Chapter
5

5 Site & Infrastructure Development

5.1 REVIEW OF CURRENT INFRASTRUCTURE

The proposed site is in close proximity to Gandhidham and Kandla which offer one of the best infrastructure facilities. The region is well connected by ports (Kandla port and Tuna port), railways, roads (National highway NH 8A to Kandla passes nearby the site) and airstrip (Kandla). Reliance Telecom is laying OFC network to provide world-wide connectivity.

a. Physical Infrastructure

- ***Transport Infrastructure:***

Port:

Kandla, the major port of Gujarat is 8 kms from the site. Kandla port serves hinterland spawning over a million sq. kms in north-west India stretching across Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Rajasthan, New Delhi and Gujarat. Kandla over a period of time, has become an important port for international trade in the form of food grains, fertilizers, timber logs, hazardous cargo and oil imports. The cargo jetty has 10 dry cargo berths – two for containers, seven for cargo and one for private; and six tanker berths with a maximum available draft of 10.7 mtrs. There are three pipelines for conveying the liquid cargo of which two are for clean products and one for black products. It has the largest liquid storage capacity in Asia. Nearness to Kandla port would be of great advantage to the proposed chemical estate for import of raw materials and export of chemicals/ chemical products.

Road:

The site is accessible from National Highway 8A (to Kandla Port) at a distance of 3 kms. The site is also accessible from Adipur via' Kidana village by a Kutcha road diversion of 1.5 kms. A Kutcha road connects Tuna village to the site. The site has few internal Kutcha roads.

Railways:

The nearest Railway station is Gandhidham which is 14 kms from site. Gandhidham and Bhuj are connected by broad gauge links, covering Bhachau, Chirai, Anjar, Gandhidham, Bhuj and Samakhiali. The rest are meter gauge rail lines. A special purpose vehicle in the form of Gujarat Railways Infrastructure Development Company is being incorporated to undertake work for 307 km. long Gandhidham-Bhildi-Palanpur railway route which will provide a direct link to the cities of Jodhpur, Delhi and Bhatinda in Punjab.

Airstrips:

Kandla and Bhuj have airstrips providing access to other areas.

- ***Water:***

The average rainfall is 325 mm. Kutch is a water scarce area with major portion of barren wasteland. The nearby settlement gets water through pipeline from Nagalpur village in Anjar. Water for adjoining Kandla FTZ gets water from Supadiya village downstream of Tapar dam. The Government of Gujarat has conceived drinking water supply project with the Sardar Sarovar Narmada Canal as a source of water. The water that would be made available to the area (proposed development) will be only about 5 MLD by the year 2005 and 20 MLD by the year 2020 (Source: GWIL). This water would essentially cater to the potable, agricultural and industrial needs as a priority of serving. Hence, for required quantity of water for the proposed industrial estate, the option of setting up of desalination plant will have to be explored into.

- ***Power:***

The irregularity in the continuous supply of power has been the second major concern of the industries' representatives. The industries in Gujarat have been facing a 'power cut' for approximately three days a week. Since the production processes in a chemical estate would be continuous, there should be intermittent supply of power. Hence, the option of captive power plant has to be looked into. Captive power has proved to be more reliable and over a longer run, even cheaper than power provided by the State Electricity Boards .

A 215 MW, lignite based thermal power station is already in place at Panandhro. A 500 MW power plant at Mundra and another 250 MW lignite-based plant at Akrimota are being set up, besides 75 MW lignite-based power generation capacity being added at Panandhro. For transmission and distribution of power in the district, Gujarat Electricity Board (GEB) has established 36 substations at nine different locations and is also planning to set up a 220 KV substation at Shivalba (Chitrod) and another eleven substations of a capacity each of 66 KV at other locations.

- ***Drainage and Sewage***

The adjoining FTZ has its own drainage and sewage network. The sewage line from Gandhidham township runs to the sea adjoining the proposed site.

- ***Industrial Estates:***

The site abuts the Kandla SEZ. With the need to promote exports from the country, the Government of India set up the first ever Free Trade Zone (FTZ) at Kandla way back in 1965. Following the success of the FTZ, similar zones have been set up elsewhere in the country. Last year, Kandla FTZ was converted into a Special Economic Zone, liberalizing the operating conditions in the zone. Apart from making available fully developed plots and industrial sheds, the SEZ complex also offers uninterrupted power supply, commercial banks with foreign exchange facilities, foreign postal services, telephone and internet services as also the private warehouses. GIDC has set up industrial estates in other parts of Kutch.

Table 5- 1 GIDC Estates in Kutch

Estates in Kutch	Distance from site (in Kms.)
Existing	
Bhuj	75
Anjar	30
Gandhidham	13
SEZ, Kandla	--
Madhapar	82
Bhachau (GGCDC)	35
Mundra	60
Mandvi	105
Proposed	
Nagore (Bhuj)	75
Nakhatrana	93
Rapar	142

- ***Pipelines***

Jamnagar- Luni pipeline runs across the site.

b. Social Infrastructure Facilities

- ***Educational Facilities:***

Gandhidham which is 15 kms from the site has good educational facilities with primary schools, secondary and higher secondary schools. Gandhidham has colleges offering courses in arts, science and commerce and an ITI. Adipur (20 kms from site) has polytechnic college imparting diploma courses in engineering. The nearest engineering college is at Bhuj (65 kms from site), where it is also proposed to have a medical college.

- ***Healthcare Facilities:***

Gandhidham has good medical facilities. Out of the 58 government hospitals in Gujarat, five hospitals are functioning in the district of Kutch.

- ***Other Social Infrastructure Facilities***

Communication, banking, commercial areas and other recreational facilities are available at Gandhidham and Kandla.

