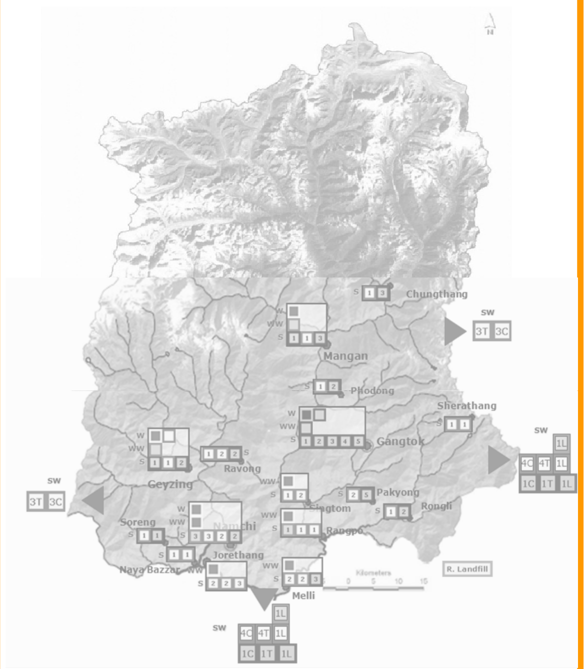
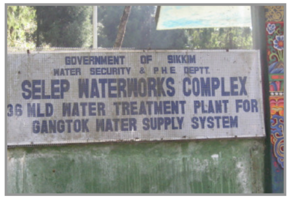
Part II :

Environmental Infrastructure



1.0 Water Supply

1.1 Background

There is no lack of pristine water in the State of Sikkim especially in the North and East District. The main challenges in urbanised areas are infrastructural costs, distribution of water, old piping, water leakage (as high as 79%), and water quality. Rural areas currently receive only untreated water from springs. As they rapidly urbanise, they will need an adequate amount of treated water.

East District: The Selep Water treatment plant, governed by the Water Security and Public Health Engineering Department (PHED), obtains water from the Ratey chu river which emerges from the glacial fed Lake Tamze. It provides 36 MLD of treated water to the urban population in the Greater Gangtok area. This is sufficient to meet the current population. However, because of distribution problems from the old piping system and significant leakages (as high as 79%), households only obtain intermittent water supply.[1a]

Water quality is also a problem caused by potential contamination of pipes. In the PHED's 11th development plan, besides augmenting the water distribution system in the Greater Gangtok area, PHED plans to provide major water supply works to Pakyong, Rongli, Rongpo, Singtam and Upper Tadong. Going beyond 2001, PHED expects water demands to be about 41 MLD.[1b]

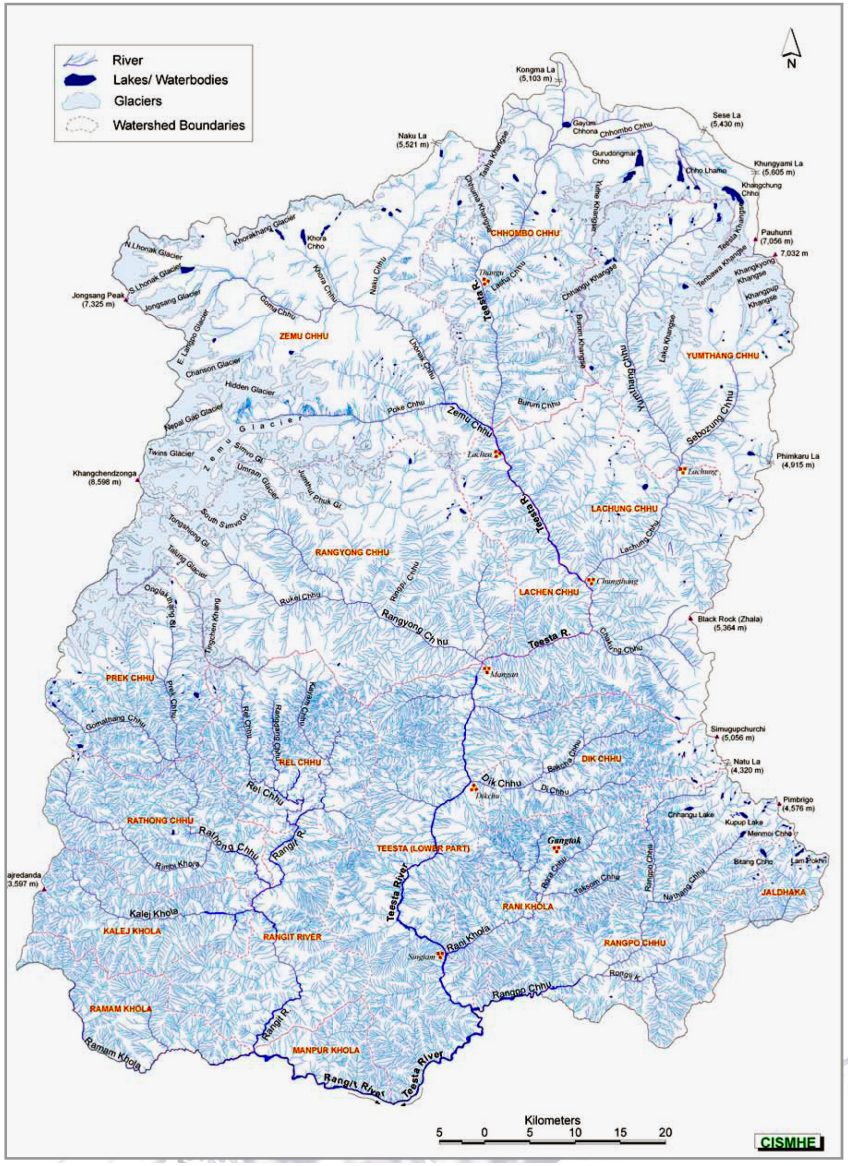


Figure 1.1.1 Drainage Map of Testa River Basin in Sikkim [1c]

1.1 Background

The PHED is responsible for providing treated water to urban areas, and the Rural Development District (RDD) is incharge of providing untreated water to the rural communities. The source of the untreated water is from springs. Although mostly untreated, some of the spring water undergoes minimal physical (sand filtration) and chemical (disinfection with chlorine) treatment. The rural sector comprises a significant portion of the Greater Gangtok area. While the source of spring water is of relatively good quality, distribution of untreated water is subjected to potential contamination from many urban sources such as livestock, waste dumping, wastewater pipe leakage, and sewage leakage from underground septic tanks. With rapid urban expansion, it is unclear how the two governmental entities (PHED and RDD) will cooperate to provide sufficient amount of good quality water to both the urban and rural populations.

North District: Mangan currently receives "untreated" water from springs with supply capacity of 0.292MLD (peak) and 0.121MLD (lean) with 0.45ML water reservoir capcity. At the current population growth rates, the existing system will not be able to meet water demands. Additional capacity of 1.77MLD will be completed by 2009. [1d]

South District: Namchi's current average water supply capacity is 1.77MLD from Bermely, about 46km away. In some area, the water is supplemented from river water pumped from the Rangit river, by RDD, with a designed capacity of 3.0MLD. [1e] Current capacity is 1.45MLD according to ground feedback.

1.1 Background

West District*:

Geyzing-Pelling areas have an existing combined water supply of 3.92MLD respectively during peak period and 0.39MLD during lean period.

An additional water supply capacity of 4.32MLD (peak) and 0.43MLD (lean) will be added to Geyzing-Pelling areas by March 2009 with additional reservoir tanks. (0.3MLD for Geyzing and Pelling respectively)

** Source: PHED staff*

1.2 Short, Medium and Long Term Projections

Assumption: 135 liters per capita per day (lpcd)*

Table 1.2.1 Projections of Water Demand by Towns at Year 2015, 2025 and 2040

Water Supply	2015	Water Demand (MLD)	2025	Water Demand (MLD)	2040	Water Demand (MLD)
East district	**184,800**	**24.95**	**213,300**	**28.80**	**347,500**	**33.41**
Gangtok	138,600	18.71	149,310	20.16	160,875	21.72
Singtam	14,784	2.00	17,064	2.30	22,275	3.01
Rangpo	14,784	2.00	17,064	2.30	22,275	3.01
Pakyong	9,240	1.25	17,064	2.30	22,275	3.01
Sherathang	3,696	0.5	6,399	0.86	12,375	1.67
Rongli	3,696	0.5	6,399	0.86	7,425	1.00
West District	**13,200**	**1.78**	**21,330**	**2.88**	**55,000**	**7.43**
Geyzing - Pelling	7,920	1.07	12,798	1.73	35,750	4.83
Nayabazaar	3,960	0.53	6,399	0.86	13,750	1.86
Soreng	1,320	0.18	2,133	0.29	5,500	0.74
North District	**13,200**	**1.78**	**21,330**	**2.88**	**55,000**	**7.43**
Mangan	7,920	1.07	12,798	1.73	35,750	4.83
Phodong	3,960	0.53	6,399	0.86	13,750	1.86
Chungthang	1,320	0.18	2,133	0.29	5,500	0.74
South District	**52,800**	**7.13**	**99,540**	**13.43**	**192,500**	**25.99**
Namchi	31,680	4.28	64,701	8.73	134,750	18.19
Jorethang	10,560	1.43	14,932	2.02	23,100	3.12
Ravong	5,280	0.71	9,954	1.34	17,325	2.34
Melli	5,280	0.71	9,954	1.34	17,325	2.34

** Source: Central Public Health and Environmental Engineering Organisation (CPHEEO)*

1.3 Conceptual Strategies

Table 1.3.1 Relationship between the Demand and Capacity of Water Treatment Plants at Years 2015, 2025 and 2040

	2015			2025			2040		
	Demand (MLD)	Capacity (MLD)		Demand (MLD)	Capacity (MLD)		Demand (MLD)	Capacity (MLD)	
Gangtok*	18.7	45	✓	20.16	45	✓	21.7	45	✓
Mangan	1.07	1.9 – 2.1	✓	1.73	1.9 – 2.1	✓	4.83	1.9 - 2.1	x
Geyzing-Peling	1.07	0.8 – 8.3	✓✗	1.73	0.8 – 8.3	✓✗	4.83	0.8 – 8.3	✓✗
Namchi**	3.92	4.28	x	8.73	3.22	x	18.19	3.22	x

East District:

Currently, the Selep Water Treatment Plant provides 36 MLD. From now (2008) to **2015**, the treatment plant needs to increase capacity to at least 45 MLD and reduce current rate of Unaccounted For Water (UFW) 79% to at least 50% by then. Only then will this amount of water meet the population growth for **2015 and through 2040**. The major challenge in providing adequate water is not in the sourcing, but in the distribution and controlling UFW. During this period (2008 to 2015), the following augmentations and enhancements on the current system are aggressively planned and will be implemented:[1b]

- Reduce water loss from 79% to 50% and to an adequate level thereafter.*
- Implement augmentation plan to rehabilitate old pipes, improve distribution to the majority of urban and rural populations.
- Develop and implement DPRs to increase water distribution to the other 5 major towns (Pakyong, Rongli, Rongpo, Singtam and Upper Tadong).
- Protect the water catchment areas at Lake Tamze and Ratey Chu to prevent potential pollution from urban activities (see slides on water catchment protection).

Note: Water Loss status unclear for North, West and South District. Actual demand may be higher

* Source [1a]. Assume a conservative reduction to 50% by 2015

** Seasonal supply of raw water not factor in. Lack of information.

1.3 Conceptual Strategies

North District

By 2009, Mangan will have 2.062 MLD of water supply, with lean period reducing to 1.891MLD. An additional capacity of 2.8 to 3.0 MLD is needed by 2040.

West District

By 2009, Geyzing-Peiling will have water supply capacities ranging from 0.82MLD to 8.26MLD. Additional capacity of 0.25, 0.91 and 4 MLD is needed during the lean period by 2015, 2025 & 2040 respectively.

South District

Namchi current water capacity is 1.77 MLD with additional 1.45 MLD "Spring Water" capacity. By 2040, Namchi will need 14.97 MLD of additional capacity. According to the future Urban Plan, Namchi has been designated as the 2nd Nuclei town other than Gangtok. To accommodate the huge increase in population, there is a need for highest priority to address the shortage of water. An integrated approach is recommended to address the water shortage issue in Namchi which will be further addressed in DGP level 2 studies in the town of Namchi.

