CHAPTER - 7

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SOIL AND LAND RESOURCES

INTRODUCTION

The quality, management and conservation of soils are critical elements in understanding the environmental problems as well as their solution. Soils can affect and are affected by environmental deterioration. They can be degraded and even destroyed by extensive soil erosion. Examination of a vertical section of a soil as seen along a roadside cut or in the walls of a pit dug in the field reveals the presence of more or less distinct horizontal layers. Such a section is called a 'profile' and individual layers are known as 'horizons'. Every well developed undisturbed soil has its own distinctive profile characteristics. The thickness of soil profile depends on extent of weathering. Profiles showing similar horizontal characters within narrowly defined limits are grouped together into 'series'. The soil survey envisages broad scale mapping of soil series. It would furnish adequate information of soil and their behaviour for general planning and implementing various development programmes such as water management practices, drainage improvement, soil and moisture conservation as well as soil conditioning for increasing agricultural products in the area. Thus with the help of soil surveys, it is possible to establish a major link between present land use and inherent soil properties, at the same time it is also possible to improve agricultural product by

proper soil and water management. The information on soils of the study area has been collected from Department of Agriculture, Govt. of Gujarat and National Bureau of Soil Survey and Land Use Planning, Nagpur (NBSS&LUP). Detailed maps of soil series, soil texture and soil depth have been prepared based on remote sensing data and field mapping. The work of the above organisations was duly considered while finalising these maps.

SOILS OF THE STUDY AREA

Among the soil forming factors, the overall climate and vegetation are more or less similar for the entire area. Relief, parent material and time are the dominant factors for soil formation. The continued effects of these factors have created different hydrological and biological systems with different soil development in the area. The soils in the area fall into two major types such as alluvium and aeolian.

ALLUVIUM

Most of the products of rock degradations are transported by such agencies as water, wind etc. In transported soils, those moved by water, constitute the major portion. They are termed as alluvial soils. A stream transports the soil particles from place to place depending upon water velocity and the gradient. With flatter slopes and wider flow channels, the particle size becomes smaller and smaller. Due to seasonal variations stratified layers of coarser and finer materials are found in alluvial deposits (Plate 7.1).

Plate 7.1: Alluvial Soil in Building Foundation at Vastrapur.

Plate 7.2: Aeolian Soil at Thaltej Tekra.

AEOLIAN

Soils that are transported by wind are called aeolian soils. There are two subclasses namely dune sand and loess. Dune sand is a wind borne soil prevalent in arid regions. Dunes are likely to be formed where the wind blows consistently from one direction. In the study area the dune sand found is fine grained, yellowish to brown with well developed top soil cover. Loess contains fine grained, sharp and angular as well as nearly equal sized soil particles. It normally contains some amounts of clay and colloidal material (Plate 7.2).

CLASSIFICATION OF SOILS

Soils of the area have been divided into different series depending on the physiography of the area, change in the morphological characteristics of the soils, soil colour, soil erosion pattern and slope of the area as well as soil texture and structure. Presence of concretions, depth of weathering, root zone depth, depth of water table etc. were noted to differentiate one soil from another. Soils of the study area have been classified as per soil taxonomy (U.S.D.A.) and as adopted by the Department of Agricultural, Soil Survey Organisation, Gujarat State. Taxonomically the soil of the area falls under two orders such as entisols and inceptisols, on the basis of physiography with respect to drainage pattern and erosion categories as described under. The detailed classification of the soil series is given in the table 7.1.

Table : 7.1 CLASSIFICATION AND CHARACTERISTICS OF SOILS

Name of series	Group	Sub-group	Order	Sub-order	Texture	Structure	Drainage and Permeability	Erosion condition	Slpoe %	Limitations
Kathial	Ustochrepts	Fluventic Ustochrepts	Inceptisols	Ochrepts	Loamy sandy to sandy loam	Weak, medium, sub-angular, blocky	Well drained with rapid to moderate permeability	Slight to moderate	1 to 3	Subject to slight to moderate erosion hazard, low water holding capacity, low fertility
Ognaj	Ustifluvents	Typic Ustifluvents	Entisols	Fluvents	Sandy loam	Weak, medium, sub-angular, blocky	Well drained with rapid to moderate permeability	Slight to moderate	1 to 3	Subject to slight to moderate erosion hazard, low water holding capacity, low fertility
Silaj	Ustochrepts	Typic Ustochrepts	Inceptisols	Ochrepts	Sandy loam to clay loam	Weak to moderate, medium, sub-angular, blocky	Moderately well drained with rapid to moderate slow permeability	Slight	1 to 2	Low water holding capacity, low fertility
Ranodar	Ustochrepts	Fluventic	Inceptisols	Ochrepts	Sandy clay loam	As Above	As Above	Slight	1 to 2	Low water holding capacity, low fertility
Pethapur	Ustochrepts	Fluventic Ustochrepts	Inceptisols	Ochrepts	Sandy loam	Weak, fine, sub-angular, blocky	Well drained with rapid permeability	Slight to severe	1 to 3	Surface texture is sandy and structure is unfavourable. WHC is low, soil conservation is required
Chhala	Ustochrepts	Fluventic Ustochrepts	Inceptisols	Ochrepts	Sandy loam	Weak, fine, sub-angular, blocky	Well drained with rapid permeability	Slight to severe	1 to 3	Nutrient status low, WHC is low, soil conservation is required
Bhoyan	Ustochrepts	Typic Ustochrepts	Inceptisols	Ochrepts	Sandy clay loam	Weak, fine, sub-angular, blocky	Well drained with rapid permeability	Slight to severe	1 to 3	Nutrient status low, WHC is low, soil conservation is required
Dabhoda	Ustochrepts	Fluventic Ustochrepts	Inceptisols	Ochrepts	Sandy loam	Weak, fine, sub-angular, blocky	As above	Slight	1 to 3	Nutrient status low, WHC is low, soil conservation is required