5.2 PROPOSED INFRASTRUCTURE

a. Physical Infrastructure

- ***Approach Roads***

The site shall have three major access points. There will be two four lane tarred roads from National Highway 8A of 3 km length each, one of which will be extending the existing entry road through Kandla Special Economic Zone. The other exclusive entry shall be through the CRZ land beyond SEZ. The third entry, a two lane road shall be from the road from Adipur via' Kidana village. Site is also accessible from Tuna village. There will be 8 km long four lane internal roads linking the major internal sectors. The internal roads shall be two lane roads of 16 km length.

- ***Desalination Plant***

For the industrial investment of the tune of 800 to 1000 Crores in the chemical estate in Kutch, the water requirement has been projected to be in the range of 17 MLD. This would cater to the industrial and the associated potable needs as well.

The Odds Against:

Today, more than 85 percent of the water that humanity uses, is for agricultural and industrial purposes. Freshwater from desalinated water seems to be more expensive for these uses, except in the energy -rich nations where desalination technology is gradually moving ahead to the point that it is now becoming inexpensive enough as a source of safe water for domestic and industrial uses. Some of the following issues are the primary constraints to desalination:

- Energy- particularly the use of fossil fuels
- Discharges from desalination plants and
- Impact on the ecosystem.

Despite the aforementioned constraints, desalination is now a major requirement in some locations (islands, coastal areas and arid regions etc.) and will attain greater importance as the population grow. Meeting water demands especially in small islands and coastal areas is increasingly likely to depend on the source of the water resource.

World Statistics:

There are approximately 11,000 desalination plants in 120 nations in the world, 60 percent of them in the Middle East. The desalination plants of the world now produce approximately 4 billion gallons daily, enough to provide about 4 percent of the world's population with fifteen gallons a day. This is equivalent to providing about one-quarter of 1 % of the world's fresh water needs.

Energy Use in Desalination

The energy used in the desalination process is primarily electricity and heat. Energy requirements for desalination plants depend on the salinity and temperature of the feedwater, the quality of the water produced, and the Desalting Technology1 used.

- **Co-generation**

In some situations, it is possible to use energy so that more than one use can be obtained from it as the energy moves from a high level to an ambient level. This occurs with co-generation where a single energy source can perform several different functions. Certain types of desalination processes, especially the distillation process, can be structured to take advantage of a co-generation situation. These units are built as part of a facility that produce both electric power and desalted seawater for use in a particular country.

The electricity is produced with high-pressure steam to run turbines that in turn power electric generators. In a typical case, boilers produce high-pressure steam at about 540ºC (1,000ºF). As this steam expands in the turbine, its temperature and energy level is reduced. Distillation plants need steam whose temperature is about 120ºC (248ºF) or below, and this can be obtained by extracting the lower temperature steam at the low pressure end of the turbine after much of its energy has been used to generate electricity. This steam is then run through the distillation plant's brine heater, thereby increasing the temperature of the incoming seawater. The condensate from the steam is then returned to the boiler to be reheated for use in the turbine.

The main advantage of a co-generation system is that it can significantly reduce the consumption of fuel when compared to the fuel needed for two separate plants. Since energy is a major operating cost in any desalination process, this can be an important economic benefit. One of the disadvantages is that the units are permanently connected together and, for the desalination plant to operate efficiently, the steam turbine must be operating. This permanent coupling can create a problem with water production when the demand for electricity is reduced or when the turbine or generator is down for repairs. Other types of co-generation facilities benefiting desalination can derive lower-cost steam from heat recovery systems on gas turbine exhausts, heat pumps, or various industrial processes including burning solid wastes in an incinerator. This type of power and water production installation is commonly referred to as a dual-purpose plant.

[1] Details included in the Annexure

Salt Pans

There is a possibility of using the waste water of the desalination plant for producing salt through salt pans. The output water would be having a salinity somewhat of the tune of 60,000 to 70,000 TDS. Out of a plant having capacity of 17 MLD, approximately 7 MLD (40%) highly concentrated brine would be made available for the same. As it is, this water was otherwise supposed to be piped back into the deep sea which is again a whopping expenditure. By constructing special salt pans in an adjoining region like the land for CRZ, this expenditure can be done away with. Besides, it can result into a very efficient and effective salt industry by virtue of the desalination plant.

Cost of Desalination

The cost of desalinated water is gradually coming down, and the cost of freshwater is gradually going up, but there remains a sizeable gap between the two, and until that gap is closed, consumers understandably will continue to opt for the cheaper water.
The cost to produce water from desalination depends on the technology used and the plant capacity, among other factors. Another major deciding factor is as to whether a captive power plant is providing its waste heat to the desalination plant to enhance the procedures reducing thereby overall cost implications. A rough estimate suggests that a dual purpose plant of 20 MLD would cost approximately 18 Mn $ with operating cost of the desalinated water being 55 Cents/cu. metre. On the other hand, a stand alone plant of similar capacity would involve approximately 25-28 Mn. $ as capital cost.

The Conclusion:

The World statistics depict that the most commonly employed desalination technologies across the World are Thermal Distillation (mainly employed by the Gulf countries) and the RO method (mainly employed by US). One of the recent successful projects for desalination of seawater for industrial and urban water supply has been carried out by Reliance Petroleum Ltd. at Jamnagar. The multi stage flash technology plant with a capacity of 48MLD has an efficiency of 60% and converts fresh water having a TDS of 5ppm. This is a dual purpose plant employing cogeneration phenomenon. It thus utilises steam at 3.5 kg/sq. cm. gauge & 147 deg. Centigrades of temp. to produce 11 cubic metres of desalinated water. Besides, Reliance Petroleum has a captive power plant, which supplies 45 tonnes of steam per hour to produce 500 cubic metres of desalinated water per hour per unit. Reliance has found this technology to be quite maintenance-free.

