11 TRAFFIC AND TRANSPORTATION

11.1 Traffic and Transport Scenario in Bengaluru

Bengaluru is spatially characterized by a ring-radial system of roads formed by five big axes, which converge towards the centre of the city. Bengaluru Metropolitan Area with more than 11 million people, travelling is getting more and more difficult as the city witnesses nearly 10 million trips a day. Traffic in Bangalore has become a scourge and is only becoming worse. Network speeds are dropping at an alarming rate as overcapacity of its junctions and links are being reached and traffic jams have become the order of the day. Being a victim of its own success, Bangalore's traffic infrastructure has just not been able to keep pace with the fast growing IT industry to which Bangalore is associated with.

Today, home to more than 11 million people the strained network is loaded with more than 100 lakh trips per day. BMTC operates more than 6000 buses and carry more than half these trips, but this is hardly enough, the rest of the traffic has simply overwhelmed the network.

The paucity of public transport services, lack of road network, over dependence of private vehicles and a high growth rate with the city (in the past decade, the city has nearly doubled), has resulted in:

- Traffic Jams/ Extreme congestion
- Decline in journey speeds from 18kmph (2008) to 11kmph (2015) leading to severely overburdened Road Network and long commute times.
- Present trip rate 0.9 per capita per day – approximately 90 lakh trips per day
- Mode share 52% trips on vehicular traffic and 48% on Public Transport (includes private buses)
- Absence of clearly defined road network hierarchy
- Network congestion hampers bus operations significantly - Share of Public Transport dropping further
- Growing use of personalized vehicles
- Intensification of existing economic nodes leading to traffic congestion
- Deficient multimodal integration
- Movement of Freight/ Goods inside the city area
- Intercity Bus Travel Movements disorganized and is scattered all over the city
- Non-Motorized Transport is inadequate with respect to provisions of footpaths and cycling facilities.
- Parking is disorganized in most parts of the city.
- A high car dependency has also added to high air and noise pollution levels

To address the growing concerns of the prevailing and anticipated traffic demands, it is imperative to understand the traffic related issues both at a macro level and a micro level. Hence, to respond to transport requirements of future more appropriately, for the first time in a master planning exercise in India, a transport model has been developed with a focus on integrating land use and transport planning. The model has more than 500 zones and includes 15000 road links and 2300 bus routes.

11.2 Model Development for the Revision of Master Plan

A state of the art transportation modelling suite (CUBE VOYAGER) has been employed for the modelling purpose. A detailed circulation network was drawn taking into cognizance the spatial growth of the city and the road proposals of RSP 2031 and RMP 2015. On this circulation network BMTC bus routes where meticulously coded. All the wards in the BBMP zones and the Villages up to the BDA limit were considered as individual zones. The model was extended to include the BMR as many transport solutions may include the BMR region as well. The Origin and destination data was estimated from the earlier Comprehensive Traffic and Transport Study (CTTS) calibrated functions and further refined and brought up to date through a process called "Matrix estimation from Counts".

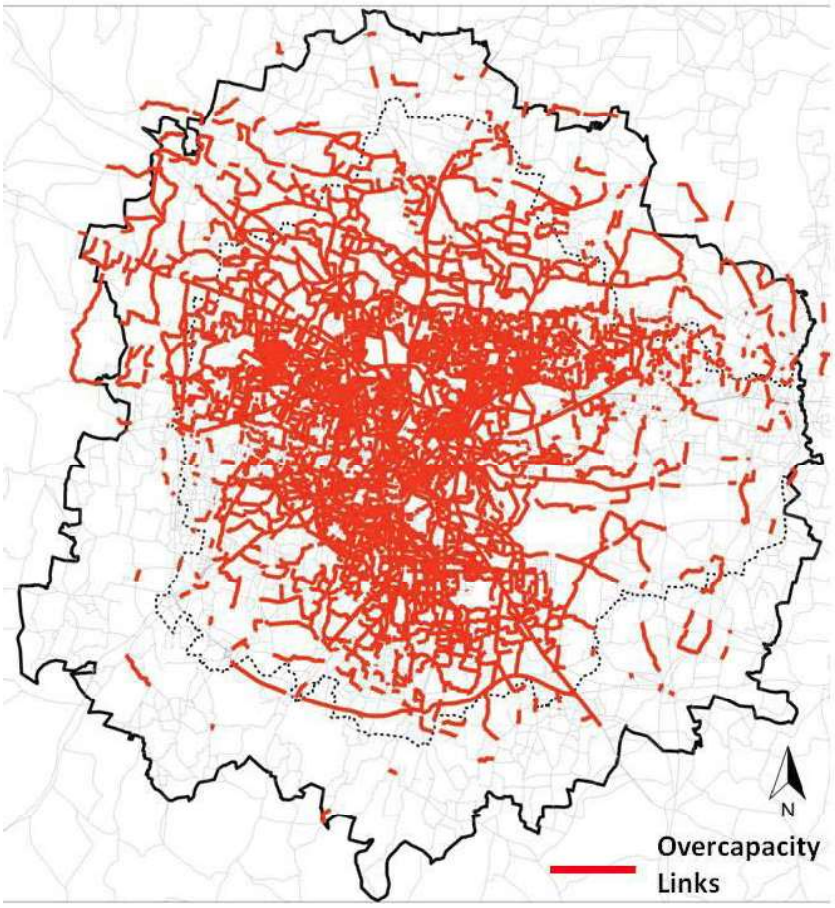
A conventional four stage model was calibrated for Bangalore afresh, and validated across screen lines to prove that the input data is satisfactorily representing city travel. The model was calibrated over 4 modes, Cars and Taxis, Two Wheelers, Auto rickshaws and Public Transport. Trucks, Multi Axial Vehicle's (MAV's), Light Commercial Vehicle's (LCV's) and Bicycles where separately considered for the assignment. The model has been calibrated to represent the morning peak period – the journey to work period (the period used for network capacity analysis)

