68	19	3
Mundi	705	201	29	201	100	21	71	16	8	0	0
Ottariya	1950	785	40	333	42	28	12	182	55	452	58
Panchi	891	330	37	182	55	56	15	51	28	148	45
Rahatalav	1395	401	29	342	85	33	63	12	4	59	15
Sandhida	989	373	38	161	43	42	2	89	55	212	57
Sangasar	1609	761	47	433	57	42	24	146	34	328	43
Hebatpur	5236	2857	55	1327	46	40	19	542	41	1530	54
Ambli	1972	691	35	509	74	33	45	107	21	182	26
Gogla	1245	715	57	468	65	43	32	108	23	247	35
Cher	342	105	31	103	98	40	40	21	20	2	2
Sodhi	3007	1474	49	804	55	31	20	390	49	670	45
Total	**37713**	**16786**	**45**	**10989**	**65**	**30**	**31**	**4169**	**38**	**5797**	**35**

9.3. Social Impact

Although a proportion of land to be developed is already in Government ownership, private land will be required to be developed to meet the scale of development envisaged in the DSIR.

Private land holdings range between less that 1 ha to over 5ha. However it is believed that the number of landowners exceeds the number of plots by some margin because the sub-division of plots has not been reflected on revenue plots, and separate plot numbers have not been extended to plots having multiple owners. Furthermore many individual owners would have stakes in multiple plots. Larger plots may also have heirs who have yet to register their interest. A full land ownership survey will therefore be required in order to ascertain a comprehensive and accurate compensation and assistance package.

Agriculture is the predominant occupation of the study area. Increase in population within the study area will reduce this proportion substantially. This points towards the need to ensure that the skills of local people is improved and an extensive livelihood support systems is put in place for the betterment of the existing village communities.

Marginal workers who do not own land are amongst the most vulnerable to the changes brought about by urban development because they have no assets to sell and they will require particular help and assistance.

9.4. Mitigation Strategy

Minimising the social impacts has been one of the foundation stones in the entire process of evolving the Draft Development plan for the DSIR. The basic elements considered while conceptualising the plan include:

- detailed assessment of the land ownership patterns;
- existing land use;
- usability of land;
- integrating the existing village settlements as part of the overall Draft Development plan.

9.4.1. Inclusive Growth

The Draft Development plan is derived on the principles of inclusive growth rather than exclusive growth of the region. The Draft Development plan makes a provision for a comprehensive village integration strategy discussed in Section 9.7, to accommodate the natural future growth in these settlements by constituting village buffer zones as a land use.

Besides the fact that spatial planning has been able to ensure that no original inhabitant of the region needs to be relocated in order to protect and conserve the existing social fabric of the society, social impacts on the livelihood and income opportunities cannot be completely avoided to achieve the objectives of planned development, where contiguity plays a vital role. Any development plan without proper supporting strategies to mitigate the negative social impacts cannot be considered as plan targeted towards inclusive growth. Though, efforts have been made even to minimise the negative impacts on livelihood through protection of agricultural land as far as possible, but for the purpose of unlocking the Government owned land and achieving the targeted development over next 30 years plan period, protecting each and every parcel of land is not possible through spatial planning measures. Thus, certain unavoidable negative impacts on the livelihood have to be mitigated through a planned economic rehabilitation strategy.

9.4.2. Providing New Economic Opportunities

It is recommended that a multi-pronged strategy covering the existing village communities of the region including land owners and landless, cultivators and agricultural labours, men and women, and the aged and youth be adopted. The strategies for economic rehabilitation can be broadly classified under the following categories:

- Land Based Economic Opportunities
- Non-land Based Economic Opportunities

9.5. Land Based Economic Opportunities

The land based economic opportunities would include:

- Land Management Strategy based on Town Planning Scheme model as explained in Chapter 10 of the report. (Suitable for economic sustainability of the aged population)
- Facilitating linkages between the land owners of readjusted land and the investors for PPP Model as explained under Chapter 10. (Suitable for economic sustainability of the aged population and the families)
- The land owners provided with readjusted land would need to be trained to negotiate with the industry/ developers for giving land for industrial use on lease rental basis rather than outright sale basis; or industrial houses setting-up industries could be encouraged to provide certain share-holding to the land owner. It would help the landowners to ensure regular income from the land allotted to them.
- The owners could also be encouraged to invest in housing and commercial uses to have an opportunity for rental incomes, for which the people would need to be supported through appropriate capacity building measures.
- Planning informal sector activities like vegetable markets, small kiosks and convenient shopping as part of the micro level plans and giving preference to the landless and indirectly affected persons in the allotment of such spaces and regulating informal activities through trade license for small vendors. (Suitable for landless and illiterate and low literacy level population)
- Facilitating agricultural training for improved productivity for farmers left with part of their agricultural land and extension of facilities for seeds and fertilizers for improved productivity.

For bigger industrial houses attracted to invest in the region, efforts shall be made to encourage them to facilitate and support the improvement of activities and facilities related to farming and the quality of life of the original inhabitants of the area as part of their Corporate-Social responsibility.

Notification of entire land needed for the purpose of planning and development regulations but allowing the possession of land to remain with the people it is actually needed for the execution of infrastructure works. They can continue to use the land for their own purpose in the meantime.

9.6. Non-land-based Economic Opportunities

9.6.1. Encouraging Investors for Local employment

Contractors for infrastructure development as well as industries would also need to be encouraged to provide appropriate employment, education, health-care facilities, priority in contract work and other such priorities at different places for which DSIRDA shall prepare the database of potential persons from the affected families for various types of employment and provide this database to industries.

9.6.2. Training for Support Services in the Industry

Large number of support services will be required both in the industrial as well as residential/ commercial sector. The Gujarat Urban Development Mission under the Urban Development Department is

implementing a state wide Urban Employability Programme with the name "UMEED" (Hope). The program is being implemented through a network of NGOs and their partner institutions. At present, three nodal NGOs are responsible for implementation of this programme throughout the state with one region comprising of few districts allocated to each nodal NGO. These nodal NGOs are:

- SAATH Charitable Trust;
- CAP Foundation and
- Aid-et-Action.

These nodal NGOs are managing the employability programme based on networking with other smaller partner organization. This has been quite successful in developing skills amongst the urban poor for meeting the requirements of the growing urban activities in industrial, commercial and service sector. SAATH Charitable Trust, an Ahmedabad based NGO with its partner institutions is responsible for implementation of "UMEED" in 8 districts including Ahmedabad.

Arrangement of Finance for Provision of Economic Opportunities

The major costs anticipated under provision of both land based and non-land based economic opportunities would include:

- Community facilitation costs (mainly hiring charges for NGOs)
- Land Marketing and Tie-up Costs (mainly at the level of DSIRDA)
- Training Costs for Skill Up-grading and Skill Development for New Trades/ Activities (NGOs/ Training Institutions)

The provisions to finance these efforts need to be made as part of the financial plans for the development of DSIR and these costs (human resource development costs) shall be treated at par with infrastructure development cost and forming a part of the project cost. Based on the experiences from other development projects, provisions equivalent to 5% of the project costs could be made to address the issues related to resettlement assistance and economic rehabilitation of the affected families.

9.7. Integration of Existing Village Settlements

A critical element of the overall development strategy is the integration of the existing village settlements with the proposed urban land uses. A rapidly changing physical environment that is driven by external developmental forces such as a planned Greenfield development like the DSIR, exerts immense pressure on the rural populace. While the opportunities in terms of overall capacity building through education, technical training, and access to public facilities and infrastructure will increase with the proposed industrial development by multi-fold, so will the local residents be exposed to the changing urban form and lifestyle. Therefore the need to formulate a strategy for streamlining the interaction between the village settlements and the proposed urban land uses was felt early in the planning process. Village Buffers will however be under the jurisdiction of DSIRDA.

9.7.1. Components of the Village Integration Strategy

The objective of the village integration model is to enable optimization of the benefits from the surrounding development and minimize any detrimental impact on the social structure, lifestyles and integrity of the village settlements.

The components of the village integration strategy are:

- Creation of Village Buffer Zones, as a separate land use category in the Draft Development plan,
- Zoning regulations to determine the land uses in the Village Buffer Zone,
- Implementing village buffer by Town Planning Schemes.

9.7.2. Village Buffer Zones

The strategy seeks to maintain a buffer zone in the area immediately surrounding the village. It is intended that the buffer lends a distinctive character to the areas surrounding the settlements, which would be different from the other urban land uses elsewhere in the DSIR.

- The principle objectives of the buffer zones are:
- Physical demarcation of areas in the Draft Development plan for prioritizing continued existing way of life in village settlements,
- Ease the integration of settlements with the surrounding urban land uses over time,
- Give the villagers a sense of control on their immediate environs,
- Prevent over-development in the vicinity of the sensitive village fabric

The extents of the Village Buffer Zones for all settlements of the 22 villages will be as illustrated on the Spatial Land Use Plan (Refer Figure 3.7). The positioning of the buffer zone around different settlement varies with respect to the surrounding land uses and road network.

The Village Buffer Zone will be predominantly a residential zone with supporting community amenities and neighbourhood retail uses. A separate set of zoning regulations will govern character of the Village Buffer Zones, discussed in General Development Control Regulations.

9.7.3. Sensitive Upgrading of the Existing Settlement

The current built form within the existing settlement areas is weather worn and in poor condition at some places. In addition to laying out plots and infrastructure network for new development, the plan for a Village Buffer Zone addresses the issue of needed upgrades to existing infrastructure and integrate it with the overall network of the DSIR for:

- Piped water supply
- Storm water drainage
- Sewage network

Some village settlements such as the ancient port town Dholera, have structures of heritage value. Therefore, the plan for any Village Buffer Zone should first identify the buildings, streets or precincts within the existing built fabric that need upgrading. A mechanism for implementing upgrades to the identified areas should also be drawn as part of the plan. This may include providing assistance to the property owners, in case of individual buildings or the Panchayat, in case of public buildings/streets/precincts in terms of use of the appropriate technology and sources of financial support to retain and enhance their value.

9.7.4. Public Participation

Participation of the village residents in determining the development within the Village Buffer Zone is a vital component of the strategy.

This strategy mandates that workshops or community charrettes should be organized in order for the village residents to express their preference and agreement to the overall pattern of development. This will be ensured during preparation of Town Planning Scheme.

9.7.5. Village Assistance Cell

In order to ensure smooth implementation of the intended development of the Village Buffer Zone, upgrading of the existing settlement area, and to ensure that the local population receives the benefits of the surrounding urban development, it is proposed that a village assistance cell, called as the Dholera Welfare Society be created in the DSIRDA.

The functions of the Dholera Welfare Society would be as follows:

- To serve as a medium of direct contact between the Panchayats, the village residents and DSIRDA;
- Protect the land development rights of the villagers;
- Assist DSIRDA for managing funds allotted for upgrading/developing infrastructure.

9.8. Benefits of the Development for the Village Residents

The planned urban development within the area notified as the DSIR will bring about certain benefits for the local village residents. An overall improvement in the standard of living will be induced through the following positive aspects of urban development:

- Capacity building through technical and non-technical skills training;
- Employment opportunities in the industrial sectors and other supporting sectors;
- Increase in income levels;
- Decrease in unemployment through direct and indirect employment;
- Increase in literacy levels and quality of education through access to better education facilities;
- Increase in health care facilities and improvement in life expectancy;

Improved infrastructure facilities such as water and power supply, sewage and drainage network, transportation, communication and community facilities in the village buffer zones and village settlements.

CHAPTER 10

IMPLEMENTATION AND REGULATORY FRAMEWORK

10. Implementation and Regulatory Framework

10.1. Introduction

The success of DSIR in generating wealth, employment and an attractive and sustainable living environment depends upon a number of factors, not just upon the how well the new city is planned. Key ingredients to the creation of a viable city are an appropriate legislative framework, a clear and equitable structure of governance, a sound economic base, good financial management, and an effective regulatory system for the control of development.

The components of the implementation framework for DSIR are shown on Figure 10.1.

The figure shows where each element of the implementation framework is dealt within the DSIR study. This Chapter provides a summary of those elements that are not covered in any other report or chapter. It covers the following aspects of implementation:

- Legislation and Governance,
- Land Procurement,
- Community Service Charge,
- Plan Monitoring and Review.

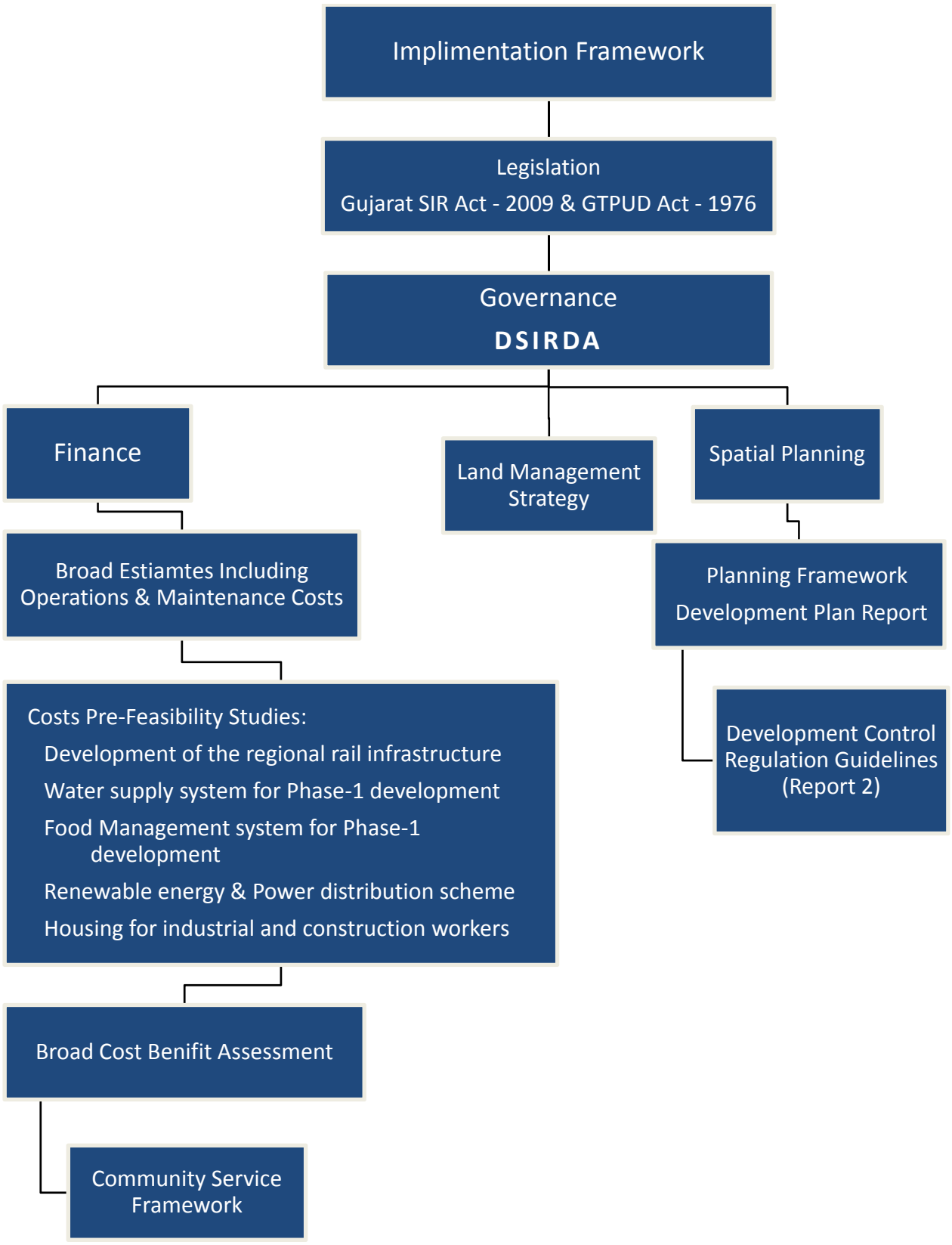


Figure 10-1: Implementation Framework

10.2. Legislation and Governance

The legal framework and organisational mechanism for the development of DSIR has been established by the Gujarat Special Investment Region Act, 2009. This sets out a clear institutional structure for development of the DSIR.

The passing of this Act and the establishment of the Dholera Special Investment Regional Development Authority (DSIRDA) lay the foundations for the development of a modern and efficient city consistent with the spirit of good urban governance. It will be important to build upon this sound legislative and institutional framework and ensure that the process of implementing the Draft Development plan brings about the dynamic growth envisaged in this Plan.

This section summarises the highlights of the Gujarat SIR Act, 2009 and sets out recommendations on a framework that will be required to implement and regulate the development of the DSIR.

10.2.1. The Gujarat SIR Act - 2009

The SIR Act provides for the State Government to declare an Investment Region as an SIR. The Act provides for, amongst other things:

- The DSIR to be outside the jurisdiction of the local area except for the village settlement (gamtal);
- Declaration of the Gujarat Infrastructure Development Board (GIDB) as the Apex Authority and a Regional Development Authority (DSIRDA).

A summary of roles of these organisations are given in the sections below.

10.2.2. The Apex Authority

As per Section 6 of the Gujarat SIR Act - 2009, the Apex Authority (GIDB) has power to make regulations for the development, operation, regulation and management of DSIRDA. It has the power to approve with or without modification, plans for the use of land within DSIR including the Draft Development plan, Town Planning Schemes and General Development Regulations proposed by DSIRDA. It also has power to approve any economic activity, amenity or infrastructure project within the DSIR.

The Apex Authority shall also fix and approve user charge rates proposed by DSIRDA, a Government Agency or the developer of infrastructure projects and propose to the State Government provisions for the development, operation, regulation and management of the DSIR.

The Apex Authority may appoint an Executive Committee and sub-committees or designate such powers to the Executive Committee of the GIDB. However the core functions of the Authority, such as approval and modification of the Draft Development plan or Town Planning Schemes, shall not be delegated.

10.2.3. The Dholera Special Investment Regional Development Authority

As per Section 15 of the GSIR Act, 2009; DSIRDA has now been established by the Government for governance in the DSIR. Responsibilities of the DSIRDA are as follows:

- Development of the DSIR;
- The management and planning of land and infrastructure within the DSIR, including the preparation of the Draft Development plan, Town Planning Schemes and their execution;
- Regulation of development in the peripheral areas of the DSIR (within 3km radius from DSIR boundary);
- Reconstitution/Allocation of land within the DSIR by sale, lease, grant , allocation, donation, town planning scheme, consent, agreement or in connection with the GTPUD Act 1976;
- Enter into contract, agreements or concessions in order to perform its functions;
- To execute works;
- To levy fees;

- To control development in accordance with the Draft Development plan, including building regulation approval ;
- To ensure and make provision for community and commercial facilities and infrastructure;
- Frame general development regulations.

Other Provisions of the Act

The Apex Authority shall be the single point of contact for starting economic activities or infrastructure in the DSIR.

The State Government may set up or designate Government agencies and assign powers to them including designation of a nodal company. Nodal companies may be assigned many functions including conceiving and detailing projects, financial structuring, marketing, raising finance, promoting and bringing on board the private sector, as well as implementing projects.

DSIRDA may transfer assets, including land, to a Government company or private entity or concession agreement for the development of infrastructure or amenities. They may also enter into agreement with a developer for carrying out work in the DSIR as stipulated in the Gujarat Infrastructure Development Act 1999 or set up a special purpose vehicle for developing or managing a particular project within the DSIR boundary.

The Act also allows private entities with a minimum area of land to undertake integrated development within the DSIR, subject to the provisions of the Draft Development plan.

State and other local authorities are not allowed to develop projects within the DSIR without the permission of DSIRDA.

The area within the SIR boundary is defined as an industrial township within the meaning of clause (1) of Article 243Q of the Constitution.

Land needed for Town Planning Scheme, Draft Development plan or infrastructure shall be deemed to be land needed for public purposes within the meaning of the Land Acquisition Act 1894.

10.3. Institutional Framework of the Village Settlements

It is proposed that the existing village settlements and the land area under the Village Buffer Zones will continue to be governed by the respective Village Panchayats. All the 22 villages and their settlements will be represented in the DSIRDA by a village assistance cell, called as the Dholera Welfare Society, whose functions are enlisted in Section 9.7.5.

The plan recommends that Dholera Welfare Society should include at least an urban planner and a social/ capacity building expert along with representatives of the Village Panchayats as its members. This is in view of handling conflicts that arise during the planning and implementation of any development in the Village Buffer zone. The area in Village Buffer zone will be under the jurisdiction of DSIRDA.

10.4. Land Management Mechanisms

Land is the key component of urban development and the formulation of an effective and equitable land procurement strategy is critical to the successful implementation of the Draft Development plan. There are, very broadly, two approaches to land procurement; one through compulsory purchase with compensation under the *Land Acquisition Act, 1894* and the other through Town Planning Schemes under the *Gujarat Town Planning and Urban Development (GTPUD) Act, 1976*.

10.4.1. Approaches Based Upon Land Acquisition and Compensation

Traditionally Government development agencies have relied on the conventional Land Acquisition Act, 1894 to acquire land from the farmers and private owners. The Act covers the entire land acquisition process from notification, hearing of grievances through to the award of compensation. Land acquisition under the 1894 Act has a number of advantages:

- Large land parcels can be assembled rapidly for urbanization purposes;
- The Government and development agencies benefit from the appreciation in land values in the change of use from agricultural to urban land uses;
- It becomes relatively straightforward to implement the Draft Development plan.

However, because the major benefits of urban development in this process accrue mainly to the development agencies and private developers, existing land owners perceive that they have been unfairly compensated, which results in a large numbers of legal disputes between the Government agencies (acquiring body) and the land owners (affected persons), so much so that land acquisition under the Act has become a very politically and socially sensitive issue nationwide. The disadvantages of land acquisition under the 1894 Act are predominantly social and include:

- Low compensation rates;
- Lack of transparency and subjectivity in working out the compensation;
- Absence of any mechanism for sharing of benefits from development with the original land owners;
- Lack of consideration for the economic rehabilitation of the affected persons, many of whom lack the knowledge and ability to find alternative means of livelihood or to invest their compensation wisely. As a result they end up in the large pool of low wage, unskilled labourers:
- Disruption caused in the social structure ;
- Loss of ownership of a permanent asset which is a strong status symbol in the society as well have associated psychological aspects of inheritance and family values;
- A time lag between the acquisition and actual development of the land acquired for development, so that farmers often see their land lying vacant and unproductive yet they have been deprived of their livelihood;
- The development agencies require large amounts of capital for bulk land acquisition. This has to be funded by State Government through budget allocations, which are usually tight or loans. Lack of allocated funds may therefore adversely affect the timely acquisition and anticipated pace of development.

Economic growth and improved access to the media and information in the country in the past two decades has resulted in increased awareness amongst farmers about the implications and disadvantages of compulsory land acquisition from their own perspective and as a result there is now very strong resistance to land acquisition under the Act.

In response to the shortcomings of the existing Act, the Land Acquisition (Amendment) Bill, and the Resettlement and Rehabilitation Bill 2007 were tabled in the Parliament but lapsed. The Bills were introduced afresh in 2009. Although the Bill has a number of good elements, such as measures to ensure the adequate resettlement and rehabilitation (R&R) of project affected persons (PAPS), and compensation based upon market values, it is also not without shortcomings and opposition has continued. Nevertheless it was reported that the Bills were passed in the Lok Sabha on 26 February 2009 but still need to be approved by the Rajya Sabha and President of India before becoming a law.

A number of State Governments have evolved alternate ways of acquiring land for development purposes in order to minimise the resistance from the owners. Notable amongst these are the Haryana “Royalty” model and the Uttar Pradesh “Negotiated Settlement Model”.

10.4.2. Land Pooling and Land Readjustment Models

Approaches based upon land pooling take many forms. They may be initiated by groups of land owners, farmers or by philanthropists on a community or cooperative basis, or by Government bodies.

There are a number of good examples of community and philanthropic initiatives. One such is that adopted by farmers from Magarpatta village in Pune, who pooled together 400 acres of farmland and set up a private limited company of farmers to develop a commercial-cum-residential project. The farmers were

provided with shares in the company in proportion to the value of their land and these shares can be sold to the member's families only. In this model, the farmers investing land for urbanization process receive their returns in the form of new homes, dividends on the shares, rent from tenants and income from contractual works for the company. The other advantage of this model was that the farmers could continue the agricultural activities until the construction work was started. The model provides long term investments of the land for continuous returns rather than a single, lump sum compensation payment.

The major limitation of this and similar models, such as Shri Bhaikaka university village at Vidyanagar near Anand, is that the project involves a relatively small group of land owners and requires their cooperation over a relatively limited land area. It could not therefore be used as a model for a large urban development project of the scale of the DSIR.

10.4.3. Town Planning Schemes

The Government of Gujarat has adopted Town Planning Scheme Model as per the GTPUD Act 1915 (54, 76). Under this model, the development authority brings together a group of landowners for the purpose of planning and a Town Planning Scheme for the area is prepared, laying out the roads and plots for public and social amenities. The remaining land is reconstituted into final plots for the original owners, with the size of the final plot in proportion to the size of the original plot, and its location as close as possible to the original plot. Infrastructure costs are recovered by levying a betterment charge on the landowners based on the cost of the infrastructure.

A town planning scheme under the provision of GTPUD Act, 1976 may be made in respect of any land which is –

1) In the course of development; e.g. fig 1
2) Likely to be used for residential or commercial or industrial or for building purposes; e.g. fig 2
3) Already built upon; e.g. fig 3
4) Already built upon; e.g. fig 3

Image Source: Manual for Preparation of Town Planning Schemes; EPC, ICE, GUDC

Town Planning Scheme provides legislative support and finance for implementation. The fundamental objective of the readjustment technique is to make land available for development at least cost to development authorities and improve the environment effectively.

Town Planning Scheme is used to make a group of land holding in a planned manner. This is essentially achieved by providing each unit with a public road access and regularizing the shape of each plot. Compensation is paid to land owner of the land taken away for roads and public facilities. At the same time, betterment charges known as incremental contribution are collected from each owner to the maximum of 50 percent of the estimated increase in the land value after plot reconstitution. The funds so generated are utilized for the development of infrastructure and common facilities within the scheme area.

The local planning agencies would be able to attain the dual objective of controlling haphazard growth as well as the timely provision of physical infrastructure such as roads, sewers, water supply etc. and social

infrastructure like schools, hospitals, parks, open spaces etc., and social infrastructure burden. Because of its self financing nature, Town Planning Schemes are also implemented in areas already developed, but with lack of adequate infrastructure.

The increase in the land value resulting from the development accrues to the original owner whenever the land is sold and developed for urban use. The advantages of this method from the development agency's point of view is that it does not have to acquire any land or bear the cost of infrastructure provision in the long term.

Pooling models similar to the Gujarat Town Planning Scheme have been used in other countries, notably Australia and Korea.

10.5. The Proposed Strategy for DSIR

A review of various examples in Town Planning Schemes suggests that each approach has its advantages and disadvantages, both in its impacts on land owners and the development agencies. The approach adopted must nevertheless must balance the legitimate rights and concerns of the land owners, be socially and economically fair to all parties and still be affordable to the Government.

In view of the potentially conflicting objectives it is considered likely that a solution acceptable to all parties can only be arrived at after extensive public consultation and community participation. This must be one of the first priorities of the development authority as soon as it has been established.

Under the Town Planning (TP) Schemes land is not acquired by the Government agency. It is reshaped, readjusted and returned to the original owner. Generally when a Town Planning Scheme is laid in an area, a certain per cent of land is deducted from original plot and utilised in providing common infrastructure and facilities like roads, gardens, play grounds etc. Land parcels retained by the authority are then used for 'public purposes'. Evidently, the land area of a land owner decreases but overall value of the land increases several times because with the implementation of the Town Planning Schemes, the land parcels become more organised and accessible with better infrastructure provision. Over various experiences it has been observed that TP Schemes have proved to have better acceptance among masses.

The mechanism of Town Planning Scheme has been chosen in DSIR for implementation of Draft Development plan. The entire area of Dholera Special Investment Region has been divided into six Town Planning Schemes as show in figure (page 161) under GTPUD Act, 1976. The primary focus is to develop the land in DSIR without having to acquire any land for infrastructure and other land use delineations.

The principle for reconstitution of plots under TP Scheme is so designed, that final plot after mandatory deduction, is allocated as close to the original plot as possible. The Government is also considering exemption to betterment/development charges, for the final plots being allocated, will not be levied on the private owner. Hence the entire process is devised to be a win-win for both Government and Private owners.

Land for roads including the 250 metre expressway corridor and other major infrastructure, as defined in the Draft Development Plan, will also be provided through land allocation under TP Schemes

The Authority should be allocated consolidated portions of strategically located land during reconstitution in order to facilitate creation of infrastructure as well as in order to leverage the value of land with the cost of provision of infrastructure in DSIR. Land being allocated to the Government will be used for sale, lease and in other ways to balance expenses incurred during development infrastructure.