The usage of Reverse Osmosis technology is ruled out owing to some of the following facts:

- The fixed and operating costs involved in an RO plant are much higher than an MSF plant of similar capacity.
- The aggregate maintenance efforts and costs involved in RO based plant are much higher than an MSF plant.
- The thermal distillation technology is the prescribed technology by the World renowned IDE Technologies which was also the vendor for the Reliance project at Jamnagar.

TCS recommends implementation of a thermal distillation desalination plant deriving the required steam from a captive power plant for the proposed chemical estate in Kutch which would be a cost effective option and can be worked out to operate with good deal of efficiency and reliability.

Comparison of Costs of Multi-stage Flash Distillation and Reverse Osmosis

A summary comparison of both processes is presented below:

Table 5- 2 Comparison of Costs of Multi-stage Flash Distillation & Reverse Osmosis

Alternative	Capacity (In MGD)	Total Capital Cost (In $Million)	Fixed Costs (In $/m3)	Power Cost (In $/m3)	Steam Cost (In $/m3)	Total Maintenance Costs ($/m3)	Chemical, Labour & Other Costs ($/m3)	Total Costs (In $/m3)
RO	0.32	2	1.00	0.35	Nil	0.25	0.15	1.75
	1.00	5	0.75	0.35	Nil	0.25	0.10	1.45
	5.00	18	0.50	0.35	Nil	0.25	0.10	1.20
MSF	0.32	4	1.50	0.10	0.60	0.25	0.10	2.55
	1.00	7	1.00	0.10	0.60	0.20	0.10	2.00
	5.00	18	0.50	0.10	0.60	0.10	0.05	1.35

Table 5- 3 Component Costs of MSF Process

A-Operating Cost	Cost/m3		
Capacity(In MGD)	0.32	1	5
Chemicals	0.01	0.01	0.01
Labour	0.06	0.04	0.03
Power (2.50KWH/m3 @$.04/KWH)	0.1	0.1	0.1
Steam(0.21 MT/m3 @$2.85/MT)	0.6	0.6	0.6
Maintenance	0.26	0.16	0.09
Administration and Overhead	0.06	0.04	0.03
Total Operating Cost	**1.09**	**0.95**	**0.86**
B-Fixed Cost per Annum			
Total Capital Cost: $Million	3.5	7	18
Cost of Capital (20 years @15%)	1.5	1	0.57
C-Total Cost of Production	**2.59**	**1.95**	**1.43**
App. Total Cost	**2.6**	**2**	**1.5**

Table 5- 4 Component Costs of RO Process

A-Operating Cost	Cost/m3		
Capacity(In MGD)	0.32	1.00	5.00
Chemicals	0.03	0.03	0.03
Labour	0.06	0.04	0.03
Power (8.61KWH/m3 @$.04/KWH)	0.36	0.36	0.36
Membrane Replacement (20% of Membrane Cost)	0.16	0.16	0.16
Maintenance	0.12	0.09	0.06
Administration and Overhead	0.06	0.04	0.03
Total Operating Cost	0.79	0.72	0.67
B-Fixed Cost per Annum			
Total Capital Cost: $Million	2.00	5.00	18.00
Cost of Capital(20 years @15%)	0.88	0.70	0.52
C-Total Cost of Production	1.67	1.42	1.19
App. Total Cost	2.00	1.50	1.20

Note: Maintenance costs for both processes: 3% of Total Capital Cost excluding Spares and Finance Charges and Administration and Overhead: 100% of Labour are applied.

- ***Water Supply Lines***

Water Supply lines will run from Desalination Plant to the individual industries. At cluster level, there will be a sump for contingency purposes. Water will be stored in an overhead tank of 6 MLD capacity, which shall be used during off-hours of desalination plant and as reserve for fire fighting purposes.

- ***Captive Power Plant***

On top of it, the remoteness of the proposed site in Kutch from the nearest power grid and the scarcity of associated infrastructure makes the necessity of a captive power plant still more essential. The cost of power generated in captive power plant on an average works out to Rs2.75-3.0 per unit.

Fuel:

In order to obtain adequate fuel linkages for the future requirements of power generation, there has to be adequate and reliable basket of fuel resources. Gujarat itself is poorly endowed with natural fuel resources such as coal and hydro. There are small deposits of lignite available in the State besides Natural Gas, which is available both off-shore and on-shore in the western region.

The quantum of lignite or gas available are not adequate to meet the power and fuel requirements of the State in the times to come. Coal available from the eastern states of the country is of low calorific value and high ash content. Transporting it across the country itself makes it economically unviable. Moreover, adequate coal linkages are also not available due to bottlenecks in transportation of coal. As a result, the State has no option but to go for external supply of fuel resources such as LNG and imported coal.

The State has a geographical advantage of having large number of ports. This will facilitate the import of Liquefied Natural Gas (LNG) which can be used for power generation. It can also be distributed as fuel consumption in different industries. This will require setting up of LNG terminals with gas distribution network. The State should actively encourage such infrastructural development.

Some Examples:

Captive plants predominantly use DG sets. But large captive projects like the 720MW plant of Hindalco at Renusagar are based on coal. The Jindal plant at Bellary uses corex gas, which is a by-product of steel manufacturing. The power plant of Rain Calcining uses flue gases generated from the manufacture of CPC as the fuel. SAIL's captive power plants at Bhilai, Bokaro, Rourkela and Durgapur are coal-based. With a rise in diesel prices on the anvil, there is an apprehension that captive power projects will become unviable vis-à-vis grid projects. However, as long as grid power remains irregular and unreliable, captive projects are expected to continue to be in vogue.

Odds Against:

- An obvious odd may be an incisive review of the plans for setting up a CPP and exercising tough guidelines to be followed, by GSEB.
- The high financials involved (4 Crores/MW approximately), which will aggravate the overall expenditure in the estate.