1.3 Conceptual Strategies

For All Districts:

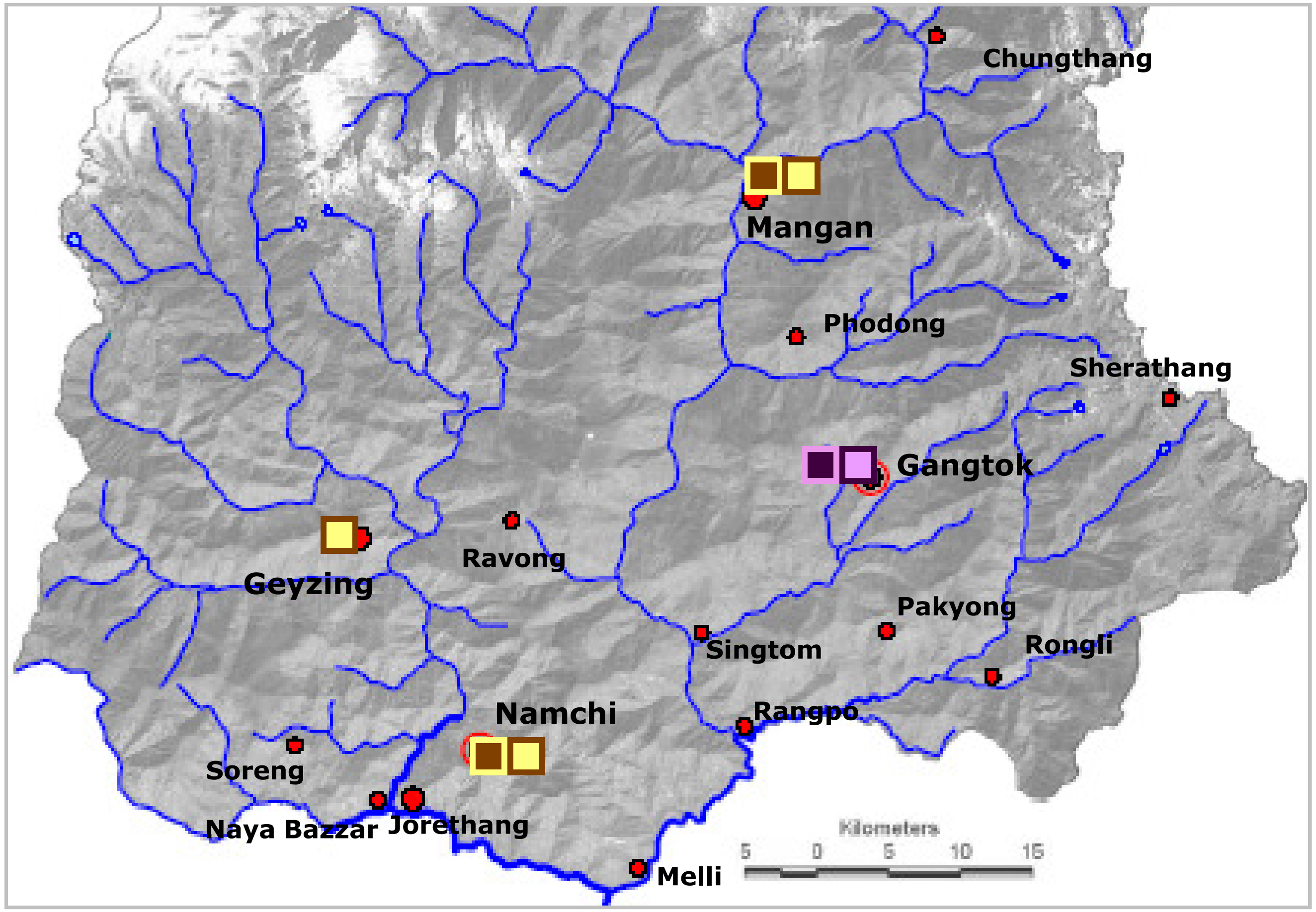
The water providers of Sikkim have multiple reports done up by previous external consultants. They are aware of the challenges faced in providing waters to the people of Sikkim. To highlight a few, the following were drawn from the information gathered which are important and on going improvement are being carried out.

- Reduce current UFW to acceptable rate, including wastage.
- Protect designated water catchment areas to prevent pollution and water loss from direct or indirect human activities.
- Mission by ADB & JNNURM under UIDSSMT (2005-2012)
- i) Improve/tighten water supply connection policies to weed out illegal or unregistered connections.
- ii) Metering of water consumption.

It is a challenge to incorporate the improvement work done by the water departments of Sikkim into this Strategic Urban Planning for Sikkim state. The team has identified a few strategic points which will complement the solution measures for Sikkim water issues.

- Include policies to support the augmentation of current water supply with alternate sources. E.g.
  - Rainwater harvesting system to augment lean period demand
  - Collection of gray water or surface runoff for non-potable usage (e.g. fire fighting)
  - Wide adoption of pumping based water supply system
- Need for close coordination between various water suppliers (PHED, RDD, Private) and foster win-win partnerships between the private, public and people sectors.
- Improve water quality of existing "Spring water" supply through new and innovative technologies, with on-the-ground adaptation.
  - E.g. Supplement conventional systems with "packaged small portable systems" that have smaller footprints, uses hollow-fiber membrane-based technology. This can be implemented in rural areas, eco-tourist resorts, and small towns <1000 persons.

1.4 Current and Proposed Plants



Water Treatment Plants	
	Existing Water Treatment Plants (as of 2008)
	Proposed PHED Treatment Plants (2015)
	Proposed PHED Expansion of Existing Plants (2015)
	Proposed expansion of capacity by consultant (2025)* Beyond existing municipal boundary

Figure 1.4.1 Distribution of Existing and Years 2015 , 2025 Proposed Water Treatment Plants

1.5 Water Catchment Protection

Measures for Protection of the Water Catchment Area

1. **Land use planning**
   - Setup of special administrative protection zones (only for designated and limited uses) according to protective requirements.

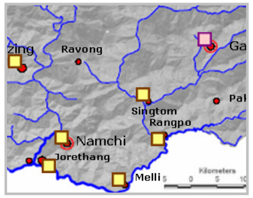
2. **Monitor and control**
   - Forbid human activities within drinking-water catchment boundary to prevent the damaging activities such as quarrying, deforestation and mining activities from happening.
   - Control population residing and density of population
   - Prohibit camping and tourism activities in catchment other than designated sites.
   - Activation of legislation and ensure environmental management plan for the site is developed, implemented and audited
   - Imposition of waste disposal requirements for solid and liquid wastes generated nearby.
   - Effectively regulate livestock grazing.
   - Implement water monitoring program including sampling at source, lakes, rivers, and intake.

4. **Introduce financial incentive measures and education program**
   - Ensure the public is aware that only approved events are permitted in the catchment.

5. **Conduct environmental impact assessments**

6. **Regulate and plan the tracks, roads, railway lines and traffic nearby to minimize the risks of erosion and pollutants from vehicles access**

2.0 Wastewater Treatment



2.1 Background

There is only one wastewater treatment plant (WTP) in the entire State. A significant amount of domestic wastewater is discharged directly to the sensitive receiving water bodies through direct discharge, illegal overflows of septic tanks, and leaking wastewater treatment pipes.

East District: There is only one WTP at Adampul with a total capacity of 4.8MLD. Assuming that the water consumption is 100LPCD (liters per capita per day) and 75% is intercepted as wastewater, the amount generated is 100 LPCD. Since only about 60% of the Gangtok area is connected to the sewer system, this treatment capacity is sufficient for about 80,000 people.

Households and villages that are not connected to the sewer system uses the septic tank system where waste is stored in underground tanks and removed by tankers when full. There is significant illegal discharge of wastewaters directly into the jhoras and from overflows of the septic tanks. The PHED 11th sewerage development plan includes planning and construction of a WTP each at Singtam and Rangpo.

North and West Districts: There is no WTP currently in the North and West Districts. Pre-feasibility reports are planned for Mangan and Geyzing-Pelling.*

South District: There is no WTP in this District. However, the PHED 11th plan includes DPRs (planning and construction) of a WTP each at Namchi (7.3 MLD by 2040*), Jorethang and Melli.

** Source: PHED.[2a,2b]*

2.2 Short, Medium and Long Term Projections

Assumption: 100 lpcd (75% of water consumed generated as wastewater)*

Table 2.2.1 Projections of Waste Water by Towns at Year 2015, 2025 and 2040

Wastewater	2015	Wastewater (MLD)	2025	Wastewater (MLD)	2040	Wastewater (MLD)
East district	**184,800**	**18.71**	**213,300**	**21.60**	**347,500**	**25.06**
Gangtok	138,600	14.03	149,310	15.12	160,875	16.29
Singtam	14,784	1.50	17,064	1.73	22,275	2.26
Rangpo	14,784	1.50	17,064	1.73	22,275	2.26
Pakyong	9,240	0.94	17,064	1.73	22,275	2.26
Sherathang	3,696	0.37	6,399	0.65	12,375	1.25
Rongli	3,696	0.37	6,399	0.65	7,425	0.75
West District	**13,200**	**1.34**	**21,330**	**2.16**	**55,000**	**5.57**
Geyzing - Pelling	7,920	0.80	12,798	1.30	35,750	3.62
Nayabazaar	3,960	0.40	6,399	0.65	13,750	1.39
Soreng	1,320	0.13	2,133	0.22	5,500	0.56
North District	**13,200**	**1.34**	**21,330**	**2.16**	**55,000**	**5.57**
Mangan	7,920	0.80	12,798	1.30	35,750	3.62
Phodong	3,960	0.40	6,399	0.65	13,750	1.39
Chungthang	1,320	0.13	2,133	0.22	5,500	0.56
South District	**52,800**	**5.34**	**99,540**	**10.08**	**192,500**	**19.49**
Namchi	31,680	3.21	64,701	6.55	134,750	13.64
Jorethang	10,560	1.07	14,932	1.51	23,100	2.34
Ravong	5,280	0.53	9,954	1.01	17,325	1.75
Melli	5,280	0.53	9,954	1.01	17,325	1.75

** Source: CPHEEO manual specifies generally 80%. We assume 75% here.*

2.3 Conceptual Strategies

East District

PHED's Plan:

To provide sufficient treatment capacity for growth to 2040, current plans are to further expand the Adampul WTP by:

- augmentation and replacement of leaking pipes;
- laying of new pipes to serve the Greater Gangtok area (from 60% to 95%).[1b]

By 2015, additional capacity will be built at Singtam and Rangpo to meet the population growth:

- Singtam: 1.4 MLD (14,784)
- Rangpo: 2.0 MLD (14,784)

For Singtam, additional capacity needed (0.1MLD) by 2015. A total of 2.26MLD needed for both towns by 2040.

Consultant's findings:

Total projected capacity demand for East district is 25MLD by 2040.

More sanitary engineers may need to be hired and trained to efficiently maintain and operate the WTP at Adampul, and in future other towns (Singtam and Rangpo). Additional responsibilities include optimal maintenance of the wastewater distribution systems.

For rural areas (such as large remote villages) not served by the conventional sewerage treatment systems but in the ambit of the town municipal, we suggest to explore Small Packaged Systems to compliment the rural rudimentary network. This allow provision for large scale upgrading in the future when the developed urban surrounding reach an economic scale.

Toxic wastewater discharge from industries (e.g. Singtam and Rangpo) should be regulated separately from domestic wastewaters. Such industries include breweries, pharmaceutical, and also agricultural processing facilities. On-site treatment of the industrial wastewaters should be monitored before permitted discharge to water bodies.

2.3 Conceptual Strategies

PHED's Plan:

South District

Proposed 2007 DPR plan to build a WTP at Namchi with a capacity of 7.3 MLD is insufficient to meet a projected urban population of 134,750 by 2040. A shortfall of 6.3MLD is projected.

Proposed DPRs for WTP treatment capacities need to increase for both Jorethang (1.4 to 2.4 MLD) and Melli (0.6 to 1.8 MLD).

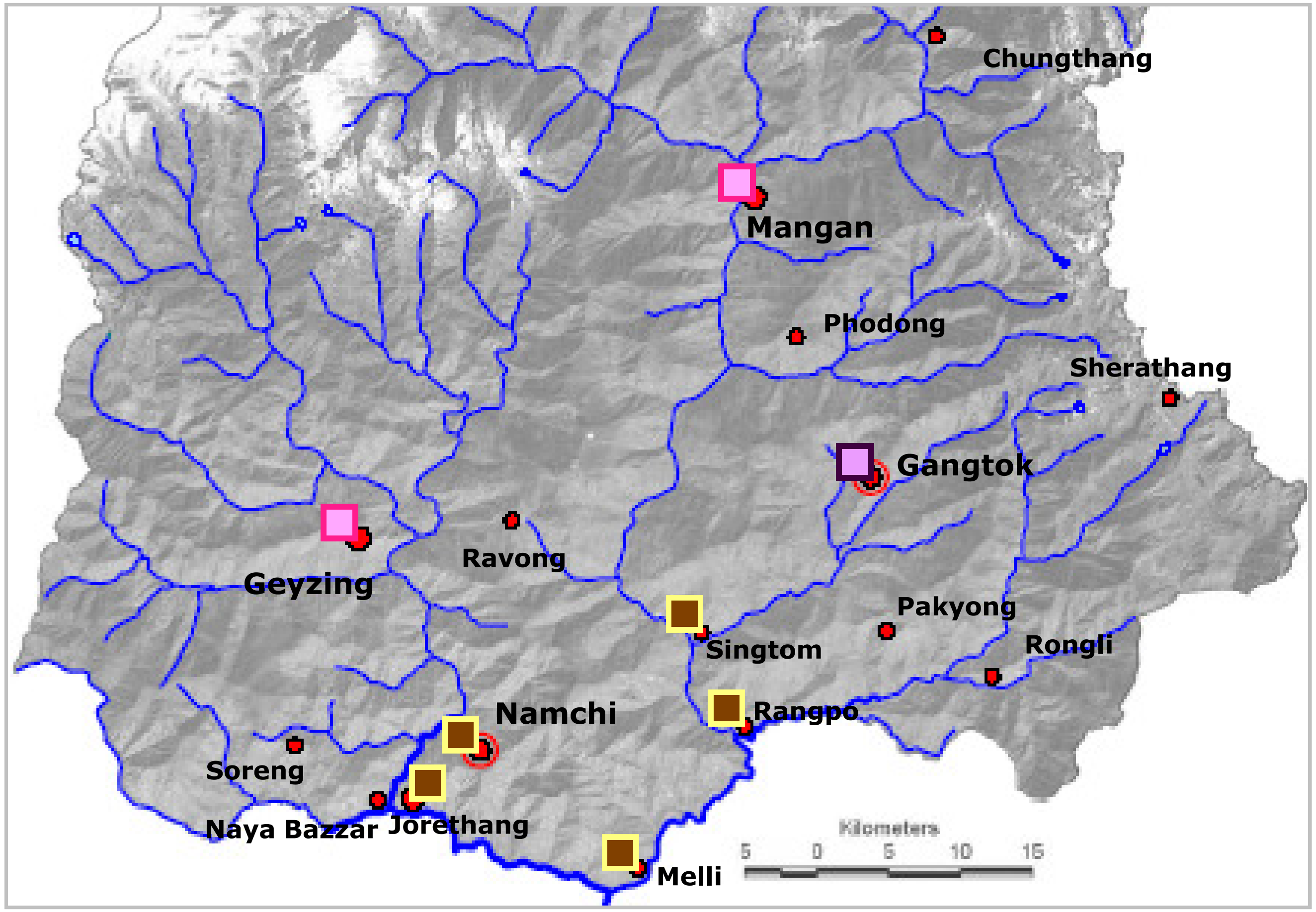
Consultant's findings:

North and West District

WTP (3.62 MLD) will be needed in Mangan and Geyzing-Pelling for a population of 35,750 by 2040. floating population is not factored in yet.