ENTISOLS

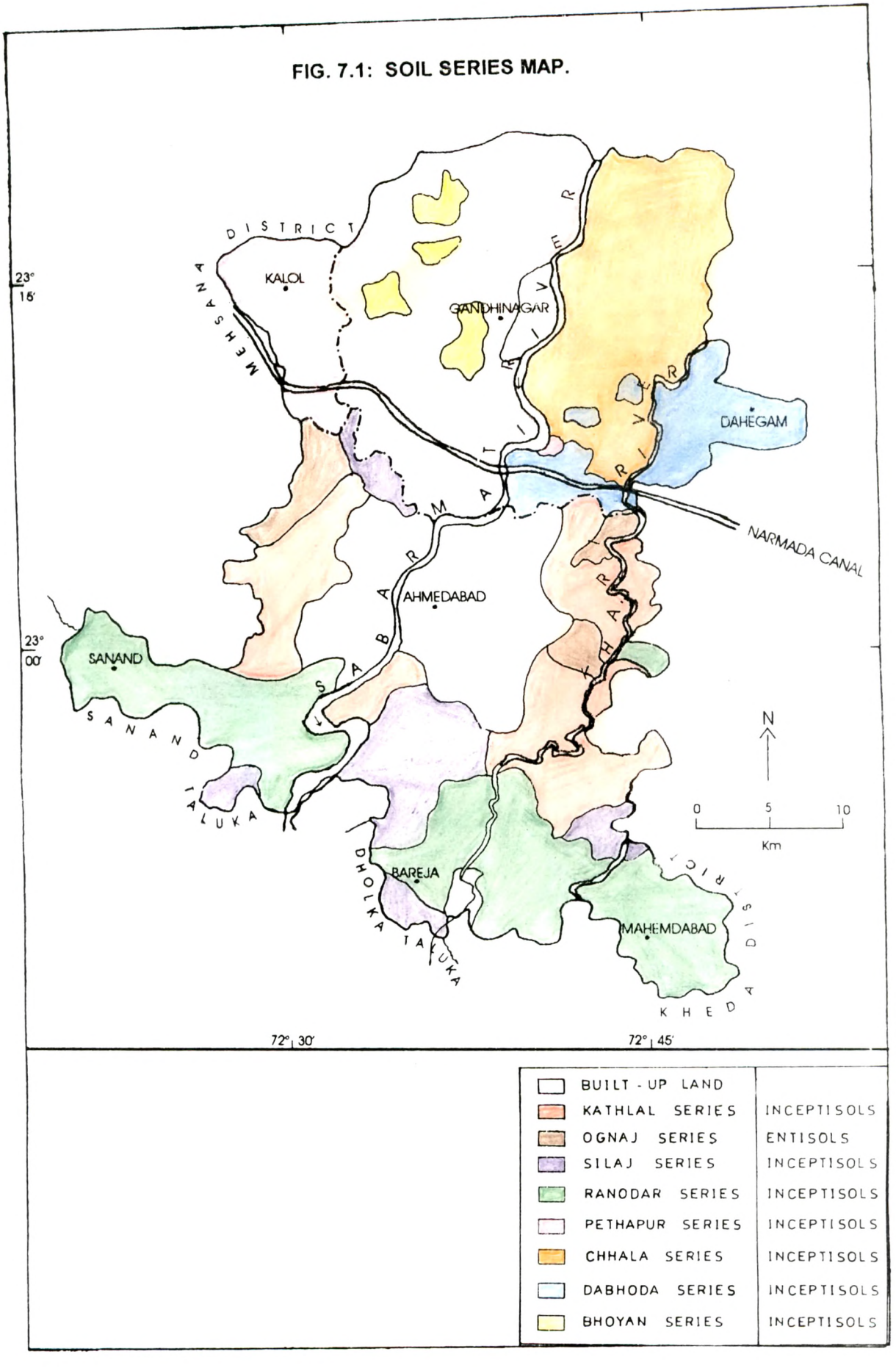
Entisols have developed over alluvium and are fairly distributed in the area. They are light grey, greyish brown and reddish brown in colour. They have been formed under semi-arid climate marked by an annual precipitation of about 500 – 600 mm, and mean temperatures of 25°C to 26°C. The depth of the soils ranges from 1 m to 1.5 m. Texturally, they are sandy clay loam or clay loam.