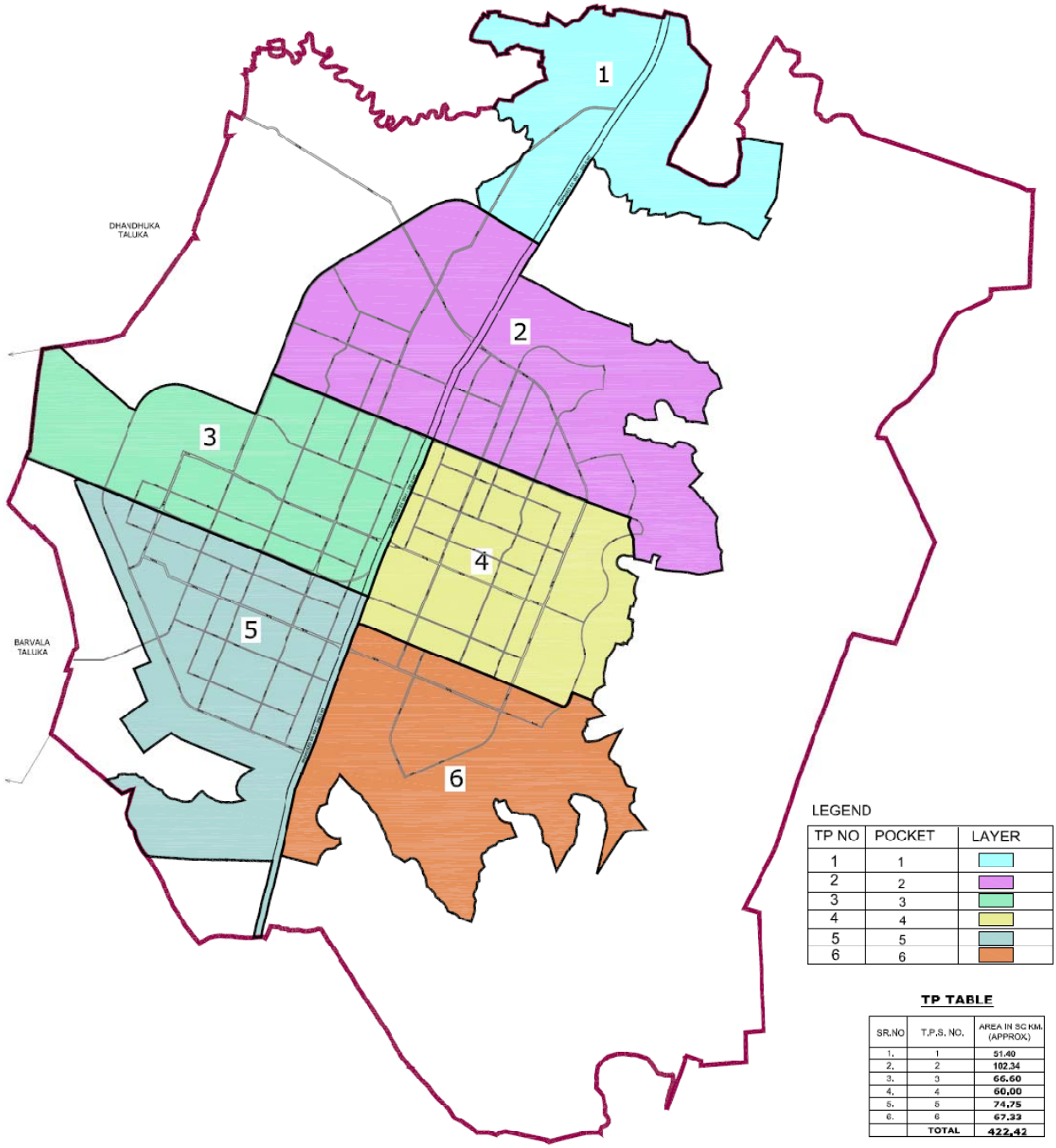


Figure 10-2: Town Planning Schemes in DSIR

10.6. Key Features of the Proposed Land Management Strategy

The proposed strategy involves a number of different organizations, and comprises a number of different components and stages. These are summarized in Figure 10.3 and explained below.

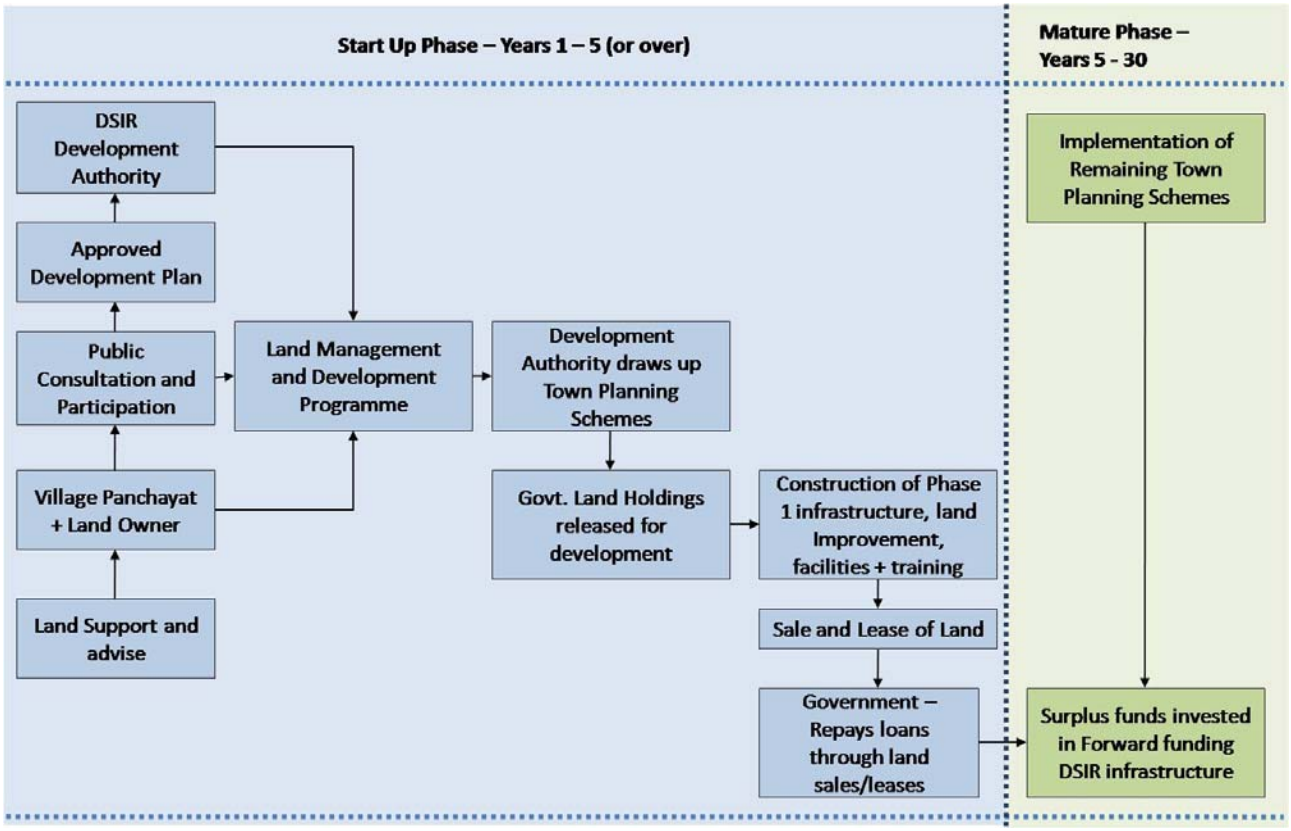


Figure 10-3: Land Management Strategy for DSIRDA

10.6.1. The Role of the Regional Development Authority

DSIRDA will be responsible for the land management process. Specialist departments will be established within the DSIR to prepare Town Planning Schemes for the development of the DSIR according to the Draft Development plan. There have been a number of large urban development schemes undertaken elsewhere in India over recent decades and a vast store of experience and expertise has been built up. DSIRDA will call upon this body of knowledge and pool of talent in putting together their team to implement the DSIR project.

10.6.2. Public Consultation and Participation

A participatory approach to development is proposed to ensure that land development in the DSIR proceeds smoothly and is equitable to all sections of the community. Village Panchayats, land owners and land-less labourers all need to be consulted and involved in the process of development through participatory forums. Experienced and reputable development organizations and NGOs should be invited to advise and facilitate the land procurement process.

Public consultation needs to be commenced at the earliest opportunity in order to inform the population of the DSIR of the Draft Development plan and the process of urban development. They should be informed on how they can be involved in decision making and their rights as land owners, residents and agricultural workers.

DSIRDA will prepare a phased land development programme. A committee comprising members of DSIRDA, State bodies such as land revenue department, infrastructure companies and village panchayats representatives will be formed to oversee the land management process. The precise make up of this

committee and its rules and regulations will be determined by the Government of Gujarat in consultation with project stakeholders, including industrial bodies and land owners.

10.6.3. TP Scheme phasing strategy

As mentioned above DSIR has been divided into six Town Planning Schemes. In order to expedite the process of development, implementation of Town Planning Schemes will be completed in three phases. The first phase will concentrate on quick introduction of Town Planning Schemes one & two together, along with provision of basic infrastructure notably roads, water supply and drainage. Reconstituted Government land will be released upfront or as and when required, from these Town Planning Schemes, to help kick-start/boost the rate of development in DSIR. The land to be released through this phase will be equivalent to the quantum of land required for the first 5 years of industrial and residential development. The phasing of the schemes will be as under

Phase 1: In Town Planning Scheme 1 (~ 52 sq km) & 2 (~102 sqkm)

Phase 2: In Town Planning Scheme 3 (~ 67 sq km) & 4 (~60 sqkm)

Phase 3: In Town Planning Scheme 5 (~ 75 sq km) & 6 (~67 sqkm)

10.7. Community Service Charge

From the outset, the DSIRDA will need to establish a clear financial model linking standards of service with appropriate levels of user or community service charge (CSC). The CSC needs to be competitive, transparent and stable if it is to be approved by the major stakeholders and prospective owners and tenants of the DSIR.

An important aspect of such a charge will be a detailed appreciation of the phasing options and requirements in order to maximize the sites revenue potential from the outset. Service charges can be applied to both commercial properties and potentially also to residential properties, depending on the vision and preferences of the developers and knowledge of 'if' and 'how much' the domestic market is willing to pay.

10.7.1. Setting an Appropriate Service Charge

Given that few communities currently charge a fully-commercial CSC, an attractive CSC must be:

1) associated with superior levels of service delivery that are differentiated from the 'free' services provided by the National, regional and local authorities;
2) competitive with other private developments in India and around the world;
3) not be seen as a deterrent by prospective buyers and/or tenants.
4) The DSIRDA will be an unregulated monopoly service provider for the public realm. Property owners at the site will make substantial investments and will not simply be able to move out if they are dissatisfied with levels of service or the level of CSC. The service charge needs to be easily understood by owners and residents who will be particularly concerned about its efficiency, equity and sustainability.

Efficiency

Receiving best-value services; the right level of service to provide them with the amenity they expect at the right price;

Equity

Paying for what they use and not cross-subsidising others; while also paying the DSIRDA for reasonable but not excessive levels of profit;

Sustainability

Sustainability over an extended period of time – i.e. no surprises in terms of unexpected CSC increases due to unforeseen costs – in addition, they also need to be satisfied that sinking fund provisions are not excessive.

10.7.2. A Stable CSC

From time to time major capital maintenance, re-building and modification of the infrastructure assets will inevitably be required. This should not lead to large increases in CSC. Even in relatively new developments, there have been instances of large unplanned increases in CSC leading to high levels of dissatisfaction. This has commercial implications. Owners and residents will need to be assured that the level of CSC has been set correctly and that adequate but not excessive sinking fund provisions have been made for capital maintenance and re-build. Not only the level of CSC but its annual adjustment should be specified from the outset.

10.7.3. Key Issues to be Addressed

These are fundamental decisions that will need to be established early and refined before a final CSC is established:

Charging Strategy

The CSC is made up of a number of elements of cost including return on capital and profit. An indicative magnitude of the various cost elements is shown in Figure 10.4 alternative revenue sources such as parking charges, road tolls, concession charges, advertising revenue, and planning fees can help to reduce the CSC levied on residents.

Ultimately the CSC will be a function of a charging strategy which will define:

- The extent of assets to be managed and the services to be provided by DSIRDA;
- The levels of service to be provided;
- The efficiency of the operations;
- The level of risk that DSIRDA and its shareholders are willing to take in terms of unforeseen costs or price inflation – which will define sinking fund provisions;
- The level and cost of financing;
- The profit objectives of the venture;

Zoning Strategy

Typically the CSC will be in the form of a schedule of tariffs. The CSC for an industrial plot will differ from that of residential property and the tariff for an apartment will differ from that for a bungalow. Similarly hotels and commercial premises with a large number of transient occupants may pay a different level of CSC from residential premises. A CSC zoning strategy should be established as far as practical on the basis of the level of consumption of community services and the occupant's ability-to-pay.

Financial Planning

Transition funding will be required before full occupancy is achieved. The construction programme, the availability of property for sale or occupation and forecasts of occupancy will define the revenue for the development. The DSIRDA will need to establish these early to enable financial forecasts to be completed and start up capital needs to be identified.

Taking over and managing the assets

Delineating the scope of DSIRDA's services, taking over the in-scope assets and activities and ensuring a smooth transition of other services and assets to other providers such as utilities and developers is a very significant task. Specific challenges include:

- Demarcation of assets and services – these need to be carefully defined and comprehensively documented for takeover by any party and any interfaces need to be managed;
- Assets being taken over by the DSIRDA need to be catalogued and the base condition documented to form the foundation for future asset management;

As far as possible contractor's ongoing warranties and maintenance provisions need to be utilised after the takeover of assets so as to minimise costs to the DSIRDA in the transition period.

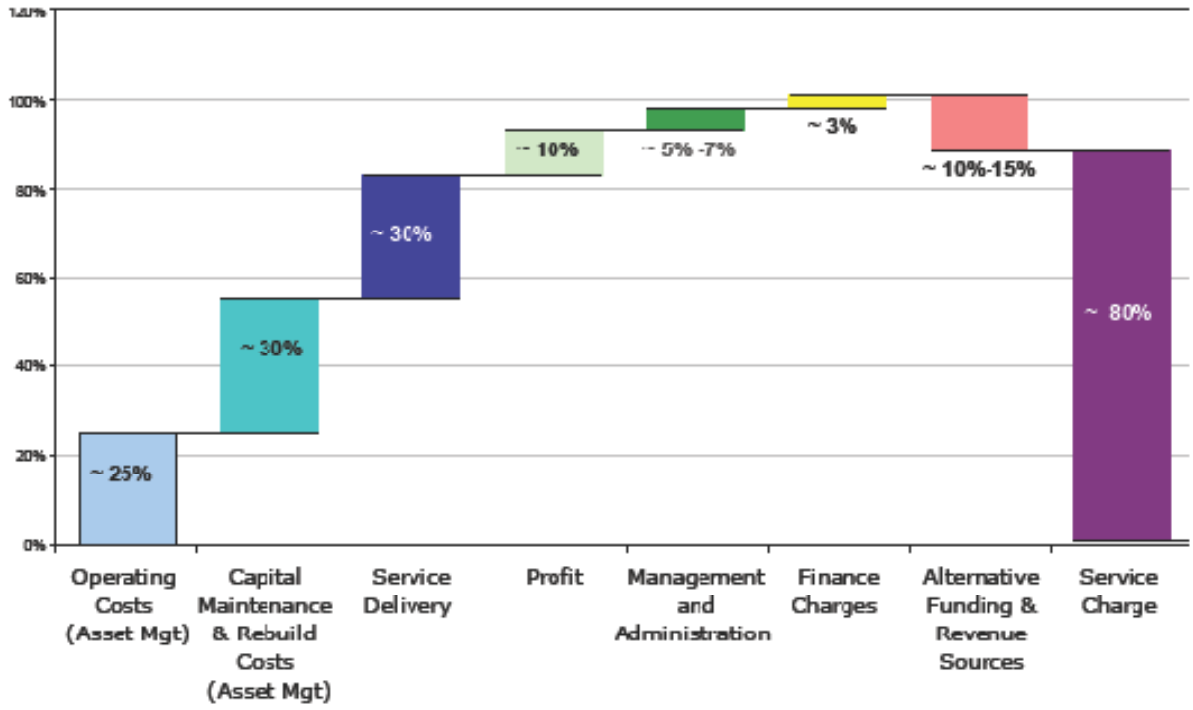


Figure 10-4: Illustrative Composition of the Community Service Charge (CSC)

10.8. Plan Monitoring and Review

The Draft Development plan must not be seen as a static document, fixed for a 30 year period. It is essentially a structure plan, which must be regularly updated and revised if it is to remain relevant.

Neither is the Plan a detailed land use plan but rather a framework for harnessing socio-economic and spatial development. More detailed Town Planning Schemes and action plans will need to be prepared for smaller parts of the DSIR over time. The Draft Development plan will nevertheless need to be constantly updated and revised so that the overall strategic guidance that it provides remains valid.

10.8.1. Monitoring

The aims of the monitoring will be to:

- Measure the implementation of the Plan over time;
- Ensure the development is in line with the Plan strategy;
- Ensure that economic and social changes can be reflected in revisions to the Plan;
- Assess the effectiveness of plan policies and whether they need to be adjusted.

The range of data to be monitored would include but necessarily be limited to:

- Permissions given for the construction of new housing units, their completion and occupation. This data shall include the size and target income level market of the units;
- Population in the DSIR according to the regular census data or other surveys, including in-migration, emigration and household size statistics;

- Permissions given for the construction of industrial and commercial plots and buildings , including the types of industry uses and floor space provided;
- Employment in the DSIR, including newly created jobs and skill levels;
- Permissions given for the construction of community facilities, including the intended uses and floor space provided;
- Development in the village buffer zones;
- Details of all infrastructure such as the road or utility, type of facility, pipe networks and so on and provision of water and electricity to villages and new housing areas;
- Agricultural production in the farmlands within the DSIR, including crops, yields, and irrigation;
- Traffic surveys on roads within and to and from the DSIR;
- Public transport provision including services provided and patronage;
- Environmental monitoring of air and water quality and the condition of any sensitive ecological habitats;

Data will be managed electronically in the GIS format.

10.8.2. Review

The Draft Development plan is divided into three phases, each phase being of ten years duration. It is necessary to update plans on a regular basis, especially strategic plans covering a long period of time. For the Draft Development plan a partial review every five years is recommended and a more thorough review and amendment every ten years.

If the Kalpasar dam project receives final approval and a firm construction programme is in place, then this will a trigger for a major review of the Draft Development plan and necessary amendment.

Township Schemes and Action Area Plans will need to be prepared for the development areas of the DSIR in accordance with the overall phasing programme. The programme of detailed plan preparation should start in the Phase 1.

10.9. Single Window Clearance

In order to facilitate quick and timely approvals of development proposals, it is recommended that the DSIRDA adopts a 'Single Window Clearance' procedure.

The Single Window Clearance system in the Pune Municipal Corporation is a good example of such an effective system for building plan approvals. An architect or citizen seeking approval of the building plan can submit specifications of the project in digital format after converting the drawings in the format required by the software (Pre DCR). Three submittals are required:

- The project drawings in Pre DCR format,
- The corporation drawing, and
- The Form detailing out the various area calculations outlined by the PMC.

Software has been specially developed and customized to the PMC Development Control Regulations. The submission can be done in an electronic format by email or by sending a CD. A scrutiny is performed by the software along with a report as an output. The report either summarises possible defects in the plan, or gives an approval certificate if all the building construction norms are met with. The approved proposals are registered in the PMC server and then sent to the building sanction department. Thereafter, the applicant is issued instructions to pay a required fee for getting the hard copy of the approval and commencement certificate. The system is not yet foolproof and efforts are on to improve the software.

Chapter 11

BROAD COST ESTIMATES

11. Broad Cost Estimates

11.1.1. Overview

Broad cost estimates for the proposed services for the following items has been prepared based on certain technical assumptions such as the site conditions, assumption on material used and future expansion and cost enhancement with time. The costing includes below mentioned heads of the development elements:

- civil works for proposed construction and utility services;
- mechanical and electrical works; and
- area development including land development.

It has been conceptualized that most infrastructure components for the DSIR will be developed on a PPP model with an active participation of industrial houses, real estate developers, infrastructure developers, hospitality industry, tourism industry, health care industry and so on.

The micro level and internal physical infrastructure and social infrastructure will be developed by the developer or by the industry and if at any stage local governing body decides to develop some townships or commercial development on its own to boost the development process to attract the investor, the costing required to be incurred on internal development will be computed on the basis of area. This aspect is mentioned separately in the costing sheet.

Table 11.1 and 11.2 indicate a summary of the CAPEX and the annual OPEX broad cost estimates derived for DSIRDA.

Components accounted for to arrive on the estimate at macro and intermediate level for cost of physical and social Infrastructure development and their supporting assumptions are listed in Table 11.3.

Table 11.4 & 11.5 (page 174 & 178) indicates the broad cost estimates.

Table 11-1: Summary of CAPEX Estimates

SR. NO.	ITEM	PHASE WISE COST ESTIMATE (crore rupees)			SUBTOTAL ESTIMATED CAPEX BUDGET
		PHASE I	PHASE II	PHASE III	
1	Land Improvement Schemes	640	336	280	1256
2	Roadwork	2,196.81	3,805.37	1,778.86	7,781.04
3	Regional Railway Line	580	300	210	1,090
4	LRT System	-	4240	1440	5,680
5	Earthworks	763.2	900	675	2338.2
6	Water supply & distribution	1,612.5	2,384.86	1,210.62	5,207.99
7	Sewerage	732	1,037.64	501.36	2,271.00
8	Storm water Drainage	704	854.59	320.61	1,879.20
9	Flood Management	225	238.75	20	483.75
10	Solid-waste management	136.12	267.73	145.55	549.40
11	Landscaping & Signage	200	325	175	700
12	Power Supply	1,191.25	2,092.50	976.25	4,260
13	Renewable Energy Plant	1,392	-	-	1,392
14	Captive Power Plant	405	405	405.	1215
15	Street Lighting	105.75	180.81	88.14	374.70
16	Telecommunications	66.29	122.06	60.25	248.61
17	Gas Grid	28.00	22.40	16.80	67.20
18	Public facility Buildings	174	395	369	938
	Subtotal CAPEX by Phase	**11,723.91**	**18,007.72**	**8,744.44**	**38,476.06**
	Physical Contingencies @ 10%				**3,847.61**
	Total CAPEX				**42,323.67**

Note:

1) *Cost of renewable energy, Captive Power Plant & Gas Grid have been excluded for financial modelling*
2) *Cost estimates at present prices*

Table 11-2: Annual OPEX Estimate

SR. NO.	ITEM	ANNUAL OPEX COST ESTIMATE (crore rupees)		
		PHASE I	PHASE II	PHASE III
1	Land Improvement Schemes	-	-	-
2	Roadwork	22.87	32.35	15.12
3	Regional Railway Line	15.9	9	6.3
4	LRT System	-	63.60	21.60
4	Earthworks	-	-	-
5	Water supply & distribution	63.65	97.67	50.21
6	Sewerage	32.37	49.26	24.63
7	Storm water Drainage	31.20	34.46	9.62
8	Flood Management	6.75	7.16	0.60
9	Solid-waste Management	24.50	48.19	26.20
10	Landscaping & Signage	30.00	48.75	26.25
11	Power supply distribution	59.56	104.63	48.81
12	Renewable Energy Power plant	-	-	-
13	Captive Power Plant	-	-	-
14	Street Lighting	10.58	18.08	8.81
15	Telecommunications	1.99	3.66	1.81
16	Gas Grid	-	-	-
17	Buildings	5.22	11.85	11.07
	Total OPEX by Phase	**304.60**	**528.66**	**251.04**
	For 10 Years	**3,045.98**	**5,286.60**	**2,510.40**
	Total OPEX for 10 years			**10,842.98**

1) *O&M cost for renewable energy, captive power plant & gas grid as CAPEX costs not factored*
2) *Cost estimates at present prices including 100% occupancy*
3) *OPEX estimate includes contingencies*

Table 11-3: Components of the Broad Cost Estimates

ITEM	DESCRIPTION	TECHNICAL/DESIGN ASSUMPTION	MATERIAL ASSUMPTION
Land Development	Area Grading	Area grading and earth work has been considered as follows: • For flood protection only raising of level in not required but combination of proper drainage system, River management, small bunding, filling and cutting to maintain proper slope has been considered based on the available contours • Sub Grade preparation for major roads, secondary roads, railway embankment has been considered with good earth • Huge quantity of available from cutting due to water front development, pond development will be utilised in local and minor roads with stabilisation, small bunding for river training etc • For utility building and social building filling with good earth is required to avoid direct contact of str. to black soil. • Sub sector level filling will be not much and will be done by the developer • Practically on about 40% area require filling	Land Development
	Land Improvement	As per the uses, loading and building type. For Road Construction: • Major Roads and Secondary Road – PVD with sustained loading to increase SBC & CBR. It will save the cost in road crust. Local Road and Village road – Soil Stabilisation will be done with lime to improve CBR of existing soil. It will save the cost in road crust. For Water retaining structure like water tank, WTP str, STP str, PVD or Stone piles will be considered depending upon the load of the structure. • For the development of container yard land improvement with PVD sustained load is considered for some area. Buildings: • Land improvement is not required for building development area. Selection of foundation is more important with respect to the SBC of soil in that area, use and loading of building. It may be pile foundation, Raft foundation and isolated footing for light and small structure. • Extra care is required to be taken in designing of plinth protection and its joints with building, it should not be	

ITEM	DESCRIPTION	TECHNICAL/DESIGN ASSUMPTION	MATERIAL ASSUMPTION
		directly laid on black cotton soil as joints may open up due to expansive property of existing soil • Cost of all these measures in building has been considered in building cost.	
Transport Infrastructure	Road Transport	• costing is done assuming flexible pavements only • costing is done for road portion only above the formation level costing includes cost of sub base, base and surface courses • Broad cost estimates include culverts, minor bridges, major bridges, underpasses, Grade separator etc. • cost of footpaths, median, traffic signs, markings is included in the costing • Road Net work has been considered up to Sub Sector level only.	Transport Infrastructure
	LRT	• Cost includes corridor, stations and other civil works. • The cost estimates for the mechanical and electrical components • Signalling costs for automatic signalling, route relay interlocking installation, train supervisory cost etc. were considered • Rolling stock is that they are air-conditioned coaches with automatic door closures	
	Rail Transport	• Cost includes corridor, other civil works. General civil works like track laying, utility diversion, traction substations etc. • mechanical and electrical components for items like substations and service connections have been considered • Signalling costs for automatic signalling has been considered. • Land acquisition costs are included Cost includes 6 standard stations in the loop, out of which 2 will be within the boundary of the DSIR • Cost of rolling stock is not considered	
Power Infrastructure	Transmission and Distribution	• Over head transmission line as per GETCO Design norms.	Power Infrastructure
Power Infrastructure	Sub Stations	• 400/132/33/11 KV Substation has been considered with SCADA System	
	HT System	• Within Development underground cabling with unitised transformers.	
	LT System	• Within Development underground cabling with both side operable panel	

ITEM	DESCRIPTION	TECHNICAL/DESIGN ASSUMPTION	MATERIAL ASSUMPTION
	Street Lighting	• Selection based on LUX level required for various ROW with automation system and electronic timer devices	
Water Infrastructure	Water Distribution System	For Raw water conveyance, augmentation and lining of proposed four minors of Vallabhipur channel has been considered. • Water from canal to WTP will be pumped from sump constructed in canal through MS Pipe. • After treatment from CWR to UGR at water works in various sectors through MS rising main. • UGR to OHSRs in various location • UGR to house level by gravity for 24x7 supply through DI distribution system • Pumping system for the transmission main can be designed for 23 hours working. • Pumps and pumping main for filling ESR from GSR may be designed for 16 hrs pumping. • "CR" and "C" Value as per CPHEEO, water supply manual • Water infrastructure considered from Source development to transmission network up to Sub Sector level only	Water Infrastructure

ITEM	DESCRIPTION	TECHNICAL/DESIGN ASSUMPTION	MATERIAL ASSUMPTION
Waste Water Infrastructure	Collection network	The waste water system will have the following assumptions: • Main collection system at parcel level to receive waste water at the outlet point of parcel of land. Internal system of the parcel/package will be planned and executed by the developer or owner. • All industrial users will follow the norms of treating the industrial waste to the second level and then discharge to the common effluent treatment network. • Trunk sewers collecting sewage from several areas and conveying it to the STPs/CETP. • Sewage pumping station to transport sewage to trunk mains or treatment plants. • Sewage /common effluent treatment plant (STP/CETPs). • Out fall for treated effluent considered as open channel up to the downstream of Kalpasar dam.	Waste Water Infrastructure
	Effluent Treatment Plant	Proposed Technology " Extended Aeration" • Design Parameters • Design Horizons The following design periods have been adopted for various project elements • STPs/CETP 30 years • Sewage collection System 30 years • Peak Factor: Peak factor can be adopted as per CPHEEO sewerage manual, 1993. • Velocity: minimum self cleansing velocity of 0.60 m/s and a maximum velocity of 3.0 m/sec can be adopted.	
Drainage Infrastructure including River Management	Drainage Network River Training	Peak Runoff: • The peak runoff for the design of drains is computed based on Rational formula • Q = C I A/36 Runoff coefficient: • Drainage infrastructure considered from Sub Sector level to out falls at multiple locations. • Under River Management smoothening of river alignment for free flow, bunding with respect to water income and holding time, lining at thrust location like at junction and bends, creation of	Drainage Infrastructure including River Management

ITEM	DESCRIPTION	TECHNICAL/DESIGN ASSUMPTION	MATERIAL ASSUMPTION
		off line water bodies to hold water to avoid spreading, creation of water channel along western boundary to hold and guide the upstream storm water flow thus avoid flooding to great extent has been considered and costing done accordingly.	
Social Infrastructure and Building Work	Police Station Place of worship Fire Station Education Infrastructure Health Infrastructure Administrative Offices Community Centre Recreation establishments like clubs, public library	Building broad cost has been arrived considering: • Assumed tentative built up area, may vary with the Govt. policy • Per sq.m area cost on BUA considered for Sub structure (Considering special foundation like Pile Foundation, Raft Foundation), Super Structure, Finishes, Services, building level external development including land development if required. • It has been understood that in the beginning phase the Govt. is suppose to develop some of the services in utility and social sector which is essentially required to attract the investor.	Social Infrastructure and Building Work