- Strict time schedule to be followed for setting up the same i.e. much before the excise exemption deadline falls in place.

Odds in Favour:

- A boost to the industry confidence in the chemical estate, which would result in an increased investment followed by the increased social benefits to be accrued by the Govt. in general.
- The desalination plant would be clubbed to the CPP to reuse the waste heat. This would in turn bring down the price of desalinated water.

- ***Transmission Lines***

A 66KV/11KV Substation is required. 24 km long transmission lines will connect the various industries and there would be continuous 24 hour power supply. The extra power, generated beyond requirement will be sold to GEB and connected to their grid.

- ***Common Effluent Treatment Plant***

The wastewater quantity is computed based on the data on manufacturing capacities of the expected industrial sectors. The quantities for different sectors were obtained through Pollution Prevention and Abatement Handbook, Part III of the World Bank and the in-house data of the Consultants. The expected wastewater quantity from the proposed chemical estate is about 13 MLD. The approximate characteristics of the untreated effluents from major polluting sectors, which are expected in the estate, are as follows:

Industry Sector	Effluent Characteristics
Petrochemicals	BOD (100 mg/L), COD (1500-6000 mg/L), Suspended Solids (100-400 mg/L), oil & grease (30-600 mg/L), Phenol (200 mg/L)
Pesticides	COD (13000 mg/L), Suspended Solids (2800 mg/L), oil & grease (800 mg/L)
Dyes	Azo dyes: BOD (2kg/kg of dye), COD (80 kg/kg of dye), pH (1.2 to 2.0), Colour (Reddish to Black), high TDS, Chloride, etc. Other dyes: BOD (6kg/kg of dye), COD (25 kg/kg of dye), SS (6 kg/kg of dye), oil & grease (30 g/kg of dye), high TDS, Chloride, etc.
Organic chemicals	Sulphides, heavy metals, halogenated hydrocarbons, polynuclear hydrocarbons
Drugs and pharmaceuticals	BOD (2000 COD (1500-6000 mg/L), Suspended Solids (100-400 mg/L), oil & grease (30-600 mg/L), COD (4000 mg/L), SS (240 mg/L), Hg (0.1 to 4 mg/L), Cd (10-600 mg/L), and toxic organics.

In general, the effluents from the chemical industries are characterised by high concentrations of Total dissolved solids (TDS), Total suspended solids (TSS), Chemical oxygen demand (COD), Biological oxygen demand (BOD), Chloride, Sulphate, Ammonical nitrogen, various toxic pollutants, and heavy metals. These effluents also contain a number of persistent organic pollutants (POPs). In addition, the mixing of highly complex waste streams, some of which may be hot and contain chemically active compounds, may also result in formation of POPs in the combined effluent. The most reliably identified groups of POPs in these effluents are halogenated carbon compounds, organo-nitrogen compounds, and other aromatics and aliphatics.

Common Effluent Treatment Plants (CETPs) are adopted as a long-term solution for the treatment of combined wastewater from industrial estates, hence their effectiveness in reducing pollutant loads into the receiving environment shall be the design base. CETP would receive wastewater from a wide range of industrial processes in the various chemical industries, which would result in more complex and variable effluent composition.

A CETP with a design capacity of 15 MLD is proposed in the chemical estate. The CETP will be connected to all industries by means of internal effluent conveyance system to carry the effluents of individual units to CETP. Primary, secondary and tertiary levels of treatment will be provided in the CETP. Details of the technology to be applied for treatment in CETP will have to be undertaken during detailed design stage of the project. Special chemical treatment of specific toxic components of effluent from individual or a group of units should be considered during design stage. In addition, segregation of the effluents with similar characteristics should also be considered while designing CETP. For instance, one of the CETPs in Gujarat has already initiated some steps towards segregating the effluents before treatment in CETP. This CETP has classified their member units according to types of effluents generated, as below:

- Problem of pH
- High COD
- High ammonical nitrogen
- Heavy metals
- Toxicants
- Persistent organic pollutants
- High intensity of colour

The CETP is planning to pretreat the wastewater streams with high concentrations of above parameters before treating the effluents in CETP. This will improve the quality of final effluent from CETP. The details on capital and operational costs of CETP are given elsewhere in this report. The following are the capital and operational costs of desalination plant and for CETP:

	Capital cost (Rs./m^3)	Operational cost (Rs./m^3)
Desalination	19	24
CETP	3	18

The above table indicates that one cubic meter of desalinated water costs Rs. 43/- and Rs. 21/- will be spent to treat the effluent. On a whole, Rs. 64/- will be spent per cubic meter of water drawn from the sea and for sending it back to the sea again. These are the costs with out considering the costs for pipelines. Thus, if a little more money is spent on treatment of the effluent to recycle back into the estate, huge costs involved in desalination could be saved.

The recycling of the effluents was not considered in the present report since it requires details on exact characteristics of the effluents, analysis of the available technologies to suit the characteristics of the effluents, and the associated costs. However, some technologies, which can be considered while designing the CETP after detailed analysis, are presented below.

- **Treatment by mixing industrial effluents with domestic sewage**

The combined effluents from industries in the IEs contain high concentrations of some critical parameters such as colour, total dissolved solids (Tds), and chemical oxygen demand (Cod). Effective reduction of these parameters has not been successful with the conventional treatment systems in CETPs.

The mixing of sewage with industrial wastewater, in appropriate proportion before treatment, improves the treatability in CETPs due to the following reasons2:

- High TDS concentration in influent wastewater to CETPs creates adverse conditions for effective biological treatment. Some of the adverse effects include high osmotic pressures causing death of organisms, reduction in oxygen transfer, poor settling of activated sludge in secondary clarifier, etc. The mixing of sewage dilutes the TDS concentration in the combined wastewater thus improving the treatability.
- Sewage provides mixed population of bacteria and nutrients essential for biological treatment.
- Sewage also stabilises the hydraulic load and imparts homogeneity of character to the combined effluent.