Structurally, they are weak, mainly sub-angular and blocky. These soils are calcareous and alkaline in nature. The entisols taxonomically represents ustorthents and ustifluvents.

INCEPTISOLS

Soils of this order are found to cover alluvium in most of the part of the study area. These are dark to light grey, reddish brown, yellowish red in colour and are the products of weathering under semi-arid to sub-humid climate with an annual precipitation of more than 500 mm and minimum temperature of 26°C. Inceptisols are calcareous in nature and extend up to a depth of 1.5 m. Structurally, these are sub-angular and blocky. Texturally, the soils are silty loam to clay. Ustochrepts is the main taxonomic soil of this order. Figure 7.1 shows the distribution of various types of soils in the study area.

FIG. 7.1: SOIL SERIES MAP.



SOIL DEPTH

Depth of the soil profile varies in the area. Thickness of the soil profile indicates the period of pedogenesis. The depth of the soil is of vital importance for plant growth. According to the depth of the soil, the area is classified as very deep soils, deep soils and moderately deep soils as shown in figure 7.2.

SOIL TEXTURE

The soil texture is determined on the basis of clay content as shown in the table 7.2:

Table – 7.2: Soil Texture Classification Based on Clay Distribution.

TEXTURE		CLAY DISTRIBUTION
Fine textured:	Clay	60% or more
	Sandy clay, silty clay	41 to 60%
	Sandy clay, clay loam and	35 to 40%
	Silty clay loam	
Medium textured:	Sandy clay loam	27 to 35%
Coarse textured:	Sandy loam, silty loam	18 to 27 %
	Loamy sand	15 to 18 %
	Sand	10 to 15 %

Area under soil texture is classified as coarse loamy soils and fine loamy soils as shown in figure 7.3.

FIG. 7.2: SOIL DEPTH MAP.