Table 11-4: Broad Cost Estimates (CAPEX)

Sr.	Item	Description	Unit	Rate (INR)	Quantity in Phase-I development	Cost Estimate-Phase I (INR)	Quantity in Phase II development	Cost Estimate-Phase II (INR)	Quantity in Phase III development	Cost Estimate-Phase III (INR)	Total Development Cost (INR)
1	**LAND IMPROVEMENT SCHEMES**	Land Development Costs for road construction, railway embankment and transport corridor	sq.m.	0.00008	8,000,000.00	640.00	4,200,000.00	336.00	3,500,000.00	280.00	1,256.00
	Land Improvement Works Total Cost					**640.00**		**336.00**		**280.00**	**1,256.00**
2	**ROADWORKS**			-	-	-	-	-	-	-	-
	A) Road Network - Major	Arterial Roads (70m)	km	12.00	44.96	539.52	56.87	682.44	14.37	172.44	1,394.40
		Collector Roads (30m)	km	5.00	30.94	154.70	48.00	240.00	35.10	175.50	570.20
		Local Road (25 and 20m.)	km	3.00	38.53	115.59	36.31	108.93	14.64	43.92	268.44
	B) Road Network - Internal	30m wide	km	5.00	49.00	245.00	98.00	490.00	49.00	245.00	980.00
		25m wide	km	5.00	97.00	485.00	194.00	970.00	97.00	485.00	1,940.00
		20m wide	km	2.50	146.00	365.00	292.00	730.00	146.00	365.00	1,460.00
		15m wide	km	2.00	146.00	292.00	292.00	584.00	146.00	292.00	1,168.00
	Subtotal					2,196.81		3,805.37		1,778.86	7,781.04
	C) Junctions	Grade seperated Interchanges (Junction 1)	No.	20.00	6.00	120.00	3.00	60.00	2.00	40.00	220.00
		Junction 2	No.	2.00	10.00	20.00	12.00	24.00	10.00	20.00	64.00
		Junction 3	No.	1.00	12.00	12.00	16.00	16.00	12.00	12.00	40.00
	Subtotal					152.00		100.00		72.00	324.00
	D) Existing Road Improvement	Improvement of SH6	km	12.00	35.00	420.00	-	-	-	-	420.00
	Subtotal					420.00		-		-	420.00
	Roadworks Total Cost (A+B+C)					**2,768.81**		**3,905.37**		**1,850.86**	**8,525.04**
3	**LAYING OF RAILWAY LINE**			-	-	-	-	-	-	-	-
		A) Laying a new railway line and Logistics park	km	6.00	55.00	330.00	-	-	-	-	330.00
		B) Logistics park	Ha	3.00	50.00	150.00	100.00	300.00	70.00	210.00	660.00
		C) Construction of station	nos.	50.00	2.00	100.00	-	-	-	-	100.00
		D) LRT	km	80.00	-	-	53.00	4,240.00	18.00	1,440.00	5,680.00
	Railway works Total Cost (A+B+C)					**580.00**		**4,540.00**		**1,650.00**	**6,770.00**

Sr.	Item	Description	Unit	Rate (INR)	Quantity in Phase-I development	Cost Estimate-Phase I (INR)	Quantity in Phase II development	Cost Estimate-Phase II (INR)	Quantity in Phase III development	Cost Estimate-Phase III (INR)	Total Development Cost (INR)
4	**EARTHWORKS**			-	-	-	-	-	-	-	-
		A) Surveys & investigation	sq.km	0.02	879.00	13.19	-	-	-	-	13.19
		B) Raising land/filling (EAST)	sq.km.	15.00	30.00	450.00	40.00	600.00	30.00	450.00	1,500.00
		C) Raising land/filling (WEST)	sq.km.	7.50	40.00	300.00	40.00	300.00	30.00	225.00	825.00
	Earthworks Total Cost (A+B+C)					**763.19**		**900.00**		**675.00**	**2,338.19**
5	**SERVICES**			-	-	-	-	-	-	-	-
	A) Water Supply			-	-	-	-	-	-	-	-
	a) Water Sourcing and transportation	Development of canal from Dhandhuka to site/water body including intake works	Km	0.30	20.00	6.00	20.00	6.00	-	-	12.00
		Construction of raw water reservoir (30 days storage, 450m wide & 3.0m deep channel with 0.5m freeboard)	Km	1.40	6.00	8.40	1.00	1.40	-	-	9.80
		Pump house to pump raw water to WTP, civil works	nos.	1.10	1.00	1.10	1.00	1.10	-	-	2.20
		Pumping system, E/M including DG sets	MLD	0.20	258.00	51.60	450.00	90.00	238.00	47.60	189.20
		Rising mains for pumping water from raw water body to WTP (dia. ranging from 700mm, 1200mm, 1400mm)	km	9.50	4.00	38.00	4.00	38.00	-	-	76.00
	b) WTP and Storage	Water treatment plant	MLD	0.20	258.00	51.60	450.00	90.00	238.00	47.60	189.20
		Creation of treated water storage reservoir at treatment plant site	Million Litres	0.80	86.00	68.80	150.00	120.00	79.00	63.20	252.00
		Pump house to pump treated water to water works, civil works	nos.	1.10	1.00	1.10	1.00	1.10	-	-	2.20
	c) Water Main, Storage & Distribution	Pump house at sector level Water Works	nos.	1.00	8.00	8.00	12.00	12.00	5.00	5.00	25.00
		Pumping system, E/M including DG sets- 2 stage (WTP to storage reservoirs at water works and water works to OHT)	MLD	0.30	258.00	77.40	450.00	135.00	238.00	71.40	283.80
		Rising mains	km	3.50	55.00	192.50	75.00	262.50	10.00	35.00	490.00

Sr.	Item	Description	Unit	Rate (INR)	Quantity in Phase-I development	Cost Estimate-Phase I (INR)	Quantity in Phase II development	Cost Estimate-Phase II (INR)	Quantity in Phase III development	Cost Estimate-Phase III (INR)	Total Development Cost (INR)
		Water storage in the GSRs and OHTs, at sector levels	Million Litres	1.00	172.00	172.00	300.00	300.00	159.00	159.00	631.00
		Distribution Network	km	1.20	780.00	936.00	1,106.47	1,327.76	651.52	781.82	3,045.59
	Subtotal					**1,612.50**		**2,384.86**		**1,210.62**	**5,207.99**
	B) Sewerage	Sewerage collection network (Trunk)	km	1.00	135.00	135.00	165.00	165.00	40.00	40.00	340.00
		Local network	km	0.30	780.00	234.00	1,106.47	331.94	651.52	195.46	761.40
		Pumping stations (IPS and MPS) including E&M	MLD	0.40	178.00	71.20	310.00	124.00	164.00	65.60	260.80
		Rising mains	km	2.00	10.00	20.00	10.00	20.00	5.00	10.00	50.00
		Treatment Plant	MLD	0.70	178.00	124.60	310.00	217.00	164.00	114.80	456.40
		Effluent disposal channel	km	1.70	18.00	30.60	11.00	18.70	11.00	18.70	68.00
		Recycling network	km	0.60	135.00	81.00	165.00	99.00	40.00	24.00	204.00
		Pumping for Recycling including civil, electrical and mechanical works	MLD	0.20	178.00	35.60	310.00	62.00	164.00	32.80	130.40
	Subtotal					**732.00**		**1,037.64**		**501.36**	**2,271.00**
	C) Storm water Drainage	Drainage Network(Trunk)	km	1.20	140.00	168.00	180.00	216.00	50.00	60.00	444.00
		Local Drain	km	0.40	780.00	312.00	1,106.47	442.59	651.52	260.61	1,015.20
		Development of Water Front/water body including gates/barrage	km	14.00	16.00	224.00	14.00	196.00	-	-	420.00
	Subtotal					**704.00**		**854.59**		**320.61**	**1,879.20**
	D) Flood Management	Bunding	km	1.50	120.00	180.00	122.50	183.75	-	-	363.75
		River training - dredging	km	1.00	20.00	20.00	20.00	20.00	10.00	10.00	50.00
		River training - pitching	km	5.00	5.00	25.00	7.00	35.00	2.00	10.00	70.00
	Subtotal					**225.00**		**238.75**		**20.00**	**483.75**
	E) Solid waste management (excluding cost for landfill site)	Primary Solid Waste Management	tons/day	0.04	332.00	13.28	653.00	26.12	355.00	14.20	53.60
		Secondary Solid Waste Management	tons/day	0.15	332.00	49.80	653.00	97.95	355.00	53.25	201.00
		Tertiary SWM - IWMF Development	tons/day	0.22	332.00	73.04	653.00	143.66	355.00	78.10	294.80
	Subtotal					**136.12**		**267.73**		**145.55**	**549.40**
	F) Landscaping & Signage	Hard & Soft Landscaping	sq.km.	5.00	20.00	100.00	25.00	125.00	15.00	75.00	300.00
		Fire fighting Line	km	1.00	100.00	100.00	200.00	200.00	100.00	100.00	400.00

Sr.	Item	Description	Unit	Rate (INR)	Quantity in Phase-I development	Cost Estimate-Phase I (INR)	Quantity in Phase II development	Cost Estimate-Phase II (INR)	Quantity in Phase III development	Cost Estimate-Phase III (INR)	Total Development Cost (INR)
	Subtotal					200.00		325.00		175.00	700.00
	G) Power Supply	400KV System: Transmission lines, Switchyards & Power Transformers	Set	250.00	1.00	250.00	1.00	250.00	-	-	500.00
		132KV & Sub-distribution System for early phase: Transmission lines, Switchyards & Power Transformers	Set	40.00	3.00	120.00	5.00	200.00	3.00	120.00	440.00
		33KV System: Substation, HT Switchboards, Transformers Underground cables	Set	10.00	10.00	100.00	20.00	200.00	10.00	100.00	400.00
		11KV System: Compact Substation, HT Switchboards, Distribution Transformers Underground cables	Set	2.25	75.00	168.75	150.00	337.50	75.00	168.75	675.00
		11KV compact substation along with its accessories	Set	0.35	150.00	52.50	300.00	105.00	250.00	87.50	245.00
		LT system: Power supply to 0.5 million DU + other SIA loads along with its metering system along with Service Cables, feeder pillards, underground cable	LS	L.S.	LS	500.00	LS	1,000.00	LS	500.00	2,000.00
	Subtotal					**1,191.25**		**2,092.50**		**976.25**	**4,260.00**
	H) Renewable Energy Plant		MW	18.08	77.00	1,392.00	-	-	-	-	1,392.00
	Subtotal					**1,392.00**		**-**		**-**	**1,392.00**
	I) Captive Power Plant		MW	4.50	90.00	405.00	90.00	405.00	90.00	405.00	1,215.00
	Subtotal					405.00		405.00		405.00	1,215.00
	J) Street Lighting	Primary Roads	km	0.35	114.43	40.05	141.18	49.41	64.11	22.44	111.90
		Local Roads	km	0.15	438.00	65.70	876.00	131.40	438.00	65.70	262.80
	Subtotal					**105.75**		**180.81**		**88.14**	**374.70**
	K) Telecommunications	Underground ducting and Junction Chamber	km	0.12	552.43	66.29	1,017.18	122.06	502.11	60.25	248.61
	Subtotal					**66.29**		**122.06**		**60.25**	**248.61**
	L) Gas Grid	Gas grid pipe line with infrastructure	km	1.12	25.00	28.00	20.00	22.40	15.00	16.80	67.20
	Subtotal					**28.00**		**22.40**		**16.80**	**67.20**

Sr.	Item	Description	Unit	Rate (INR)	Quantity in Phase-I development	Cost Estimate-Phase I (INR)	Quantity in Phase II development	Cost Estimate-Phase II (INR)	Quantity in Phase III development	Cost Estimate-Phase III (INR)	Total Development Cost (INR)
	Services Total Cost (A+B+C+D+E+F+H+I+J+K+L)					**6,797.91**		**7,931.35**		**3,919.58**	**18,648.84**
6	**A) BUILDINGS**	Public Buildings	sqm	0.0015	60,000.00	90.00	200,000.00	300.00	200,000.00	300.00	690.00
		Civic Centre	nos.	0.0015	30,000.00	45.00	20,000.00	30.00	20,000.00	30.00	105.00
		Utility Buildings	nos.	0.0013	30,000.00	39.00	50,000.00	65.00	30,000.00	39.00	143.00
	Building works Total Cost (A)					**174.00**		**395.00**		**369.00**	**938.00**
Total CAPEX Cost						**11,723.91**		**18,007.72**		**8,744.44**	**38,476.06**
Physical Contingencies at 10%											**3,847.61**
GRAND TOTAL COST											**42,323.67**

Table 11-5: Broad Cost Estimates (OPEX)

Sr.	Item	Description	Unit		OPEX Charges %	Phase I	Phase II	Phase III	Total OPEX Charges
1	**LAND IMPROVEMENT SCHEMES**	Land Development Costs for road construction, railway embankment and transport corridor	sq.m.	NPPP	0.00%	-	-	-	-
	Land Improvement Works Total Cost			**NPPP**		**-**	**-**	**-**	**-**
2	**ROADWORKS**								-
	A) Road Network - Major	Arterial Roads (70m)	km	NPPP	0.85%	4.59	5.80	1.47	11.85
		Collector Roads (30m)	km	NPPP	0.85%	1.31	2.04	1.49	4.85
		Local Road (25 and 20m.)	km	NPPP	0.85%	0.98	0.93	0.37	2.28
	B) Road Network - Internal	30m wide	km	NPPP	0.85%	2.08	4.17	2.08	8.33
		25m wide	km	NPPP	0.85%	4.12	8.25	4.12	16.49
		20m wide	km	NPPP	0.85%	3.10	6.21	3.10	12.41
		15m wide	km	NPPP	0.85%	2.48	4.96	2.48	3.93
	Subtotal					-	-	-	-
	C) Junctions	Grade separated Interchanges (Junction 1)	No.		0.00%	-	-	-	-
		Junction 2	No.		0.00%	-	-	-	-

Sr.	Item	Description	Unit		OPEX Charges %	Phase I	Phase II	Phase III	Total OPEX Charges
		Junction 3	No.		0.00%	-	-	-	-
	Subtotal					-	-	-	-
	D) Existing Road Improvement	Improvement of SH6	km	NPPP	1.00%	4.20	-	-	4.20
	Subtotal					-	-	-	-
	Road works Total Cost (A+B+C)			NPPP	0.85%	**22.87**	**32.35**	**15.12**	**70.53**
3	**LAYING OF RAILWAY LINE**			PPP					-
		A) Laying a new railway line and Logistics park	km	PPP	3.00%	9.90	-	-	9.90
		B) Logistics park	Ha	PPP	3.00%	4.50	9.00	6.30	19.80
		C) Construction of station	nos.	PPP	1.50%	1.50	-	-	1.5
		D) LRT	km	PPP	1.50%	-	63.60	21.60	85.2
	Railway works Total Cost (A+B+C)			**PPP**		**15.90**	**72.60**	**27.90**	**116.40**
4	**EARTHWORKS**								-
		A) Surveys & investigation	sq.km	NPPP	0.00%	-	-	-	-
		B) Raising land/filling (EAST)	sq.km.	NPPP	0.00%	-	-	-	-
		C) Raising land/filling (WEST)	sq.km.	NPPP	0.00%	-	-	-	-
	Earthworks Total Cost (A+B+C)			NPPP		-	-	-	-
5	**SERVICES**								-
	A) Water Supply			PPP					-
	a) Water Sourcing and transportation	Development of canal from Dhandhuka to site/water body including intake works	Km	PPP	2.00%	0.12	0.12	-	0.24
		Construction of raw water reservoir (30 days storage, 450m wide & 3.0m deep channel with 0.5m freeboard)	Km	PPP	2.00%	0.17	0.03	-	0.20
		Pump house to pump raw water to WTP, civil works	nos.	PPP	7.50%	0.08	0.08	-	0.17
		Pumping system, E/M including DG sets	MLD	PPP	7.50%	3.87	6.75	3.57	14.19
		Rising mains for pumping water from raw water body to WTP (dia. ranging from 700mm, 1200mm, 1400mm)	km	PPP	7.50%	2.85	2.85	-	5.7
	b) WTP and Storage	Water treatment plant	MLD	PPP	7.50%	3.87	6.75	3.57	14.19
		Creation of treated water storage reservoir at treatment plant site	Million Litres	PPP	2.00%	1.38	2.40	1.26	5.04

Sr.	Item	Description	Unit		OPEX Charges %	Phase I	Phase II	Phase III	Total OPEX Charges
		Pump house to pump treated water to water works, civil works	nos.	PPP	7.50%	0.08	0.08	-	0.17
	c) Water Main, Storage & Distribution	Pump house at sector level Water Works	nos.	PPP	7.50%	0.60	0.90	0.38	1.88
		Pumping system, E/M including DG sets- 2 stage (WTP to storage reservoirs at water works and water works to OHT)	MLD	PPP	7.50%	5.81	10.13	5.36	21.29
		Rising mains	km	PPP	2.00%	3.85	5.25	0.70	9.80
		Water storage in the GSRs and OHTs, at sector levels	Million Litres	PPP	7.50%	12.90	22.50	11.93	47.33
		Distribution Network	km	PPP	3.00%	28.08	39.83	23.45	91.37
	Subtotal			**PPP**		**63.65**	**97.67**	**50.21**	**211.54**
	B) Sewerage	Sewerage collection network (Trunk)	km	NPPP	3.00%	4.05	4.95	1.20	10.20
		Local network	km	NPPP	3.00%	7.02	9.96	5.86	22.84
		Pumping stations (IPS and MPS) including E&M	MLD	NPPP	7.50%	5.34	9.30	4.92	19.56
		Rising mains	km	NPPP	3.00%	0.60	0.60	0.30	1.50
		Treatment Plant	MLD	NPPP	7.50%	9.35	16.28	8.61	34.23
		Effluent disposal channel	km	NPPP	3.00%	0.92	0.56	0.56	2.04
		Recycling network	km	NPPP	3.00%	2.43	2.97	0.72	6.12
		Pumping for Recycling including civil, electrical and mechanical works	MLD	NPPP	7.50%	2.67	4.65	2.46	9.78
	Subtotal			**NPPP**		**32.37**	**49.26**	**24.63**	**106.27**
	C) Stormwater Drainage	Drainage Network(Trunk)	km	NPPP	3.00%	5.04	6.48	1.80	13.32
		Local Drain	km	NPPP	3.00%	9.36	13.28	7.82	30.46
		Development of Water Front/water body including gates/barrage	km	NPPP	7.50%	16.80	14.70	-	31.50
	Subtotal					**31.20**	**34.46**	**9.62**	**75.28**
	D) Flood Management	Bunding	km	NPPP	3.00%	5.40	5.51	-	10.91
		River training - dredging	km	NPPP	3.00%	0.60	0.60	0.30	1.50
		River training - pitching	km	NPPP	3.00%	0.75	1.05	0.30	2.10
	Subtotal					**6.75**	**7.16**	**0.60**	**14.51**
	E) Solid waste management (excluding cost for landfill site)	Primary Solid Waste Management	tons/day	NPPP	18.00%	2.39	4.70	2.56	9.65
		Secondary Solid Waste Management	tons/day	NPPP	18.00%	8.96	17.63	9.59	36.18

Sr.	Item	Description	Unit		OPEX Charges %	Phase I	Phase II	Phase III	Total OPEX Charges
		Tertiary SWM - IWMF Development	tons/day	NPPP	18.00%	13.15	25.86	14.06	53.06
	Subtotal					**24.50**	**48.19**	**26.20**	**98.89**
	F) Landscaping & Signage	Hard & Soft Landscaping	sq.km.	NPPP	15.00%	15.00	18.75	11.25	45.00
		Fire fighting Line	km	NPPP	15.00%	15.00	30.00	15.00	60.00
	Subtotal					**30.00**	**48.75**	**26.25**	**105.00**
	G) Power Supply	400KV System: Transmission lines, Switchyards & Power Transformers	Set	PPP	5.00%	12.50	12.50	-	25.00
		132KV & Sub-distribution System for early phase: Transmission lines, Switchyards & Power Transformers	Set	PPP	5.00%	6.00	10.00	6.00	22.00
		33KV System: Substation, HT Switchboards, Transformers, Underground cables	Set	PPP	5.00%	5.00	10.00	5.00	20.00
		11KV System: Compact Substation, HT Switchboards, Distribution Transformers Underground cables	Set	PPP	5.00%	8.44	16.88	8.44	33.75
		11KV compact substation along with its accessories	Set	PPP	5.00%	2.63	5.25	4.38	12.25
		LT system: Power supply to 0.5 million DU + other SIA loads along with its metering system along with Service Cables, feeder pillards, underground cable	LS	PPP	5.00%	25.00	50.00	25.00	100.00
	Subtotal			**PPP**		**59.56**	**104.63**	**48.81**	**213.00**
	H) Renewable Energy Plant		MW	PPP	0.00%	-	-	-	-
	Subtotal					-	-	-	-
	I) Captive Power Plant		MW	PPP	0.00%	-	-	-	-
	Subtotal								-
	J) Street Lighting	Primary Roads	km	NPPP	10.00%	4.01	4.94	2.24	11.19
		Local Roads	km	NPPP	10.00%	6.57	13.14	6.57	26.28
	Subtotal					**10.58**	**18.08**	**8.81**	**37.47**
	K) Telecommunications	Underground ducting and Junction Chamber	km	PPP	3.00%	1.99	3.66	1.81	7.46
	Subtotal			**PPP**		**1.99**	**3.66**	**1.81**	**7.46**
	L) Gas Grid	Gas grid pipe line with infrastructure	km	PPP	0.00%	-	-	-	-

Sr.	Item	Description	Unit		OPEX Charges %	Phase I	Phase II	Phase III	Total OPEX Charges
	Subtotal			**PPP**		**-**	**-**	**-**	**-**
	Services Total Cost (A+B+C+D+E+F+H+I+J+K+L)					**260.60**	**411.86**	**196.95**	**869.42**
6	**A) BUILDINGS**	Public Buildings	sqm	NPPP	3.00%	2.70	9.00	9.00	20.70
		Civic Centre	nos.	NPPP	3.00%	1.35	0.90	0.90	3.15
		Utility Buildings	nos.	NPPP	3.00%	1.17	1.95	1.17	4.29
	Building works Total Cost (A)					**5.22**	**11.85**	**11.07**	**28.14**
Total OPEX Cost				**NPPP**		**304.60**	**528.66**	**251.04**	**1,084.30**
					For 10 years	**3,045.98**	**5286.90**	**2,510.40**	**10,842.98**

CHAPTER 12

BENEFITS FROM DSIR

12. Benefits from DSIR

The various direct and indirect benefits that will accrue from the project are given below

12.1. Direct Benefits

12.1.1. Employment Generation

Employment generated in the DSIR will comprise "base" jobs and "support" jobs. The base jobs by the end of Phase 3 will include industrial jobs totalling about 312,900 people, 29,500 additional base jobs in tourism and 600 jobs in higher education, making a total 343,000 base jobs. Support jobs will include all occupations within the commercial, administrative, institutional, residential and recreational sectors necessary to enable the DSIRDA to develop into a self sustaining and diverse city. Support jobs will total 483,630 by the end of Phase 3, giving a total workforce in the DSIR of 826,630 by the end of the Plan period.

12.1.2. Developed Land in the DSIR

Total developable land in the DSIR is about 33,846 ha. The major saleable elements of this will be industrial land at 11,457 ha and housing and commercial land at about 2,165 ha (See Table 3.5, Chapter 3). 2 million people will reside in the DSIR, creating a demand for about 500,000 houses by the end of Phase 3.

Table 12-1: Key Jobs and Land Use Provisions

	PHASE 1	PHASE 2	PHASE 3	TOTAL
Total Urban Land Area (ha)	11,505	12,045	10,147	33,696
Target Employment (base and support jobs)	204,850	402,470	219,310	826,630
Target Resident Population (rounded)	496,000	970,000	534,000	2,000,000
Number of Housing Units (rounded)	124,000	242,500	133,500	500,000

12.1.3. Industrial Investment

Investment in the main industrial sectors of the economy are shown below in Table 12.2.

Table 12-2: Industrial Investment and Base Employment by Sector

SR. NO.	INDUSTRY	TOTAL EMPLOYMENT POTENTIAL	INVESTMENT POTENTIAL (IN USD BILLION)
1	Heavy Engineering	45,100	7.12
2	Automobile & Auto Ancillary	43,900	12.85
3	Electronics & Emerging Technologies	87,300	14.99
4	Pharmaceuticals & Biotechnology	49,100	1.79
5	Metals & Metallurgical Products	11,400	1.4
6	General Manufacturing	42,400	0.45
7	Agro & Food Processing	27,500	3.72
8	IT/ITES	6,200	0.71
	Total	**312,900**	**43.03**

12.2. Indirect Benefits

12.2.1. Benefits of Greenfield Development

Greenfields include previously undeveloped land, restored land, agricultural properties, and parks. These areas have high ecological, social, and community values. Some of the benefits of Greenfield development have been summarized as follows.

12.2.2. Green Infrastructure

Preservation of large open spaces is facilitated by large - scale community development. Environmental protection and enhancement are served because the site is evaluated in its larger context, and project economics often allow for development areas to underwrite both initial and long-term management costs associated with conservation measures.

12.2.3. Efficient and Responsible Infrastructure Use

A planned process offers opportunities to locate, design, and phase infrastructure incrementally, together with residential and other land uses, in ways not possible with small-scale subdivisions. A comprehensive approach often improves systems' operating efficiency and financial feasibility, and makes sustainable technologies more accessible. Examples include integrating potable water, storm drainage, and wastewater treatment with habitat development, employing low-energy natural treatment instead of mechanical systems. Finally, comprehensive development can take advantage of special service districts, which are difficult to obtain with fragmented ownerships.

12.2.4. Mobility and Alternative Transportation

A comprehensive planning and development process can foster a diverse, efficient transportation network connecting neighbourhoods, employment, retail, and recreation centres within and outside the planned community. Interconnected streets, walking and hiking trails and path systems for alternative vehicles (e.g., electric cars and carts) offer residents the benefits of increased exercise and fewer car trips. Large planned communities can plan far into the future to provide room for transit links that may not be supportable at the outset of development, but could never even be considered in incremental development.

12.2.5. Jobs / Housing Balance

Planned development would help in creating employment centres that can give more people the option of living near work, shopping, and recreation and education facilities. The regional vision described earlier is essential to fostering communities that develop in a mutually supportive manner, so that one community may be the employment focus, while another may serve as the residential focus, and still another may provide a major recreation resource.

12.2.6. Mixed Uses and Varied Housing Types

Integration of a variety of land uses, neighbourhood designs, housing types, densities, and price ranges is often best accomplished in a planned community. By shifting density and allocating land costs, the region can deliver more diversity and affordability through non - traditional products. Examples include over garage apartments, live/work lofts, English basements, and multifamily mansions.

CHAPTER 13

SPATIAL PLANNING IN THE POST – KALPASAR DAM SCENARIO

13. Spatial Planning in the Post - Kalpasar Dam Scenario

13.1. Increased Land Availability Post Kalpasar dam

Feasibility studies for construction of the Kalpasar Dam in the Gulf of Khambhat are currently underway. The construction of the Dam will increase the amount of land available for urban development because the level of the fresh water lake will be lower than the existing high tide level of the sea. The high water level of the fresh water lake will be established at about the 13m contour level, thus increasing the land area of the DSIR by approximately 315 sq km. That is about the same area of land that is required to accommodate all of the land needed to meet the forecast demand for urban uses in the Draft Development plan for 30 years.

Construction of the Kalpasar dam will also create additional dry land areas all around the Gulf of Khambhat, not just within the DSIR. In total the new land areas will roughly amount to about 1300,000 ha of potential development land. This is over thirteen times the area of land released by the dam for potential development in the DSIR.

It is evident therefore that should the Kalpasar dam be constructed, a new strategic study covering the whole of the Kalpasar dam shoreline area will need to be prepared. This will need to determine the strategy for the use of the whole 1300,000 ha released around the Gulf of Khambhat, plus the hinterland of this area, not just the land released in the DSIR.

13.2. The Demand for additional Land

The studies into the demand for land in the DSIR covered in report for Industrial Market Potential and Critical Gap Assessment prepared by Halcrow, show that the construction of the Kalpasar dam will have only a relatively small impact upon job generation and floor space demand in the DSIR. To ensure that any positive impacts of the dam are taken into account, a slightly higher market demand assumption was adopted to provide for the possibility of the Kalpasar dam generating additional demand for land. Even with this slightly higher forecast land demand, it is evident that a viable spatial plan for the DSIR can be developed without recourse to any additional land released by the Kalpasar dam.

13.3. Reducing Uncertainty

The Kalpasar project has received State approval in principle but funding is not yet in place, nor have all environmental studies been completed or approved. Given this uncertainty about the eventual completion of the project, it is considered prudent to continue the planning of the DSIR on the basis that the Kalpasar dam will not be constructed within the plan period. All of the land forecast to be required for urban purposes in the DSIR can be comfortably accommodated within the existing DSIR boundary outside the CRZ.

Even if the Kalpasar dam is constructed within the time-scale of the Draft Development plan, the current Plan will still offer a viable spatial strategy that accommodates in an economic manner all of the forecast urban land demands.

It is therefore proposed that spatial planning proceeds on the basis that the CRZ will continue to shape the development of the DSIR and that all land within the CRZ will be left undeveloped except for the range of uses permitted in the area according to the regulations. In effect this means that a narrow strip of the CRZ on its western boundary falling within CRZ III can be used for recreation purposes such as open sports pitches and parks and non permanent structures as specified in the official regulations. Land in the DSIR falling within CRZ I will not be available for any urban development purposes.