This practice of mixing industrial effluents with sewage before treatment is prevalent in several medium- and large-scale chemical, petrochemical, and allied industries. Odhav Enviro Projects Limited (OEPL) is operating a CETP at Odhav IE in Ahmedabad. Presently, they are treating the industrial effluents, mainly from dyes and dye intermediate industries, in a conventional treatment system.

OEPL conducted pilot plant studies to evaluate the effectiveness of mixing the sewage with industrial wastewater before treatment. The results shows that the COD is reducing by 84% after mixing with sewage against 70% reduction achieved before mixing with sewage. Similarly, the percentage reduction in case of BOD also shows improvement from 88% to 95%. These results are encouraging since the effluent is not only meeting the concentration standards for BOD and COD but is also showing an actual reduction in loads.

Jeedimetla Effluent Treatment Limited (JETL) has been operating a CETP for treating the effluents from Jeedimetla IE in Andhra Pradesh since 1989. The CETP has to treat industrial wastewater with very high concentrations of TDS (50,000 mg/L), COD (11,000 mg/L), and BOD (3500 mg/L). Until 1997, JETL treated the industrial wastewater in conventional treatment plant. The effluent quality was not complying with the specified norms.

In 1997, JETL decided to improve their treatment by mixing the city sewage with industrial wastewater (0.75:1 industrial to domestic ratio) before treating it in CETP. This system, however, is not showing any significant improvement in load reduction though the effluent quality has improved in terms of concentration of COD (from a COD of 5500 mg/L to 2500 mg/L) due to dilution.

In the above two cases, the objective of improving the effluent quality in terms of concentrations in the effluent could be achieved because of the dilution of industrial wastewater with sewage. In terms of pollutant load (quantity of COD in kg per day) reduction, however, the two cases show contrasting results. While the pilot plant study of

[2] *A Decade of Experience on Common Effluent Treatment Plant in Jeedimetla Industrial Estate, Hyderabad, India*, Jeedimetla Effluent Treatment Limited, Hyderabad, March 2000

OEPL shows an improvement, the JETL case doesn't show any significant load reduction.

The contrasting results may possibly be explained by the fact that the ratio of industrial sewage to domestic sewage in both the cases was not designed to achieve a certain desired level of efficiency. In case of OEPL, the ratio was limited by the availability of excess capacity for domestic sewage in the CETP while for JETL, the ratio was limited by the availability of sewage itself. Also critical is the TDS concentration at which the CETPs are operating. The CETP of JETL is operating at a TDS level of approximately 25,000 mg/L and the one at Odhav would operate at a TDS level of 13,000 mg/L when industrial wastewater is mixed with sewage. As already discussed, lower the TDS levels, better will be the efficiency of biological treatment.

Hence, a detailed study to arrive at an optimum ratio of sewage to industrial wastewater and any other critical design conditions that are required to achieve certain load-reduction efficiency, will help in assessing the effectiveness of this technology.

- **Combination of anaerobic and aerobic biological treatment**

Conventional aerobic systems such as activated sludge process, aerated lagoons, trickling filters, etc. work efficiently for wastewater with high biodegradability. For predominantly non-biodegradable wastes, an anaerobic treatment system followed by an aerobic system will improve the efficiency of treatment.

When industrial wastewater is pre-treated in an anaerobic system, it improves the biodegradability of wastewater due to reduction of recalcitrant compounds. This treatment system is particularly effective for treatment of wastewater from bulk drugs and pharmaceuticals, pesticides, and rubber and leather production. The combined anaerobic-aerobic treatment systems are in operation for handling effluents from distillery, mini-paper, and antibiotic production plants.

- **Reverse osmosis**

Reverse Osmosis is a process in which water is separated from dissolved salts in the solution by filtering through a semi-permeable membrane at a pressure greater than the osmotic pressure caused by the dissolved salts in the wastewater.

The reverse osmosis is an advanced treatment system and is generally applied to treat the wastewater to recyclable levels. A textile unit of Arvind Mills is operating a reverse osmosis plant at Kalol in Gujarat where more than 85% of water is recycled back into the process. This process could be useful for treating effluents in CETPs after they are subjected to tertiary treatment. This process could be effective in treating even the total dissolved solids (TDS) concentrations to acceptable levels.

- **Physico-chemical techniques**

Segregation of the effluents with similar characteristics has already been mentioned earlier. Several physico-chemical methods are available to treat some of these segregated effluents.

A few examples are:

- Lime treatment (high quality lime with 75-80% CaO) followed by chemical flocculation with alum, ferric chloride, or polyelectrolytes - this treatment is particularly useful for dyes and dye intermediates, textiles, and other coloured effluents.
- Lime treatment followed by hydrogen peroxide treatment – this can remove 90% of colour and 60-75% of COD under controlled conditions.
- Lime treatment followed by ozone and lime treatment followed by activated carbon - these methods are expensive though effective
- Air stripping – useful for ammonia containing-effluents
- Treatment with sodium hypochloride – for removing cyanides

▪ ***Effluent Disposal***

Pipelines will carry treated wastewater 8 km on land towards Tuna side. From there, pipelines will run under sea for a distance of 10 kms for Deep sea discharge. Detailed EIA studies would be required to finalise the final discharge point.

▪ ***Hazardous Waste Site Development***

There shall be wasteland fill site for Solid Waste and Hazardous Waste. The Hazardous Waste Site will be developed according to specifications.

▪ ***Testing Laboratories:***

The estate will have a fully equipped laboratory with the following areas of testing:

- Raw Material Testing
- Products Testing
- Wastes Testing

Raw Materials Testing: There will be testing facilities for various raw materials like Ores, Minerals, Metals, Chemicals, Products from other factories etc.