Note: Floating population has not been factored in. See slide on other considerations.

2.4 Current and Proposed Plants

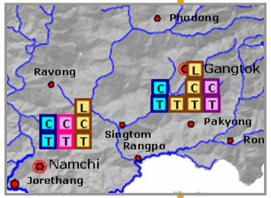


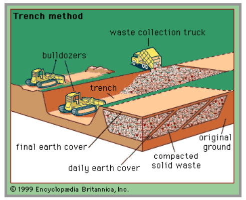
Wastewater Treatment Plants	
■ (purple)	Existing wastewater treatment plants (as in 2008)
■ (brown)	Proposed wastewater treatment plant by PHED (2015)
■ (pink)	Proposed wastewater treatment plant by consultant (2025)*

Figure 2.4.1 Distribution of Existing and Years 2015, 2025 Proposed Water Treatment Plants

** Pre-feasibility report for WTP done by PHED*

3.0 Municipal Solid Waste





3.1 Background

In order to secure a safe environment for the future, the extensive amount of municipal solid waste (MSW) generated has to be systematically collected, sorted, treated and disposed.

East District*: In this district, MSW collection is marginal. Only about 40% of MSW is collected in the Gangtok area. A significant amount of wastes are dumped into the nearest water course (jhora), streets and valleys. There is also no provision for collection & disposal of hazardous toxic wastes generated from industries. With the increasing numbers of industries (e.g. pharmaceutical) starting up, these wastes have to be collected and treated separately from the MSW.

In 2005, the AusAID project conducted a demonstration project to collect household waste in the Arithang sub-district of Gangtok. Through technical innovation, appropriate institutional arrangements and intensive community mobilisation, the demo project introduced a new operating systems on a sustainable basis.

Waste disposal and treatment is poor. Disposal is at an open grounds at Marchak, located next to the river. Some waste is segregated and collected for recycling by rural labourers at the dump site. Composting of waste is barely working because of operational problems. After collection of valuables for recycling and some composting, the remainder of the waste is dumped on-site. It is expected that this site will reach "capacity" in 4 years and a new site is needed.

The current practice of waste disposal at open grounds near the river are discouraged without appropriate pollution control measures. At the current and previously abandoned disposal sites (e.g. Martam), there is huge potential for contamination of the underlying soils, groundwater and the adjacent river.

Contamination occurs from rapid leaching of toxics from the waste both vertically downwards and horizontally to adjacent areas.

* Source[3a – d]

Toxics include nitrates (decomposing organic material), and metals (metallic waste scrap e.g. batteries, and electronic components). Other industrial pollutants such as chemicals from industrial wastes could also be present.

North District: There is limited information, and no proper MSW management system or disposal site.

South and West Districts: MSW collected from urban areas around Geyzing-pelling and Namchi is currently dumped at an open disposal site near Jorethang. This dump site poses serious contamination problems for the surrounding areas. A new MSW treatment and compost production plant at Sipchu (Phase 1) West Sikkim is being constructed and expected to be completed by end 2008. The new site will cater to the South and West Districts, designed for 20 years with a daily capacity of 1020 MT/day.

3.2 Proposed Integrated MSW Plan

In order to tackle this massive solid waste problem, an Integrated MSW Plan is proposed for the State. The framework is summarised in Figure 3.2.1 in the next page, and described below.

Description of Integrated MSW Plan

Wastes: Waste collected at the source are categorised into wet waste (A) and dry waste (B). The MSW is considered as an kind of garbage generated at residences, shops, hotels, and commercial establishments. It includes kitchen waste, plant waste, dry waste, paper, cardboard, glass, as well as demolition ash produced from minor modifications of households / buildings. An aggressive program to collect all the waste at source has to be implemented.

As much as 50% of the waste collected can be recycled as valuable materials (40%) and composted (10%). Separate garbage bins for wet and dry wastes are provided. This program will be modeled after the AusAID Arithang 2005 demonstration project.

A. Wet Waste: These wastes include kitchen waste, vegetable peels, fruit waste and uneaten food.

B. Dry Waste: These wastes include plastic bottles, glass bottles, metal waste, rubber items, articles made up of textiles, and other items which have resale value.

B.1 Transfer Station (dry waste): The dry waste collected is transported to specific transfer stations for sorting. Sorting is performed to group them into valuable materials (B3) and other materials (B2). The sorting process is performed by a combination of equipment sorters and trained workers.

B.2 Unsorted Waste (dry waste): Unsorted waste that has no value will be transported to a regional landfill (B.4). Please refer to description of the regional landfill in the next section.

B.3 Valuable Materials (dry waste): These are materials that can be sold for value including metal parts (e.g. aluminum and steel cans, scrap metal, computers, metal electronic parts), plastic bottles (clear, opaque), rubber, glass, textile. Each type of materials is sorted separately, packed and weighed. These materials are then transported by contracted waste haulers to West Bengal (e.g. Siliguri) for sale to recycling vendors.

A.1 Composting (wet waste): All wet waste collected are trucked to a composting facility.

A.2 At the facility, two waste streams are produced – **fine composted residue** (A.2), which can be sold as fertilizers (A.4); and

A.3 Uncomposted materials (wet waste): The uncomposted materials will be transported to the regional landfill (B.4).

B.4 Regional Landfill (dry waste): Because of the steep mountainous terrain, it would be very difficult to locate an engineered MSW landfill in Sikkim. Additionally, there is a recent call for collaboration from large urban cities in neighbouring states to jointly combine resources to select an engineered landfill. (Source: Guidance note for private sector participation and regional municipal waste management facilities. Jan. 2007). Thus, transporting the Unsorted wastes (B.2) and Uncomposted residues (A.3) to a regional landfill would be a reasonable option. Therefore, to avoid the current practice of open dumping, there is urgency to source for this regional landfill outside of Sikkim. It is imperative that UDHD lead this effort to jointly work with the neighbouring states (e.g. West Bengal) to locate and manage the engineered landfill. Details of selecting a typical engineered MSW landfill are summarised in Section 3.5.

(Note: A possible landfill site in a relatively flat area could be selected around the Jerathang vicinity.)

3.2 Proposed Integrated MSW Plan

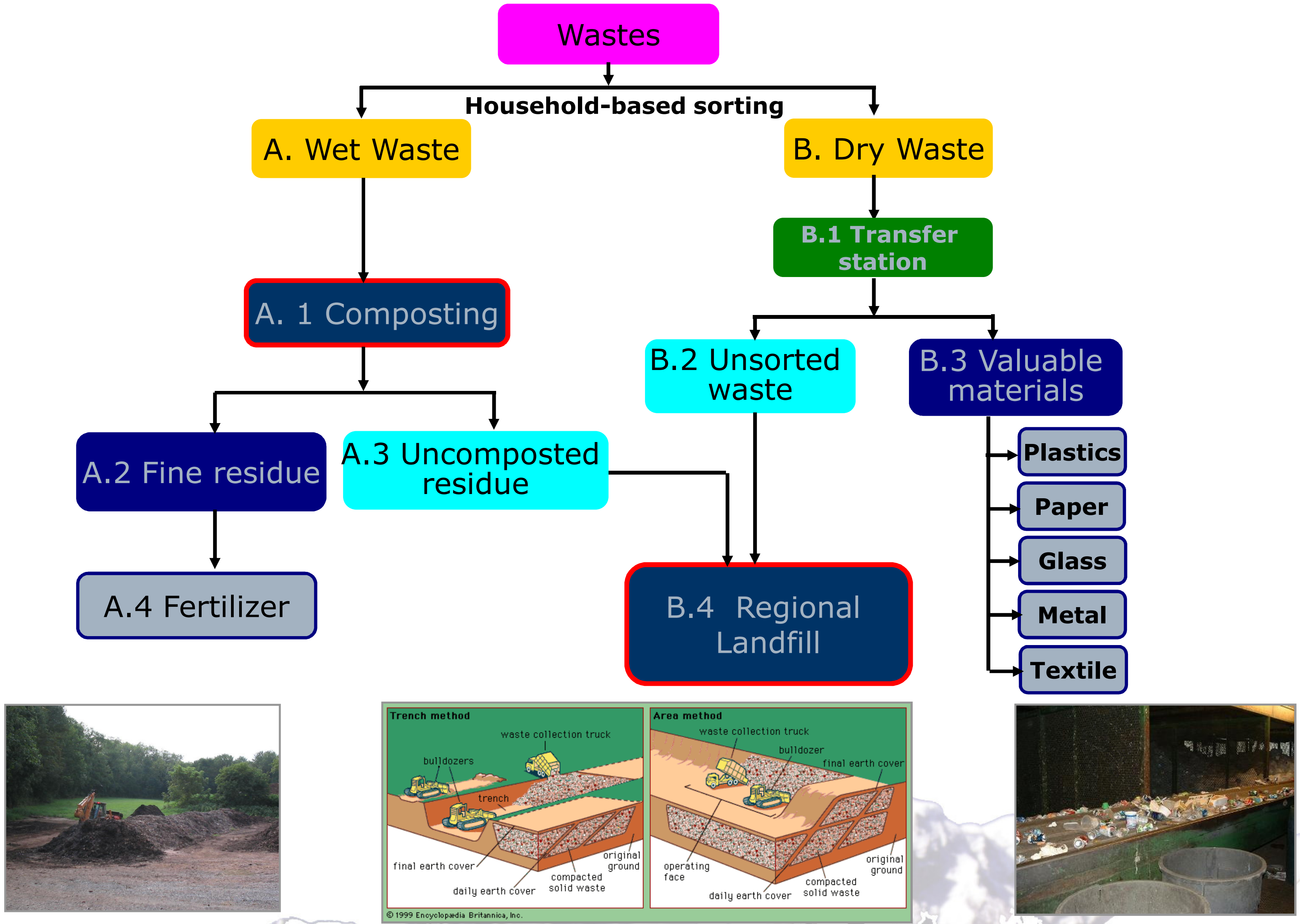


Figure 3.2.1 Flowchart illustrating Proposed Integrated MSW Plan

3.3 Short, Medium and Long Term Projections

Assumption: 0.4 kg solid waste per day per person [3b]

Table 3.3.1 Projections of Solid Waste by Towns at Year 2015, 2025 and 2040

Solid Waste	2015	Solid Waste (MT/day)	2025	Solid Waste (MT/day)	2040	Solid Waste (MT/day)
East district	**184,800**	**74**	**213,300**	**85**	**347,500**	**99**
Gangtok	138,600	55.4	149,310	59.7	160,875	64.4
Singtam	14,784	5.9	17,064	6.8	22,275	8.9
Rangpo	14,784	5.9	17,064	6.8	22,275	8.9
Pakyong	9,240	3.7	17,064	6.8	22,275	8.9
Sherathang	3,696	1.5	6,399	2.6	12,375	5.0
Rongli	3,696	1.5	6,399	2.6	7,425	3.0
West District	**13,200**	**5.3**	**21,330**	**8.5**	**55,000**	**22.0**
Geyzing - Pelling	7,920	3.2	12,798	5.1	35,750	14.3
Nayabazaar	3,960	1.6	6,399	2.6	13,750	5.5
Soreng	1,320	0.5	2,133	0.9	5,500	2.2
North District	**13,200**	**5.3**	**21,330**	**8.5**	**55,000**	**22.0**
Mangan	7,920	3.2	12,798	5.1	35,750	14.3
Phodong	3,960	1.6	6,399	2.6	13,750	5.5
Chungthang	1,320	0.5	2,133	0.9	5,500	2.2
South District	**52,800**	**21.1**	**99,540**	**39.9**	**192,500**	**77**
Namchi	31,680	12.7	64,701	25.9	134,750	53.9
Jorethang	10,560	4.2	14,932	6.0	23,100	9.2
Ravong	5,280	2.1	9,954	4.0	17,325	6.9
Melli	5,280	2.1	9,954	4.0	17,325	6.9

3.4 Conceptual Strategies

To meet the MSW collection, treatment and disposal challenges, the integrated MSW plan needs to be planned, funded and implemented.

East District:

- The AusAID Arithang demo program, followed by outsourcing to NGOs/Private sectors should be expanded to other Gangtok sub-districts and other district towns to implement: a systematic waste collection system and moved to transfer stations; treated at composting plants; and disposed properly at designated landfills.
- Existing facilities of 40 MT/day composting facility at Marchak is not operating optimally and may need repairs, maintenance, and operational changes.
- For 2025, possible additional facilities required: 4 transfer stations, 4 composting facilities and 1 landfill.