13.4. Post Kalpasar Strategy

A new Draft Development plan for the DSIR will be required should the Kalpasar dam construction start at any time within the 30 year time frame of the current Draft Development plan. This new plan cannot be developed in isolation however. In the event that the Kalpasar dam is constructed, a new strategic study covering the whole of the Kalpasar dam shoreline of 1300,000 ha area will need to be prepared, not just the land released in the DSIR.

Such a study may well find that there is no market for the additional land created in the DSIR and that land released closer to the DFC and the main urban centres of Ahmedabad and Vadodara on the eastern shore of the new lake is more attractive for urban development than the land released in the DSIR. This will not be known until the Kalpasar project becomes a reality.

Even if the Kalpasar dam project is approved and eventually constructed and a new strategic plan for the whole shoreline area put in place, a substantial period of time will have lapsed from completion of the current Draft Development plan.

Development of the DSIR cannot be delayed on the basis of the Kalpasar project, which may or may not eventually proceed and development in the DSIR will of necessity have to be been carried out on the basis of the Draft Development plan presented in this report.

13.4.1. Potential land Use and spatial implications of the Kalpasar Dam Project for the DSIR

An alternative spatial Draft Development plan has been prepared to show how the DSIR might evolve should the Kalpasar dam be constructed. The earliest possible date for the completion of the Kalpasar dam would be between 5 and 10 years after the final approvals, including environmental clearances and funding, are place. Therefore the very earliest likely date for the Kalpasar dam to influence the current Draft Development plan would be at the end of Phase 1 of the current Plan. The alternative illustrative plan presented here therefore assumes that the existing Phase 1 of the current Draft Development plan is implemented according to plan and only in Phases 2 and 3 would the impact of the new post Kalpasar land availability scenario affect land use planning in the DSIR.

The alternative illustrative post Kalpasar spatial plan is shown in Figure 13.1 and the indicative land use budget for this shown on Table 13.1.

The illustrative plan shows how the DSIR might develop in the context of the new releases of land to the east and the removal of the CRZ restrictions on development. The market studies undertaken during the preparation of the Draft Development plan have indicated that for most uses, demand for land in the DSIR will not change significantly between the pre and post Kalpasar scenarios. The notable exceptions to this are:

- There is likely to be increased demand for leisure and second homes, since the fresh water lake may attract additional investors to the DSIR. Investors will also, of course, be attracted to sites elsewhere to the new lake shore, so the DSIR will only gain a portion of this new market;
- Increased opportunities for new leisure resorts and facilities, although not necessarily new demand;
- There will be substantial new areas available on the reclaimed seabed for the development of solar energy parks and, in time, possibly new forms of agriculture;
- Other benefits of the post Kalpasar scenario plan would include:
- Utilisation of a substantially greater proportion of Government owned land – which will be increased from about 3,000ha to over 10,000ha in the post Kalpasar plan;
- Retention of additional agricultural land in the west of the DSIR, and a reduced need for land procurement in this area as development shifts eastwards towards the freshwater lake.

Disadvantages of the post Kalpasar illustrative plan would be:

- The resulting spatial plan is less balanced that the Draft Development plan and the centre of gravity of the city is away from the expressway and passenger railway station and freight logistics centre, leading to a less efficient urban structure;
- Land developed in the former tidal zone may well be unsuitable for construction purposes or require such substantial remediation works as to make its development for urban purposes unviable.

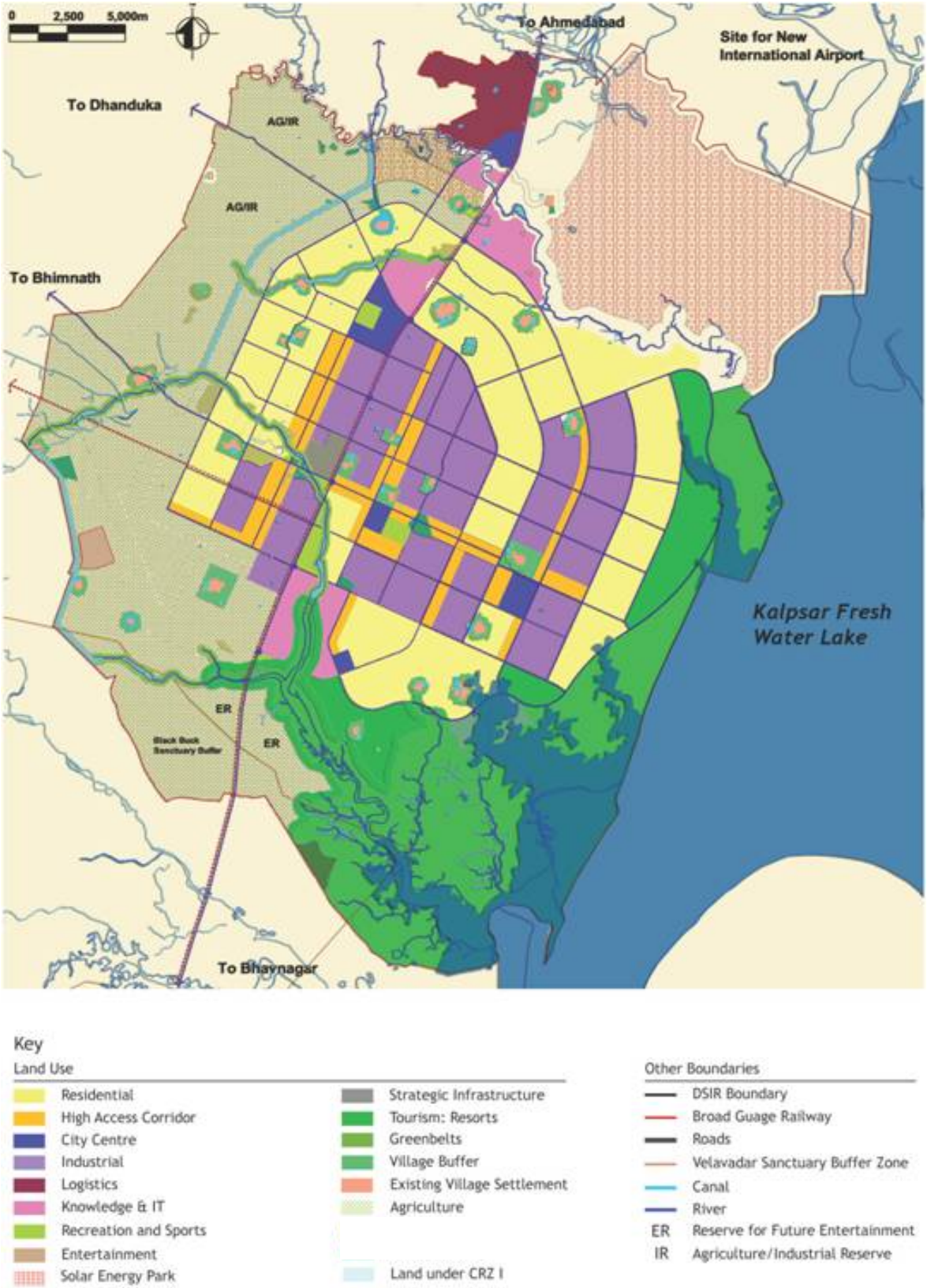


Figure 13-1: Spatial Land Use Plan in the Post - Kalpasar Scenario

Table 13-1: Indicative Land Use allocation post Kalapsar Scenario

SR. NO.	BROAD LAND USE ZONES	TOTAL AREA (ha)	PERCENT OF TOTAL AREA (%)
1	Residential	6,255	6.9
2	Leisure Homes	6,000	6.6
3	High Access Corridor	2,370	2.6
4	City Centre	870	1.0
5	Industrial	9,100	10.1
6	Logistics	220	0.2
7	Knowledge	1,015	1.1
8	Recreation and sports	2,000	2.2
9	Tourism and entertainment	1,170	1.3
10	Solar Energy Park	12,000	13.3
11	Roads	6,570	7.3
Area under Active Land Uses		47,570	52.6
12	Agriculture	27,300	30.2
13	Green Spaces, lakes and Canals	7,000	7.7
14	Existing villages and buffer	1,300	1.4
15	Forest and Grazing	2,500	2.8
16	Area under the CRZ	-	-
17	Area submerged under the Reservoir	4,700	5.2
	Total	**90,370**	**100.0**

All numbers rounded
**Developable Land is area outside the CRZ*

APPENDICES

APPENDIX A: STRATEGIC CONTEXT

The Delhi - Mumbai Industrial Corridor (DMIC)

The DMIC is conceived as a highly industrialised development corridor running either side of a new dedicated freight railway between Delhi and Mumbai, to be known as the Delhi and Mumbai Freight Corridor (DFC). A zone of influence either side of the DFC railway line of between 150 km to 200km is being promoted as locations for the development of industrial nodes.

An overall Perspective Plan has been prepared for the Corridor, in which a target is set of over 24 million new jobs by 2040.

The Plan aims to triple industrial output within 9 years, double employment in 7 years and quadruple exports in 8 to 9 years.

The DSIR, which falls in Ahmedabad District, is expected to be the largest of all of the industrial nodes to be developed within the DMIC.

The relationship of the DSIR to the DMIC is shown on Figure A-1.

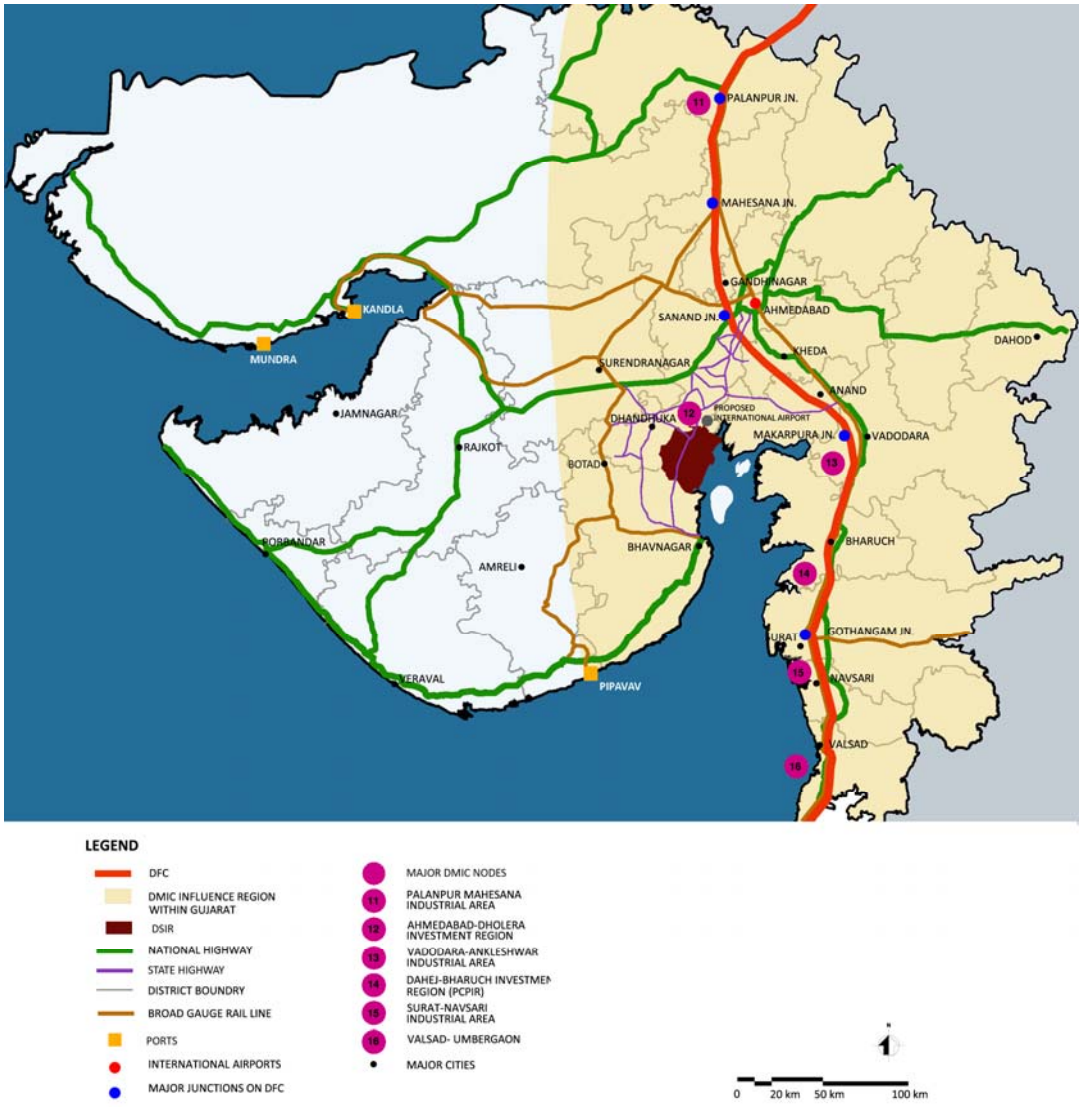


Figure A- 1: The DSIR, DFC Alignment and the DMIC Influence Region in Gujarat

Spatial Context

The DSIR is located at the following distances from the key commercial, administrative and urban centres of Gujarat:

- Ahmedabad - 100 km
- Gandhinagar - 140 km
- Vadodra - 225 km
- Surat - 365 km
- Bhavnagar - 65 km
- Kandla Port - 350 km
- Mundra Port - 400 km
- Pipavav Port - 160 km

Transport Connectivity

Access to Sea Ports

The nearest port to the DSIR is at Bhavnagar, at a distance of about 65 km. This port has a limited draft of 4 meters and is currently not operational. Pipavav Port is about 160 km to the south of the DSIR and is an all-weather, privately operated port. It is connected to its hinterland via Surendranagar.

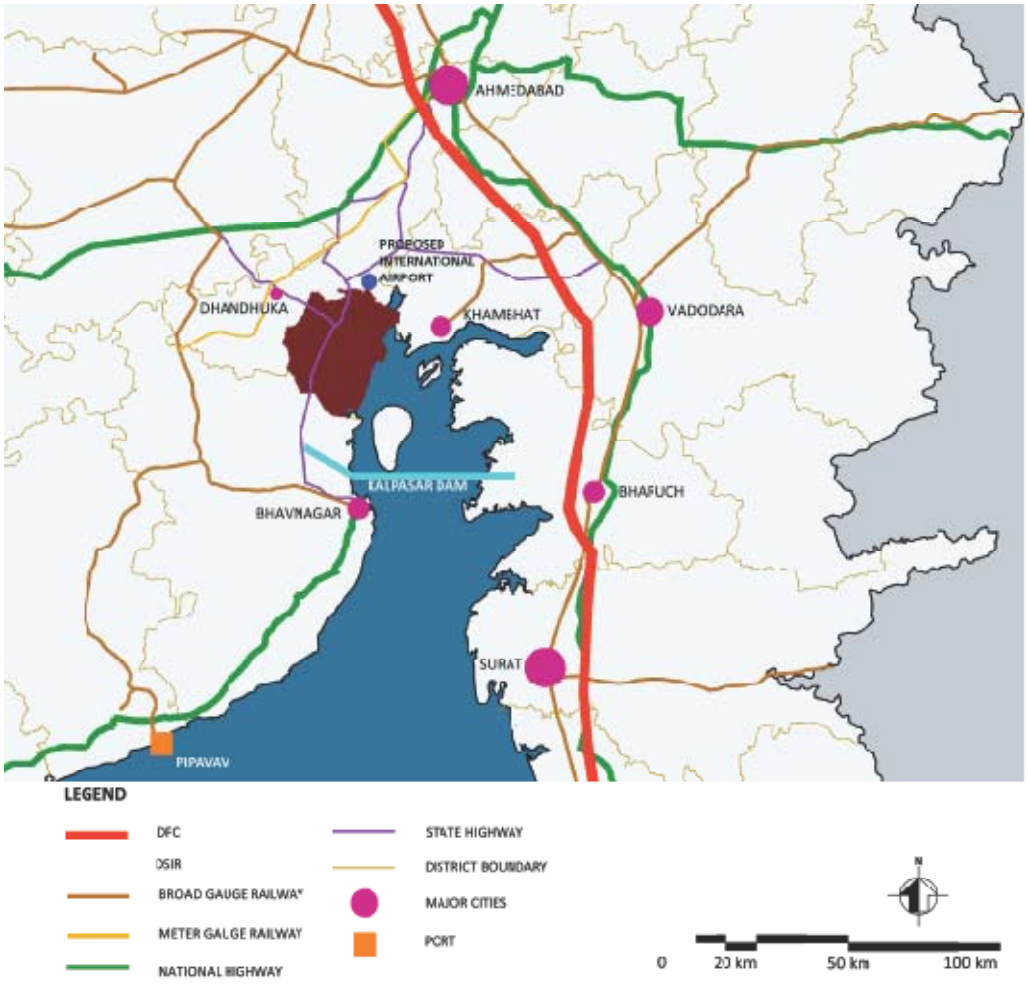


Figure A- 2: Strategic Planning Determinants

Strategic Road Connectivity

The DSIR is presently connected to the rest of the State by a two-lane road (SH-6), one major district road and other village roads as shown in Figure A-2. Parallel or diagonal to the site are other State Highways, notably SH-1, SH-4, SH-20 and SH-36 that connect to SH-6. The GIDB has long term plans to develop a six lane access-controlled highway along SH-6 from Ahmedabad to Bhavnagar via Dholera.

In the interim the SH-6 is being upgraded to a 4-lane dual carriageway road. At present NH-8A, SH-38 and SH-117 connect to the ports at Mundra and Kandla while SH-6 and NH-8E connect to Pipavav Port through Bhavnagar. These roads have been identified for improvement and augmentation by the Ministry of Shipping, Road Transport and Highways (MOSRTH), the National Highways Authority of India (NHAI) and the Gujarat Public Works Department (PWD).

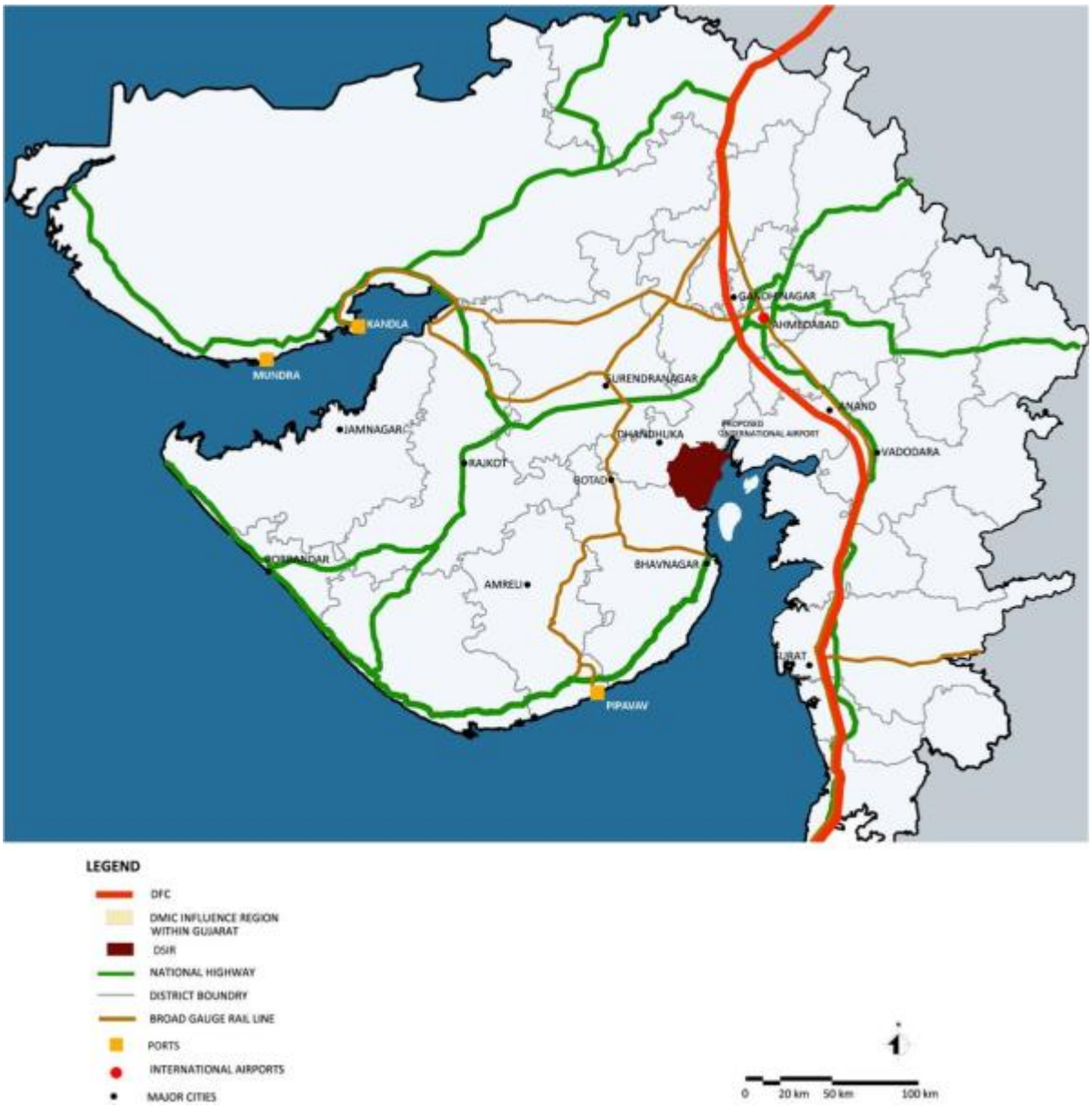


Figure A- 3: Transport Connectivity

Figure A-4 shows the sub-regional context for the site with the regional and local road connections.

Rail Connectivity

There is no rail connection to the DSIR at present. The nearest railway station is at Dhandhuka on the metre gauge rail line from Gandhigram to Botad. This line is due to be converted to broad gauge (BG) in the near future. Botad is on the BG system and connects Bhavnagar and Pipavav Port to Northern India via Surendranagar - Viramgam - Mehasana – Palanpur - Marwar - Jaipur - Rewari. Improvements to the freight services on the line from Pipavav northwards have been undertaken by Pipavav Rail Corporation Limited (PRCL) promoted by Gujarat Pipavav Port Limited and the Ministry of Railways (MoR). Pipavav Port can handle the incoming and outgoing trains simultaneously and the current capacity of the rail link is 22 trains per day while the port handles an average of two trains per day. The MoR proposes doubling the BG line

from Surendranagar - Botad - Dhasa - Rajula to Pipavav Port as a feeder link connecting to the DFC at Sanand Junction.

Air Services

Sardar Vallabhbhai Patel International Airport at Ahmedabad, nearly 100 kms away from the site is the nearest air facility to the DSIR. It is well connected to the major Indian cities as well as to the international destinations in USA, Europe, Singapore and Middle East. Due to the limited room for the expansion of the existing international airport at Ahmedabad, together with additional air safety issues in relation to the existing bird hazard and high structures near the airport, there are proposals to develop a new international airport at a approximate distance of about 25 km north-east of the DSIR near Navagam village.

There is also a smaller domestic airport at Bhavnagar, about 37 km away.

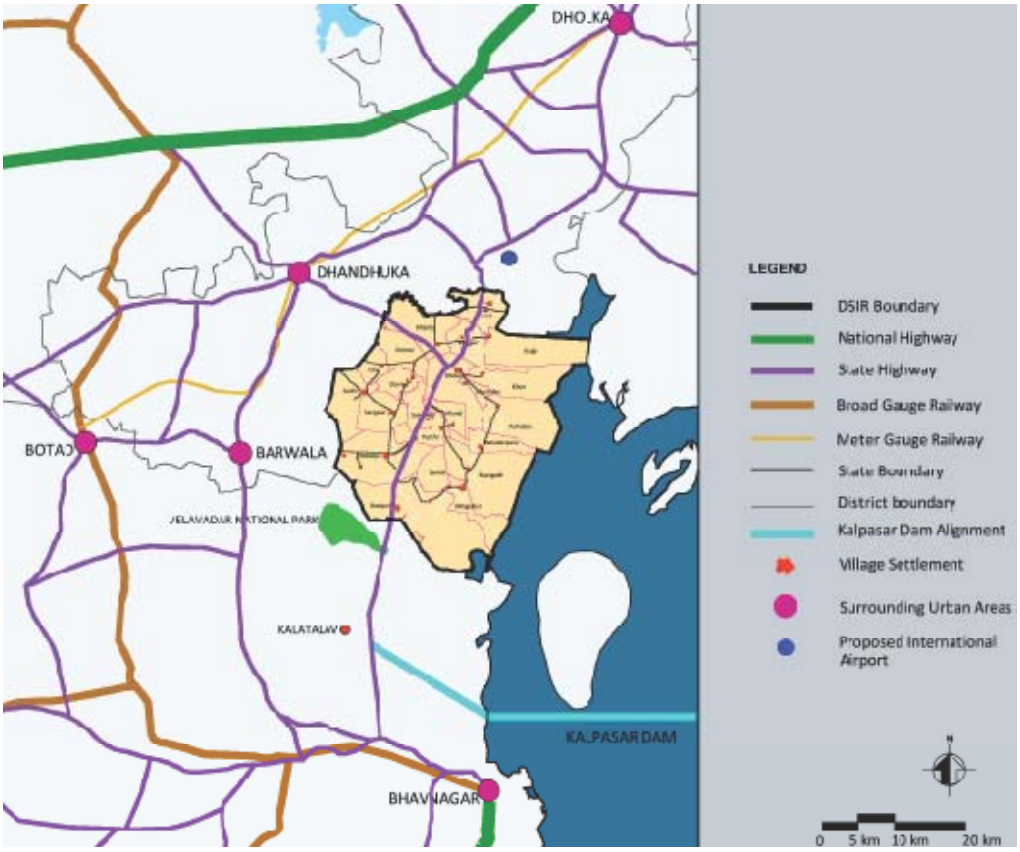


Figure A- 4: Sub - Regional Context

Major Schemes and Proposals influencing the project

Strategic projects influencing the DSIR are shown in Figure A-5 and are summarized below:

Kalpasar Freshwater Reservoir Project

The Kalpasar freshwater reservoir project dates back to 1975 when it was proposed that two reservoirs be developed, one for fresh water and the other a salt water tidal basin. This scheme comprised a 64 km long dam connecting Ghogha in the west and Hansot to the east and would have generated tidal power (5,880 MW) and provided a fresh water lake of 14,000 million cubic metres (mcm) capacity. Locks would have allowed existing and proposed ports to operate after construction of the dam and roads and railways would be built on top of the dam.

The original proposal was found to be uneconomic and a more limited scheme has now been approved by the State Government. This will comprise a shorter dam of about 29km, enclosing a sweet water reservoir with a storage capacity of 10,000 mcm and a fresh water fishery. It would also reduce the sea level in the enclosed lake from the existing high tide level of about 5.5m to 4m. This will release approximately 400,000 ha of land currently within the existing high tide line to be reclaimed. Of his total, approximately 3400 ha would fall within the DSIR.

The Kalpasar Department have indicated that the project will require a construction period of about five years, with a further 4-5 years before the salt water in the enclosed basin is converted into fresh water.

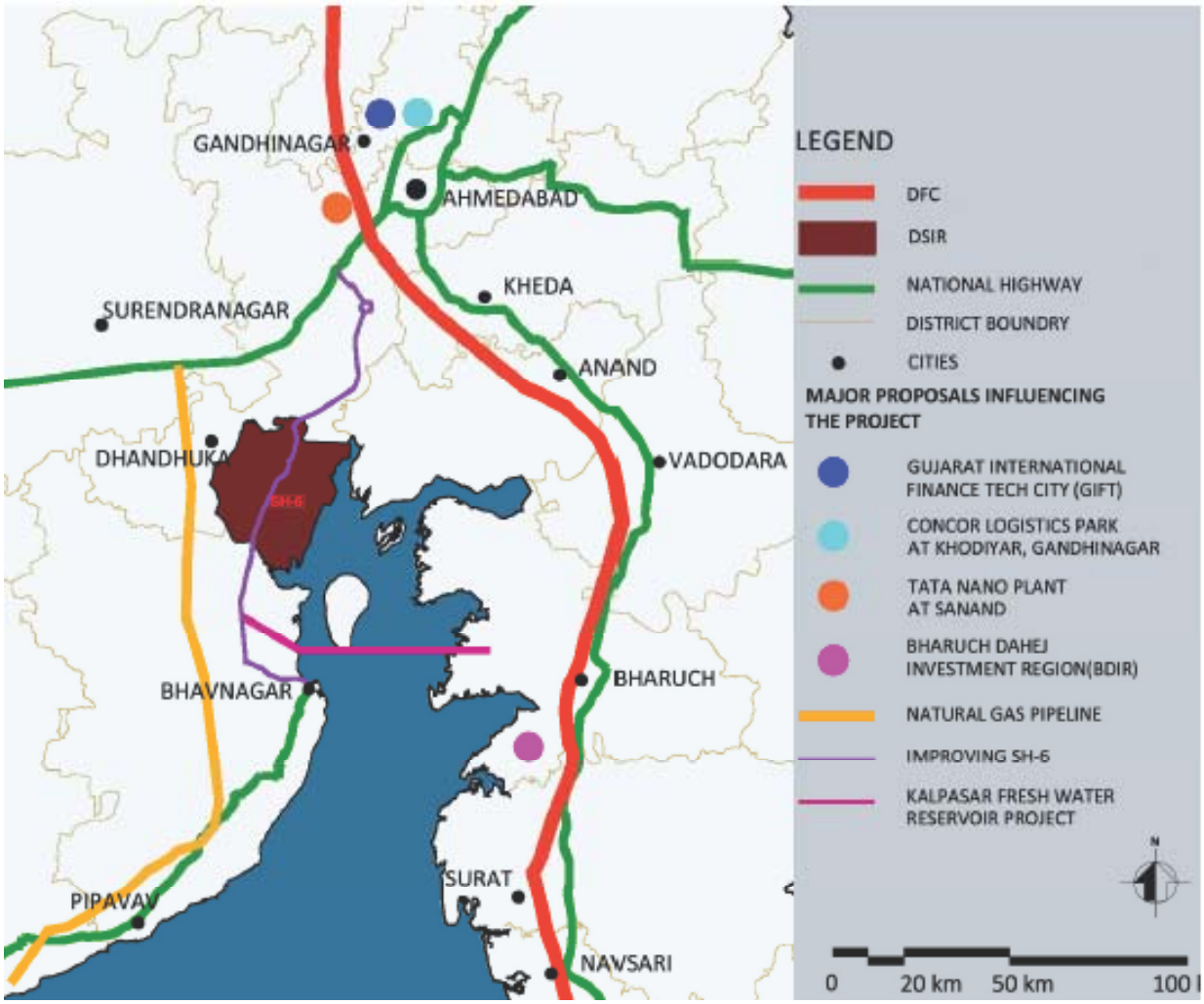


Figure A- 5: Major Schemes and Proposals Influencing the Project

Bharuch -Dahej Investment Region (BDIR)

The Conceptual Plan for the Bharuch -Dahej Investment Region (BDIR), also referred to as the Gujarat Petroleum, Chemical & Petrochemical Investment Region (GPCPIR) is the second investment region within the DMIC Corridor designated in Gujarat. The initial proposals for the area include major petrochemicals and chemical based processing activities with other uses including residential, commercial and open spaces making up the balance of land uses.