Products Testing: Testing facilities for Products coming out of the various chemical industries in terms of weights, standards and specifications, quality checking, errors etc will be available.

Wastes Testing: The wastes testing lab will have four labs: Chemistry Lab, Microbiology lab, TOC lab, R & D lab. The physical and the chemical analysis of the wastewater before and after treatment will be conducted on a daily basis.

▪ ***Cleaner Production Centre***

The focus shall be on a strategy of continuously reducing pollution and environmental impact through source reduction (i.e, eliminating waste within the process rather than at the end-of-pipe). This integrated preventive environmental strategy shall be adopted to reduce environmental and human health impact.

Cleaner Production centre shall have a Process improvement wing, Material wing and R & D wing. There will be two staff personnel in charge of the centre. The centre shall provide information and technical assistance in cleaner production. Cleaner Production shall be achieved through Improved operation and good housekeeping, Process modifications, Changes in plant and equipment, Raw or toxic material substitution, Redesign and/or reformulation of product, Management systems to avoid and minimise waste etc.

The benefits of Cleaner Production lie in reducing production costs through greater efficiency, decrease wastage of material inputs, increase productivity and often improve products, Reduce energy consumption, recover valuable by-products, minimise waste disposal problems, including charges for waste treatment

- ***Land Development***

Since the land is relatively flat, there will not be much of land filling and cutting except in the South Eastern part of the site. Land clearing will be done to remove the dry bushes partly spread over the site. Fencing will be done around the estate. A 50 m wide green belt will be spread all around the boundary of the estate to prevent any pollution from reaching outside the estate and also for beautification purposes. The major internal roads shall be lined with trees. Street lighting shall be provided all along for around 20 km length.

- ***Fire Fighting***

There will be 24 hours fire-fighting service, with atleast two fire-fighting engines. Overhead tank will reserve water for fire fighting purposes. The estate will be well connected to the fire fighting services from Gandhidham. Hydrants shall be placed at all strategic locations and at hazardous material storage places if any.

- ***Steam Network***

Since most of the industries require steam, there could be a centralised steam network with common boilers and steam network for fuel minimisation. This could also be developed at cluster level.

- ***Customs Centre/ Customs Department***

A dedicated customs department office catering to the needs of the industries in the estate can be setup in the estate. Also the centre can avail services from the Customs centre at Kandla.

- ***Logistic Management Offices***

Logistics management office shall be equipped with state of the art logistic support systems. Logistics would play an important role for the industries in the estate in Kutch

- ***Communication/ Internet Connectivity***

Internet connectivity with atleast 128 KBPS bandwidth can be made available to the industry in the estate. This will be clubbed with the cleaner production centre which will also provide online information on latest technologies, contacts with outside facilitators etc. The estate will have telephone booths as well.

- ***Insurance Services***

Insurance companies (especially the national insurance agencies) shall be persuaded to setup a representative office in the estate.

- ***Banks***

Banks or lending agencies shall be persuaded by the government to open their representative offices in the estate.

- ***Post Office***

Post office is available in Gandhidham

- ***Courier Services***

A private courier service centre could be developed as this would form a common facility centre for all the industries.

- ***Petrol and Maintenance Station***

Petrol pumps and maintenance station are available in Gandhidham.

- ***Permanent Exhibition***

This can be like a permanent exhibition where industries can display their products, capabilities, etc.

- ***Restaurant & Super Market***

The Estate shall have a restaurant/ canteen for the various levels of workers in the industries. Also, there would be a supermarket providing consumer items at subsidised/ margin free rates.

- ***Police Station***

Police deployment can also be considered for adequate security measures.

- ***Educational Facilities***

Substantial number of respondents had expressed that good educational facilities should be available in the region. Good schools would be required in this region in addition to the existing educational facilities in Gandhidham once the estate starts functioning.

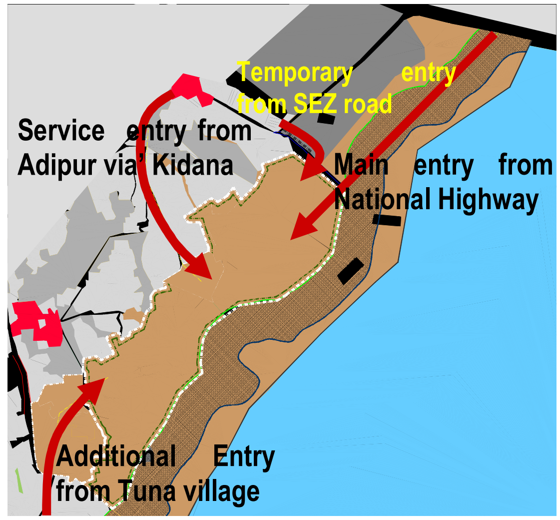
- ***Training Centre / Vocational Training Corporation***

The training centre could be an added advantage if provided in the region. This would thus help in getting trained workers and thus reduce the problem of skilled manpower availability to a large extent.

5.3 CONCEPTUAL LAYOUT PLAN

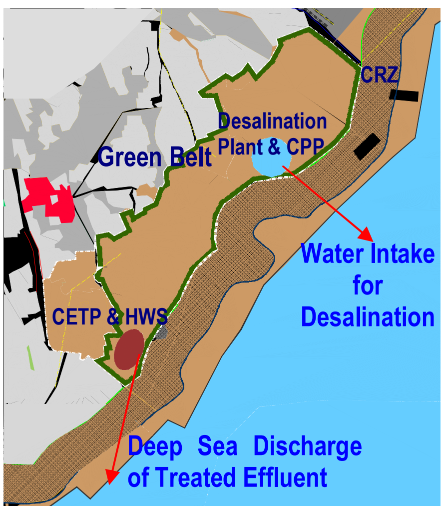
Conceptual Layout Plan for the proposed Industrial Estate was prepared based on critical zoning criteria.

a. Accessibility



Proper Accessibility to site is a critical factor in an industrial estate. The main entry hence should be from the National Highway. Service entry could be by strengthening the road from Adipur via' Kidana. The existing road abutting FTZ (from NH) with entry through SEZ could be used as a temporary road. The existing access from Tuna village could be developed as a two lane additional entry.