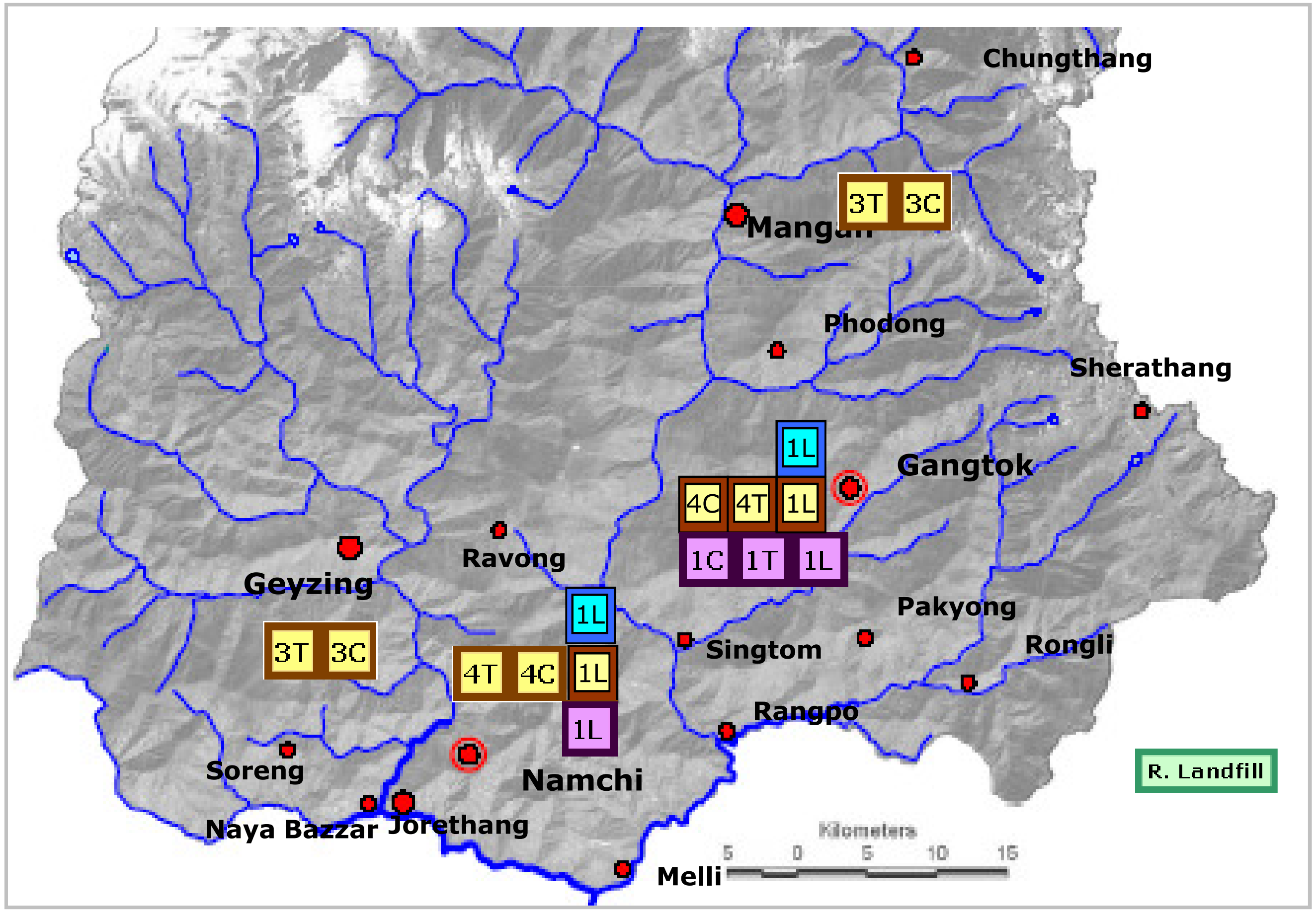
North and West Districts: For each of the town for 2025, one new facility is required - transfer station and composting facility.

South Districts: For 2025, possible additional facilities required: 4 transfer stations, 4 composting facilities and 1 landfill.

Regional Landfill

Beyond 2025, it is anticipated that a new sanitary engineered landfill will need to be sited, designed and built either in Sikkim State or out-of-state in collaboration with regional states like West Bengal.

3.5 Current and Proposed MSW Facilities



Transfer station/ Composting/ Landfill *	
(pink square)	Existing infrastructure (as in 2008)
(yellow square)	Proposed possible infrastructure by consultant (for 2025)
(cyan square)	Proposed possible infrastructure by consultant (for 2040)

Substation capacity

T ▶ Transfer station **C** ▶ Composting

L ▶ Landfill

R. Landfill ▶ Alternate Regional Landfill

*For each district except for landfill. Landfill serves North & East, South & West districts

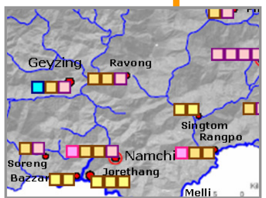
Figure 3.5.1 Distribution of Existing and Years 2025, 2040 Proposed Transfer Stations/Composting/Landfills

3.6 Factors to Consider in Landfill Design

Table 3.6.1 Landfill Design Considerations

Factors	Features
Access	Paved all-weather access roads to landfill site. Temporary roads to unloading areas.
Land Area	Area should be large enough to hold all community wastes for 10 - 25 years. Area for buffer strips must also be included. In the Jan 2007 draft report on the concept of a regional landfill, the proposed landfill capacity for an estimated population of 500,000 is about 250 tons / day.
Landfilling Method	Method will vary with terrain and available cover. The most common method is excavated cell and trench. (see figure 2).
Completed Landfill Characteristics	Finished slopes of landfill: 3to1; height of bench, if used 50 - 75ft; slope of final landfill cover: 3 - 6%.
Surface Drainage	Install drainage ditches to divert surface water runoff; maintain 3 - 6% grade on finished landfill cover to prevent ponding; develop plan to divert stormwater from lined but unused portions of landfill.
Intermediate Cover Material	Maximise use of onsite soil materials, other materials such as compost produced from yard waste and MSW can also be used to maximise landfill capacity.
Final Cover	Use multilayer design. Slope of final landfill cover: 3-6%.
Landfill Liner	Single clay layer (2 - 4 ft) or multilayer design incorporating the use of a geomembrane.
Cell Design and Construction	Each day's wastes should form one cell; cover at end of day with 6ft of earth or other suitable material; typical cell width 10-30ft; typical lift height including intermediate cover 10-14ft; slope of working faces 2:1 to 3:1.
Groundwater Protection	Divert any underground springs, if required, install perimeter drains, well point system, or other control measures.
Landfill Gas Management	Develop landfill gas management plan including extraction wells, manifold collection system, condensate collection facilities, vacuum blower and flaring facilities and/or energy production facilities.
Leachate Collection	Determine maximum leachate flow rates and size leachate collection pipe and / or trenches; size leachate pumping facilities; select collection pipe materials to withstand static pressures corresponding to the maximum length of the landfill.
Environmental Requirements	Install Vadose zone gas and liquid monitoring system; install up and downgradient groundwater monitoring facilities; locate ambient air monitoring stations.

4.0 Power Supply Facilities



4.1 Background – Power Supply

The development level of a country directly related to its economical and social level. One of the most important factors that takes an active role in achieving such development level is "energy". The demand for energy increases rapidly in parallel with the population increase, industrialization and technological development.

Power Sources

According to the most recent official report provided by Energy & Power Department, Government of Sikkim (Annual Report 2006-07), the sources of power supply (127.7 MW) in Sikkim are originated from three major sources: State Sector or Sikkim Government 40.7 MW, Central Sector or Indian Government 77 MW, and Interstate Sector or Independent Power Producers (IPPs) 10 MW. From these numbers, almost 70% of power supplied in Sikkim is imported. However, Teesta V (510MW), the second biggest hydropower project in Sikim, has been recently commissioned.

Power Generation in Sikkim

Regardless of Teesta V, there are currently fourteen power generation plants in Sikkim. Among these fourteen plants, there are twelve hydropower plants (35.7MW) and with two diesel generating plants (5MW) used for emergency cases [4a]. The developed hydropower plants are dependent directly on the flow rate of the rivers having no dam or major reservoir for generation of rated capacities, especially during the lean period or the winter months (November till early March). The peak power demand also occurs during these winter months when the hydropower generation diminishes down to less than half of the installed capacity. In 2008, Teesta V has been recently commissioned and this results in an additional installed capacity of 510 MW. Therefore, a total installed capacity of power generation plants in Sikkim is around 550MW.

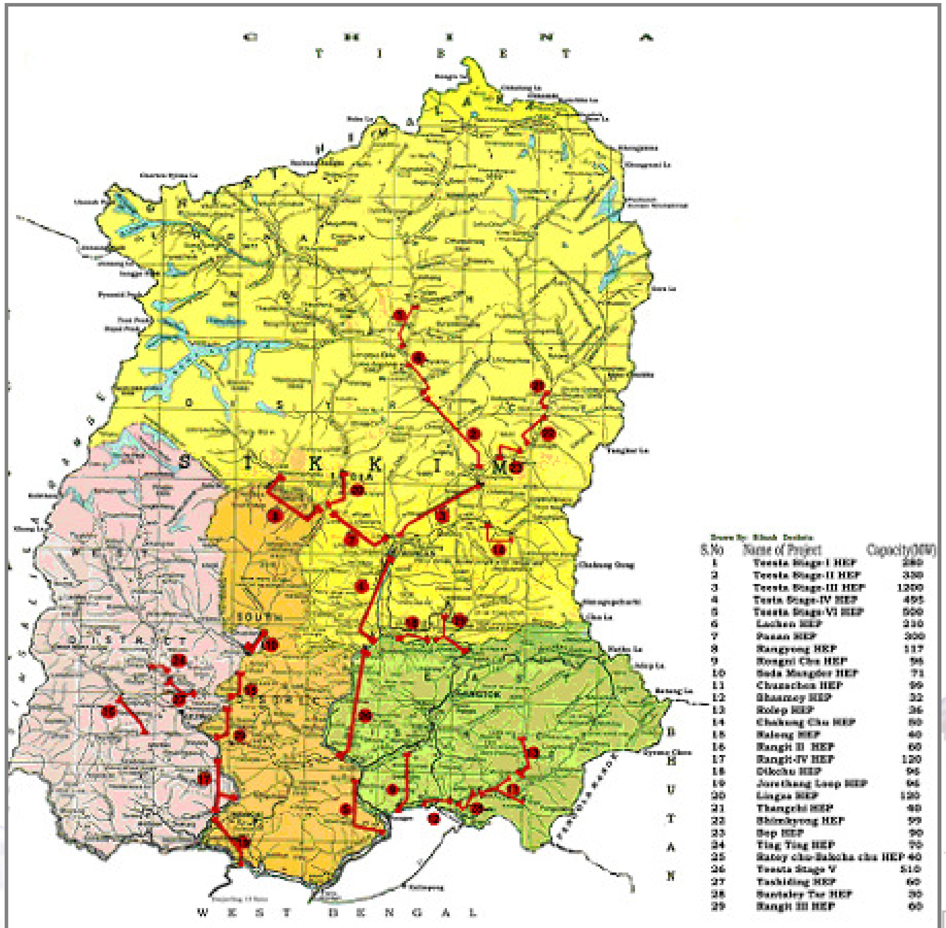
Transmission System

The import and export of power relies solely on the transmission system belonging to West Bengal State Electricity Board. This system is considered as a "*weak system*" and it is one of major causes of blackout in Sikkim.

Also, most of the substations are in the east district, especially in Gangtok, the most developed city in Sikkim.

Ongoing/Upcoming Power Generation Projects

The presence of rivers and their tributaries allows the state to fully exploit the usage of hydro power. Accordingly, the Sikkim Government has initiated 29 projects with a total installed capacity of 5,347 MW throughout the State. As mentioned previously, one of the 29 projects, Teesta V, has been commissioned in 2008. All of the 28 projects are expected to be commissioned by 2012.



4.2 Short, Medium and Long Term Projections

In 2005-2006, Sikkim energy demand is ranked 23rd out of 33 states in India. The average per capita annual consumption of energy in Sikkim is 430 kWh while that of India is 630 kWh [4d]. In order to provide sufficient electric power to sustain the development, the projection of the peak demand is based on the average number in India and peak hours is considered to be 6 hours. From these, peak power consumption per capita = 287.7 W. The projections of peak power consumption for each urban centres for the short-term, medium-term and long-term are provided in the below table.

Table 4.2.1 Projections of Power Demand by Towns at Year 2015, 2025 and 2040

Power Demand	2015	Peak Demand (MW)	2025	Peak Demand (MW)	2040	Peak Demand (MW)
East district*	**184,800**	**53.1**	**213,300**	**61.4**	**347,500**	**71.2**
Gangtok	138,600	39.9	149,310	43	160,875	46.3
Singtam	14,784	4.3	17,064	4.9	22,275	6.4
Rangpo	14,784	4.3	17,064	4.9	22,275	6.4
Pakyong	9,240	2.7	17,064	4.9	22,275	6.4
Sherathang	3,696	1.1	6,399	1.8	12,375	3.6
Rongli	3,696	1.1	6,399	1.8	7,425	2.1
West District	**13,200**	**3.8**	**21,330**	**6.1**	**55,000**	**15.8**
Geyzing - Pelling	7,920	2.3	12,798	3.7	35,750	10.3
Nayabazaar	3,960	1.1	6,399	1.8	13,750	4
Soreng	1,320	0.4	2,133	0.6	5,500	1.6
North District	**13,200**	**3.8**	**21,330**	**6.1**	**55,000**	**15.8**
Mangan	7,920	2.3	12,798	3.7	35,750	10.3
Phodong	3,960	1.1	6,399	1.8	13,750	4
Chungthang	1,320	0.4	2,133	0.6	5,500	1.6
South District	**52,800**	**15.2**	**99,540**	**28.7**	**192,500**	**55.5**
Namchi	31,680	9.1	64,701	18.6	134,750	38.8
Jorethang	10,560	3.1	14,932	4.3	23,100	6.7
Ravong	5,280	1.5	9,954	2.9	17,325	5.0
Melli	5,280	1.5	9,954	2.9	17,325	5.0

4.3 Conceptual Strategies

Power Generation

Assuming that all of the 28 hydro power projects are going to get commissioned by end of 2012, the government will be able to tap approximately 640 MW of free power(12% of total installed capacity) from 2012 until 2027. At the end of 2027, the government will be able to tap approximately 800 MW of free power(15% of total installed capacity).