11.3 Forecast Scenario

The model was run for 2031 assuming spatial growth in line with the growth trends observed today. The metro phase 1 and phase 2 were included in the model. The peripheral ring road was included. The existing network was also improved to a limited extent – example the outer ring road was fully completed and buses have been doubled. The forecast Business As Usual (BAU) scenario shows very high congestion, the followings are the key observations. Refer **Figure 11-1**.

- The Vehicular trips increase more than 3 times and the network is severely congested
- Public Transport share reduces substantially
- Bus frequency would reduce to less than half even with double the fleet
- Almost all roads will be operating at higher than Capacity
- Network speed drops to 8kmph. In the peak direction its < 5kmph. A clearly non sustainable situation.
- The pollution levels from vehicular emission would increase 3 times
- Doing nothing but believing that the Metro phase-II will solve Bengaluru's problem is not a solution

Figure 11-1: Map showing Over-capacity links as per Business as Usual or Do Nothing scenario for BMA 2031



Source: RMP 2031 Analysis

11.4 Approach to Traffic and Transport Planning of the BMA

Conceptually, the larger mobility strategy has been to move people through rings and radials of higher order mass transit systems and a well formed road network that exhibits a strong hierarchy of roads. The main intent has been towards integration of land use with the overall transport network to significantly enhance public transport use. The circulation network establishes strong grid patterns which represent the spatial organization of an orbital and radial form. Also integration of intermodal hubs are being proposed at locations where different mass transit corridors meet, independent of the selected system to help in efficient interchanging. The accessibility is not being addressed in detail within the ambit of the Master Plan study but the essential base network is being setup to ensure that good end mile connectivity to the mobility corridors are easily achievable.

- A major mass transit station is within 3 to 4 kms of any part of Bangalore which can be fitted with an end mile connectivity solution.
- Cross sectional elements of the road networks are set with proper footpaths and segregated cycle tracks.
- Minor bus terminals are being provided in all areas to ensure that a feeder system can be operated. These can be fitted with charging ports to facilitate Electric Vehicle's (EV's).

- The Multi Utility Zones proposed in the larger road network have been conceived to include Intermediate Public Transport (IPT) stands or Taxi Stands which can be included adjacent to mass transit stations to enable efficient end mile connectivity.
- Also, the Multi Utility Zones proposed as part of the road cross sections can also house Public Bicycle docking stations. Given that all major roads will compulsorily have a cycle track dedicated), it should be easy to put in place a Public Bicycle Sharing System to help improve end mile connectivity

11.5 Transport Strategy

Considering the current challenges that Bangalore is facing and the Business as Usual forecasts which shows a totally unsustainable situation, a set of key priorities or principles are devised that underpin the development of the transport strategy. The strategy seeks to address the concerns of all segments of commuting population by emphasizing the pre-eminence of public transport and non-motorized modes of travel; adopting various elements of Travel Demand Management and integrating with the land use development scenarios. This is in line with the National Urban Transport Policy. The following measures have to be considered while implementing the master plan:

- Improve the existing road network by developing a network structure and define the road hierarchy. Provide additional rings/radials wherever possible and consider urban road design as an important element.
- Focus on providing more public transport targeting to carry 70% of trips of the city from the present 50%. Seriously consider more transport spends on provision of Metro/BRT/Monorails etc. Push for the Commuter rail system.
- Establish a street network model design which intrinsically has provisions for pedestrians and cyclists. Consider that the Pedestrian is also a road user – provide comfortable/safe facilities for pedestrians. Re-establish the role of bicycles in Bangalore and encourage/provide for them.
- To bring 20-25% of Planning Area under Transit Oriented Development
- Provide a freight movement plan with logistic hubs and warehouses interconnected with dedicated freight corridors
- Reorganize interstate bus and rail hubs and integrate the same with the local public transit systems for seamless intermodal transfers.