Gujarat International Finance Tec-City (GIFT)

Gujarat International Finance Tec-City Company Limited (GIFTCL) is responsible for the 200 ha development to be benchmarked as an International Finance City with a built-up area of 7,900,000 sq m. Location of the

site is 12 km from the Ahmedabad International Airport and abuts the four-lane NH-8 connecting Ahmedabad and Gandhinagar. This is intended to be a major development attracting global investors through a Special Economic Zone, international education zone, integrated townships, an entertainment zone, hotels, a convention centre, an international techno park, Software Technology Parks of India (STPI) units, shopping malls, stock exchange and service units.

Improving State Highway 6

In order to improve connectivity to the DSIR from Ahmedabad to Dholera via Dholka, Vataman, and Pipli, the existing 2-lane SH-6 is proposed to be upgraded to 4-lane carriageway, with 1.5 m paved shoulders, geometric improvements, longitudinal profile improvement, rearrangement of junctions, bridge and cross drainage structures and traffic control and safety measures. The alignment is connected with important towns and villages through other State Highways including Limdi & Dhandhuka (SH-20), Gadhda (SH-108), Fedara (SH- 40), Lothal (SH-117).

Proposal for connecting Gandhinagar – Ahmedabad – Dholera in Metro Phase II

The Gujarat Urban Development Company (GUDC) is in the process of assessment of the feasibility of connecting the DSIR to the proposed Gandhinagar - Ahmedabad Metro project. The project is intended to provide a safe, high capacity urban transport system connecting the main railway stations and bus stations, the existing International Airport and urban centres. The system, which will be developed in phases, is expected to carry 40,000 passengers per hour in each direction and according to estimates; up to 1.70 million commuters are expected to use the metro rail by 2031.

CONCOR Logistics Park at Khodiyar, Gandhinagar

In order to strengthen the logistics infrastructure in the State, a Logistics Park will be set up at Khodiyar, in Gandhinagar, with a projected export-import (EXIM) traffic handling capacity of 0.2 Million TEUs. It will act as an opening point on the DFC at Sanand and will have connectivity to major cargo generation areas in the north of Gujarat and Jawaharlal Nehru Port Trust (JNPT) in Navi Mumbai. The new ICD will have access to NH-8 and the north-south BG rail corridor on the Mehsana route.

Tata Nano Plant

The Tata Nano Project is being constructed at Sanand located at about 35 km south-west of Ahmedabad and in close proximity to the NH-8 connecting Ahmedabad and Rajkot. It will comprise the mother plant and the vendor park on an area of about 445 ha. The plant will initially produce 250,000 cars per annum with the capacity expandable up to 500,000 cars per annum. The project, including Tata Motors' plant, vendor facilities and service providers, is expected to generate over 10,000 direct and indirect jobs in Gujarat and give a boost to the small-scale industrial units. In future the plant may use the Pipavav, Kandla and Mundra Port for its exports and will promote development of auto-manufacture and supply car components such as casting, forging, and bearings in locations such as Ahmedabad, Rajkot and the DSIR. The project has already stimulated residential development and road improvement projects in the surrounding regions.

Natural Gas Pipeline

Gujarat enjoys an extensive network of natural gas pipelines with a route length of 1130 kms, covering the Hazira-Baroda-Ahmedabad-Kalol-Himmatnagar- Mehsana-Rajkot-Morbi-Vapi regions. An additional 425 km of pipeline is also currently under construction. A gas pipeline is planned from Darod- Dhandhuka-Jafrabad near Pipavav for which the route identification is complete. The current volume of gas being transported is more than 16 million metric standard cubic metre per day (MMSCMD) out of which approximately 8 MMSCMD is Regassified - Liquified Natural Gas (R-LNG).

Revised Development Plan, AUDA, 2011 & City Development Plan, Ahmedabad (2006-2012)

The existing development planning area under the Ahmedabad Urban Development Authority (AUDA) is about 1800 sq. km, housing a population of 4.6 million in 2001. AUDA has undertaken preparation of the Development Plan for 2011 where the revised Draft Development Plan expects to grow at a moderate rate and stabilize by the year 2035 with a population of about 10 to 11 million. The land use proposes an increase in residential areas from 35 percent to 44 percent with no significant change in industrial area due to the State Government's restrictive policy and an increase in land area for transportation uses from 9.5 percent to 11.1 percent. A large area of land currently occupied by the closed textile mills in eastern Ahmedabad will become a major source of redevelopment land.

APPENDIX B: EXISTING CONDITIONS IN DSIR

The Project Site

The DSIR site falls on the edge of the 150 km band of influence area of the DMIC and at a distance of nearly 95km from the proposed alignment of the DFC. It is located in Dhadhuka and Barwala Talukas of Ahmedabad district and covers 22 villages including Dholera, an ancient port city. The site touches the Gulf of Khambat on the eastern side, spreads beyond River Sukhbhadar on the northern boundary and the River Utavali on the southern boundary. Figure B-1 gives an introduction to the predominant site features. The eastern boundary abuts the Gulf of Khambat and about 33,885 ha land is rendered unavailable for development as it is included under the Coastal Regulation Zone (CRZ). SH-6 is the primary transport artery that connects the site to the regional road network and to the adjoining cities of Ahmedabad to its north and Bhavnagar to the south.

Regional Macro-Climate and the Environment

Climate

The Indian Meteorological Department has identified four seasons in the DSIR, namely summer, south-west monsoon, post-monsoon, and winter. The summer season starts from March and continues up to June end. October and November constitute the post monsoon season. The weather is generally cold during December to February.

Temperature

The maximum and minimum temperature recorded at Ahmedabad and Bhavnagar and the monthly temperature variation and is given in Table B-1 and Table B-2 respectively. It is clear from Table B-2 that average temperature at 0830 hours and 1730 hours for both, Ahmedabad and Bhavnagar is in the same range in all months of the year. May is the hottest month of the year both at Ahmedabad and Bhavnagar and the same trend is expected at the Project site with the temperature decreasing slightly in June with the onset of the monsoon but remaining steady until September. After cessation of the monsoon season in September, the temperature continues to decrease in post-monsoon and winter season and the minimum temperature is recorded in the month of January.

Table B- 1: Maximum and Minimum Temperatures

PLACE	MAX TEMPERATURE (˚C)	MIN TEMPERATURE (˚C)
Ahmedabad	47.8 (27/5/1916)	3.3 (23/11/1912)
Bhavnagar	46.7 (7/5/1912)	0.6 (31/1/1929)

Table B- 2: Monthly Average Variation in Dry Bulb Temperature at Bhavnagar and Ahmedabad

MONTH	TEMPERATURE (˚C)			
	0830 HOURS		1730 HOURS	
	AHMEDABAD	BYHAVNAGAR	AHMEDABAD	BYHAVNAGAR
January	14.6	15.4	26.8	26.8
February	17.4	18.2	30.1	29.7
March	22.8	23.6	34.9	33.8
April	27.4	28.1	38.8	36.8
May	29.4	29.9	40.6	37.5

MONTH	TEMPERATURE (˚C)			
	0830 HOURS		1730 HOURS	
	AHMEDABAD	BYHAVNAGAR	AHMEDABAD	BYHAVNAGAR
June	29.4	29.8	36.5	34.4
July	27.4	28.1	31.6	31.1
August	26.3	27	30.3	30.2
September	26.5	26.7	31.9	31.1
October	25.5	26.6	33.8	33.5
November	21.4	22.3	30.6	30.8
December	16.6	17.3	27.5	27.5

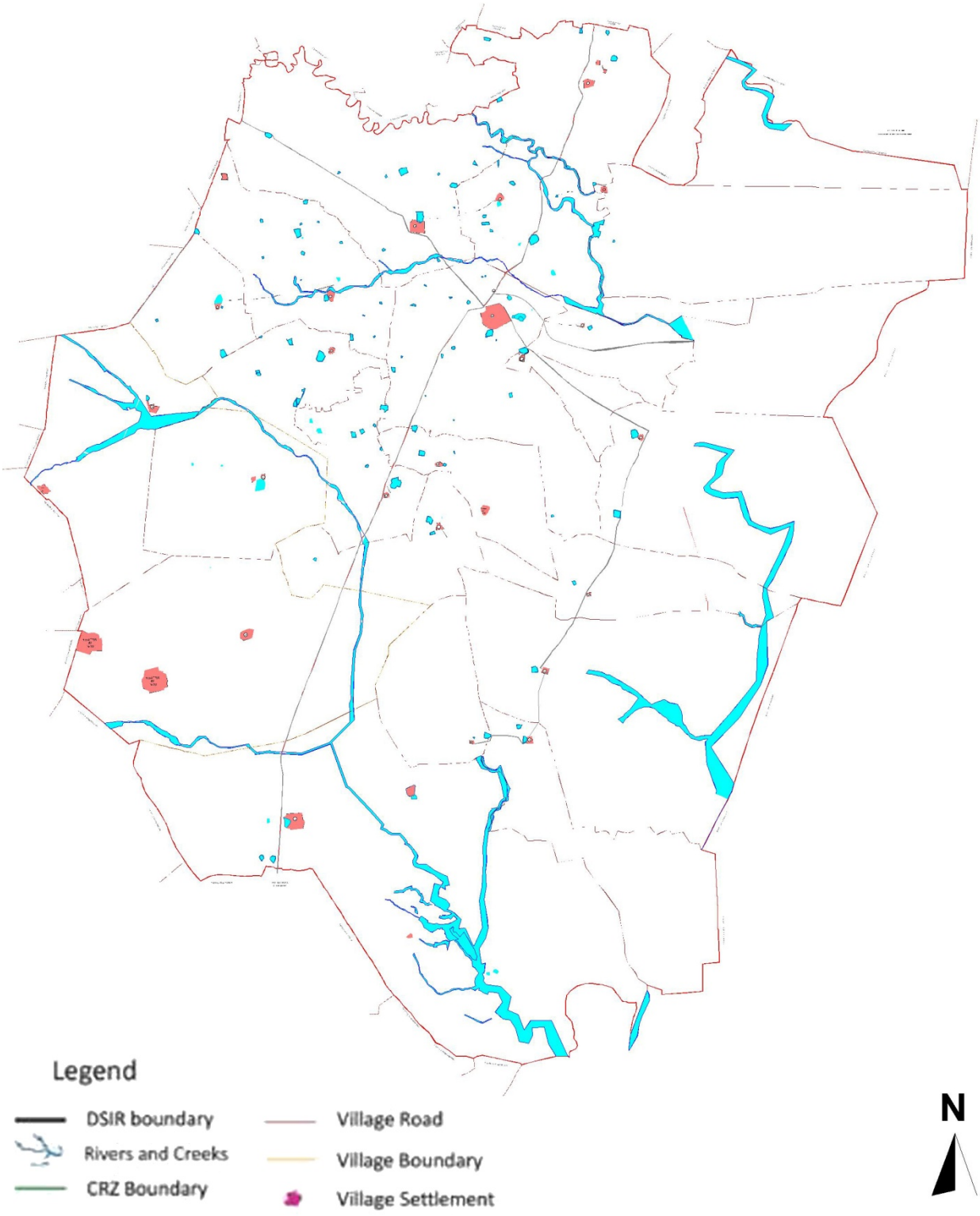


Figure B- 1: The DSIR

Rainfall

It is anticipated that the annual rainfall in DSIR will be about 800 mm as climatological conditions of Bhavnagar district dominate this area. The mean average monthly rainfall for Ahmedabad and Bhavnagar districts from 1952-80 is given in Table B-3.

Table B- 3: Total Monthly Rainfall

MONTH	AHMEDABAD (mm)	BHAVNAGAR (mm)
January	2.6	1.2
February	1.1	1.5
March	1	2.4
April	0.9	0.4
May	6	4.6
June	108.7	114.9
July	265.3	180.5
August	219.8	152.9
September	171.9	117.4
October	10.8	26.1
November	8.9	10.8
December	2.6	2

Table B- 4: Surface and Ground Water Quality

CONCENTRATION IN MG/L EXCEPT Ph	SURFACE WATER	GROUND WATER
Source	Creek	Bore well
pH	7.66	7.17
TDS	27940	5664
TSS	2444	16
Sulphate	1782	468
Phosphate	0.83	0.32
Chloride	13596	2444
Turbidity (NTU)	416	0.9
Alkalinity	240	260
Iron	0.9	Nil
Hardness	5700	1100

Wind Speed

The wind speeds in the sub-region are light to moderate with some strengthening during the south west monsoon. The wind speed is generally high during the period from April to August. The mean monthly average wind speed recorded by IMD at Ahmedabad and Bhavnagar are presented in Table B-4.

Wind speed at the Project site is likely to be in the range indicated for Bhavnagar as the DSIR site is close to the estuarine region.

Table B- 5: Monthly Average Wind Speed

MONTH	WIND SPEED (km/hr)	
	AHMEDABAD	BHAVNAGAR
January	5.8	13.7
February	5.9	14.6
March	6.3	16.1
April	7	18
May	9.2	22.6
June	10.1	25.9
July	8.7	23.2
August	7.2	19.3
September	6	15.7
October	4.3	13.1
November	4.6	11.9
December	5.3	11.9

Wind Persistence in Various Direction & Wind Rose Diagram

In this region, wind persistence as prevailing at Bhavnagar is anticipated. The Wind Rose diagram is given in Figure B-2.

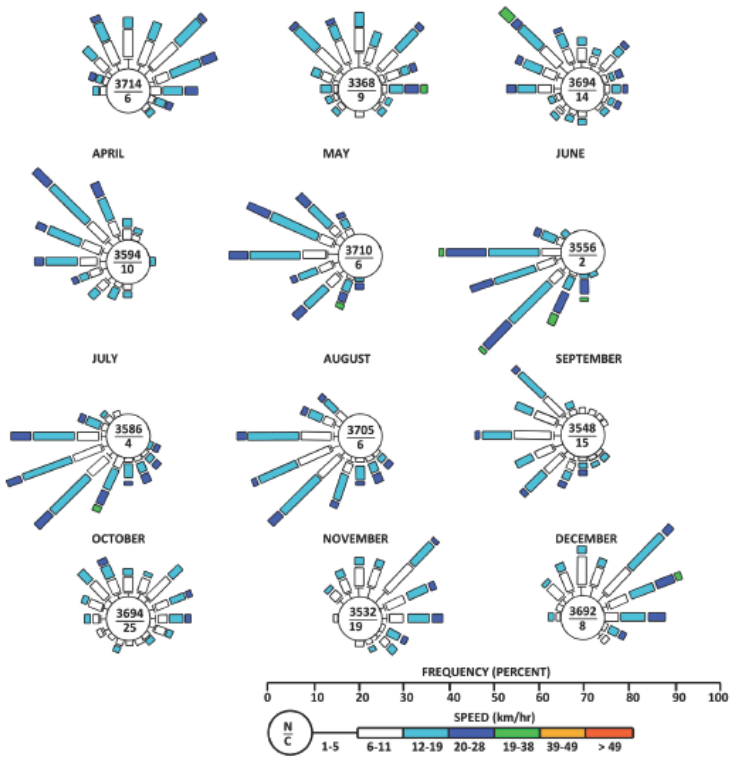


Figure B- 2: Wind Rose Diagram for Bhavnagar

Geology

The geomorphic units in the DSIR are occupied by sediments that date back to the Quaternary period. The surface sediments comprise Katpur Formation containing Rann Clay (tidal deposits) deposited by marine agencies, Varahi Formation (flood plain deposits) and Akaj Formations (channel fill & flood plain deposits) deposited by fluvial agencies occupying the western part of Dholera – Adhelai (See Figure B-3). Soils are fine to coarse loamy, mixed montomorillonitic (shrinkage and swelling characteristics) calcareous and mostly saline.

Seismicity

The DSIR falls under the Zone III of the Seismic zoning map of India - IS 1893-2002 as shown in Figure B-4, which suggests only a moderate risk of earthquakes. The site lies to the west of the West Cambay Fault but this does not appear to be active as only a few shocks have occurred along it in historical times.

The Institute of Seismological Research at Gandhinager is currently advising Gujarat Infrastructure Development Board (GIDB) on seismic issues related to the DSIR. They are undertaking a 15 month geotechnical and geophysical study involving extensive borehole investigations. Their preliminary advice on soil strengthening and engineering solutions to reduce risk has been incorporated into the building guidelines.

Topography

The DSIR occupies a low lying plain that falls very gradually from the 8m contour on the western boundary to the 4m boundary in the east. The eastern edge of the site therefore lies below the high tide level which is at about 5.5 to 6m. A large portion of the site lies within the Coastal Protection Zone (CRZ). (See Figure B-5)

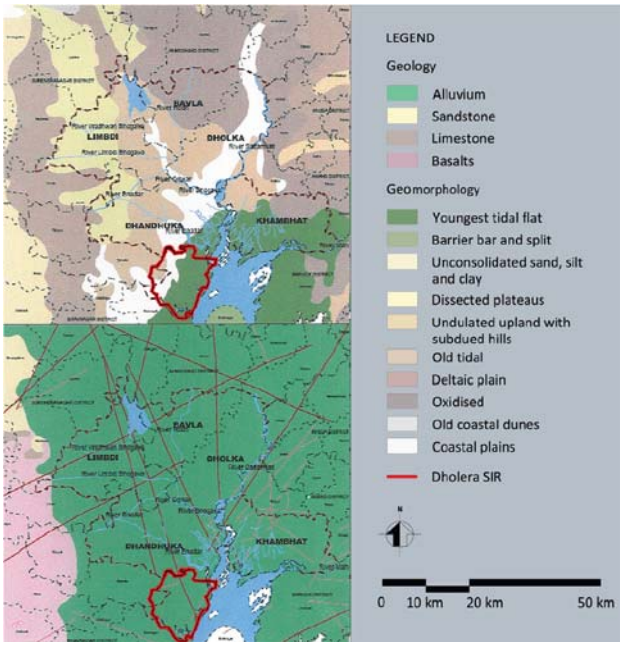


Figure B- 3: Regional Geology

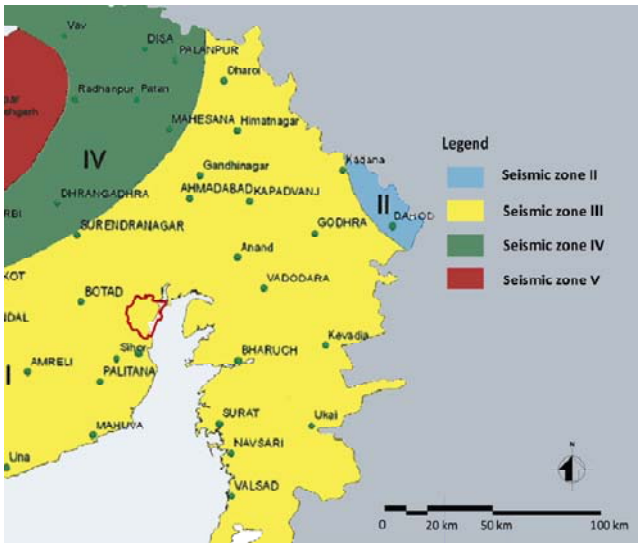


Figure B- 4: Seismic Zones in Gujarat

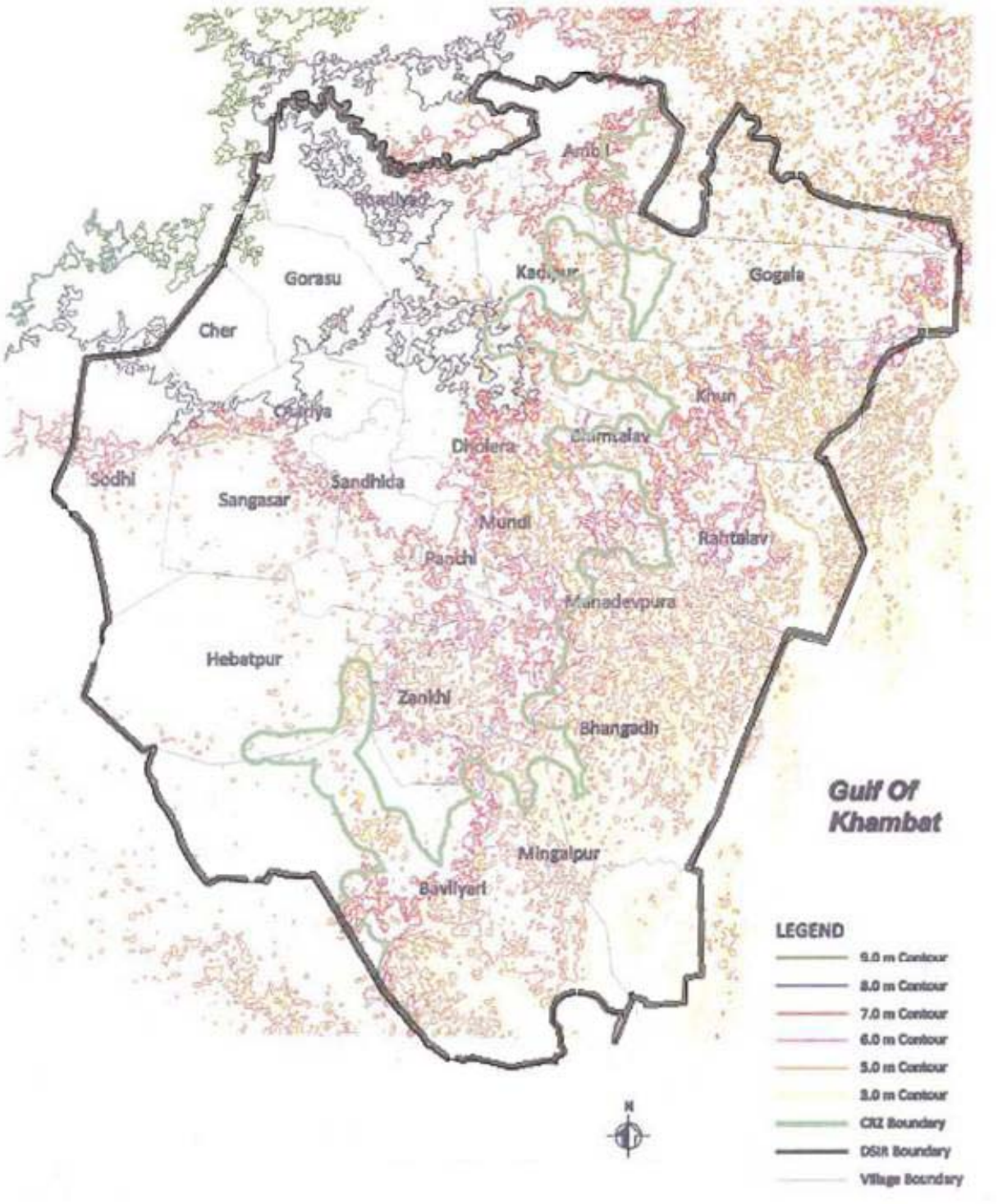


Figure B- 5: Seismic Zones in Gujarat

Soils

In general, the soil type in the DSIR is fine to coarse loamy, mixed montomorillonitic, (shrinkage and swelling characteristics) calcareous and mostly saline. The ground water table is observed at 1 to 2.85 m in Dhandhuka, Dholera and Bavaliyari and the region gets water logged from 6 to 24 hours during the monsoons. The sub-soil is made up of the alternate layers of soft silty clay/clayey silt of medium to high plasticity and fine to medium grained sand.

In most of the regions, the bed rock is not encountered at a considerable depth. The typical cross-section through the soil layers is illustrated in Figure B-6.

The shear strength of the soil i.e. the load carrying capacity or Safe Bearing Capacity (SBC) of soil is about 5 T/sq m, which is very low. The magnitude of the settlement under the applied load will be 300 to 800 mm depending on the applied pressure intensity. Table B-6 indicates properties of the top soil prevalent in the project region. Generally, construction of rigid structures on such soils is not deemed feasible. Even in the case of flexible structures, though the settlements occur uniformly, such heavy settlements are not permissible. The need for improving ground conditions prior to commencement in construction activity is extremely critical.

Existing Land use/Ownership

The existing land use within the delineated DSIR primarily comprises agricultural land under both private and Government ownership, land for cattle grazing, forest, village settlements and village ponds, and mangrove habitation along the Gulf of Khambat. The total area classified under each category is divided as 'Area under CRZ' and 'Developable Area' as indicated in the Table B-7. The Figure B-7 indicates this existing land use mix and its division into the CRZ and developable areas.

Table B- 6: Properties of Top Soil in DSIR

ASPECTS OF SILTY CLAY OF HIGH PLASTICITY	UNIT	PROPERTY
Gravel	%	00 – 00
Sand	%	20 – 30
Silt	%	30 – 40
Clay	%	30 – 40
Natural Moisture Content (NMC)	%	10 – 30
Atterberg Limits		
Liquid Limit	%	55 – 70
Plastic Limit	%	30 – 40
Plasticity Index	%	20 – 30
Shrinkage Limit	%	8 – 11
Swelling Pressure	T/m2	1.00 – 3.50
Free Swell Index	%	70 – 135
Specific Gravity		2.63 – 2.65
Dry Density	T/m3	1.40 – 1.60
Consolidation Properties		
Compression Index		0.20 – 0.35
Initial Void Ratio		0.70 – 1.00
Shear Strength Properties		
Cohesion	T/m2	2.00 – 3.00
Friction Angle	Deg	3 – 10
Standard Penetration Resistance, 'N'		2 – 15

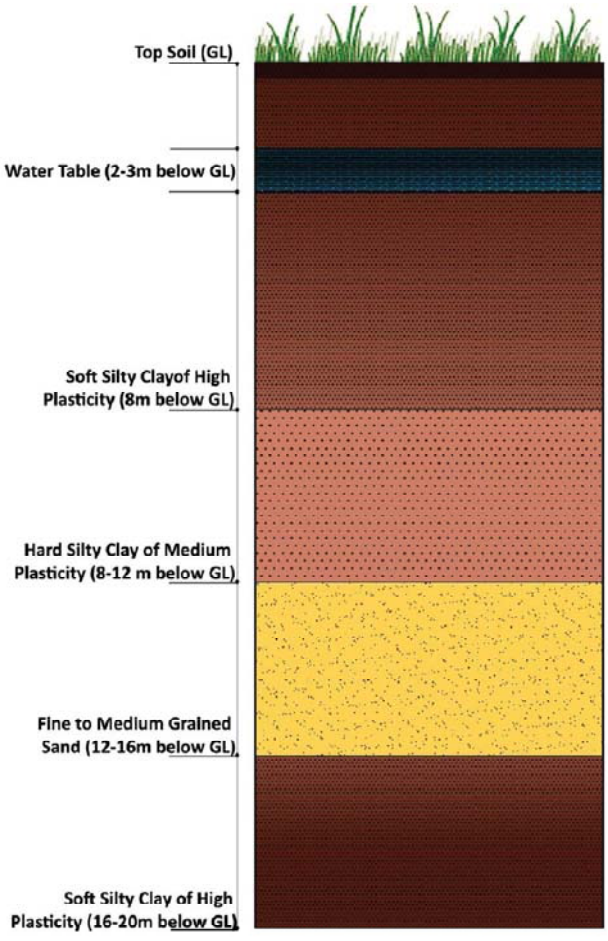


Figure B- 6: Cross section through Soil

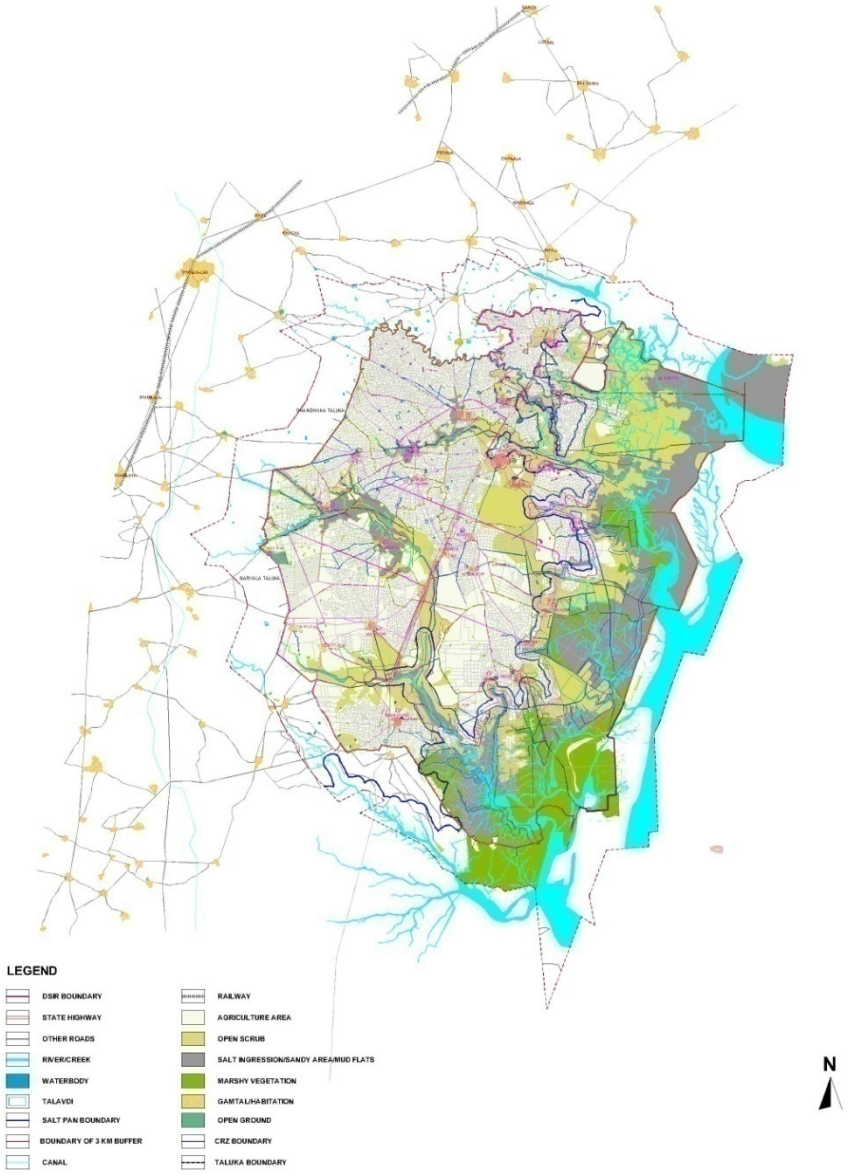


Figure B- 7: Existing Land Use Plan

Table B- 7: Existing Land Use Mix

CLASSIFICATION	AREA OUTSIDE CRZ (ha)	AREA UNER CRZ (ha)	TOTAL AREA (ha)	PERCENT OF TOTAL
Village Settlements (Gamtal)	376	113	488	0.5
Village Ponds (Gam talav) & other Water Bodies	256	92	348	0.4
Rivers and Creeks	366	2814	3180	3.6
Forest (Van vibhag)	834	1524	2358	2.7
Government Owned Land	9110	15420	24530	28
Land under Private Ownership	41001	12685	53686	61
Total	54260	33630	87890	100

All numbers rounded; Land ownership information is sourced from the map provided by GIDB (BISAG). The site area as per this map was about 87890 ha. However, as per the GIS and CAD database prepared from the high resolution satellite imagery provided by the Client, the site area is understood to be 9197 ha.