In conjunction with existing 12 power plants of 40.7 MW, the confirmed capacity will be around 340 MW from 2012 to 2027 and around 400 MW from 2027 onwards. At glance, power generation should be sufficient throughout the periods of planning, i.e. 2015, 2025 and 2040. However, South District does not seem to have sufficient power but this can be made amend with allocation from either East or West Districts. Thus, the power generation is no longer a pertinent issue in Sikkim.

Table 4.3.1 Relationship between the Demand and Generation of Power Supple at Years 2015, 2025 and 2040

	2015			2025			2040		
	Peak Demand (MW)	Generation (MW)		Peak Demand (MW)	Generation (MW)		Peak Demand (MW)	Generation (MW)	
East district	53.1	95	✓	61.4	95	✓	71.2	115	✓
West District	3.8	20	✓	6.1	20	✓	15.8	24	✓
North District	3.8	210	✓	6.1	210	✓	15.8	262	✓
South District	15.2	15	x	28.6	15	x	55.4	19	x
Total	75.9	340	✓	102.3	340	✓	158.2	420	✓

4.3 Conceptual Strategies

Transmission System

Regarding transmission loss, the ongoing/upcoming plants are distributed throughout the state and this can greatly enhances the reduction of transmission loss.

The recent problem lies in the transmission system. The major criteria of the good transmission system consists of having sufficient capability to meet peak demand, providing satisfactory continuity of service to the connected consumer, being "*networks*" for reasons of reliability and operating flow – if any of the element (line) fails, there is an alternative route and thus, power flow is not interrupted. It provides a strong electrical tie between generators so that each can stay synchronized with the system and with the other generators as well. From all these reasons in conjunction with the expansion of urban centres, the substations used for transmission are recommended to be commissioned in 2015, 2025 and 2040. Apart from Gangtok, there will be a need to cater for more substations as the population sizes multiplies, especially in urban centres like Numchi and Rangpo. The location and capacities of the required substations are shown in Appendix C.

For Gangtok, it is the most populated city whereby the population growth is controlled and at the same time, it is equipped with reasonably adequate infrastructure, including substations. In case of Pakyong, for example, it is envisaged that Pakyong will be developed into an aviation centre. Apparently, the existing substation capacity is more than sufficient, but however, it does not provide any business continuity contingency. Henceforth, another substation is required in order to serve as a backup to the existing system.

Environmental Concerns

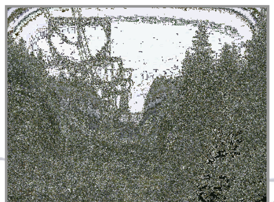
Another issue that is needed to be considered is the *"Effect of electromagnetic field"* on people who live under or nearby high voltage transmission lines is still controversial.

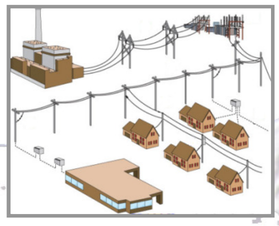
According to previous studies, the electromagnetic field can cause leukemia. However, the results leading to the conclusion were still obscure, i.e. no effect = 70% and cancer = 30%. Although the results did not show the obvious trend, this still need to be taken into the consideration. In order to reduce the impact of electromagnetic field on human, corridor sharing of transmission line with other infrastructures, especially roads and trains, should be explore.

Other Concerns

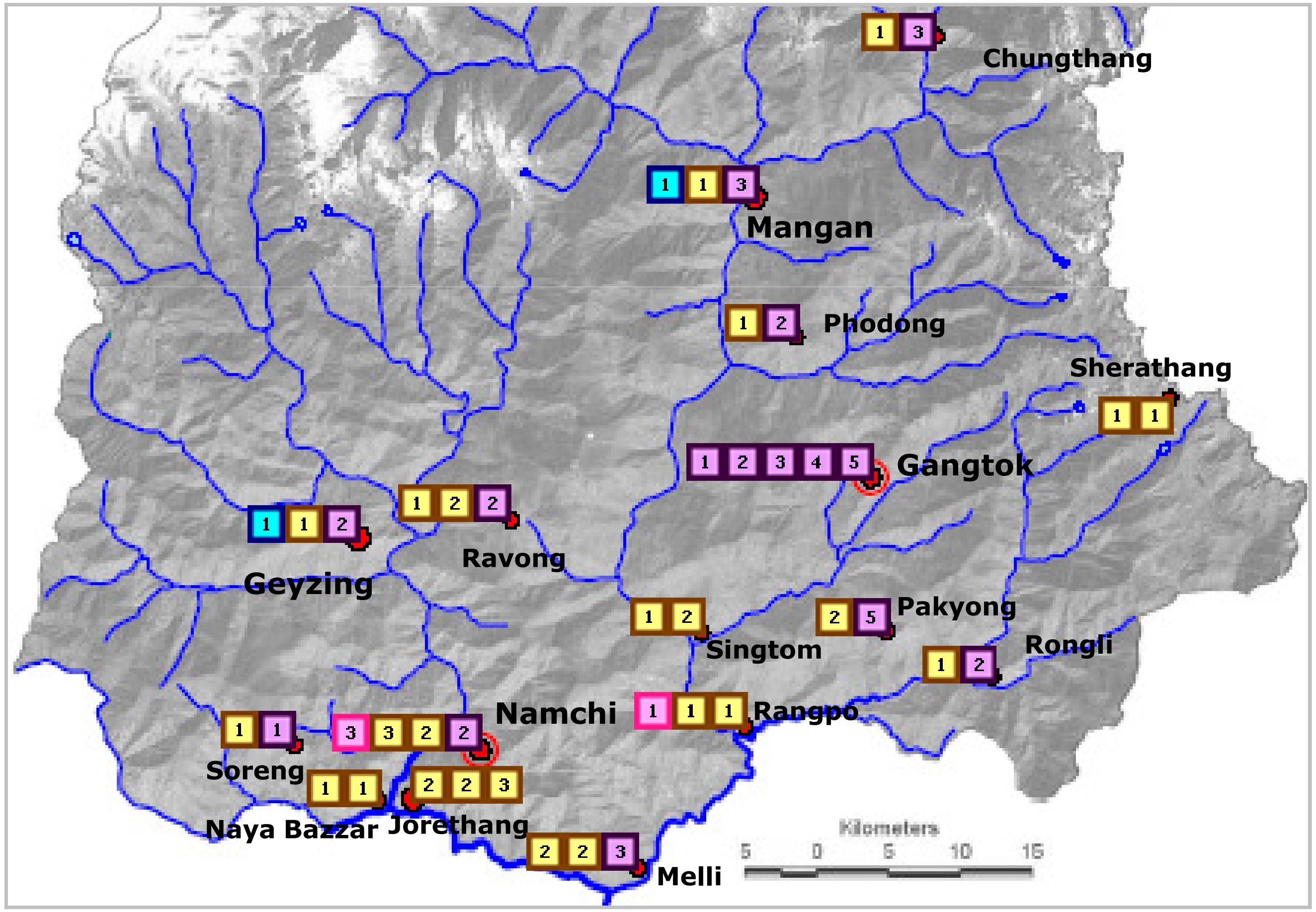
Power generation is not an issue for floating populations. However, transmission will be critical problems for some urban centres, especially Numchi and Geyzing-Pelling. These urban centres will require additional substations in order to support the floating population, i.e. tourists, seasonally. However, concerns over capital cost must be factored in.

There is a need for power transmission line to be laid underground for major urban centres with high density of population.





4.4 Current and Proposed Substations



	Infrastructure for Substations
	Existing substations (as in 2008)
	Proposed substations by consultant (2015)
	Proposed substations by consultant (2025)
	Proposed substations by consultant (2040)

Substation capacity

- **1** ▶ 1x2.5 MVA
- **2** ▶ 2x2.5 MVA, 1x5 MVA
- **3** ▶ 2x5.0 MVA, 1x10 MVA
- **4** ▶ 3x5.0 MVA
- **5** ▶ 2x10.0 MVA

Figure 4.4.1 Distribution of Existing and Years 2015, 2025, 2040 Proposed Substations

5.0 Overall Environmental Infrastructure

Environmental Infrastructure	
■ (purple)	Existing infrastructure
■ ■ (brown / yellow)	Proposed infrastructure PHED/ Consultant (2015)
■ (pink)	Proposed infrastructure (2025)
■ (cyan)	Proposed infrastructure (2040)

W ▶	Water Treatment Plants
WW ▶	Wastewater Treatment Plants
SW ▶	Solid Waste Facilities
S ▶	Substations

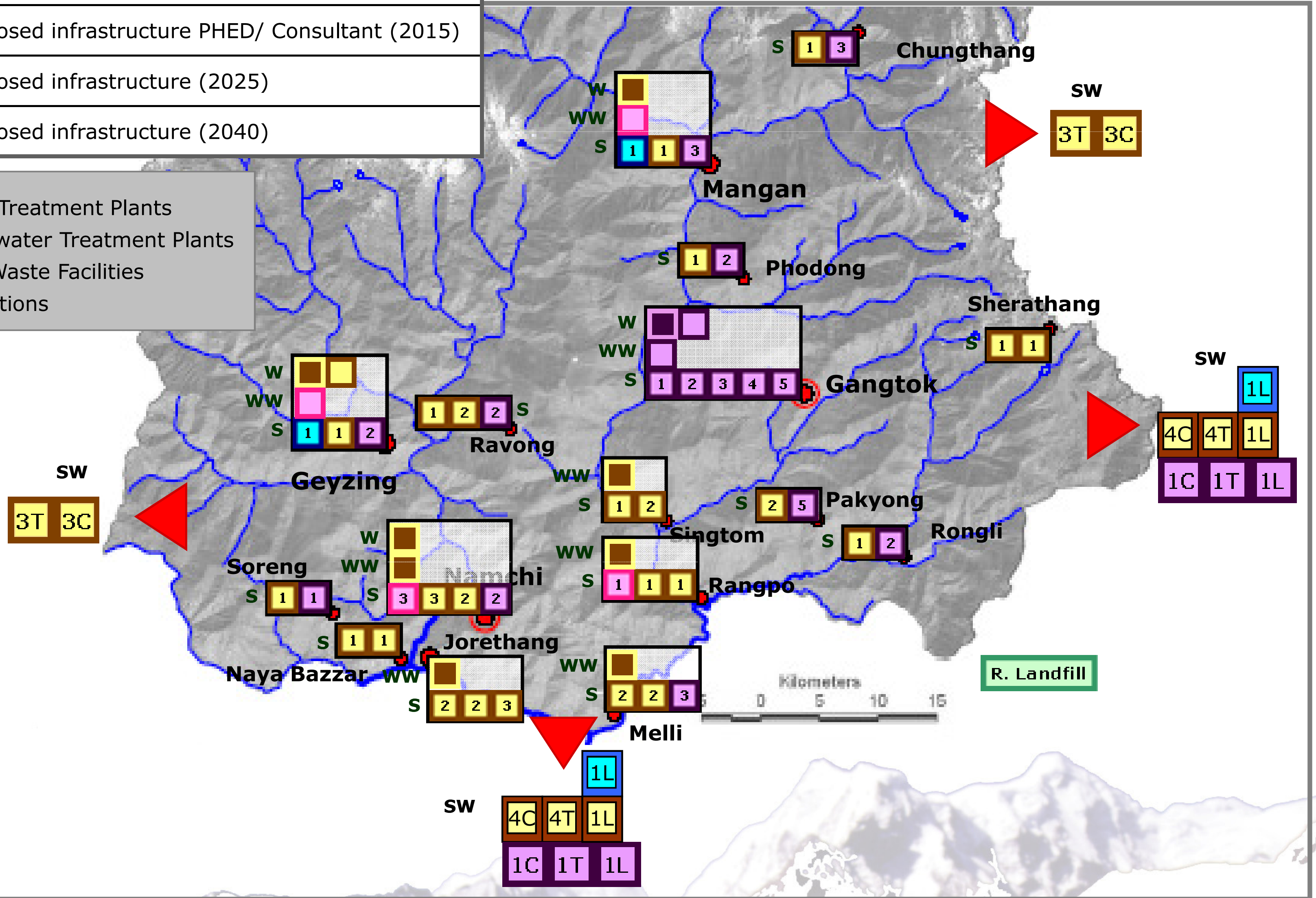


Figure 5.1 Overall Distribution of Existing and Years 2015, 2025, 2040 Proposed Environmental Infrastructure

5.1 Other Considerations

Tourism

Table 5.1.1 Projected Number of Visitors to Sikkim at Peak Period

	*Total Tourist Projection to Sikkim		
	2015	2025	2040
May (Peak Season)	147,742	392,567	1,192,788
Ave. 7 days stay	34,473	91,599	278,317

** Assume average stay of tourists at Sikkim is 7 days*

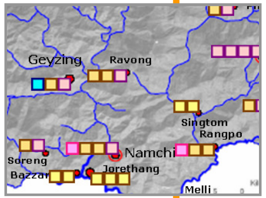
** Tourist projection numbers from Strategic Planning - Tourism*

Table 5.1.2 Projected Capacity of Infrastructure Required by Visitors to Sikkim During Peak Period

	Projected Tourist's Capacity to Sikkim		
	2015	2025	2040
Water needs (MLD)	4.65	12.37	37.57
Waste Water Generation (MLD)	3.49	9.27	28.18
Solid Waste (MT/D)	14	37	111
Power Consumption (MW)	9.9	26.4	80

With the inclusion of the tourist's floating population, the above additional projected capacities are required for the state of Sikkim. Specific capacity at each town will depend on the visit pattern of the tourists.