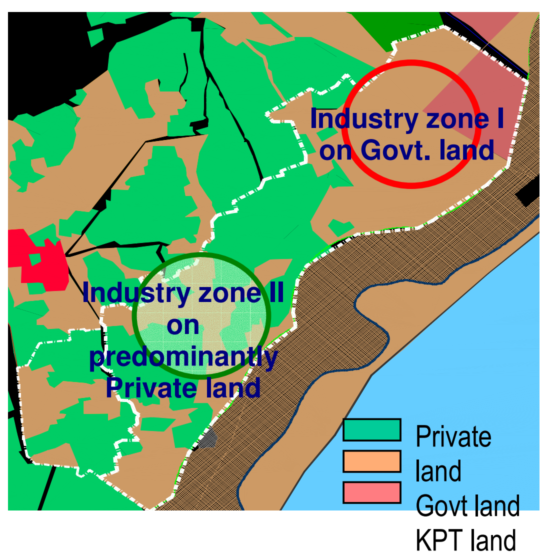
b. Environmental Considerations



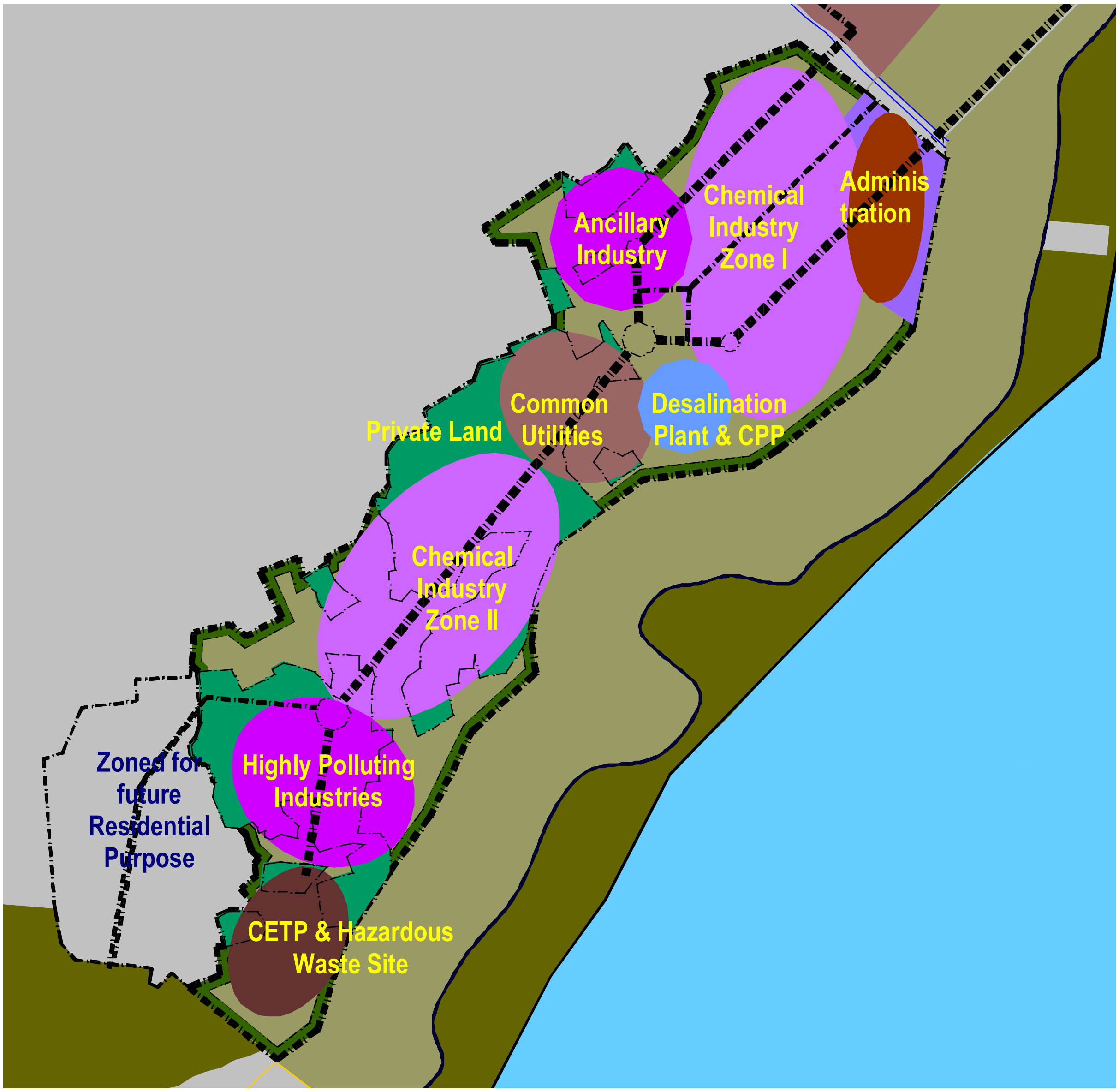
A green belt of 50 m is provided all around the chemical estate as a barrier zone. The highly polluting chemical industries are located on the south western side so that the air pollution if any from them after adopting cleaner production technologies will not affect the settlements of Kidana and Gandhidham. CETP is located on the South Western area as the Deep Sea Discharge point should be to the Western wide mouth so as to have enough dilution and dispersion before it reaches the creek mouth and desalination water intake point which is placed on the north eastern side. CRZ zone is left devoid of any construction.

c. Land Ownership & Phasing

As the time frame taken for the setting up of estate has to be minimum inorder to avail the exemptions, the phasing and zoning has to be done accordingly. The Industry zones will have to zoned such that Industry zone I is located on predominantly govt land and zone II on private land so that the time required for acquisition is not wasted. Also the land for essential common infrastructure facilities like Desalination Plant, Captive Power Plant, CETP etc will have to be on Govt land so that setting up of them can start in the beginning itself.