APPENDIX C: DEMOGRAPHIC PROFILE - EXISTING VILLAGE SETTLEMENTS

Existing Village Settlements

Socio-economic Profile of Project Affected Villages

The DSIR will directly impact the land and livelihood of 22 villages from Dhanduka (19 villages) and Barvala (3 villages) Talukas.

Population

According to the 2001 Census, the existing villages of the DSIR supported a population of about 38,000 (See Table C-1). The villages range in size from just over 140 residents in Bhimtalav to over 5,000 in Hebatpur, the largest village by population in the DSIR.

Sex Ratio

The overall sex ratio for the 22 villages is 902, which is higher than the sex ratio of Ahmedabad District (886) but lower than the National (927) and State (919) sex ratios. The highest sex ratio is in the villages of Mingalpur at 986 and the lowest sex ratio of 741 is observed in Bhadiyad. See Table C-2.

Literacy

In 2001, according to the Census of that year, the overall literacy of the State of Gujarat was 70 percent (calculated by excluding the population of 0-6 years age group), compared to the literacy of India of about 65 percent. It can be seen from Table C-3 that in the Project area one village, Ottariya has a literacy rate of 83 percent which is more than the district average of 80 percent. However the overall literacy rate for the villages in the DSIR is only about 57 percent.

Table C- 1: Distribution of Population by Village

POPULATION CRITERIA	NUMBER OF VILLAGES	NAME OF VILLAGES WITH POPULATION (CENSUS 2001)
Less than 1000	7	Bhimtalav(141), Zankhi (526), Mundi(705), Panchi (891), Khadipur (923), Sandhida (989), Cher (342)
1001-1999	8	Mahadevpura (1211), Rahatalav (1395),Sangasar(1609), Khun (1628), Bhangadh (1734), Ottariya (1950), Ambli (1972), Gogla (1245)
More than 2000	7	Mingalpur (2133),Bavaliyari (2325), Gorasu (2484), Bhadiyad (2630),Dholera(2637),Hebatpur(5236), Sodhi (3007)

Workforce Structure

The Census reveals that there has been a marginal net loss of the total rural workforce (percentage of total workers to total population) in Dhanduka Taluka between 1991 and 2001. There has been a higher net loss in the category of main workers at nearly 6 percent and the proportion of main workers to total worker has decreased, so that the proportion of marginal workers has gone up by the corresponding proportion. Marginal workers make up approximately 35% of the total workforce. The marginalization of the workforce manifests itself in migration and joblessness in much of the study area.

Occupation

Agriculture is the predominant occupation of the study area population and about 62% of those classed as main workers are cultivators. Urbanisation of the study area will reduce this proportion substantially and points to the need to ensure concentrated efforts on developing the skills of local people and evolving extensive livelihood support systems for the existing village communities.

Table C- 2: Sex Ratio by Village

SEX RATIO	NUMBER OF VILLAGES	SEX RATIO IN VILLAGES (CENSUS 2001)
700-800	2	Bhadiyad (741), Ottariya (791)
800-900	4	Khadipur (850), Mahadevpura (895), Rahatalav (865), Gogla (878)
900-1000	16	Bavaliyari (909), Bhangadh (942), Bhimtalav (932), Dholera (908), Gorasu (911), Zankhi (977), Khun (913), Mingalpur (986), Mundi (986), Panchi (908), Sangasar (911), Sandhida (913), Hebatpur (953), Ambli (930), Cher (911), Sodhi (934)

Table C- 3: Literacy Rate by Village

LITERACY RATE	NUMBER OF VILLAGES	NAME OF VILLAGES WITH POPULATION (CENSUS 2001)
Less than 40 Percent	5	Bhangadh (36.78), Mahadevpura (22.88), Mingalpur (25.27), Rahatalav (36.60), Zankhi (38.42)
40-60 Percent	7	Bavaliyari (48.70), Khun (52.08), Mundi (53.04), Panchi (59.62),Hebatpur (54.13), Ambli (51.02),Gogla (42.59)
60-80 Percent	9	Bhadiyad (72.09),Bhimtalav (61.40), Dholera (76.19), Gorasu (72.30), Khadipur (66.71), Sandhida (66.63),Sangasar (70.06), Cher (68.84), Sodhi (61.36)
More than 80 Percent	1	Ottariya (82.66)

APPENDIX D: POPULATION BASE ESTIMATES

Significant population growth in the DSIR will be driven by establishment of economic activities. A strategic, employment led, demographic model has therefore been developed and the main components of this are summarised in Figure D-1.

The model takes as its starting point an estimate of the likely demand for industrial and other "base" employment land in the DSIR over a period of 30 years, derived from in-depth market demand studies undertaken during the preparation of this Plan in 2009. From this estimate of employment land demand it has been possible to forecast the likely generation of jobs, based upon international and national norms for job creation for each industrial sector based, commonly expressed on either on the basis of number of jobs per ha or sq metre per employee.

Base employment generates further jobs in services such as transport, commerce, Government and so on. The ratio of support jobs to base jobs varies across industrial sectors but for planning purposes an average ratio across all sectors has been used, based upon a study of Indian norms and experience, adjusted to reflect local conditions and circumstances that are likely to apply to the DSIR. Together base and support jobs provide an estimate of the total jobs created, that is, the workforce. From this it is possible to forecast the total population supported by total employment by applying a dependency ratio. The dependency ratio used in the model is a broad estimate of future dependency rates in Gujarat. The number of workers in jobs plus their dependents provides the estimate of the population supported by the DSIR. Not all of the jobs likely to be generated in the DSIR will be taken by residents and some workers will commute into the area on a daily basis from their homes in nearby settlements or large cities such as Bhavnager or Ahmedabad.

Table D- 1: Demographic Indicators

PARAMETER	PHASE 1	PHASE 2	PHASE 3	TOTAL	ASSUPMTION NOTES
Base Employment	85,000	167,000	91,000	343,000	Industrial Market Research
Support Jobs	119,850	235,470	128,310	483,630	1.41 Support jobs/base job
Total Jobs	204,850	402,470	219,310	826,630	
Dependents per Worker	409,700	804,940	438,620	1,653,260	Gujarat Dependency Ratio: 2
Total Supported Population	614,550	1,207,410	657,930	2,479,890	
Total Number of Households	153,638	301,853	164,483	619,973	Household size: 4
Commuting Propensity	40,970	80,494	43,862	165,326	20% of household heads
Population Residing in the DSIR	491,640	965,928	526,344	1,983,912	Workers residing in the DSIR and their families
	496,000	**970,000**	**534,000**	**2,000,000**	**Rounding Numbers**

It is not possible to precisely predict the proportion of the workforce that will commute on a daily basis into the DSIR from outside because of the large number of variables involved, such as the quality, speed, reliability, price and availability of public transport to and from the DSIR and the relative cost and availability of housing in and outside the area. For planning purposes, a commuting propensity of 20% has been taken as a working assumption, meaning that of the total workers and their dependents, only 80% will live in the new city. This is a very broad estimate, which should be monitoring over time and adjustments

made to policies and plans as the city develops if required. The forecast demographic parameters derived from this model over the plan period are summarised in Table D-1.

The population "target" is a very broad estimate, based upon the studies into the potential demand for industrial and other employment generating land in the DSIR. Actual land demand and take up may vary, depending upon a wide range of variables, including the success of the area in attracting investment, competing industrial locations, local land prices and incentives offered to investors, and national and world economic conditions over the plan period. A further constraint may be the ability of the construction sector to deliver the very high levels of physical development implied in the employment and housing targets. It may therefore take a longer period than 30 years to realise the growth target but this would in no way invalidates the spatial strategy that underpins the Draft Development plan, which is flexible enough to cater for a faster or slower rate of growth.

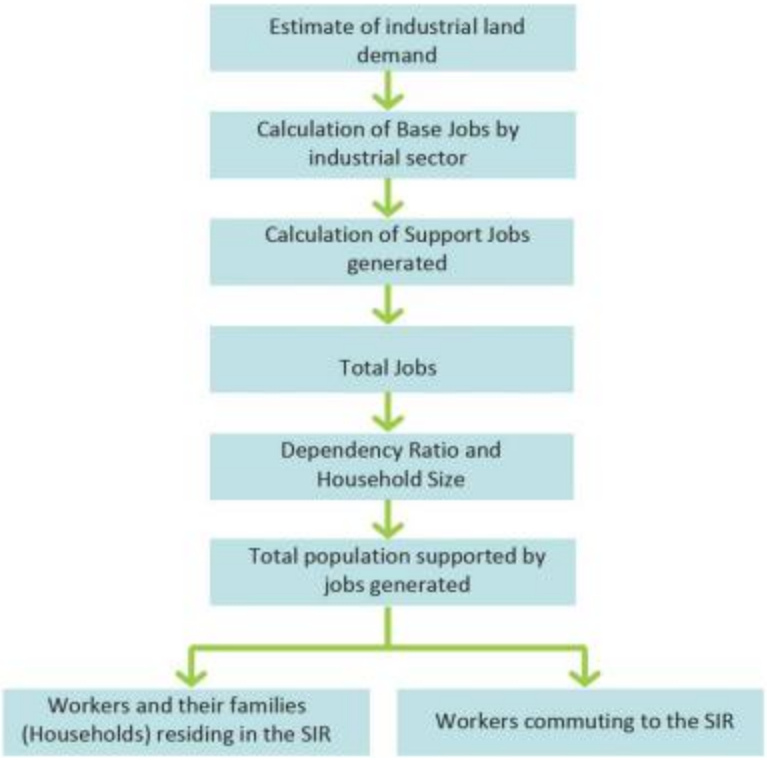


Figure D- 1: Derivation of Total Population from Industrial Demand Estimate

Validating the Estimates

The estimated population potential of the DSIR is nearly 2 million over a 30 year period. In order to ensure that the resulting total population estimates are realistic, they have been validated with respect to three factors:

- correlation with historic, current population and projections by Census, Govt. of India and the United Nations India forecasts;
- comparison with population growth performances of other planned cities in India and
- housing construction rates in the sub-region

It includes consideration of the forecast urban-rural divide and forecasts for population in urban agglomerations in Gujarat.

Population of the DSIR in the Broader Perspective of the Population of Gujarat

The Urban and Rural Divide

The first validation exercise undertaken was an examination of the forecast urban-rural divide in Gujarat population projections as per Census 2001 and forecasts for urban agglomerations in India by the United Nations.

Figure D-2 shows the projected population of Gujarat up to the benchmark year 2040.

In 2001, the population of the State was recorded to about 51.3 million people, out of which about 38 percent resided in urban agglomerations and 62 percent in rural areas. In continuation with historic demographic trends in India, the Census of India projects rural population contributing a higher percent of the total population up to year 2020. Within the next decade, forecasts reveal a reversal in this trend with a sharp decline in the rural population growth and a corresponding increase in the urban share. Thus by year 2025, the percent share of the urban population of Gujarat is expected to be about 35.4 million, which is 51 percent of the total population. This trend of rapid urbanization is expected to continue and by 2040 there will have been a drastic reversal of the urban-rural divide of 2001.

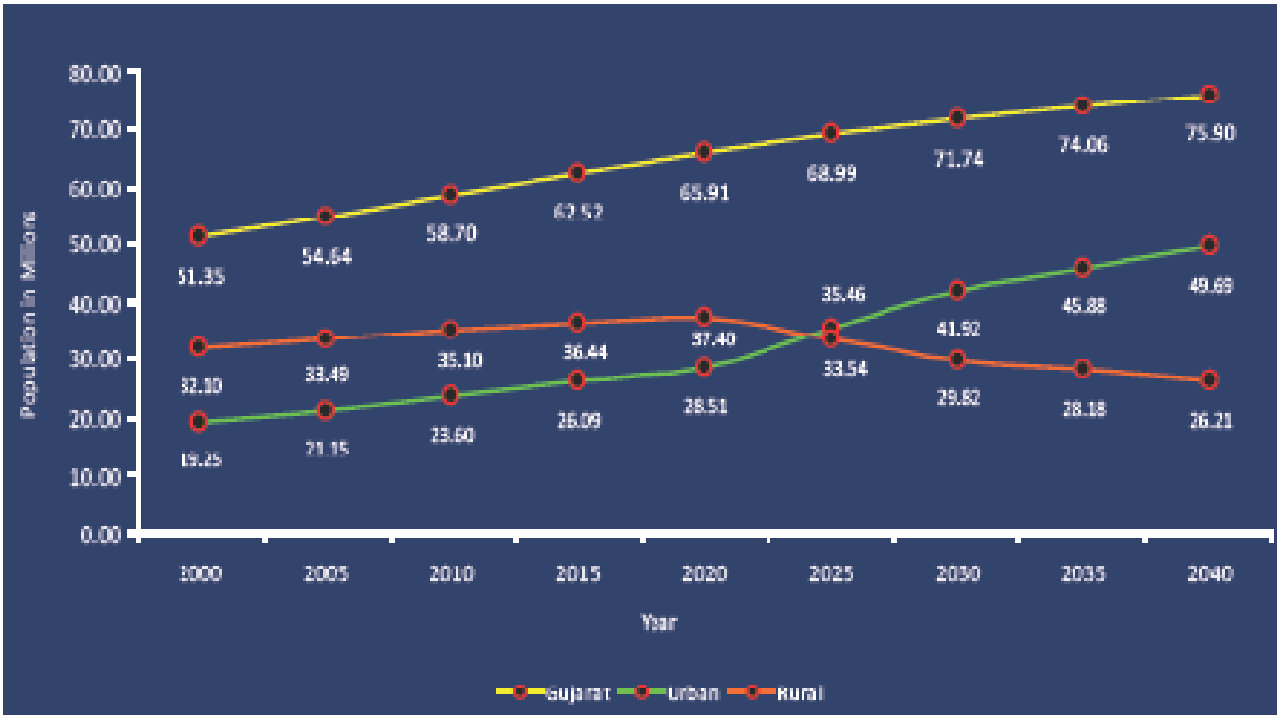


Figure D- 2: Urban - Rural Divide in Gujarat

By 2040, about 65 percent of the Gujarat population (50 million) will reside in urban agglomerations whereas about 35 percent (26 million) will continue to live in rural areas. Thus by 2040 the State will have to allocate adequate urban resources – land, infrastructure and social amenities for its additional urban population of 31 million, which is about 165 percent of the 2001 figures.

The Distribution of Population in Urban Agglomerations

The distribution of urban land in 2001 and projected growth by 2025 is indicated in Figure D-3. The chart indicates the share of the population of the main Urban Agglomerations (UA) in 2001 and quantifies the need for new urban centres to accommodate the increased population in 2025.

The forecast population numbers have been sourced from the United Nations India Forecasts, and are supported with Census data and projections to year 2026. While the four major agglomerations in Gujarat, namely Ahmedabad, Surat, Vadodara and Rajkot are cited individually, other smaller urban agglomerations are termed as 'Other UA'. The gap between projected total urban population in the State and projected

growth in existing centres is classified as 'Growth to be accommodated' represented by new urban growth centres like the DSIR.

Out of the projected urban population of 35.4 million by the year 2025, it is forecasted that the Ahmedabad UA will continue to account for the largest share with about 7.7 million people, followed by 5.7 million from Surat, 2.6 million from Vadodara and 1.9 million from Rajkot. Other agglomerations in Gujarat will account for about 11.6 million people by 2025. This leaves an estimated 5.9 million people that will have to be accommodated in 'new' urban centres, in addition to those that will be housed in the existing urban regions.

Assuming that the DSIR will be nearing the end of its Phase 1, its supported population could be about 0.6 million inhabitants by 2025, which is about 30% of its target estimated population of 2 million.

Given that the un-allocated urban growth for Gujarat will be 5.9 million by 2025, the target for the DSIR does not appear to be overly ambitious.

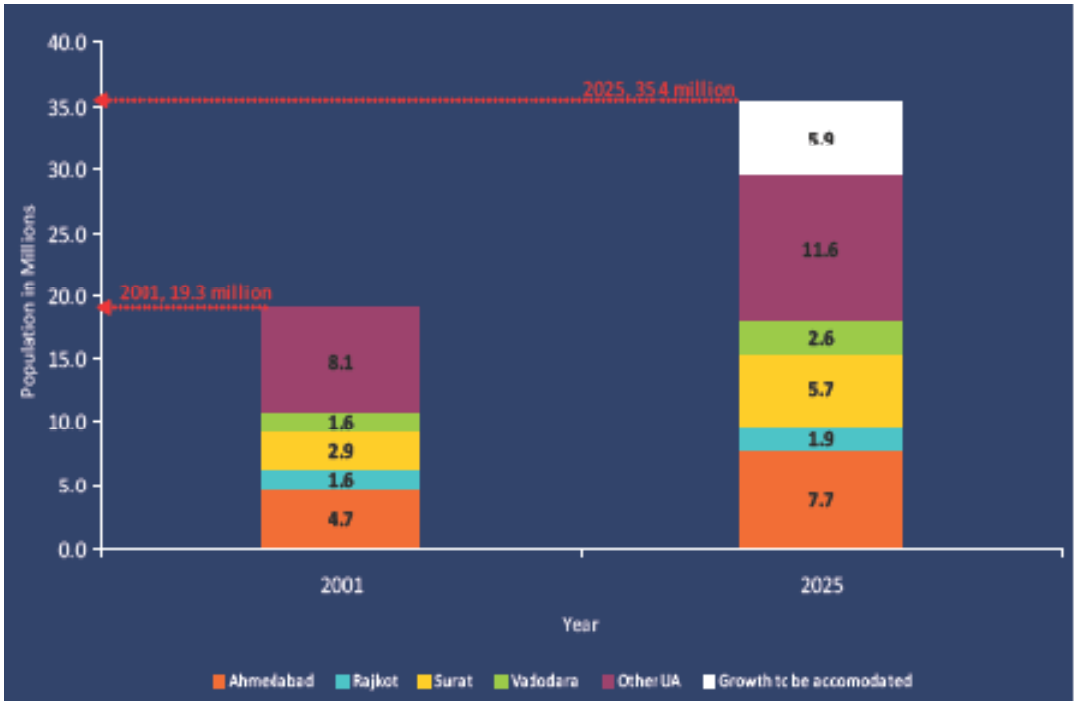


Figure D- 3: Current and Projected growth in Urban Agglomerations in Gujarat

Interestingly, the investment region is a fitting example of the dramatic rural to urban shift that manifests in 2025. The present character of the DSIR is predominantly rural and it has been chosen as the location for an economically diverse and productive urban city. Indeed, without proposed new cities such as Dholera, it is difficult to see how the forecast increase in urban growth in the State could be accommodated.

Capacity of the Construction Industry to build housing units

An appreciation of the prevalent annual housing construction rates in the sub-region is perhaps a reliable indicator of the construction industry capacity to realize the development envisioned. It helps provide a realistic correlation between the target populations to be housed each year and the dynamics of the construction industry; that is availability of labour, positive or negative impact of economic performance (inflation) to cost of raw material, real estate market pricing, investors interests and so on.

For illustrative purposes, Table D-2 indicates number of 'Grade A' housing units constructed in Ahmedabad, the nearest major urban centre to the DSIR for which reliable statistics are available.

In absence of actual numbers for Grade B and C housing units it is assumed that they will be at least 3 times more in number than those of Grade A. The past three to five years have witnessed an unprecedented boom in the real estate and construction sectors in India and it would be reasonable to assume that this has resulted in a very good supply or even an over-supply of Grade A housing units. With a 20 percent

correction accountable to real estate market instability, it can be broadly assumed that the average number of housing units constructed annually in the Ahmedabad region is about 12,000.

This is a very rough estimate of recent housing supply. In comparison, the annual supply of housing required to meet forecast demand in the DSIR is about 14,000 dwellings per annum over a 30 year period. This is a very ambitious target and appears to exceed what has been achieved in Ahmedabad in recent years.

Housing production is not a straight linear process but requires years of slow build up to reach a high throughput, as supply chains are established, workers trained and production facilities created. Production starts slowly, especially if there is no established market in the location. So to reach an annual target of 14,000 dwellings could take many years. In the meantime the annual build rates required to meet the target increases every year that the production remains below the norm. The build up of the required run rate in limited over cricket provides a good analogy.

Significant support at all levels will therefore be required from Government and the private sector to meet this very difficult house building target.

Conclusion on the Population Estimation

Three validation exercises were conducted in order to assess how realistic is the population target of for the DSIR. The population target for the DSIR is just under 2 million inhabitants within 30 years of the start of its development. The target, which was an outcome of the number of base jobs derived from the industrial market assessment, was set in the context of the likely population growth in the state, the past growth of other new cities in India and the house building rate implied by the total dwelling requirement over 30 years.

Turning first to the question of population growth, it can be seen that the growth forecast for the urban population of Gujarat state to 2025 is substantial and that a number of new urban settlements such as that proposed at Dholera will be required to accommodate this growth. On this count, it is therefore concluded that the target population for the DSIR is appropriate.

With regard to the past growth performance of other new cities in India, the answer is less convincing. New cities, as compared to the growth of existing cities or major city expansion schemes, are generally slow to develop, especially where they are remote from existing centres of population. It is considered that the required rate of growth for Dholera will need to be higher than has been achieved in the three other new cities that have been examined above. This presents a sizable challenge to those charged with implementing the development of the new city.

Lastly it is considered that the rate of house construction implied by the housing target for the city is extremely high and will test the construction industry, which may require technical and financial assistance by the Government to achieve the required rate of house building.

Overall, it is concluded that reaching the population target for the DSIR represents a challenge and one that will only be possible to achieve if the project receives a very high degree of Government support.

Table D- 2: Average Annual Housing Construction Rate

YEAR	GRADE A HOUSING	GRADE B & C HOUSING	TOTAL	20% MARKET CORRECTION
2006-07	2929	8787	11716	9373
2007-08	4992	14976	19968	15974
2008-09	3236	9708	12944	10355
Average Annual Dwellings Construction Rate for Ahmedabad				11901