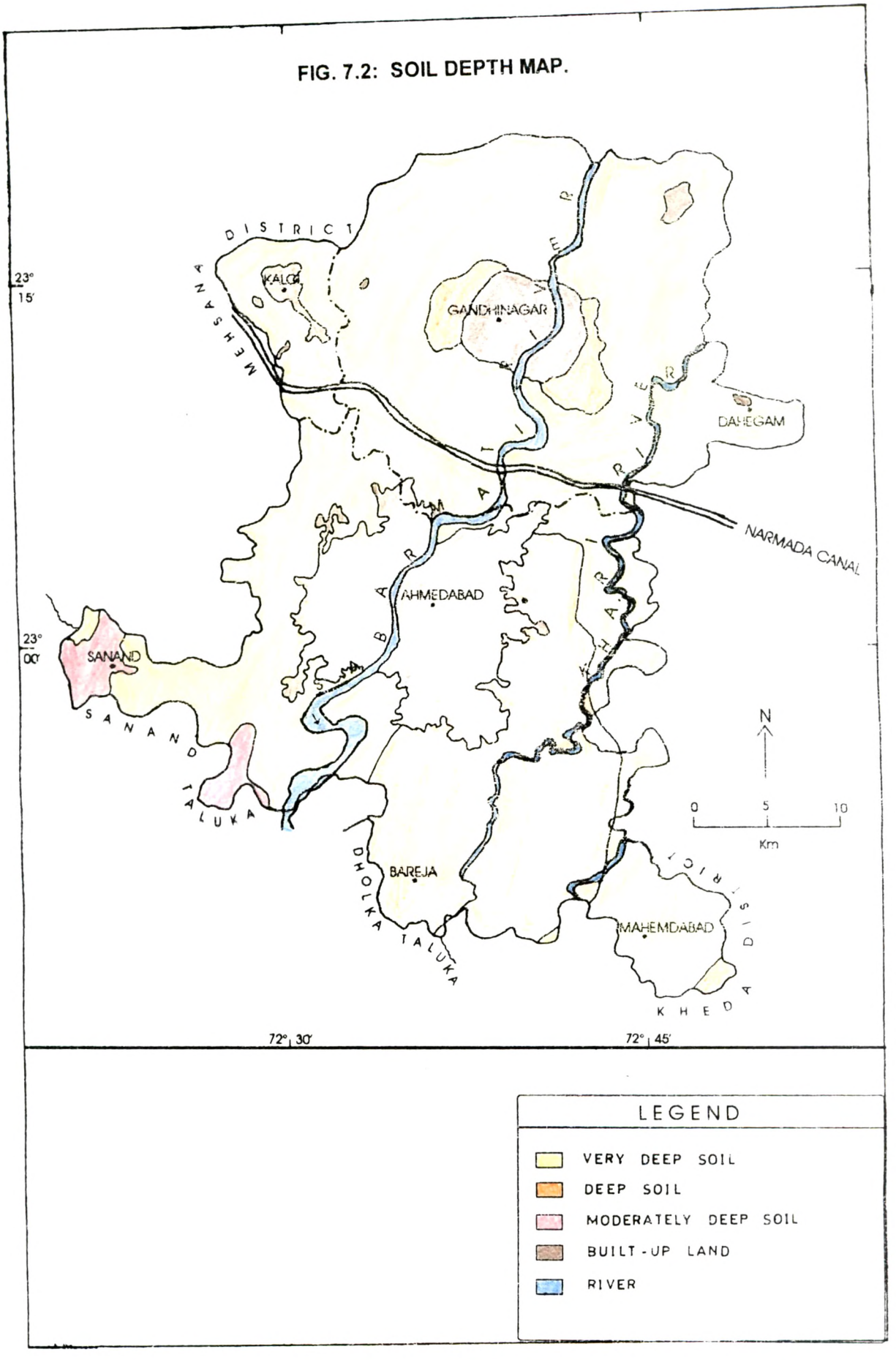
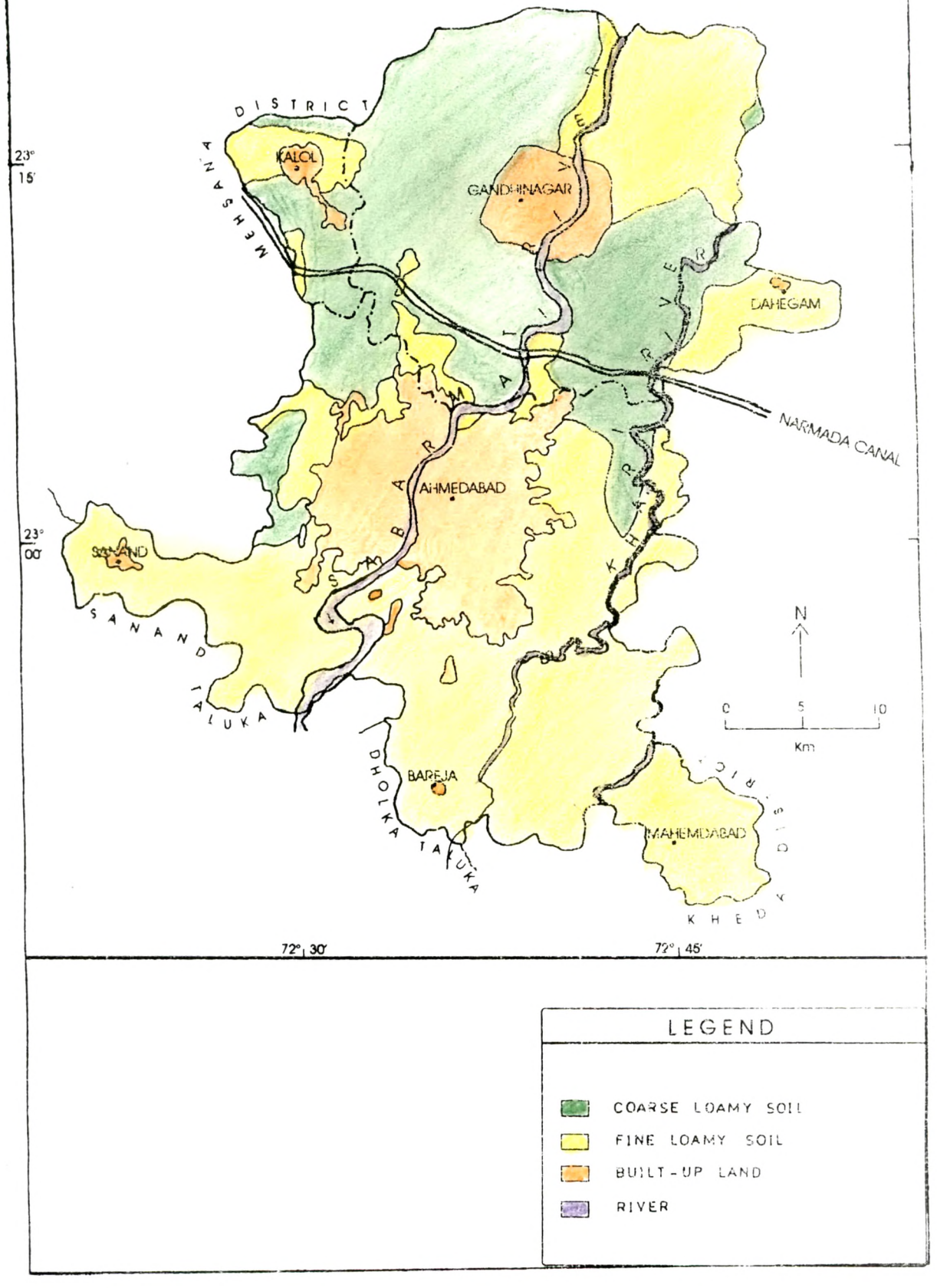


FIG. 7.3: SOIL TEXTURE MAP.