Other critical transport elements that need to be considered but is not explicitly spelt out in the master plan are as follows:

- Traffic management is assumed to be efficiently handled through state of the art ITS. The BTRAC programme that is already part implemented in Bangalore should be continued to bring in the best technologies in the market to ensure that traffic management is at its efficient best.
- It is assumed that BMTC buses have to be increased to 15,000 by 2031.

- The shift to public transport can never be achieved if some form of demand management is applied. One of the best forms of demand management that is already in an advanced stage of thinking is parking charges. While this would push private mode users away from cars and two wheelers the city authorities can also be assured of a regular source of income.
- Other demand management measures such as increasing restriction; corridor pricing etc must be pursued after the implementation of the Public Transport Network.

11.6 Traffic and Transportation Proposals

11.6.1 Circulation Plan

The circulation network has identified radial and ring roads to create more opportunities for mobility within the metropolitan area and the larger region. The proposed circulation network will have about 800 Kms (including existing 375 kms) of Primary Arterial which has 26 radials and 5 rings. The primary circulation network embraces completely new ring road (Inner Peripheral Ring Road) apart from the completion of the Intermediate Ring Road and the Peripheral Ring Road. A detailed Primary Circulation Network Plan along with an inventory is shown in Figure 11-2 and a summary of the inventory is given in Table 11-1.

Figure 11-2: Map showing Proposed Primary Circulation Network- RMP 2031

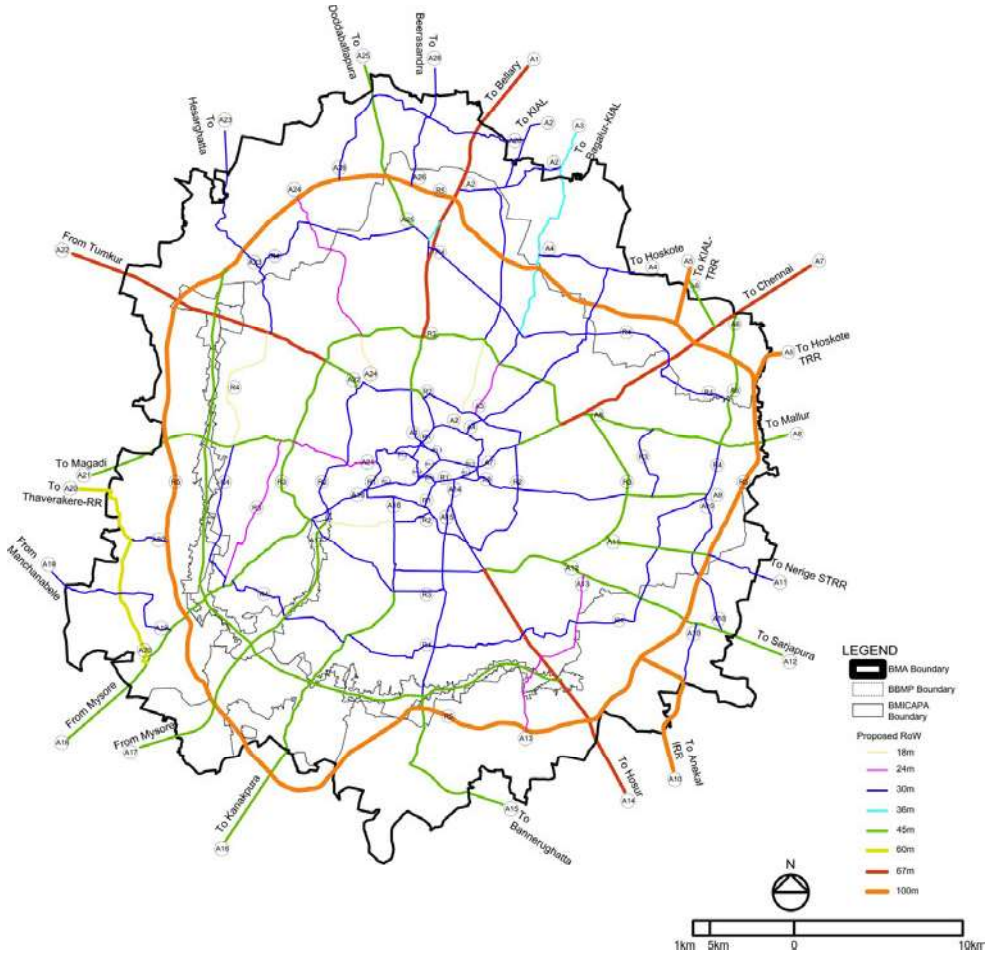


Table 11-1: Inventory of Existing and Proposed Primary Circulation Network (Category-1 Projects)