APPENDIX E: GOVERNMENT LAND OWNERSHIP BY PHASE

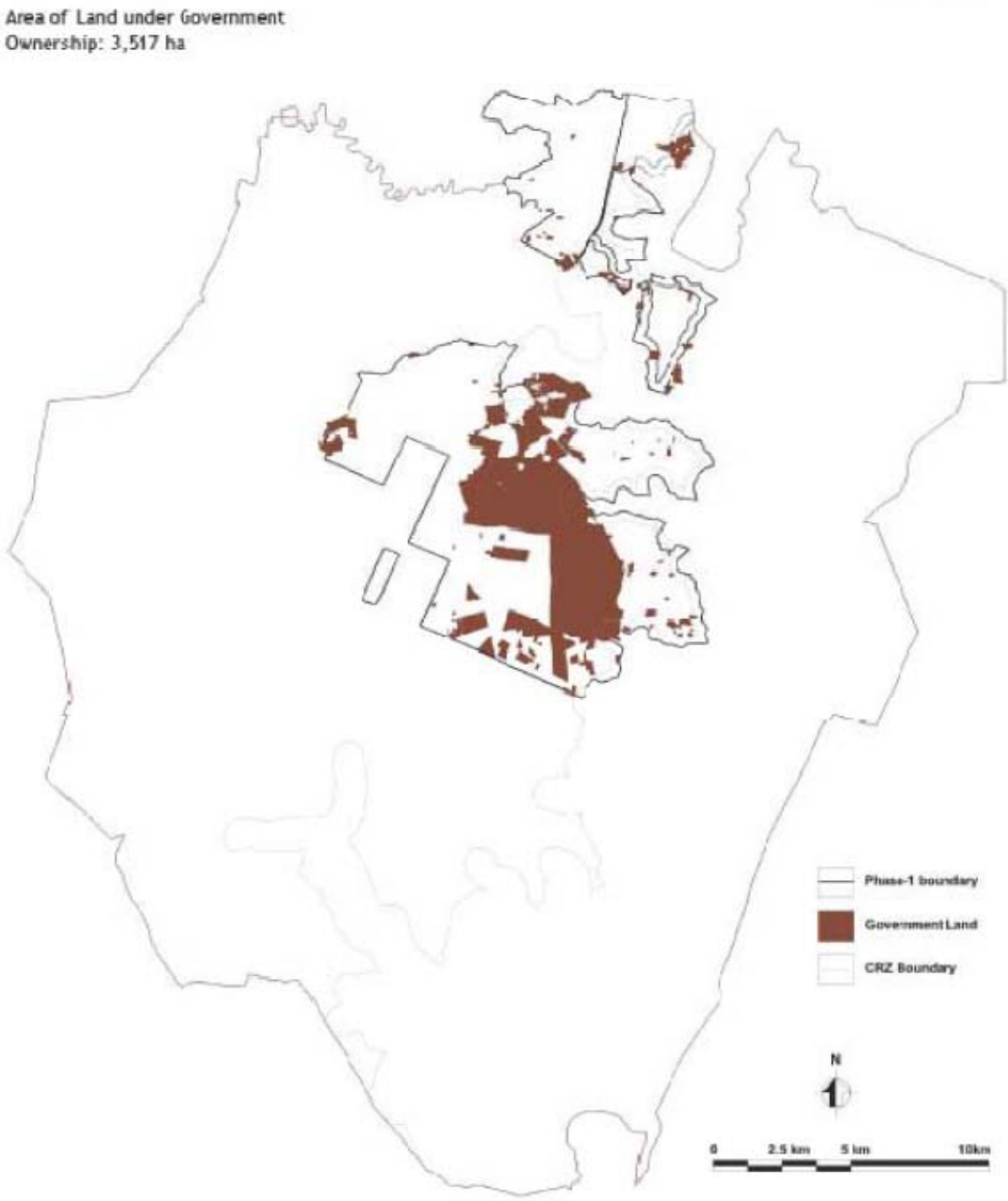


Figure E- 1: Land under Phase -1 Development Owned by the Government

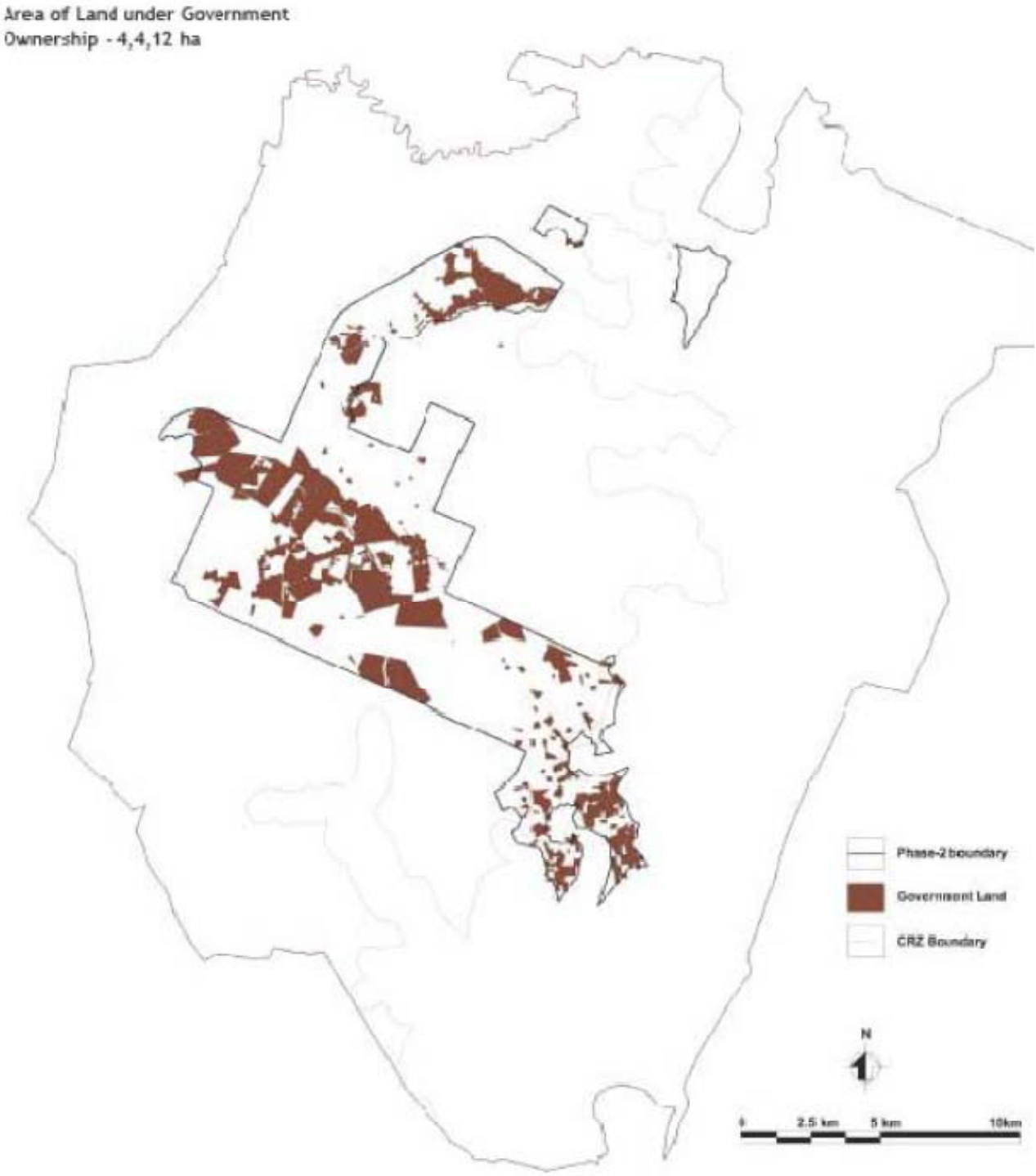


Figure E- 2: Land under Phase -2 Development Owned by the Government

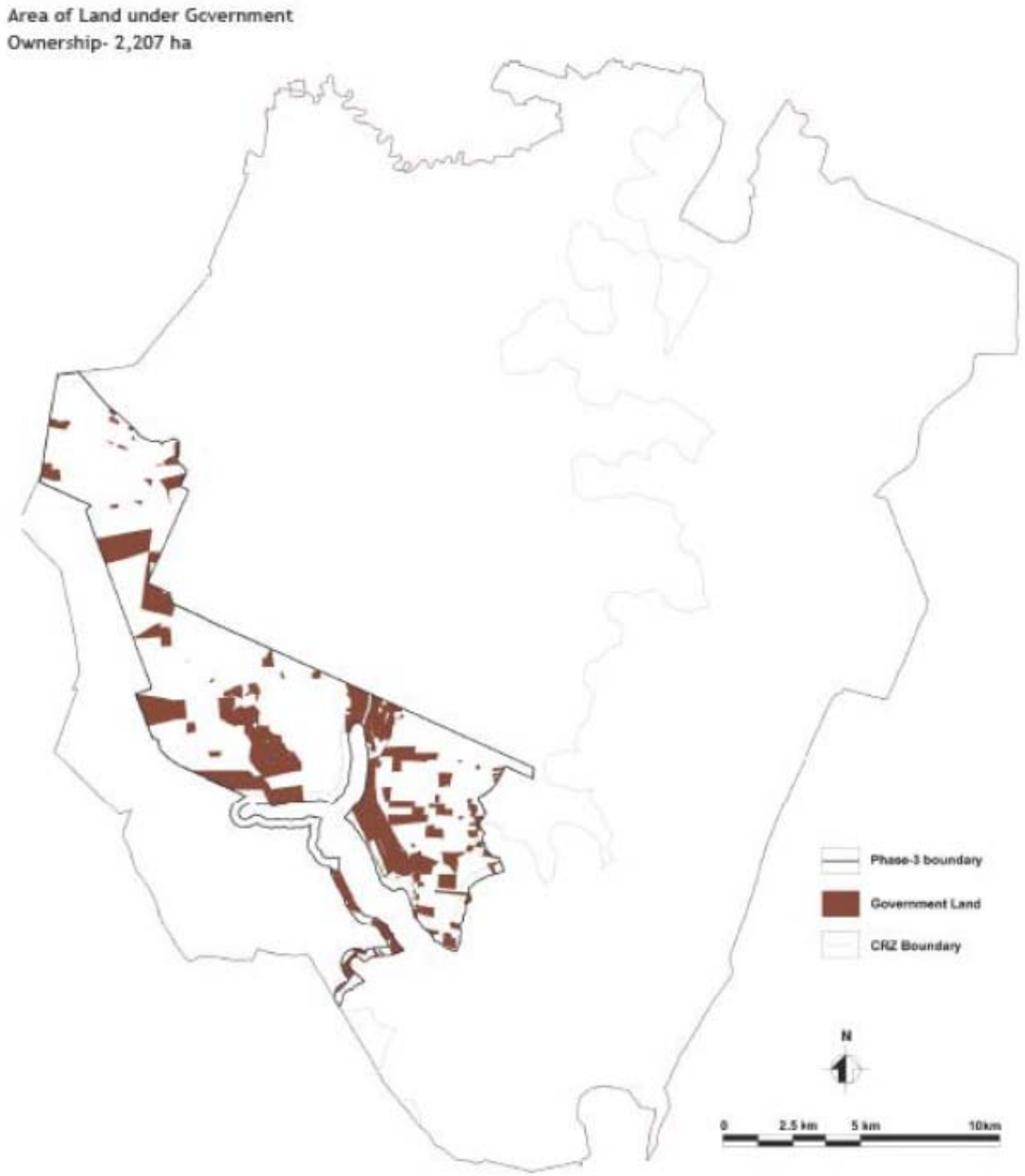


Figure E- 3: Land under Phase -3 Development Owned by the Government

APPENDIX F: TRAFFIC STUDY

Traffic Surveys and Locations

A reconnaissance survey was carried out to identify the possible impact of regional and local network after the development of the DSIR.

NH-8E provides connectivity to Pipavav which is one of the important ports of Gujarat. Traffic Volume Count (TVC) was conducted on NH-8E to assess the current incoming and outgoing port traffic. The two lane road is in good condition and the traffic plying on this road is mainly industrial.

SH-8 plays an important role providing connectivity to the south-bound traffic from Gujarat or other States. Therefore it is chosen as the second location for the TVC.

The State Highways influencing the DSIR are two lane and these are in good condition. NH- 8A is 50 km away connecting Limbdi to DSIR via SH-20. The observed Average Daily Traffic (ADT) at the survey location on the NH-8A is around 30,000 PCUs catering mainly to the Kandla port. An alternative shorter route to the Kandla port is also available from SH-20 after crossing NH-8A at Limbdi. This link presently faces congestion due to urban linkages like Surendranagar and Wadhwan. This State Highway is likely to shorten the distance to Kandla Port once developed and it was thus considered as the third location for the TVC. Fourth TVC was conducted on NH-8A after Limbdi. Speed-delay surveys were also conducted at the identified locations in and around DSIR area. The average journey speed near Dholera on SH-6 is about 40 Km per hour.

The data collected from the traffic surveys was used for the analysis and interpretation of results with respect to existing traffic, travel pattern and for forecasting purposes. The traffic volume data collected through one day survey at the survey locations are presented in Table F-1.

Apart from above mentioned locations, past traffic census data on some of the important linkages relevant to DSIR has been provided by the GIDB. This provided the base traffic on the influential road network of DSIR. Table F-2 provides this traffic data on SH-4, SH-6, SH-8 and SH-20, which are important road connections to the DSIR. The hourly details pertaining to Average Daily Traffic with total Passenger Car Units (PCUs) by direction at the survey locations is given in Table F-3. The link wise details for other external linkages are given in Table F-4.

It was observed that the truck traffic on NH-8 is very heavy as compared to other State Highways. The reason being, that it connects Ahmedabad with other ports in the State, whereas the State Highways carry local traffic and thus have a higher percentage of two wheelers.

Table F- 1: Results of the Traffic Survey

MODE	NH – 8A	NH - 8E	SH - 20	SH - 36
	NEAR LIMDI	NEAR GHOGA	NEAR LIMDI	NEAR BHAVNAGAR
Mini LCV	105	227	34	220
LCV	1017	520	191	504
2 Axle	2050	1260	257	1683
3 Axle	2817	1348	263	1205
MAV	1183	393	71	381
Oversize	0	0	0	0
Other	0	0	0	0
Toll Exempt Vehicles				
Car/Jeep/Van	58	24	11	21
Mini Bus	6	12	5	8
Bus	4	0	2	2

MODE	NH – 8A	NH - 8E	SH - 20	SH - 36
	NEAR LIMDI	NEAR GHOGA	NEAR LIMDI	NEAR BHAVNAGAR
LCV	14	4	1	8
Trucks	1	1	0	3
Vehicles for which toll is not applicable				
2-wheelers	1002	4570	1227	5571
Auto Rickshaw	425	2180	452	4912
Tractors	141	162	75	198
Total Non Motorized	209	176	170	182
Total Tollable	11,766	7,156	2,166	8,181
Total Toll Exempt	83	41	19	42
Total Vehicles	13,626	14,285	4,109	19,086
Total PCU	30,263	20,062	5,255	25,239

Table F- 2: Average Daily Traffic (ADT) at Survey locations – Traffic Census Data (2008)

MODE	NH – 8A	NH - 8E	SH - 20	SH - 36
	NEAR LIMDI	NEAR GHOGA	NEAR LIMDI	NEAR BHAVNAGAR
Sc/Mc	715	2312	533	790
Auto Rickshaw	411	31	560	17
Car/Jeep/Van	667	1326	1418	990
Mini Bus	311	102	325	105
Std. Bus	285	537	355	114
Tempo/ LCV	722	550	1388	199
2-Axle Truck	651	602	1778	246
3-Axle Truck	134	276	542	37
M-Axle Truck	72	46	399	0
Tractor with Trailer	184	19	115	10
Tractor without Trailer	269	10	87	4
Cycle	262	382	280	312
Cycle Rickshaw	15	11	62	0
Animal Drawn	73	26	163	20
Others	41	0	26	0
Total Vehicles	4813	6231	8031	2843
Total (PCU)	8427	8310	15977	3295

Table F- 3: Average Daily Traffic Count

DMIC Ahemdabad-Dholera Region

Average Daily Traffic

Location No : 0 | Road Section : NH-8E | Duration : 21-Jan-09 to 21-Jan-09
Location Name : 0 | Road Name : 0 | Day(s) : Wednesday to Wednesday
Chainage (Km) : 0.0 | Direction : Both Directions

Time Period	Motorized Vehicles								Vehicles			PCUs	
	Two wheeler	Auto Rickshaw	Car/ Jeep/ Van	Buses	Trucks	Other vehicles	Tractors	Non-Motorized	Total Motorized Vehicles	Total Non-Motorized Vehicles	Total Vehicles	Motorized PCUs	Non-Motorized PCUs
08:00 - 09:00	288	116	89	38	177	0	9	8	717	8	**725**	970	15
09:00 - 10:00	314	235	154	31	185	0	19	15	938	15	**953**	1,198	8
10:00 - 11:00	342	283	233	31	183	0	6	13	1,078	13	**1,091**	1,290	7
11:00 - 12:00	356	153	237	36	203	0	6	5	991	5	**996**	1,261	3
12:00 - 13:00	318	222	206	28	273	0	6	11	1,053	11	**1,064**	1,496	6
13:00 - 14:00	286	185	213	25	229	0	1	13	939	13	**952**	1,284	7
14:00 - 15:00	254	75	171	31	193	0	7	12	731	12	**743**	1,018	6
15:00 - 16:00	202	102	226	29	158	0	13	14	820	14	**834**	1,026	7
16:00 - 17:00	323	227	141	38	172	0	16	22	917	22	**939**	1,146	11
17:00 - 18:00	352	115	132	35	214	0	7	25	855	25	**880**	1,106	13
18:00 - 19:00	379	201	185	33	186	0	16	10	1,000	10	**1,010**	1,221	5
19:00 - 20.00	318	66	200	37	232	0	15	10	868	10	**878**	1,226	5
20:00 - 21:00	262	42	239	21	163	0	9	5	736	5	**741**	946	3
21:00 - 22:00	132	28	155	16	200	0	8	3	539	3	**542**	895	2
22:00 - 23:00	81	22	87	13	163	0	4	0	370	0	**370**	644	0
23:00 - 24:00	56	11	44	9	132	0	4	0	256	0	**256**	496	0
00:00 - 01:00	26	5	37	4	110	0	2	0	184	0	**184**	398	0
01:00 - 02:00	11	4	18	8	75	0	2	0	118	0	**118**	283	0
02:00 - 03:00	13	5	14	6	56	0	0	0	94	0	**94**	215	0
03:00 - 04:00	10	10	18	16	78	0	1	0	133	0	**133**	306	0
04:00 - 05:00	6	10	14	6	69	0	0	0	105	0	**105**	241	0
05:00 - 06:00	21	23	19	11	83	0	2	0	159	0	**159**	325	0
06:00 - 07:00	35	13	22	18	94	0	4	1	186	1	**187**	390	1
07:00 - 08:00	95	27	43	27	125	0	5	9	322	9	**331**	587	5
Total	4,570	2,180	2,897	547	3,753	0	162	176	14,109	176	14,285	19,963	99

DMIC Ahemdabad-Dholera Region

Average Daily Traffic

Location No : 1 | Road Section : 0 | Duration : 21-Jan-09 to 21-Jan-09
Location Name : 0 | Road Name : NH-8A | Day(s) : Wednesday to Wednesday
Chainage (Km) : 104.0 | Direction : Both Directions

Time Period	Motorized Vehicles								Vehicles			PCUs		
	Two wheeler	Auto Rickshaw	Car/ Jeep/ Van	Buses	Trucks	Other vehicles	Tractors	Non-Motorized	Total Motorized Vehicles	Total Non-Motorized Vehicles	Total Vehicles	Motorized PCUs	Non-Motorized PCUs	Total PCUs
08:00 - 09:00	64	32	228	41	307	0	9	34	681	34	**715**	1,366	17	**1,383**
09:00 - 10:00	72	31	199	58	405	0	12	17	777	17	**794**	1,661	9	**1,670**
10:00 - 11:00	82	40	181	34	323	0	14	10	674	10	**684**	1,382	5	**1,387**
11:00 - 12:00	88	34	153	30	235	0	12	14	552	14	**566**	1,105	7	**1,112**
12:00 - 13:00	98	64	179	57	261	0	13	15	672	15	**687**	1,310	8	**1,317**
13:00 - 14:00	79	36	162	36	185	0	15	16	513	16	**529**	946	8	**954**
14:00 - 15:00	58	42	150	42	347	0	11	19	650	19	**669**	1,425	10	**1,434**
15:00 - 16:00	70	19	156	42	170	0	7	8	464	8	**472**	853	4	**857**
16:00 - 17:00	62	18	141	25	215	0	3	8	464	8	**472**	947	4	**951**
17:00 - 18:00	66	15	132	19	207	0	7	12	446	12	**458**	899	6	**905**
18:00 - 19:00	55	20	127	32	199	0	9	7	442	7	**449**	907	4	**911**
19:00 - 20.00	51	8	155	22	237	0	3	6	476	6	**482**	977	3	**980**
20:00 - 21:00	36	14	165	36	315	0	1	4	567	4	**571**	1,254	2	**1,256**
21:00 - 22:00	31	5	140	39	317	0	0	0	532	0	**532**	1,177	0	**1,177**
22:00 - 23:00	21	4	105	33	350	0	1	2	514	2	**516**	1,241	1	**1,242**
23:00 - 24:00	19	3	149	123	396	0	2	4	692	4	**696**	1,735	2	**1,737**
00:00 - 01:00	8	4	104	91	418	0	7	2	632	2	**634**	1,664	1	**1,665**
01:00 - 02:00	6	5	103	101	416	0	0	0	631	0	**631**	1,613	0	**1,613**
02:00 - 03:00	0	3	89	63	385	0	1	2	541	2	**543**	1,448	1	**1,449**
03:00 - 04:00	1	5	65	60	278	0	0	0	409	0	**409**	1,068	0	**1,068**
04:00 - 05:00	5	4	82	122	364	0	0	0	577	0	**577**	1,554	0	**1,554**
05:00 - 06:00	6	3	121	95	296	0	4	0	525	0	**525**	1,274	0	**1,274**
06:00 - 07:00	4	6	105	42	289	0	1	6	447	6	**453**	1,120	3	**1,123**
07:00 - 08:00	20	10	157	71	272	0	9	23	539	23	**562**	1,235	12	**1,246**
Total	1,002	425	3,348	1,314	7,187	0	141	209	13,417	209	13,626	30,158	105	30,263

Table F- 4: Average Daily Traffic Count (Cont.)

DMIC Ahemdabad- Dholera Region

Average Daily Traffic

Location No : 0 | Road Section : SH-20 | Duration : 21-Jan-09 to 21-Jan-09
Location Name : Limbdi Junction | Road Name : 0 | Day(s) : Wednesday to Wednesday
Chainage (Km) : 0.0 | Direction : Both Directions

Time Period	Motorized Vehicles							Non-Motorized	Vehicles			PCUs	
	Two wheeler	Auto Rickshaw	Car/ Jeep/ Van	Buses	Trucks	Other vehicles	Tractors		Total Motorized Vehicles	Total Non-Motorized Vehicles	Total Vehicles	Motorized PCUs	Non-Motorized PCUs
08:00 - 09:00	86	40	83	15	21	0	3	20	248	20	268	274	10
09:00 - 10:00	103	41	70	22	49	0	6	11	291	11	302	372	6
10:00 - 11:00	94	35	51	15	39	0	7	12	241	12	253	283	6
11:00 - 12:00	106	29	65	10	30	0	3	5	243	5	248	277	3
12:00 - 13:00	69	56	61	24	31	0	3	15	244	15	259	299	8
13:00 - 14:00	90	21	46	8	24	0	2	5	191	5	196	188	3
14:00 - 15:00	59	17	57	12	34	0	2	5	181	5	186	228	3
15:00 - 16:00	89	33	67	16	27	0	4	5	236	5	241	260	3
16:00 - 17:00	72	20	65	7	18	0	2	7	184	7	191	186	4
17:00 - 18:00	66	14	54	7	15	0	2	5	158	5	163	156	3
18:00 - 19:00	63	7	53	3	20	0	1	7	147	7	154	152	4
19:00 - 20.00	42	8	43	3	15	0	2	5	113	5	118	120	3
20:00 - 21:00	62	15	50	15	47	0	7	5	196	5	201	278	3
21:00 - 22:00	37	19	45	6	41	0	3	5	151	5	156	212	4
22:00 - 23:00	43	15	41	8	91	0	20	18	218	18	236	392	15
23:00 - 24:00	15	11	52	7	45	0	0	3	130	3	133	216	2
00:00 - 01:00	17	9	43	4	29	0	1	0	103	0	103	170	0
01:00 - 02:00	23	7	30	11	24	0	0	0	95	0	95	142	0
02:00 - 03:00	12	11	23	11	45	0	3	0	105	0	105	193	0
03:00 - 04:00	11	1	25	8	35	0	0	0	80	0	80	155	0
04:00 - 05:00	15	21	48	4	26	0	0	1	114	1	115	158	1
05:00 - 06:00	13	9	28	4	47	0	3	0	104	0	104	195	0
06:00 - 07:00	12	3	14	1	25	0	0	4	55	4	59	94	2
07:00 - 08:00	28	10	27	6	39	0	1	32	111	32	143	170	16
Total	1,227	452	1,141	227	817	0	75	170	3,939	170	4,109	5,163	92

Table F- 5: External Link Data

	ROAD/SECTION	LENGTH (km)	JOURNEY SPEED (kmph)	RUNNING SPEED (kmph)
SH-4 & SH-6				
	Kamod Junction	0		
	Dholka	30	49	49
	Vataman	25	38	39
	Pipli	23	39	41
	Dholera	17	41	43
	Adhelui	30	45	46
	Bhavnagar	30	45	46
	Total	155		
National Highway				
	NH-8A			
	Sarkej Junction	0		
	Bavla	20	40	41
	Bagodra	28	48	48
	Limbdi	43	47	49
	Sayla	34	51	52
	Chotila	33	50	51
	Bamanbor Circle	13	39	41
	Morbi	52	52	53
	Bhachau	95	50	50
	Ghandhidham	35	53	54
	Kandla	20	48	50
	Total	373		

	ROAD/SECTION	LENGTH (km)	JOURNEY SPEED (kmph)	RUNNING SPEED (kmph)
	NH-8E			
	Bhavnagar	0		
	Ghogha	15	45	50
	Talaja	44	53	54
	Mauva	46	50	51
	Victor/Pipavav	16	48	48
	Jafrabad	25	50	52
	Una	37	56	56
	Total	183		
Other State Highways				
	SH-25			
	Bhavnagar	0		
	Sihor	22	47	51
	Babra	65	65	66
	Sardhar	55	55	56
	Rajkot	31	53	55
	Total	173		
	SH-36			
	Bhavnagar	0		
	Vallbhipur	38	57	65
	Barvala	27	54	54
	Dhandhuka Junction	28	56	58
	Total	93		
	SH-1			
	Dhandhuka Junction	0		
	Ferada	20	48	50
	Lothal	15	45	45
	Total	35		
	SH-20			
	Dholera	0		
	Dhandhuka Junction	27	58	60
	Limbdi	31	41	42
	Wadhwan	22	47	47
	Surendranagar	5	30	43
	Dhrangadhra	35	53	54
	Halvad	27	54	54
	Morvi	43	52	52

Capacity Analysis

Capacity Analysis for DSIR Regional connectivity and influencing road sections are carried out to define the Level of Service (LOS) offered by roads under the prevailing roadway and traffic conditions and to recommend capacity augmentation based on traffic levels. The roadway and traffic conditions include design hour traffic, vehicle composition, and directional distribution of traffic, lane width and type of terrain. The identified road sections pass through plain terrains.

As peak hour traffic of project road sections are different, capacity for single lane and intermediate lane are calculated by using hourly capacity values recommended by IRC and applying actual peak hour factors. The estimated capacities based on IRC recommendations are presented in Table F-5.

Table F- 6: Estimated Capacities of Strategic Road Connections

SECTION	ROAD	LANE CONFIGURATION	ADT (VEHICLE)	ADT (PCU)	V/C RATIO	LEVEL OF SERVICE
Sarkej - Bagodra	NH-8A	4	28770	45142	0.56	C
Limdi – Chotila	NH-8A	4	13626	30263	0.38	B
Bhavnagar - Trapaj/Pipavav	NH-8E	2	19963	20062	0.58	C
Limdi - Wadhwan	SH-20	2	4109	5255	0.15	A
Dhanduka - Bhavnagar	SH-36	2	19086	25239	0.73	D
Simej – Wataman	SH-4	2	4813	8427	0.24	A
Wataman- Dholera	SH-6	2	6231	8310	0.24	A
Wataman – Taranagar	SH-8	2	8031	15977	0.46	B
Dhandhuka – Limbdi	SH-20	2	2843	3295	0.1	A

Vehicle Occupancy for Estimation of Trips

Tables F-7 and F-8 give assumed occupancy rates for passenger and freight traffic for estimation of external and internal trips within the DSIR.

Table F- 7: Occupancy for Estimation of Trips

MODE	OCCUPANCY
2-W	1.2
Car	2
Taxi	1.5
Sharing jeeps	7
Mini bus	30
Bus	55

Table F- 8: Freight Traffic Trip

MODE	VEHICLES/DAY/Ha
Light Commercial Vehicles (LCV)	2.34
Trucks	4.2

APPENDIX G: EVALUATION OF FRESH WATER SOURCES FOR DSIR

Introduction

A number of agencies have been contacted and documents studied in order to identify an adequate and reliable water source for DSIR. These include:

- Gujarat Water Supply and Sanitation Board (GWSSB)
- Gujarat Water Infrastructure Limited (GWIL)
- Sardar Sarovar Narmada Nigam Limited (SSNNL)
- Indian Metrological Department (IMD)
- Gujarat Infrastructure Development Board (GIDB)
- Narmada Water Resources, Water Supply and Kalpasar Department
- Irrigation/Canal Network Map
- Water Supply Network Map of the Region
- Khambhat Gulf Development Project (Kalpasar) - Pre-Feasibility Report and
- The Water Resource Development Atlas of India

Options

After detailed study of the reports, information and post discussion with the different authorities, the following possible sources of fresh water have been identified and evaluated;

Narmada Canal;

- Pariyej Reservoir and Kaneval Reservoir Development of reservoirs in and around the project area;
- Desalination of sea water;
- Ground Water and
- The Kalpasar sweet water lake.

Narmada Canal and its Tributaries

The Narmada canal is the primary water source for the region. This canal originates from the reservoir of the Sardar Sarovar Dam (terminal dam) on the Narmada River located at 170 kms upstream from where the river flows into the Gulf of Khambhat in the Arabian Sea. The gross area of the reservoir is about 37,000 ha with a linear stretch of 214 km of water and an average width of 1.77 km. Figure G-1 indicates a schematic location of the Vallabhipur Branch of the Narmada Canal, and its four minors that intercept the site.

Table G-1 gives salient features of the Sardar Sarovar Dam.

The total availability of fresh water from the Narmada River for the four States of Madhya Pradesh, Gujarat, Maharashtra and Rajasthan will be about 28 million acre feet (MAF). The shares of each State have been given in Table G-2.

Out of 28.00 MAF, 9.00 MAF will be distributed from the Sardar Sarovar Dam to Gujarat, the breakup of which is indicated in the Table G-3.

Table G- 1: Salient Features of the Sardar Sarovar Dam

1	Full Reservoir Level (FRL)	138.68m
2	Maximum Water Level	140.21m
3	Minimum draw down level	110.64m
4	Normal tail water level	25.91m
5	Gross storage capacity of the reservoir	0.95 M ha m (7.7 MAF)
6	Live storage capacity	0.58 M ha m (4.75 MAF)
7	Dead storage capacity	0.37 M ha m (2.97 MAF)

Table G- 2: Allocation of Narmada Water for different States

SR. NO.	PARTY STATE	ALLOCATED SHARE OF WATER
1	Madhya Pradesh	18.25 MAF (22.51 km^3)
2	Gujarat	9.00 MAF (11 km^3)
3	Maharashtra	0.25 MAF (0.31 km^3)
4	Rajasthan	0.50 MAF (0.62 km^3)
	Total	28.00 MAF (35 km^3)

Table G- 3: Narmada Water Utilization Share in Gujarat

SR. NO.	TYPE OF USE	QUANTITY
1	Water for Irrigation	7.94 MAF
2	Water for Drinking	0.86 MAF
3	Water for Industrial Uses	0.20 MAF
4	Total	9.00 MAF

There is network of canals to transport water from the Narmada River to different locations of the State.

The nearest tributary of the Narmada Canal to the DSIR is the Vallabhipur branch, which is a sub-branch of the main Saurashtra Channel. The discharge from the Vallabhipur branch is about 70 cum/sec at the head of the canal, and the discharge from the Dholka branch is about 57 cum/sec. In order to satisfy the total water demand of the DSIR, about 10% of this water supply would need to be diverted to the project area.

The alignment of the Vallabhipur channel and its networks is shown on Figure G-1. The transportation distance to the storage tanks in the DSIR will be about 10kms and water from the minor channels can be transported to the proposed storage locations by gravity.

Distributaries off-taking from Vallabhipur Branch Canal and Minors are given in Table G-4.