SOIL EROSION

The consequence of soil erosion is all pervasive. Soil erosion adversely affects the functioning of natural ecosystems, the production base and the quality of life of the people. The major factor which has contributed to the large scale soil erosion in certain parts of the study area is very extensive misuse and mismanagement of land in Ahmedabad urban complex. Removal of natural protective cover of vegetation leading to accelerated erosion and sediment generation (Khoshoo, et al., 1993). Soil erosion has not only affected the genesis and fertility of soils but it has also adversely affected the land use. As a result of the progressive and continued erosion of land along the banks of Sabarmati river and its tributaries, the agricultural land as well as habitation have been destroyed (Plate 7.3).

Area under soil erosion class in the area is classified as high erosion, low erosion and no erosion areas (figure 7.4).

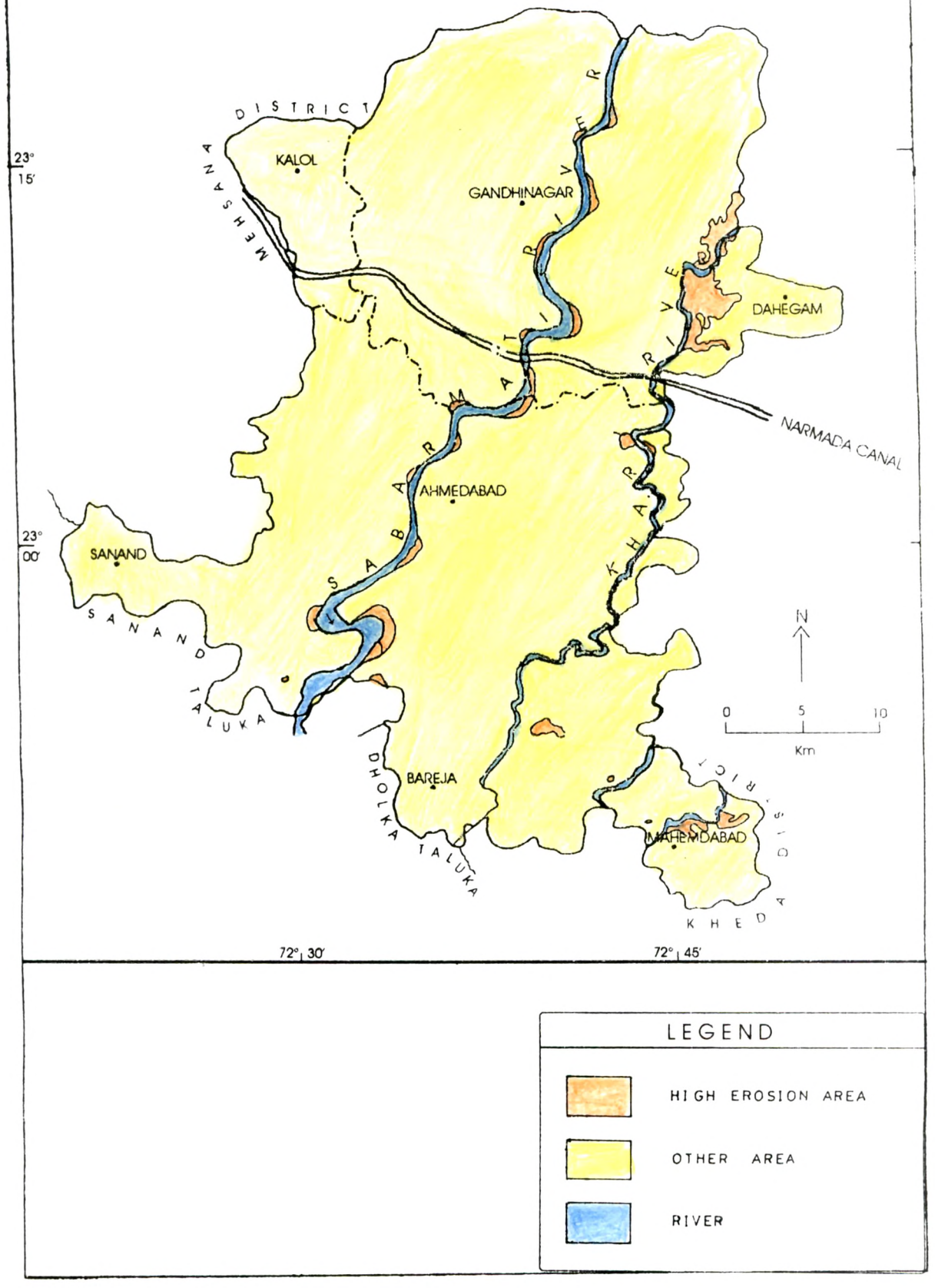
SOIL AS A RESOURCE

The soils in the area is cultivated, very gently sloping, coarse to medium textured, with rapid permeability. The texture varies from sandy loam to clay loam. These soils have capacity to maintain physical condition with available water. Organic manure is suggested for increasing water holding capability and fertility. Soil conservation measures like land levelling is required. Soils are susceptible to erosion hazards. The evaluation of soil as a resource depends on the time and place and on its use. It is a resource used chiefly for agriculture, but as land it is

Plate 7.3: Soil Erosion in Agricultural Field at Gandhinagar.

Plate 7.4: Soil Conservation by Plantation at Indroda.

FIG. 7.4: SOIL EROSION MAP.



also used for forestry, industrial, urban and recreation purposes. Weathering and pedogenesis produce materials, which are exploited for industrial use. Crop production is affected particularly by soil properties like texture, structure, bulk density, depth, organic matter and nutrient status. Chemical toxicity has affected certain parts of the study area because of excessive use of fertilisers and pesticides. Since last few decades, the application of nitrogen has raised the levels of nitrates in the soils. The risks of this very vital resource include erosion and loss of fertility. This requires improvement of all soil properties. Planned soil conservation is the call of the day by implementing soil management and conservation practice in the study area (Plate 7.4).