6.0 Environmental Management



6.1 Reduce, Reuse and Recycle (3R) Program

In order to reduce the amount of waste headed for final disposal, it is strongly recommended that the "***Integrated Solid Waste Programme***" should be promoted in all urban centres in Sikkim. The integrated solid waste programme, also known as "***3R programme***" is a sustainable waste management approach which consists of: Reduce, Reuse and Recycle. Currently, full scheme of 3R program has not yet been planned in any area of Sikkim. Since Gangtok is the most populated and manageable city and the program, it should be started from Gangtok.

Main Players: Three groups in society are key main players in this process: government, industry & commerce and individuals. Policies need to be designed to change behaviors of all these groups.

Policies: It is necessary for government to provide some support through policy measures. Policies which encourage waste avoidance and minimization are to be preferred over those which focus purely on further encouraging present recycling, recovery and reuse. Five types of policy options that should be considered are as follows:

1) Producer Responsibility
2) Eco-labeling
3) Charges and economic incentives: pay-as-you-throw
4) Persuasion measures
5) Integrated product policy

Approach: Approaches used in different countries are given in Table 6.1.1.

Technologies: Whatever success is achieved in reducing waste arising and in separating materials for recycling, some waste will always remain. To achieve high waste reduction rate in terms of landfill demand, a technology component is required. Available options are listed below:

1.Size reduction technologies: baling, pulverization/shredding, homoginization/wet pulping
2.Weight reduction technologies: separation, materials recycling facilities, waste derived fuel
3.Waste to energy generation: Mass burn incineration, fluidized bed incineration, combustion of prepared waste derived fuel
4.Other combustion technologies: Aggregate/block production, cement kiln firing, wood burning power/CHP (Combined Heat and Power) stations, tyre burning power/CHP stations, gasification, pyrolysis
5.Biological systems: Composting, Vermicuture, hydrolysis, anaerobic digestion

6.1 Reduce, Reuse and Recycle (3R) Program

Table 6.1.1 Criteria for Reduce, Reuse, Recycle (3R) Program

CRITERION	GERMANY	NETHERLANDS	CALIFORNIA	AUSTRALIA
Principal recycling drivers	• Landfill disposal costs • Organic waste landfill ban • Consumer waste charges • Strong public relation	• Landfill ban • High cost of incineration	Volume-based billing system	Community awareness and endorsement
Recycling targets	• Recycling of 80% of collected recyclable materials • Organic waste-a maximum of 120 kg per capita • Bulky waste – 50% of generation to be collected	• At national level, 60% for reuse and recycling • Organic waste-a maximum of 120 kg per capita • Arnhem has set a target of 60%+10%	Reduce amount of MSW by 50% by 2000, from a baseline 1990	No waste by 2010
Target achievement	Yes. Recyclate production of 210 kg per capita	No.37% recycling achieved	Yes, but not sustained. 38% recycling achieved	No. 57% recycling achieved
Legal/regulation	• Banning of organic landfill after 2005, phasing out of landfilling household waste by 2020 • Eco-labelling • Packaging ordnance	• Landfill ban on household waste from 1995 • Producer responsibility for various waste streams	• Reduction of solid waste by 2000 • California Beverage, Container Recycling and Litter Reduction Act • State law on purchase of recyclates	None
Markets for end products	• Compost: agricultural markets • Cork: insulating materials • Wood: shipboard and thermal treatment • Paper and glass: retailers	Markets are available for paper and compost. Paper price volatility is addressed by giving recovered product free	• Bottles/cans/paper: sold to Pacific rim • Yard/green waste: landfill cover, mulch • Tyres/wood: fuel for cement kiln and boilers	• Paper/compost: used by government • Aggregates/compost: construction firms and civil contractors
Public awareness	• Quarterly newsletters • Literature on recycling practice	Waste calendar	• Quarterly city newsletter • Cable channel providing information on service • Customer service line	• Literature dissemination • Media advertising

6.2 Illness Associated with MSW Management

As mentioned previously in Chapter 3 (Part II of the report), the proposed integrated solid waste management program consists of three major parts waste: waste recycling, composting and landfill. The health risk associated with these three component will be discussed here.

1. Waste recycling facilities

Household waste contains a diversity of materials and therefore potentially numerous hazards, with sheer volume exacerbating any difficulties. The potential health related problem of waste recycling facilities arise from the exposure of operatives with wastes due to hand-sorting of materials.

These hazards can be divided into three categories: physical, chemical and biological hazards.

1.1 Physical hazards

Manual handling of materials and the ergonomic aspects of materials handling hand-sorting are the main physical hazards, followed by the potential for accident, e.g. cuts (broken bottles), broken limbs etc. especially during interaction with heavy machinery and movement of vehicles. Many waste recycling facilities are also venerable to potential fires. Noise and vibration are present in waster recycling facilities due to the use of various sorting and baling machinery.

1.2 Chemical hazards

Chemical hazards include vapors and residues from household hazardous waste (HHW), e.g. garden chemicals, wood preservatives, paints, cleaning materials etc. Heavy metals are include in this category due to the possibility of exposure to cadmium and mercury from batteries in HWW. Volatile organic compounds (VOCs) are produced when waste is degrading, e.g. organic sulfur compounds are thought to contribute to nausea, irritation and intestinal problems experienced by some operatives.

1.3 Biological hazards

Biological hazards have caused most concern in waste recycling facilities. Collection and separation of household waste generates organic dusts. These include airborne bacteria and fungi (bioaerosols) and their cell wall components. Microbial cell wall components are an important constitute in organic dusts.

Dust generated in waste facilities could also include airborne viruses. Viable or live microorganisms are implicated in infection and allergy, and pathogenic species are of some concern in composting. They are implicated in fever, flu-like symptom, headache, excessive tiredness and joint pains (called Organic Dust Toxic Syndrome) and gastrointestinal problems. These symptoms have been reported in studies on waste sorting facilities.

2. Composting

Commonly in the composting systems, high concentration of bacteria and fungi are present in composts. Whenever composting materials are moved around, for example during the shredding, turning and screening processes, these microorganisms can be aerosolized, forming what is termed a bioaerosol. The handling of large quantities of compost potentially can lead to the release into the air of large quantities of the bacteria, fungi and actinomycetes and their components, found in compost, as a bioaerosol. Exposure to the microorganisms found in compost could potentially cause ill-health in the people exposed to them either by infection, allergy or an adverse response to toxins. The composting process generate heat, so any human pathogens present in the raw materials, such as coliform bacteria from faecal material which could give rise to gastrointestinal infection, should be rapidly killed off during the composting process. Some of the microorganisms which increase in number during the composting process are toxic and/or allergenic and still have the potential to cause problems when they are dead. They are two main routes of exposure to compost microorganisms: ingestion of the microorganisms or inhalation of bioaerosols created during the handling of compost.

Good hygiene practices such as wearing of gloves and provision of hand washing facilities on composting sites should control risk form ingestion. However, control of

3. Landfill

The potential for a fundamental link between landfill and certain adverse health outcomes in neighboring residents is a matter of continuing concern. The primary potential exposure pathways that may occur as a result of landfill operations are summarized in the Table 6.2.1 below.

Table 6.2.1 Primary Potential Exposure Pathways Resulting from Landfill Operations

EXPOSURE PATHWAY	SOURCE	RELEASE/ TRANSPORT MECHANISM	POTENTIAL RECEPTORS AT RISK	EXPOSURE ROUTE	LIKELYHOOD OF COMPLETE PATHWAY	CIRCUMSTANCES LEADING TO POTENTIAL COMPLETE PATHWAY
Aerial gaseous emission	• Decomposing waste	Emission of trace constituents in landfill gas	Atmospheric dispersion	Residences, schools, hospitals, OAP home within up to app 3 km of landfill	Moderate: • Containment and treatment controls can reduce but cannot eliminate aerial gaseous emissions	• Sensitive receptors located in vicinity of site
Subsurface gas migration	• Decomposing waste	Emission of bulk and trace constituents in landfill gas	Subsurface migration	Properties within up to app 500 m of landfill	Low: • Migration generally limited by natural barriers (e.g. substrata, surface water courses, groundwater table) • Emissions limited by standard control	• Sensitive receptors located immediately adjacent to site • Site underlain by extensively fractured/fissured strata • Site linked to receptors by man-made structures (sewers, drains etc)
Airborne dust	• Unpaved haul roads • Soil stock piles • Bare earth • Earth works • Dusty waste inputs	Disturbance, by wind or mechanically, of surface dust onto which contaminants are adsorbed	Atmospheric dispersion	Residences, schools, hospitals, OPA homes, food outlet within app 250 m of landfill	Low: • Concentration diminish rapidly with distance • Emission limited by standard control	• Sensitive receptors located immediately adjacent to site • Site receives large inputs of highly dusty, hazardous wastes (e.g. incinerator ash, asbestos, industrial powder)
Deposited dust	See above	See above	See above	See above	Low: • See above	See above
Direct contact	• Uncovered waste • Contaminated soil	None required	None required	None required	Low: • Most sites not accessible by public	• Sites adjacent to residences or schools • Sites with no perimeters fencing or other security measures

6.3 Review of Environmental Regulations

The discharge norms pertaining to water, air, solid & hazardous waste and noise vary from country to country depending on the status of process and technology adopted, geographical location and environmental management practices used as well as public awareness and concern. However, some critical parameters are basically essential to be present in the standards in order to ensure that the environment is not polluted by any activities. This section is focused on the review of the existing environmental standards enforced by the Sikkim Government and the comparison of the existing standard with the international standards, especially World Health Organization Guideline. Finally, the recommendation is provided.

In Sikkim, the State Pollution Control Board has given the power to govern all the pollution regulations which were passed by Indian Parliament. The State Pollution Control Board Sikkim is entrusted with the implementation of following Acts & Rules:

1. Water (Prevention & Control of Pollution) Act, 1974

2. Water (Prevention & Control of Pollution) Cess Act, 1977

3. Air (Prevention and Control Pollution) Act, 1981

- National Ambient Air Quality Standards

4. The Environmental Protection Act 1986 and its amendment, 1999

- Primary Water Criteria, including drinking water
- General Standard for Discharge of Environment Pollutants Part-A: Effluent
- General Standard for Discharge of Environment Pollutants Part-B: Wastewater generation standard

5. Hazardous Waste (Management & Handling) Rules, 1989

6. Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989

7. Public Liability Insurance Act, 1991

8. Biomedical Waste (Management & Handling) Rules, 1998

9. The Recycled Plastics Manufacture and Usage Rules, 1999

10. Noise Pollution (Regulation and Control) Rules, 2000

11. The Municipal Solid Wastes (Management & Handling) Rules, 2000

12. Ozone Depletion Substances (Regulation & Control) Rules, 2000

The review of criteria/standard specified in the above mentioned Acts and Rules are as follows.

6.3 Review of Environmental Regulations

1. The National Ambient Air Standard

Air pollution denotes a change of quality of air in the natural environment manifested generally in terms of identified parameters such as Suspended Particulate Matter (SPM), Sulfur dioxide, Nitrous oxide, Carbon monoxide, Lead, Poly-nuclear Aromatic Hydrocarbon (PHA), Heavy metals, Respiratory Particulate Matter (RPM), etc. From a review and a comparison of the notified standard and WHO standard, given in Table 6.3.1, the main findings are as follows:

1) Different standards, including SO_2, NO_2, PM_{10}, Pb and CO, have been laid down for industrial, residential and sensitive areas. The sensitive areas are to be notified by the State Government/State Board.

2) Apart from SO_2 concentration, all of the concentrations notified in the standards are comparable to the concentrations recommended by WHO. In general, the concentration of SO_2 recommended by WHO is much lower than that notified in this regulation.

3) Apart from *ozone concentration*, all basic parameters have been included in the Indian NAAQS (1994). The concentration of ozone recommended by WHO should not be higher than 100 μg/m^3.

Table 6.3.1 The National Ambient Air Standard Notified by Central Pollution Control Board and WHO Standard

POLLUTANT	TIME WEIGHT AVERAGE	National Ambient Air Quality Standard (1994)			WHO Standard
		Industrial area	Residential, Rural & other areas	Sensitive areas	
Sulphur dioxide (SO_2)	Annual avg	80 μg/m^3	60 μg/m^3	15 μg/m^3	-
	24 hour	120 μg/m^3	80 μg/m^3	30 μg/m^3	20 μg/m^3
Oxide of Nitrogen as NO_2	Annual avg	80 μg/m^3	60 μg/m^3	15 μg/m^3	40 μg/m^3
	24 hour**	120 μg/m^3	80 μg/m^3	30 μg/m^3	-
Suspended Particulate Matter (SPM)	Annual avg*	360 μg/m^3	140 μg/m^3	70 μg/m^3	-
	24 hour**	500 μg/m^3	200 μg/m^3	100 μg/m^3	-
Respiratory Particulate Matter (PM_{10})	Annual avg*	120 μg/m^3	60 μg/m^3	50 μg/m^3	20 μg/m^3
	24 hour**	150 μg/m^3	100 μg/m^3	75 μg/m^3	50 μg/m^3
Lead (Pb)	Annual avg*	1.0 μg/m^3	0.75 μg/m^3	0.50 μg/m^3	0.5-1 μg/m^3
	24 hour**	1.5 μg/m^3	1.0 μg/m^3	0.75 μg/m^3	-
Carbon monoxide (CO)	8 hours	5.0 mg/m^3	2.0 μg/m^3	1.0 mg/m^3	10.0 mg/m^3
Carbon monoxide (CO)	1 hour	10.0 mg/m^3	4.0 μg/m^3	2.0 mg/m^3	10.0 mg/m^3

2. The National Ambient Noise Standard

Noise can cause irritation and multiple health problems, including loss of hearing, hypertension, annoyance, fatigue and so no. Noise may be caused by a number of business activities related to community life, industry and transport. A comparative standard of National Ambient Noise Standard notified in Noise Pollution (Regulation and Control) Rules, 2000 and WHO guideline is given in Table 6.3.2. The noise standards are generally set on the basis of WHO stipulations. A comparison shows that in India the noise standard set are more or less in tune with the WHO guideline. But however, an issue to be considered is the implementation.