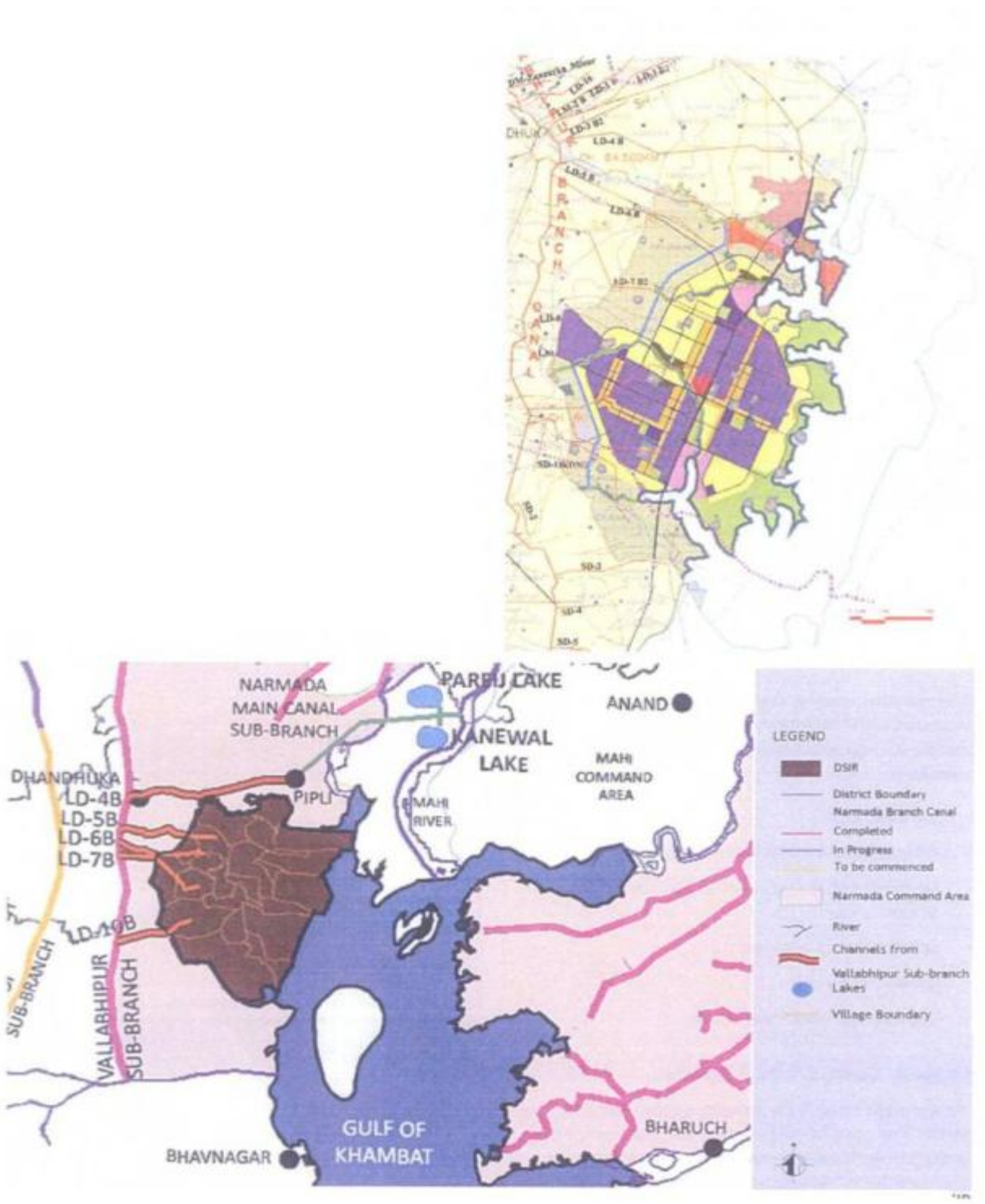


Figure G- 1: Vallabhipur Sub-branch and Channel Alignment near the DSIR

Table G- 4: Details of Distributaries off-taking from Vallabhipur Branch Canal and Minors

NAME OF DISTRIBUTARY	OFF TAKING CHAINAGE FROM V.B.C. (km)	LENGTH (km)	COMM - AND AREA (ha)	DISCHARGE OF DISTR. (CUMECS)		CANAL SECTION (m)				FREE BOARD (m)		FULL SUPPLY LEVEL (m)		GROUND LEVEL (m)		ENCOMPASSING VILLAGES
			AREA	HEAD	TAIL	BED WIDTH (H)	FSD (H)	BED WIDTH (H)	FSD (T)	HEAD	TAIL	HEAD	TAIL	HEAD	TAIL	
LD-4B	64.795	27.277	13168	5.7669	0.3978	1.2	1.96	0.45	0.72	0.55	0.4	17.99	10.375	16.648	6.477	Dhandhuka, Kasindra, Khasta, Ganf, Shela, Amali, Gogla, Kamatalav
LD-5B (Kadipur Distr.)	65.951	21.989	5721	2.567	0.8094	0.85	1.46	0.6	1	0.4	0.4	17.437	9.389	16.788	7.637	Dhandhuka, Rojka, Bhadiyad, Ganf, Kadipur
LD-6B (Gorasu Distr.)	67.542	16.818	7384	3.2769	0.4459	1	0.57	0.45	0.75	0.55	0.4	17.436	9.773	16.349	8.424	Dhandukha, Rojka, Kothadia, Kharnal, Bhadiad, Gorasu
LD-7B (Bavliyari Distr.)	71.802	39.09	21543	10.78	0.6676	1.6	2.62	0.6	1	0.55	0.4	16.396	8.509	15.174	5.739	Akru, Kharad, Sodhi, Cher, Gorasu, Otariya, Sandhida, Mundi, Dholera, Jankhi, Bavaliyari, Zinjar, Nabhoi, Bhadiad, Khun, Bhimtalav, Rahtalav, Mahadevpura, Bhangarh, Maingalpur

Pariyej Reservoir and Kaneval Reservoir

There are two large water reservoirs at Pariyej and Kaneval about 50 km from the DSIR. Pariyej and Kaneval reservoirs are 445 ha and 625 ha in area and their storage capacities are 287 million cubic feet (mcft) and 289 mcft respectively. These reservoirs are well connected and fed by the Mahi Sagar River as well as the Narmada Canal. The Pariyej and Kaneval are perennial water storage reservoirs for the supply of 250 MLD of water.

The Saurashtra branch canal is under construction to supply irrigation and drinking water to the Saurashtra region and once this canal is commissioned, the water from Pariyej and Kaneval reservoirs may be available to the DSIR.

Development of water reservoirs in and around the DSIR

An off line water reservoir in the form of wide water channels could be developed to tap the rain water of the area. It is proposed that rivers that are joining the development area on its western and northern boundaries are impounded in a linear reservoir. Surplus water would be disposed off in the sea by remodelling the existing rivers downstream. Special structures, including weirs and other de-silting mechanisms would be constructed to avoid siltation. The upstream course of the river can also be utilized to store rain water.

To study the availability of water, the entire Catchment Area (C.A.) shall be considered. There after the intercepted C.A by upstream projects shall be deducted and net C.A. available shall be considered for working out rainfall-run off co-relation (R.R. relation). From R.R. relation, the available yield at 50%, 60%, 75% and 98% reliability shall be worked out. As the DSIR is an industrial and residential area, 98% reliability should be assumed. Also the spill water available from the upstream releases through existing irrigation projects shall be considered and added, for total surface water availability.

The DSIR lies within the Sukhbhadar and Utavali river basins. There are three medium scale irrigation projects located in the Sukhbhadar basin: the Dhari Irrigation Project in Chotila taluka and the Goma Irrigation Project and the Sukhbhadar Irrigation Project, both in Botad taluka. The medium scale Khambhada Irrigation Project is located on the River Utavali in Dhandhuka taluka.

The average yield persq.km of the catchment area of each of these projects is 0.07 mcum, 0.11 mcum, 0.086 mcum and 0.074 mcum for the Dhari, Goma, Sukhbhadar and Khambhada irrigation projects respectively. For the purpose of broadly estimating the availability of surface water, the average annual yield can be assumed as 0.085 mm3/sq.k.m. The free catchment area below the Sukhbhadar dam, which is the terminal dam in that river basin is about 900 sq. km and free catchment area below the Khambhada dam is 296 sq. km. Assuming the rainfall pattern & topographical features of the catchment area are similar as the existing projects, then the average annual yield from the free catchment area can be broadly assumed for estimation purposes as 100 m cum, subject to more detailed study.

To obtain actual yield estimation, the detailed rainfall-runoff Co-Relation shall be established based an observed data for at least the last 15 to 20 years of rainfall & gauge discharge, and yield series This will give the actual estimation of the availability of water and would be the basis for further planning.

With regard to upstream releases, it should be noted that the Sukhbhadar Dam and Khambhada Dam are gated dams and during flood, regulated releases may be available depending upon the storage capacity of the reservoir. The observed data, since construction of these dam shows no significant overflow from these dams, that is the yield was less or just sufficient to fill the reservoir to its capacity. The Dhari Dam & Goma

Dam are un-gated and hence during floods over-flow, water becomes available if the water level in the reservoir is above the crest level of the dam. However the observed data shows no significant overflow of the dam. Hence for the purpose of estimating the dependable availability of fresh water it can be safely assumed that there will be no contribution of flood water from upstream releases.

Channels (minors) from the Vallabhipur sub-branch proposed by the SSNNL passing through the DSIR as shown in the Figure H-1 can be tapped into the proposed water reservoirs and canals to augment the water source in the DSIR. This approach to water resource development for the DSIR should prove a sustainable water supply to meet the demands of the area. The water reservoirs can also be used for other purposes, including water sports and picnic areas, parks, , fish farms and nature conservation areas. During heavy rains surplus storm water shall be drained downstream of the river to avoid flooding.

Desalination of Sea Water

The DSIR is a coastal region and fresh water can be produced through desalination. Water produced through this process is generally more costly than water obtained through other sources.

Ground Water

The ground water table in the DSIR is very shallow but it is saline and contains arsenic and fluoride and cannot therefore be used without treatment. Treatment of such water is very costly. There may be fresh water in a confined form at relatively greater depth. To determine this will require more detailed investigations such as resistivity surveys and remote sensing techniques or the drilling of sample bore wells.

Kalpasar Sweet Water Lake

The Government of Gujarat is planning to construct a very large dam across the Gulf of Khambhat and thereby to create a fresh water reservoir from the impounded waters of the Narmada, Sabarmati, Mahi, and Dhadar Rivers. The stored water would be used to meet the irrigation, water supply and industrial requirement of the Saurashtra region.

Evaluation of Options

An evaluation was made of the water supply options outlined above. From this evaluation it is concluded that:

- Tapping of the Narmada Canal should be considered as the prime source of water for the DSIR.
- Development of water reservoirs could also help supplement the supply of raw water for the DSIR but since the rivers are not perennial and remain dry for about 9 months of the year, it would be always be necessary to connect and augment the water body from the tributary of the Narmada Canal.
- If the Kalpasar dam is constructed, it would provide the best long term solution for the water supply for the DSIR.

APPENDIX H: GROUND IMPROVEMENT STRATEGY

Ground Improvement Methods

Different schemes of treatment for the soil are proposed in order that development remains cost effective and these are discussed below.

Basal Reinforcement

In this method the existing soil is excavated and the geotextile/geogrid layer is installed at the designed depth and the area is then re-filled with sand or 'murrum' material. Geotextiles/geogrids distribute the stresses uniformly on the underlain soil. The stress distribution and transfer depend on the interlocking and / or friction between the soil and geotextile/geogrid. This method has been widely used for highway and railway embankments.

This method is fast to execute and also economic when the required safe bearing capacity is comparatively low at about 10 tonnes per metre squared (T/m^2). However the settlements cannot be controlled in this method and hence they are only suitable for flexible structures.

The improved safe bearing capacity can be verified by conducting the plate load test after the treatment.

Prefabricated Vertical Drains (PVD) / Band Drains

This treatment method helps to increase the safe bearing capacity, reduce the settlements and accelerate the time required to achieve these settlements.

The permeability of soft clays, silty clays and clayey silts which are prevalent in the DSIR are very low and this does not allow the water to drain out quickly. When a load is applied on such soils the load is initially taken by the pore water and then slowly transferred to soil particles as the water is expelled out. The expulsion of water leads to settlements and increases the load carrying capacity of the soil. The process can be advanced by applying the preload ahead of the actual construction load and by reducing the drainage path of the water.

Prefabricated Vertical Drains (PVD) or band drain is band shaped geo-synthetic material which is installed in the ground to the required depth by hydraulic machinery. The use of band drain reduces the drainage path drastically and thus the time required for consolidation (settlement) is reduced considerably. The settlements thus can be advanced before the actual construction work.

The method requires a period of 4 to 6 months to be assigned as a waiting period after the preload application, depending upon the spacing of the band drains and existing soil properties. However, the post-construction settlements will be within the permissible limits and the rate of settlement will also be less. This method is most suitable for loadings such as road and railway embankments, airports and container yards and the safe bearing capacity of the soil can be increased to 10 to 12 T/sq.m.

The applied preload embankment can be used for construction work if required without removal.

The improved capacity can be verified by comparing the test results of penetration tests including the Standard Penetration Test (SPT), Cone Penetration Test (CPT), or In-situ Vane Shear test conducted before and after the treatment.

Sand Drains/Sand Piles

Sand piles as the name indicates are the piles made up of gravel or sand. A hole of the required diameter, usually 200 – 300 mm, is drilled to the depth of relatively firm stratum (N > 15 in most cases). The hole is then filled up by granular sand free from organic matter and silts in the lifts of 1.00 m and compaction is achieved by vibrations. This is called the replacement method. However when the existing material is very soft and may cave in during the drilling, the stability of nearby existing structure may reduce. In this case, the sand piles are installed by the displacement method in which the casing pipe is pushed in the ground by

force and the hole is filled by granular sand free from organic matter and silts. This densifies the surrounding soil.

The sand drains / sand piles also act as a drainage way and hence the changes of liquefaction reduces. As in case of band drains, the preload shall be applied equivalent to the proposed loading intensity. The preload shall be kept for 4 to 6 months depending on the spacing of band drains and existing soil properties in order to achieve the required degree of consolidation.

However the construction of sand drains / sand piles is tedious job and is more labour intensive than band drain installation. The method is also expensive compared to band drains if the sand is not available. Furthermore as the settlement occurs, soil moves laterally as well as vertically down and sand drains may fail due to this movement.

The method has been used for high speed railway embankments and expressways. This method is fast in construction and the safe bearing capacity can be increased to 15 T/sq.m. The sand piles also act as drainage material and in case of silts / fine sand the chance of liquefaction is also reduced.

The improved capacity of the soil can be verified by conducting the load test on single and / or group of sand piles.

Stone Columns

These are columns made up of stone aggregate. The depth of the stone column in this region is about 6 – 10m. The construction of stone columns involves partial replacement of weak soil with the stones (aggregates). The stones are compacted by ramming or vibrations. General practice is to replace 15 – 35 % of weak soil by stones. Design loads of stone columns typically vary from 20 to 50 T.

The installation of stone columns creates a composite material of overall lower compressibility and higher shear strength than the virgin weak soil. Also as stones are free draining material, this helps to drain the pore water and reduces the possibility of liquefaction.

The waiting period required in sand drains or band drains for achieving gain in shear strength is not necessary in the case of stone columns. The load is taken by the stone columns. Usually a layer of drainage material is provided on the top of stone columns to allow the drain water to come out. A layer of geogrid/geotextile is also provided on the top of the drainage material to distribute the stresses uniformly over the soil.

The use of stone columns is particularly useful where the load is not uniform. The method has been used for many ports, highways and slope stabilization works.

The safe bearing capacity of the soil can be increased to 15 to 25 T/m^2. The improved capacity of the soil can be verified by conducting the load test on single and / or a group of stone columns.

This land improvement treatment methodology is particularly suitable and cost effective for structures underground and piers for flyovers and bridges

Jet Grouting

This method involves mixing cement (or in some cases fly ash or lime) with soil and causes the properties of the soil to become more like the properties of a soft rock, such as a clay shale or lightly cemented sandstone. As the post construction settlements are negligible, this will be the most suitable method for rigid structures.

The modulus of elasticity and unconfined compressive strengths are typically 1/5 to 1/10 that of normal concrete. Almost all soil types are amenable to treatment.

This treatment can be done by two methods. In the first method, mechanical soil mixing is typically performed using single shafts of augers and mixing paddles. The auger is slowly rotated into the ground, typically 10-20 rpm, and advanced at 0.5-1.5 meters per minute.

As the auger advances, cement slurry is pumped through the hollow stem of the shaft(s) feeding out at the tip of the auger. Mixing paddles are arrayed along the shaft above the auger to provide mixing and blending

of the slurry and soil. The slurry helps to lubricate the tool and assists in the breaking up of the soil into smaller pieces. Since fluid volume is being introduced into the ground, spoils must come to the surface. These spoils are a combination of the cement slurry and soil particles, typically with similar cement content as what remains in the ground. After the final depth is reached, the tools remain on the bottom of the hole, rotating for about 0.5 to 2 minutes for complete mixing. At this point, the tools are raised while continuing to pump slurry at a reduced rate. Withdrawal is typically at twice the speed of penetration, 1-3 meters per minute. Treatment of the soil can be done to a replacement ratio of 100% wherein all the soil inside a particular block is treated to a specified strength by mixing with cement.

In another method the high pressure cement slurry 200 bar is pumped through horizontal ports in a drill string above the drill bit. The high velocity and pressure of the cement jets cuts and mixes the soil in situ.

The Improved capacity of the soil can be verified by conducting the load test on single and / or group of grout columns.

Over Burden Pressure

This is one of the oldest and most conventional methods for the compaction and consolidation of soil to increase its bearing capacity. In this method the land area which is to be utilised for building structures is loaded with heaps of soils or other material to over burden the soil for the desired time period. The quantum and time period required for over burden depends on the type of soil, its characteristics and the required safe bearing capacity for the development. The time period may vary from one to several months.

Selection of over burden material is done in such a manner that in due course the over burden material becomes an integral part of the existing soil.

Considering the soil characteristics of the project site, this process of over burden is required to be combined with the draining process to allow the water to be expelled out with pressure and time.

This process is useful and economical where sufficient time is available for the process of compaction to be achieved and where the development can be planned in a phased manner.

This land improvement treatment technique is most suitable and cost effective for development such as road embankments, container yards and sports tracks.

Evaluation of Foundation Systems

Roads/Railway Embankment/Approaches

For roads and railway embankments constructed over soft soil it is observed that the embankment material sinks into the existing soil and potholes and rutting occurs. Furthermore, the settlements are non-uniform.

Use of geotextiles as separation material stops the embankment material penetrating the existing soil and redistributes the applied stresses uniformly. Hence, for the low traffic intensity, the use of geotextile will be the best solution.

However, for heavy traffic intensity, the magnitude of settlement may be above the permissible limits. In such case to advance the settlements, the PVD or Band Drains will be the effective solution for uniform loading conditions. However for triangular or non-uniform loading; though the required safe bearing capacity may not be more than 10 T/m^2 to 15 T/m^2, the settlements may be non-uniform. Hence, sand piles or stone columns will be the appropriate solution.

Buildings

In buildings, the pressure acting on the sub-soil depends on the design of buildings, its use and hence loading. The load intensity may not be uniform over the entire plan area of the building.

PVD or band drain will not be an effective solution as the required preload will be non-uniform (depending on the column loadings) and will lead to non-uniform settlements. Also though the basal reinforcement distributes the loads uniformly, it cannot restrict the settlement and hence cannot be used for these structures.

In such case, depending on the required SBC, the sand piles or stone columns will be the most appropriate solution. A drainage layer shall be provided on the top of the sand piles or stone columns and a layer of geogrid/geotextile shall be provided to distribute the stresses uniformly over the soil in between the sand piles/stone columns. In the case of jet grouting, a direct raft can be constructed on the grouted columns.

Tank Foundations

The settlements of very small magnitude may hamper the stability of the tank depending on its loading condition (fully loaded / partially loaded / empty). Hence the settlements will not be tolerable for the tank foundation and the applied loads will be very high of the order of 30 – 35 T/m^2. For such case the stone columns with the raft constructed on the top will be the appropriate solution.

Container Yard / Stack-yards

The load intensity for these structures is low. However the applied pressure may remain for a longer duration i.e. the sustained loading condition. The settlements due to such loading will be consolidation settlements and the most appropriate solution for this will be PVD or band drains. By applying the surcharge in addition to expected loads the expected settlements can be advanced by use of PVD and hence the post-construction settlements will not occur or will be within the allowed limits.

Bridges, Flyovers, Underpasses and Culverts

As the stiff / hard stratum is available at greater depths; the abutment and piers of bridges and flyovers shall be supported by pile foundations. The pile shall be designed as mainly friction piles and the effect of negative or drag friction due to the settlement of silty clay and clayey silt shall also be taken care of.

The approaches of bridges, flyovers, underpasses and culverts can be constructed by a new technique of reinforced earth wall (REW). REW is a tie back wall that suppresses lateral deformations in the structure and enhances the load carrying capacity of the system. The soil is held by the friction between soil particles and reinforcement. Soil particles not in direct contact with reinforcement are assumed to be held in place by arching of soil particles between two successive layers of reinforcement. Advantages of the REW method are:

- maximizing usable space and minimizing land acquisition costs;
- delivering long term durability;
- simplified construction;
- pleasing appearance;
- low construction cost with reduced construction time; and
- increased space availability at the top and bottom of the wall.

Dam Foundations

Small dams and check dams will be required to support the supply of water to the DSIR. The applied pressure intensity will be high due to the water forces and resulting movements. Furthermore, the important requirement of the dam foundation is the control of leakage below the dam body. For such reasons, the jet grouting method will be the appropriate solution for dams.

Canal Bank Protection

To develop the existing and to create new water bodies, the widening and deepening of the existing channels will be required. The river training works all along the periphery or bank is necessary. Therefore sound bank protection schemes will be required. The slopes shall be protected by jet grout columns which will provide the stability and to control seepage, the canals shall be lined with geo-membranes and geo-textiles.

Excavation Suitability

Multi-storied buildings or some underground structures such as storage tanks require the construction of one or more basements. The excavation for such structures may be as deep as 6 to 9 m. The sub-soil at this

location is identified as “soft silty clay/clayey silt” which not purely cohesive soil and cannot stand more than 1 to 2m. Hence support systems such as diaphragm wall with nails/shore piles/jet grouting will be required to carry out the excavation. The ground water table is available at very shallow depth and during monsoons it is at ground level. Hence, the de-watering system using well points will be required to carry out the excavation work.

Suitability of Material for Filling

Sources of fill material for construction purposes will need to be identified. Detailed investigations will need to be undertaken in order to determine which source or combination of sources offers the best material at an economic price for the land improvement of the DSIR. These investigations should form a part of the program of studies required to implement the Project.

A number of sources have been identified, including dredging within the site as a by-product of the creation of water bodies, dredging in the Gulf of Khambat and creation of borrow pits.

The basic hurdle of the first solution is the quality of the excavated material, which is soft silty clay / clayey silt with medium to high plasticity. The material also has high swelling characteristics and the soil is highly expansive. Generally structures cannot be directly rested on such soils, unless there is an additional layer of cohesive non-swelling (CNS) lying on top of it at a thickness of 0.50 to 0.60 m.

It is also considered that sand can also be sourced from the River Sabarmati, River Kalubhar and River Bhogavo which are near the DSIR. The quality of filling material available from these sources can be used for area grading and preparation of sub grade for transport infrastructure.

This fill material can be supplemented through the fly ash available from the Torrent thermal power station at Sabarmati and the Bhavnagar thermal power stations.

Besides the above mentioned options, the soil likely to be obtained from the creation of water channels and other cutting options can also be used as filling material where the filling depth is more than 0.75m. The excavated material can also be used for the core portion of earth dam, road embankments and sub grade preparation with soil stabilization with lime between 2% to 4% for minor and internal roads.

The borehole data received from GIDB indicates that there are certain locations within the DSIR from where suitable filling material can be obtained. The details have been provided in Table H-1.

Table H- 1: Depth of Construction Material available in DSIR

Bore Hole	Depth Of Construction Material Available
M6	0m to 25m and more
BH – M 8	6m to 12m
BH – 6	0m to 12m
BH – 5	1m to 25m
BH – 4	3m to 25m and more
BH – 3	3m to 25m and more
BH – 20	3m to 25m
BH – 14	3m to the depth of hole i.e. 50m

Ground Improvement Scheme as per Land Use and Structure

In terms of the overall ground improvement strategy for the DSIR, it is proposed that works are instigated in advance of requirement so that adequate time is allowed for consolidation and thus improved SBC and CBR value. This will contribute to huge saving in development and construction cost. Table H-2 shows the applicability of ground improvement methods discussed earlier to various structures/schemes proposed in the DSIR

Based on the borehole data received from GIDB, broadly it may be concluded that:

- up to a depth of 10 m the soil is Blackish Silty Clay and expansive in nature;
- up to 10 m depth the N value is as low as in the range of 12 to 30;
- the bore hole data shows the soil is structurally poor in character with very low SBC (around 4 T/m^2).

Based on the available data it can be suggested at a very broad level the best possible land improvement method considering techno commercial viability is as given below in Table H-2.

Construction of Road Embankment:

- major/ Minor Roads – Land improvement is not requirement apart from lime stabilisation for sub grade;
- expressways – PVD and lime stabilisation;
- Railway Embankment – PVD or Band drain.

Container Yard:

PVD or Band drain based on technical requirement after detailed study.

Bridges and Flyovers:

Pile Foundation

Utility Structure:

PVD/Sand Pile/Pile foundation depending upon the technical requirement and detail soil analysis and SBC requirement

Small Scale Industries:

PVD/Sand Piles

Table H- 2: Ground Improvement Methods for Different Types of Structures

Sr. No.	Method	SBC (T/m^2)	Suitable For Structures	Pos Treatment Settlements (mm)
1	Basal Reinforcement	8	Low traffic intensity roads	400 - 600
2	PVD	10	Heavy traffic intensity roads, Railways,	80 - 100
3	PVD with Preload	10	Container Yards	80-100
4	PVD with Preload	10	Container Yards	80-100
5	Stone Columns	15	Tank Foundations, Railways, Ground+1 storied buildings	50 - 150
6	Sand Piles	15	Railway embankment	100 - 200
7	Jet Grouting	15	Tank Foundations, Dam Foundation, Dam Seepage control, River bank protection, Ground +1 storied buildings	10 - 50
8	Jet Grouting	20	Industrial structures	No settlement
9	Pile Foundation		Multi-storied Buildings, Bridges etc	No settlement
10	Reinforced Earth Wall, Alternative to RCC retaining Wall		Approaches	-

Medium Industries

Pile Foundation

Large Industry with heavy machine foundations:

Pile foundations for building footprint only and major structures such as chimneys and cooling towers. Other facilities such as yards, PVD would be adequate.

Water and Canal Structure:

PVD or Band Drain

Underground Structure:

Pile Foundation

Building Structures:

Pile Foundation

The requirement of land improvement as stated earlier would be based on the land use pattern. The land improvement is envisaged for those areas where structures are likely to be built. This would exclude green/ open spaces, land under water bodies, land under CRZ, and agricultural areas. Based on the proposed land use budget, it is estimated that the area grading would be required for about 50% of the total developable area.

At this initial stage of planning, the formation levels of road and major structures can only be tentatively assessed and hence only approximate depth of filling can be ascertained. With the available contours of the area, the existing formation level of SH-6 and the general topography of the site it is estimated that approximately 1.0m filling would be required on the eastern side of SH-6 and approximately 0.5m filling would be required on the western side of SH-6.

The final area grading strategy however will depend upon the detailed planning of specific areas, the phasing of development and the identification of suitable filling material.

APPENDIX I: FOREST AREA DETAILS

Table I- 1: Forest Area Details

Sr.No.	Taluka	Villagename	Survey Number as per published Gazette	Area in Gazette Ha.	Gazette no. / date
1	Dhandhuka	Kadipur	354/1/Part	152.59	AKH/4/75/FLD/1674-90520/P/Dt.20/12/74
			186/1	313.42	---"---
2	Barwala	Shothi	7 Part	77.32	AKH/3278/FLD/1677-77722/P/Dt.16/2/78
3	Dhandhuka	Mingalpur	184	6.12	AKH/143/75/FLD/1175/69677/P/Dt.16/4/75
			185	6.65	---"---
			186	4.42	---"---
			187	3.36	---"---
			190	3.24	---"---
			191	1.40	---"---
			202	165.43	---"---
4	Barwala	Sangasar	194/Paiki	202.35	AKH/143/75/FLD/1175/69677/P/Dt.17/9/99
			195/Paiki	212.46	---"---
			196/Paiki	293.39	---"---
5	Dhandhuka	Ambli	800/Part	283.81	AKH/136/75/FLD/1175/62868/P/Dt.1/5/75
			806/Part	564.52	---"---
6	Barwala	Sodhi	240	20.75	AKH/143/75/FLD/1175/69677/P/Dt.16/4/75
			258	37.14	---"---
7	Dhandhuka	Bhangadh	1	87.75	AKH/156/75/FLD/475/62868/P/Dt.1/5/75
			2	199.38	---"---
			299	30.42	---"---
			309	24.58	---"---
			314	206.03	---"---
			433	206.39	---"---
			434	53.82	---"---
			435	199.11	---"---
8	Barwala	Hebatpur	28/2	130.76	AKH/156/75/FLD/1175/62868/P/Dt.1/5/75
TOTAL SECTION 20				**3486.61**	
9	Dhandhuka	Mahadevpura	141	158.24	AKH/34-84/FLD/1384/364/V-3/Dt.30/5/84
			142	225.91	---"---
			143	263.25	---"---
10	Dhandhuka	Gogala	293	74.34	AKH/34-84/FLD/1384/364/V-3/Dt.30/5/84
			297	95.82	---"---
			201	3941.91	---"---
11	Barwala	Sodhi	7/A/1	104.82	AKH/34-84/FLD/1384/364-V3/Dt.30/5/84
12	Barwala	Hebatpur	201	79.09	AKH/34-84/FLD/1384/364-V3/Dt.30/5/84

Sr.No.	Taluka	Villagename	Survey Number as per published Gazette	Area in Gazette Ha.	Gazette no. / date
			202/2	253.11	---"---
			203/1	87.81	---"---
			204/2	64.49	---"---
			57/2	143.42	---"---
13	Dhandhuka	Ottariya	414/paiki	299.47	
14	Barwala	Bavaliyari	315/1	202.04	AKH/34-84/FLD/1384/364/V-3/Dt.30/5/84
TOTAL SECTION				**5993.72**	
GRAND TOTAL				**9480.33**	