Drainage condition of the soil is of vital importance in determining crop yields. Most of the soils are well drained means water is removed from the soil moderately slowly to rapidly to keep the sub soil wet for long duration. Important crops growing in the area include Bajara, Paddy, Castor, Wheat, Mastar, Tur vegetable, Maize etc. The greater part of the area is under irrigation facility and double or triple crops are raised. There is no natural forest in the area. There are man made plantations along roadsides, canal banks, railway sides etc.

A comparative statement of the mechanical and chemical properties of different categories of soils is given in the table 7.3.

TABLE 7.3: ANALYTICAL STATEMENT OF AHMEDABAD – GANDHINAGAR SOILS

Name of soil series	Soil Texture	Mechanical Analysis				Moisture %	Water holding capacity %	Porosity %	Volume of expansion %	Apparent density	Chemical Analysis		
		Clay %	Silt %	Fine Sand %	Coarse Sand %						Lime %	Ca %	Mg %
Kathlal	Sandy loam	17.45	22.23	2.05	58.23	3.68	48.06	49.92	15.6	1.27	0.5	10.96	4.32
Ognaj	Sandy loam	17.58	23.16	2.1	57.16	3.69	32.7	43.89	15.71	1.32	1.1	10.36	3.76
Silaj	Sandy clay loam	24.69	23.93	2.33	49.05	4.22	47.2	48.01	16.36	1.28	0.66	12.84	7.28
Ranodar	Clay loam	28.87	30.12	4	36.7	2.34	45.11	53.39	18.7	1.25	2.22	12.68	8.76
Pethapur	Sandy loam	18.3	14.4	16.3	50.9	3.6	34.7	44.67	6.55	1.36	3.26	10.15	5.35
Chhala	Sandy loam	16.2	20	24.6	39.4	3.3	46.04	52.84	13.31	1.3	1.14	9.4	3.92
Bhoyan	Sandy clay loam	16.7	17.6	22.7	37	5.9	44.6	49.84	17.84	1.32	1.75	9.75	1.97
Dabhoda	Sandy clay loam	20.3	14.6	19.7	43.5	3.9	43.74	47.42	17.25	1.32	1.38	7.68	3.16

LAND USE

The rapid and haphazard growth of urban sprawl and increasing population presser is resulting in deterioration of infrastructure facilities, loss of productive agricultural land, open spaces, loss of surface water reservoirs, depletion of ground water aquifer zones, air pollution, water contamination, health hazards and many micro-climatic changes. It is therefore essential to understand the linkages and interactions that exist between different components of the urbanization process or urban environment. Basic caveat for this is the availability of systematic detailed, reliable and accurate information on various facets of urban environment.

The area of Ahmedabad Urban Development Authority (AUDA) comprises parts of Ahmedabad, Kheda, Mehsana and Gandhinagar districts measuring about 1300 sq. km. The land use classification adopted by AUDA is as under:

LEVEL I	LEVEL II
Urban or built up	Residential, Industrial, Transportation, Recreational etc.
Agricultural land	Crop, Fallow etc. and Plantation land
Wasteland	Salt affected land, gullies and ravenous land, water logged area, undulating terrain, sandy area
Water bodies	Rivers, streams, reservoirs, tanks, lakes, canals, drains

Urban landuse capability of the study area modified after Water and Soil Miscellaneous Publications is given in the table 7.4.