Table 6.3.2 The National Ambient Noise Standard Notified by Central Pollution Control Board and in a Comparison with WHO Guideline

AREA CLASS	**National Ambient Noise Standard**		**WHO Guideline (Day and Night time)** Limits in dB
	Day Time (6am-9pm)	**Night Time (9pm-6am)**	
Residential	55	45	45
Commercial	65	55	60
Industrial	75	70	65
Silence zone	50	40	45

NOTE: As stated in the National Ambient Noise Standard, *Silent zone* is an area comprising not less than 100 metres around hospitals, educational institution, courts, religious places or any other area which is declared as such by the competent authority.

3. Primary Water Quality Criteria

The Central Pollution Control Board has classified water resources of the country according to their uses for setting water quality objectives for different water bodies. Five water quality classes have been designated (A-E) on the basis of the water quality requirements for a particular use. The classification system is present in Table 6.3.3. The main finding of the regulation review are as follows:

Class A and C: Drinking water source

- WHO does not produce any guideline for quality of drinking water source. However, it is recommended that parameters specified for the drinking water source, either with/without treatment, should be based on drinking water standard.
- For parameters specified in the Primary Water Criteria (Total coliform, pH, DO and BOD), all the criteria, except total coliform organisms, are more or less in line with good quality surface water. It should be noted that all these parameters are not mentioned in drinking water quality guideline set by WHO. Pertaining to Total coliform organisms, it should be around 0 in 250 mL according to the EU standard.
- According to WHO guideline, the important parameters that are necessary to be considered consist of conductivity, cations, anions and chlorine dioxide (ClO_2).

Class B and D: Surface water for bathing and Propagation of wild life and fisheries

- Quality of water for the purpose of irrigation, industrial cooling and controlled waste disposal is not mentioned by WHO.
- The criteria indicated by the rules, including the coliform organisms, pH, BOD and DO are in line with international standards, indicating surface water with a good quality.
- The parameters specified should include heavy metals and organic pollutants.

Class E: Irrigation, industrial cooling, controlled waste disposal

- Quality of water for the purpose of irrigation, industrial cooling and controlled waste disposal is not mentioned by WHO.
- For Agricultural use & Irrigation, according to the international guidelines such as in Canadian guideline, it is emphasized on organic and inorganic substances. The organic substances include carbon tetrachloride and pesticides such as aldicarb, atrazine, bromacil, bromoform, bromoxynil, captan, carbofuran, chlordane and carbaryl. As for inorganic substances, these include aluminium, beryllium, boron, cadmium, calcium and arsenic. Apart from these, blue-green algae is also included in the guideline.

Table 6.3.3 Primary Water Quality Criteria for Various Uses of Fresh Water

CLASS	DESIGNATED BEST USE	CRITERIA
A	Drinking water source without conventional treatment but after disinfections	• Total coliform organisms MPN/100mL shall be 50 or less. • pH between 6.5-8.5 • DO 6 mg/l or more • BOD 2 mg/l or less
B	Outdoor bathing (organised)	• Total coliform organisms MPN/100mL shall be 500 or less. • pH between 6.5-8.5 • DO 5 mg/l or more • BOD 3 mg/l or less
C	Drinking water source with conventional treatment followed by disinfections	• Total coliform organisms MPN/100mL shall be 500 or less. • pH between 6-9 • DO 4 mg/l or more • BOD 3 mg/l or less
D	Propagation of wild life, fisheries	• pH between 6.5-8.5 • DO 4 mg/l or more • Free ammonia (as N) 1.2 mg/l or less
E	Irrigation, industrial cooling, controlled waste disposal	• pH between 6.0-8.5 • Electrical conductivity less than 2250 μmhos/cm • Free ammonia (as N) 1.2 mg/l or less

The Environmental (Protection) Rules, 1986

Schedule –VI

General Standards for Discharge of Environment Pollutants Part-A: Effluent

Table 6.3.4 Environmental (Protection) Rules 1986

SI. NO.	PARAMETER	STANDARD			
		Inland surface water	Public Sewer	Land for irrigation	Marine coastal areas
1	Colour and odour	Sec.6 of Annexure-I	-	Sec.6 of Annexure-I	Sec.6 of Annexure-I
2	Suspended solids, mg/l	100	600	200	(a) For process waste water-100 (b) For cooling water effluent 10%above total suspended matter of influent
3	Particle size of suspended solids, µm	Shall pass 850 µm SI Sieve	-	-	(a) Floatable solids, max 3 mm (b) Settleable solids, max 850 µm
4	pH value	5.5 - 9.0	5.5 - 9.0	5.5 - 9.0	5.5 - 9.0
5	Temperature, ° C	Shall not be exceed 5° C above the receiving water temperature	-	-	Shall not be exceed 5° C above the receiving water temperature
6	Oil and grease, mg/l	10	20	10	20
7	Total residual chlorine, mg/l	1.0	-	-	1.0
8	Ammonia nitrogen, mg/l (as N)	50	50	-	50
9	Total Kjedahl nitrogen, mg/l (as NH_3)	100	-	-	100
10	Free ammonia, mg/l (as NH_3)	5.0	0	-	5.0
11	BOD_5 @20° C, mg/l	30	350	100	100
12	COD, mg/l	250	-	-	250
13	Arsenic, mg/l (as As)	0.2	0.2	0.2	0.2
14	Mercury, mg/l (as Hg)	0.01	0.01	-	0.01

The Environmental (Protection) Rules, 1986

Schedule –VI

General Standards for Discharge of Environment Pollutants Part-A: Effluent (Cont)

SI. NO.	PARAMETER	STANDARD			
		Inland surface water	Public Sewer	Land for irrigation	Marine coastal areas
15	Lead, mg/l (as Pb)	0.1	1.0	-	2.0
16	Cadmium, mg/l (as Cd)	2.0	1.0	-	2.0
17	Hexavalent chromium, mg/l (as Cr^{+6})	0.1	2.0	-	1.0
18	Total chromium, mg/l (as Cr)	2.0	2.0	-	2.0
19	Copper, mg/l (as copper)	3.0	3.0	-	3.0
20	Zinc, mg/l (as zinc)	5.0	15	-	15
21	Selenium, mg/l (as Sc)	0.05	0.05	-	0.05
22	Nickel, mg/l (as Ni)	3.0	3.0	-	5.0
23	Cyanide, mg/l (as CN)	0.2	2.0	0.2	0.2
24	Fluoride, mg/l (as F)	2.0	15	-	15
25	Dissolved phosphates, mg/l (as P)	5.0	-	-	-
26	Sulphide, mg/l (as S)	2.0	-	-	5.0
27	Phenol compounds, mg/l (as C_6H_5OH)	1.0	5.0	-	5.0
28	Radioactive materials: (a) alpha emitter, µcurie/ml (b) Beta emitter, µcurie/ml	10^{-7} 10^{-6}	10^{-7} 10^{-6}	10^{-7} 10^{-7}	10^{-7} 10^{-6}
29	Bio-assay test	90% survival of fish after 97 hours in 100% effluent	90% survival of fish after 97 hours in 100% effluent	90% survival of fish after 97 hours in 100% effluent	90% survival of fish after 97 hours in 100% effluent
30	Manganese, mg/l (as Mn)	2.0	2.0	-	2.0
31	Iron, mg/l (as Fe)	3.0	3.0	-	3.0
32	Vanadium, mg/l (as V)	0.2	0.2	-	0.2
33	Nitrate nitrogen, mg/l (as N)	10	-	-	20

6.3 Environmental Policies, Rules and Regulations

		WHO	EPA UK	USEPA National Ambient Air Quality Standard (NAAQS)	
POLLUTANTS	**TIME WEIGHT AVERAGE**	**Air Quality Guideline**		**Primary standard**	**Secondary standard**
1. Sulphur dioxide (SO_2)	Annual avg*	-		39 µg/m³	
	24 hour**	20 µg/m³		184 µg/m³	
	3 hour				1,300 µg/m³
	15 min	-	266 µg/m³		
	10 min	500 µg/m³			
2. Oxide of Nitrogen as NO_2	Annual avg*	40 µg/m³		100 µg/m³	100 µg/m³
	24 hour**				
	1 hour	200 µg/m³	200 µg/m³		
3. Suspended Particulate Matter (SPM)	Annual avg*			15.0 µg/m³	15.0 µg/m³
	24 hour**				
4. Respirable Particulate Matter (PM_{10})	Annual avg*	20 µg/m³			
	24 hour**	50 µg/m³	50 µg/m³	150 µg/m³	150 µg/m³
5. Lead (Pb)	Annual avg*	0.5-1 µg/m³	0.25 µg/m³		
	Quaterly avg			1.5 µg/m³	1.5 µg/m³
6. Carbon monoxide (CO)	Annual avg*				
	24 hour**				
	8 hour	10 mg/m³	11.6 mg/m³	10 mg/m³	None
	1 hour**	30 mg/m³		40 mg/m³	None
7. Ozone	8 hour	100 µg/m³	100 µg/m³	150 µg/m³	150 µg/m³
	1 hour			240 µg/m³	240 µg/m³
8. Benzene	Annual avg		11.25 µg/m³		
9. 1,3-Butadiene	Annual avg		2.25 µg/m³		

6.4 Environmental Awareness Amongst the Public

Activities Set up by the Government

Awareness is the fundamental tool for protection of the environment. In Sikkim, the Public Environmental Awareness Programmes had been carried out by the State Pollution Control Board of Sikkim in order to create awareness among the public about the importance of prevention and control of pollution at all levels. The activities, which are celebrated by State Pollution Control Board in 2004, are as follows:

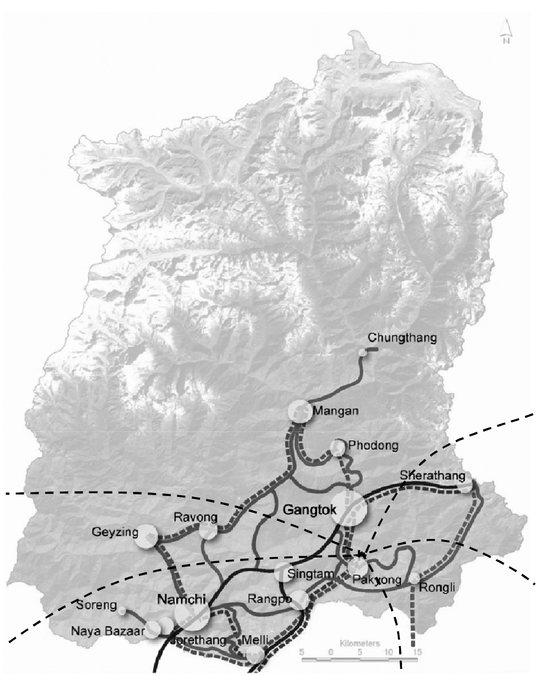
1) World Environmental Day on 5th June
2) International Ozone Day on 16th September
3) National Science Day.

Besides the above celebrations, the State Pollution Control Board also produced:

1) Documentaries and telecast them in the local cable TV network on environmental issue
2) Regular environmental reports
3) Advertisement in the local paper
4) The State Pollution Control Board also acts as a nodal agency in the Implementation of National Environmental Awareness Campaign funded by Ministry of Environment and Forest, Government of India.

Part III :

Implementation & Conclusion



1.0 Key Policy Considerations for Implementation of the State Strategic Urban Plan

2.0 The Significance of the Strategic Urban Plan

3.0 Next Step

4.0 References

5.0 Appendices

1.0 Key Policy Considerations

Key policies for realizing the State Strategic Urban Plan

The above State Strategic Urban Plan will remain as a documented proposal if no corresponding policies are put in place to enforce execution of the Plan. Therefore, the following actions are recommended:

1. Chart an "Action Plan" to guide the implementation of the Plan, which may include:

- Endorsing the State Strategic Urban Plan as an official planning document ready to be rolled out to guide all future developments across the State at different milestones

- Setting up a Strategic Planning Team within UD&HD to administer review of the State Strategic Urban Plan every 5 years so as to ensure that the plan is updated to address the prevailing needs due to any dynamic changes to the social, cultural, and economic environment of Sikkim

- Setting up a permanent Strategic Planning Review Panel comprising at least the following 11 government agencies:
  - UD&HD, Building & Housing Dept, Tourism Dept, Roads & Bridges Dept, Mines & Geology Dept, Rural Management & Development Dept, Transport Dept, PHED, Power Dept, District Collector, and Block Development Office.
  - In co-operation with Land Revenue Dept, Forest Dept, Health, Agriculture, Education, Sports Depts, etc., through consultations.
  - Panel to be chaired and administered by UD&HD.

In addition to the action plan stated for the State Strategic Urban Plan, the following points shall be considered for the implementation of infrastructure strategies:

- Set up a Strategic Infrastructure Planning Team comprising of PHED, RDD, Private Water suppliers as well as Energy & Power Department (EPD) to administer the State Water, Wastewater and Power Infrastructure Strategic Plan Review every 5 years.