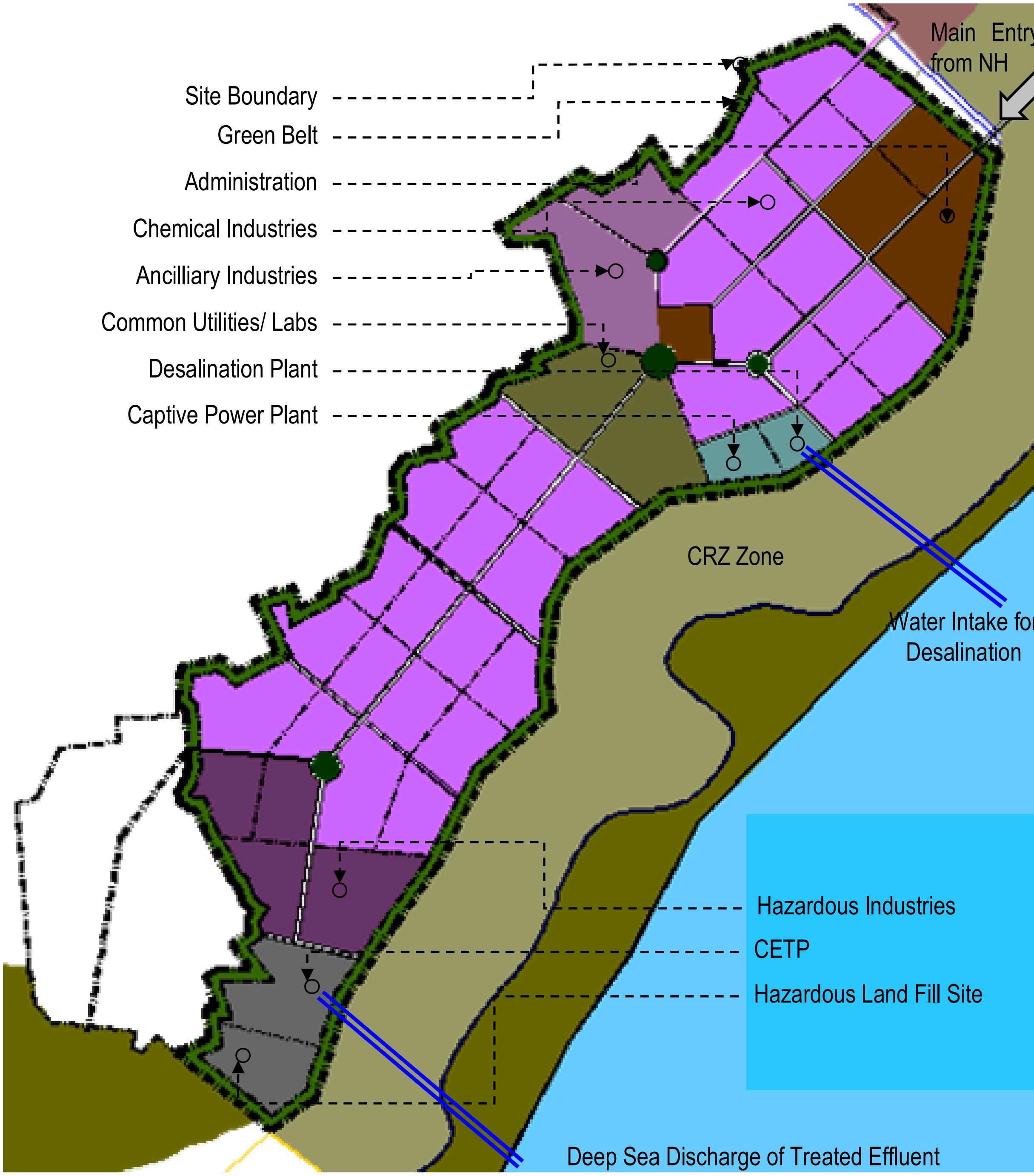


5.4 SITE ZONING



Highly Polluting Industries are located on the South Western side nearby the CETP. This cluster will have a separate specific treatment plant to treat the POPs and the thus treated effluent will be let into the effluent channel of the estate. The chemical industries will be in two zones with the common utilities like testing laboratories, cleaner production centre etc in between. The administration wing will be near the entrance in North East, the logistics support wing will be associated with the administration wing. The ancilliary industries will be in the NorthWestern area as these will not be as polluting as the chemical industries and hence nearer the settlement. The SouthWestern part outside the Estate boundary is zoned for future residential occupancy of the industrial labourers as required.

5.5 BROAD LAYOUT PLAN



The total area of the Estate is 525 hectare. The individual plots for chemical industries, total 31 in no., are configured at six acre to ten acre each. As per the requirement of the specific industries, plots could be divided or merged. Four plots of size varying from six acre to fifteen acre are reserved for highly polluting industries. Ancillary industries are expected to occupy 30 hectare of land. Hazardous Waste Landfill Site is zoned on the SouthWestern site near the CETP. 35 hectare of land is reserved for common utilities in the centre of site. Administration and logistics would cover around 35 hectare of land. 10 hectare of land is reserved for Captive Power Plant and Desalination Plant.