Table – 7.4: Relationship between landform types and their urban suitability

Landform	Description	Suitability
Alluvial plain	Flat, nearly level to very gentle surface composed of river borne sediments	Highly suitable for construction. Over exploitation should be checked
Flood plain	Alluvial surface close to river which is frequently subjected to inundation	Potential flooding area, not recommended for construction
Sand dune and inter dunal area	Along stable sand dune	Suitable for construction activity

Land Use Suitability

Information on land use/cover pattern, especially the extent of spatial is a prerequisite for any urban developmental programme. Identification of land

suitability for urban development is based on the assessment and analysing the physical parameters such as land use, soil, geology, physiography, flood hazard etc. Thus the assessment of physical parameters is an indication of the limitation of the land for urban development. The constraints with respect to terrain characteristics and its urban suitability are given in the table 7.5. The physical parameters considered for the analysis include soil development, soil texture, slope, land use, flood hazard, erosion hazard, surface water body and ground water prospects.

The preparation of urban land use suitability plan requires consideration of all components of the environment. Basically it refers to the potentiality of land for development. Land potentiality includes both land suitability as well as land value. Identification of suitable areas for urban development is one of the critical issues in the preparation of development plan. Plate 7.5 shows urban construction with proper planning of open land and roads in western side of Ahmedabad city.

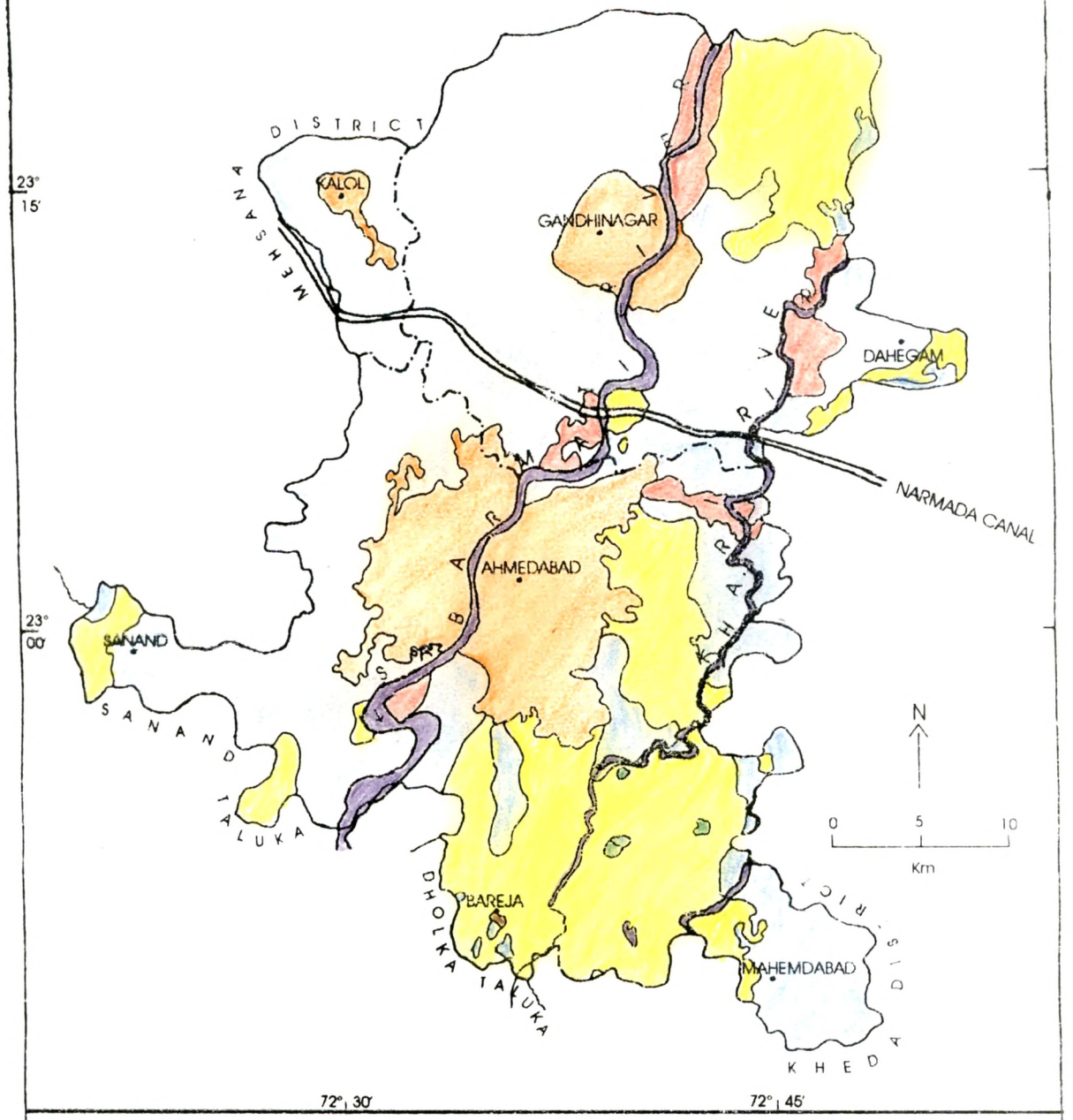
Physical parameters considered for the suitability analysis of land in the study area include: (1) Soil depth (2) Soil texture (3) Slope (4) Land use/cover (5) Ground water prospects (6) Flood hazard (7) Erosion hazard (8) surface water bodies (9) Distance from road and (10) Distance from rail head. Concidering these geo-environmental attributes, a composite land use suitability map has been prepared and presented in figure 7.5. These factors have been described in table 7.6.