- UD&HD should be represented in the Strategic Infrastructure Planning Team for the purpose of overall coordination amongst infrastructure and physical developments.

1.0 Key Policy Considerations

2. For day-to-day regular businesses, various planning mandates have to be given in support of enforcement of the Plan. They are:

- Formulate appropriate development control regulations according to respective Land Use Development Guide Plan for individual towns which should be given statutory significance

- Empower responsible agencies for enforcement through regular monitoring and inspection

- Require mandatory consultations with the Strategic Planning Team (SPT) of UD&HD on all development projects which are hence better coordinated

- Hold regular bi-weekly or monthly coordination meetings between SPT and the relevant infrastructure and development agencies to address planning issues arising from individual key development proposals

2.0 The State Strategic Urban Plan

The Significance of the State Strategic Urban Plan

As the population of Sikkim continues to grow from the current 580,000 people to the projected 1.1 million by 2040, many resources will be mobilized to meet the natural and inevitable growth of various urban centers which are expected to accommodate 50% of this population. It is therefore essential to have a structured Strategic Urban Plan at the State level to guide utilization and distributions of the precious resources across the State such that all physical developments from amenities to transport and utility infrastructures are thoroughly planned and work toward a balanced and healthy growth of urban centers across Sikkim in the interests of all urban dwellers in the State.

While the State Strategic Urban Plan offers a clear conceptual blueprint giving a big picture of how the physical development of Sikkim should take place in order to achieve an optimal result, the conceptual proposals outlined in the Plan will have to be examined further through separate or ad-hoc technical feasibility studies or detailed planning at a micro scale. Nevertheless, they will serve as useful references or pointers giving directions to the Sikkim Government on what should be done in next 35 years.

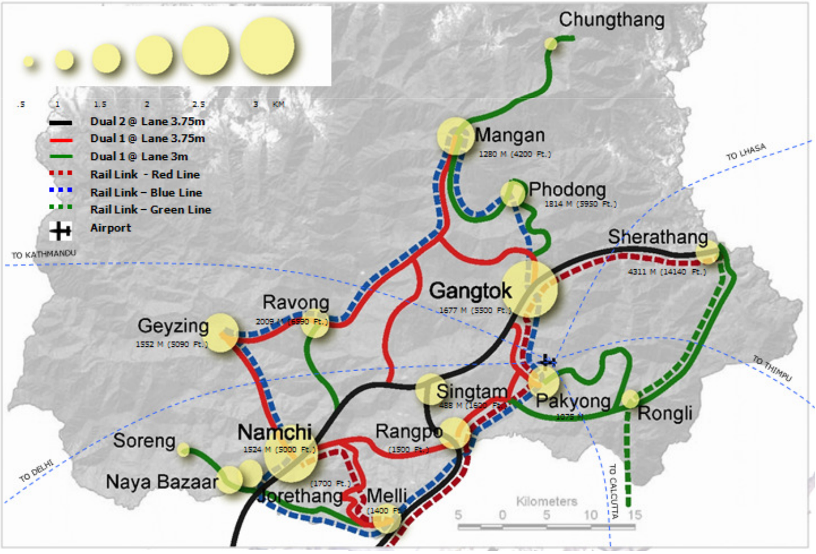


Figure 2.1 State Strategic Plan at Year 2040

3.0 Next Step

Going Forward

The planning proposals, as illustrated in the preceding chapters, will give a clear guide on development strategies in the short-term, medium-term and long-term for the State of Sikkim.

The various proposed planning parameters and infrastructure estimates will be used as key planning basis for next stage of planning task on formulation of Development Control Plans for 4 major urban centers in Sikkim.

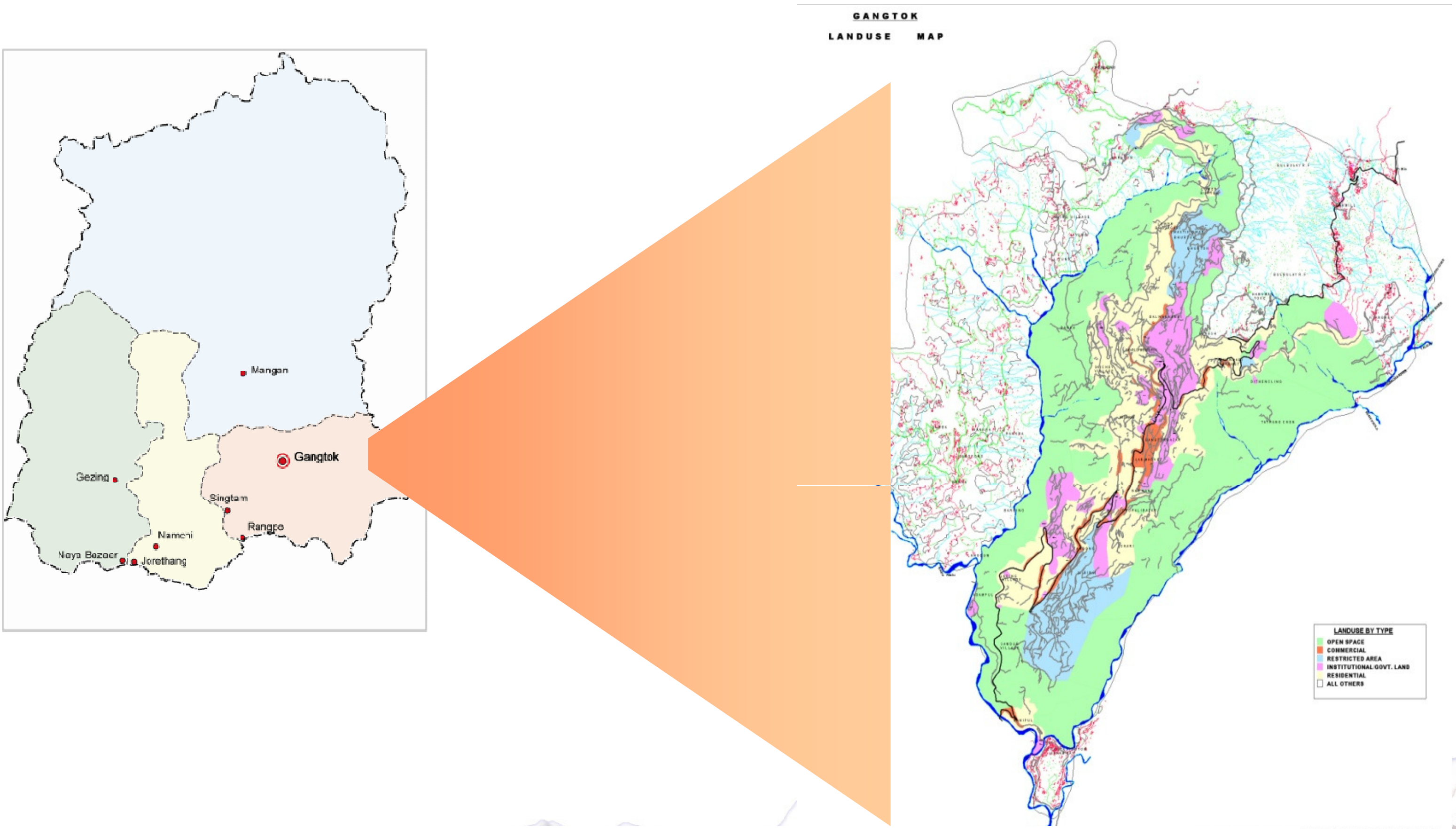


Figure 3.1 Illustration of Detailed Planning for Gangtok, Namchi. Mangan and Geyzing in the Next Level of Planning

4.0 References – State Strategic Urban Plan

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1-b. Eleventh (XI) Plan and Annual plan 2007-08 for Gangtok. Water Security and P.H.E. Department. Government of Sikkim, Gangtok.

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2. Wastewater Treatment

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5.0 Appendix A- MSW Facility

MSW Facilities		
	Existing	New
A. East District	L: Max out by 2012	L:279,225MT (2025), L:325,215MT (2040)
Gangtok	T: 1 x 20MT/d, C: 1 x 40MT/d	-
Singtam - Rangpo	0	T: 1 x 15MT/d, C: 1 x 15MT/d
Pakyong	0	T: 1x 5MT/d, C: 1 x 5MT/d
Sherathang	0	T: 1x 5MT/d, C: 1 x 5MT/d
Rongli	0	T: 1x5MT/d, C: 1 x 5MT/d
B. North District		L:27,923MT (2025), L:72,270MT (2040)
Mangan	0	T: 1x10MT/d, C: 1 x 10MT/d
Phodong	0	T: 1x5MT/d, C: 1 x 5MT/d
Chungthang	0	T: 1x5MT/d, C: 1 x 5MT/d
C. West District	L: 7.446mil MT (2009-2029)	L:27,923MT (2025), L:72,270MT (2040)
Geyzing-Pelling	0	T: 1x10MT/d, C: 1 x 10MT/d
Nayabazaar	0	T: 1x5MT/d, C: 1 x 5MT/d
Soreng	0	T: 1x5MT/d, C: 1 x 5MT/d
D. South District	Covered by West District	L:130,743MT (2025), L:252,945MT (2040)
Namchi	0	T: 1x30MT/d, C: 1 x 30MT/d
Jorethang	L: NA	T: 1x10MT/d, C: 1 x 10MT/d
Ravong	0	T: 1x5MT/d, C: 1 x 5MT/d
Melli	0	T: 1x5MT/d, C: 1 x 5MT/d

*For Landfill (L): MSW landfill waste x 365 days x 15 yrs

5.1 Appendix B – MSW Projection to Landfill

Assumption: 60% of MSW goes to Landfill [3b]

Solid Waste	2015	Landfill Waste (MT/day)	2025	Landfill Waste (MT/day)	2040	Landfill Waste (MT/day)
East district	**184,800**	**44.4**	**213,300**	**51**	**347,500**	**59.4**
Gangtok	138,600	33.24	149,310	35.82	160,875	38.64
Singtam	14,784	3.54	17,064	4.08	22,275	5.34
Rangpo	14,784	3.54	17,064	4.08	22,275	5.34
Pakyong	9,240	2.22	17,064	4.08	22,275	5.34
Sherathang	3,696	0.9	6,399	1.56	12,375	3
Rongli	3,696	0.9	6,399	1.56	7,425	1.8
West District	**13,200**	**3.18**	**21,330**	**5.1**	**55,000**	**13.2**
Geyzing - Pelling	7,920	1.92	12,798	3.06	35,750	8.58
Nayabazaar	3,960	0.96	6,399	1.56	13,750	3.3
Soreng	1,320	0.3	2,133	0.54	5,500	1.32
North District	**13,200**	**3.18**	**21,330**	**5.1**	**55,000**	**13.2**
Mangan	7,920	1.92	12,798	3.06	35,750	8.58
Phodong	3,960	0.96	6,399	1.56	13,750	3.3
Chungthang	1,320	0.3	2,133	0.54	5,500	1.32
South District	**52,800**	**12.66**	**99,540**	**23.94**	**192,500**	**46.2**
Namchi	31,680	7.62	64,701	15.54	134,750	32.34
Jorethang	10,560	2.52	14,932	3.6	23,100	5.52
Ravong	5,280	1.26	9,954	2.4	17,325	4.14
Melli	5,280	1.26	9,954	2.4	17,325	4.14

5.2 Appendix C – Proposed Substations

	Existing	2015	2025	2040
East district				
Gangtok*	(1) 2x 5 =10 MVA, (2) 3x 5 = 15 MVA, (3) 1x 5 = 5 MVA, (4) 2x10 = 20 MVA	-	-	-
Singtam	-	(1) 2x2.5 = 5 MVA, (2) 1x2.5 = 2.5 MVA	-	-
Rangpo	-	(1) 1x2.5 = 2.5 MVA, (2) 1x2.5 = 2.5 MVA	(1) 1x2.5 = 2.5 MVA	
Pakyong	(1) 2x10 = 20 MVA	(1) 1x5 = 5 MVA	-	-
Sherathang	-	(1) 1x2.5 = 2.5 MVA, (2) 1x2.5 =2.5 MVA	-	-
Rongli	(1) 2x2.5 = 5 MVA	(1) 1x2.5 = 2.5 MVA	-	-
West District				
Geyzing	(1) 2x2.5 = 5 MVA	(1) 1x2.5 = 2.5 MVA	-	(1) 1x2.5 = 2.5 MVA
Nayabazaar	-	(1) 1x2.5 = 2.5 MVA, (2) 1x2.5 = 2.5 MVA	-	-
Soreng	(1) 2x2.5 = 2.5 MVA	(1) 1x2.5 = 2.5 MVA	-	-
North District				
Mangan	(1) 2x5 = 10 MVA	(1) 1x2.5 = 2.5 MVA	-	(1) 1x2.5 = 2.5 MVA
Phodong	(1) 2x2.5 = 5 MVA	(1) 1x2.5 = 2.5 MVA	-	-
Chungthang	(1) 2x5 = 10 MVA	(1) 1x2.5 = 2.5 MVA	-	-
South District				
Namchi**	(1) 2x2.5 = 5 MVA	(1) 2x5 = 10 MVA, (2) 1x5 = 5 MVA	(1) 2x5 = 10 MVA	-
Jorethang	-	(1) 2x2.5 = 5 MVA, (2) 2x2.5 = 5 MVA, (3) 2x5 = 10 MVA	-	-
Ravong	(1) 1x5 = 5 MVA	(1) 2x2.5 = 5 MVA, (2) 1x2.5 = 2.5 MVA	-	-
Melli	(1) 2x5 = 10 MVA	(1) 2x2.5 = 5 MVA, (2) 1x5 = 5MVA	-	-

Surbana