Table – 7.5: Development constraints and feasibility in urban land use suitability.

Parameter	Category	Constraint	Development consideration	Land use Suitability
Soil	Soil depth	Foundation	Deep to very deep soils are required for the foundation	The soil depth in the area is deep to very deep, development can be carried out without any constraint
	Soil texture	Foundation	Swelling or compressible soils require pile foundation which is expensive	Sandy loam type of soil makes construction work cheap
Physiography	Slope	Stability	Land with high or medium slope is unsuitable for development	Gentle to very gentle terrain in the area allows the development without the problem of stability
Land use	Agricultural and forest land	Productivity	Productive agricultural land should not be considered for development	Use of waste land should be encouraged in the area while productive land should be preserved
Flood	Flood plains and low lying areas	Land subject of flooding	Development of low lying areas causes problems of inundation	Areas away from the river banks are safe from flood hazards, hence they should be developed.
Erosion	Ravinous land	Land subject to gully erosion	Construction cost may be high in loose and unconsolidated material	Erosional land lying along the river Sabarmati should not be used for development
Ground water	Excellent, very good and good prospects	Nil	These areas are to be conserved for future requirement of water and not to be taken up for development as water is already been over exploited	Areas through which ground water is recharged should be identified should not be used for construction while arreas with low ground water prospects are to considered for development
Surface water	Lakes, ponds	Nil	Needs conservation for future use	Possible ground water recharge zones, may be conserved
Drainage	rivers, streams	Poorly or excessively drained	Drainage limits should be clearly delineated	In the area drainage is used for waste disposal making it highly polluted river. Construction on point bars or deposition banks should be controlled

Plate 7.5: Large Scale Construction in AUDA in Accordance with Town Planning Scheme in Vastrapur Area.

FIG. 7.5: URBAN LAND USE SUITABILITY MAP.



LEGEND

- HIGH SUITABILITY
- MODERATE SUITABILITY
- FAIR SUITABILITY
- LOW SUITABILITY
- BUILT-UP LAND
- RIVER

Table - 7.6: Land Use Suitability in Relation to Morphostratigraphy and Lithology.		
Morphostratigraphic unit	Lithology	Appropriate land use
Sabarmati Surface: Present river channels and flood plains.	Fine to coarse grained, loose sand.	In dry seasons river bed can be exploited for water supply by constructing infiltration wells. Limited agriculture on flood plains during dry seasons is possible.
Fluvial Terraces: Presently deposited terraces along Sabarmati, Khari and Meshwo rivers.	Grey silty sand and clay (T1), semi-consolidated brownish grey clay and silty sand (T2).	Agriculture for two crops possible, tree plantation along polluted surface water zone for absorption of pollutants.
Bavla Surface : Younger deltaic plain (a) : Low lying tracts as mud flats. (b) : Buried channels, cut off meanders, levee etc.	(a) : Grey and greyish black silt and clay. (b) : Reddish grey, brownish grey, fine grained sand.	(a) : Agriculture through limited irrigation by groundwater on the clay soil is possible. (b) : On the sandy soil prospect of lift irrigation is good.
Gandhinagar Surface : Older deltaic plain Low line flat/undulating tracts, buried channels, cut off meanders.	Reddish brown and grey, fine to coarse grained sandy clay, silt with lime concretions.	Agriculture by irrigation, green belt, existing and possible urbanisation. Afforastation is suggested to protect soil erosion along dissected banks.
Vinjhol Surface: Stabilized dunes, inter dunes, sandy flats with few buried channels.	Greyish yellow, grey, fine to coarse grained aeolian sand, lime leached clay and silt in interdunal areas.	Urban construction is not feasible, it may cause remobilization of aeolian sand, grass plantation suggested to stabilise dunes.
Ahmedabad Surface: Aggradational plain, dissected surface near river.	Yellow, white, grey, fine to coarse grained sand with many lime concretions. Nodules of lime conglomerate at the base.	Urban construction and agriculture not possible due to extensive gulling and calcareous nature of the soil adjacent to rivers. Afforestation will stabilise the banks and prevent further dissection. Existing urban construction is on the flat exposed surface, away from the river where there is no dissection.