Sl. No.	Road Code	Road Name	Road Type	Approximate Length (kms)	Alignment Status	
					Existing	Proposed
1	R1	Inner Ring Road	Arterial	40		
2	R2	Intermediate Ring Road	Arterial	40		
3	R3	Outer Ring Road	Major Arterial	60		
	R3	Old Outer Ring Road	Arterial	9		
	R3	Hoodi/ Graphite India Main Road	Arterial	5		
4	R4	Inner Peripheral Ring Road	Arterial	105		
5	R5	Peripheral Ring Road	Major Arterial	118		
	R5	NICE Ring Road	Major Arterial	44		
6	A1	Bellary Road (AH43)	Major Arterial	20		
7	A2	Nagawara Main Road	Major Arterial	26		
8	A3	Hennur Main Road	Major Arterial	16		
9	A4	Banaswadi Main Road	Major Arterial	12		
10	A5	Hoskote TRR Road	Major Arterial	6		
11	A6	SH 35/ Sivas Road	Major Arterial	7		
12	A7	Old Madras Road (NH4)	Major Arterial	18		
13	A8	Whitefield Main Road	Major Arterial	11		
14	A9	Old Airport Road	Arterial	14		

Sl. No.	Road Code	Road Name	Road Type	Approximate Length (kms)	Alignment Status	
					Existing	Proposed
15	A10	SH 35/ Chandapura-Domasandra Main Road/ Anekal IRR Road	Major Arterial	13		
16	A11	Kadabessanahalli Main Road	Arterial	9		
17	A12	Sarjapur Main Road	Major Arterial	13		
18	A13	Haralur Main Road	Arterial	11		
19	A14	Hosur Main Road (AH45)	Major Arterial	18		
20	A15	Bannerughatta Main Road (SH87)	Major Arterial	20		
21	A16	Kanakpura Main Road (NH 209)	Major Arterial	18		
22	A17	Mysore Express Way	Arterial	17		
23	A18	Mysore Main Road (SH17)	Major Arterial	19		
24	A19	Dodda Almara Main Road	Arterial	9		
25	A20	Thaverakere Ring Road	Arterial	18		
26	A21	Magadi Main Road (SH85)	Major Arterial	14		
27	A22	Tumkur Main Road (AH47)	Major Arterial	16		
28	A23	Hessaraghatta Main Road (SH39)	Major Arterial	6		
29	A24	Jallahalli West Main Road	Arterial	10		

Sl. No.	Road Code	Road Name	Road Type	Approximate Length (kms)	Alignment Status	
					Existing	Proposed
30	A25	Dodda Ballapur Main Road (SH9)	Major Arterial	12		
31	A26	Sir MVIT College Road/ Beerasandra Road	Arterial	21		
Total				**795**		

Some of the important new alignments identified are:

- Completing missing links within the Intermediate Ring Road which include connecting CIL Main Road and Pottery Main Road, connecting Byapanahalli Main Road and Pottery Main Road and augmentation of Banashankari 50 feet road which connects to BMIC Expressway
- Inner Peripheral Ring Road, which is a newly identified ring in between ORR and PRR. The alignment is a combination of existing and new roads. It connects suburbs such as Yelahanka, Jakkur, RK Hegde Nagar, Horamavu, Kithaganur, Sonnenahalli, Kadugodi, Varthur, Chikka Begur, Hulimavu, Kengeri, Ullal, Nagasandra and Chikbanavara. This is a critical link as it constitutes areas which will further densify in the coming years.
- As mentioned earlier the PRR is critical to BMA, the master plan also proposes that the PRR connects to NICE corridor at Tumkur road portion.
- Two new links are proposed to BIAL other than the existing Bellary Road and Hennur Road. One is an extension of existing Nagawara Main Road and the other is extension of SH-35 at Old Madras Road via Sivas Road.
- Extension of Banaswadi Main Road via Panathur Main Road towards Hoskote LPA
- Developing a 30m road between Dodda Ballapur Main Road and Bellary Road towards Beerasandra (SH 104) in BIAPPA LPA
- Integration of Regional connections with STRR at Nelamangala, Hoskote and Anekal LPA's respectively.

11.6.2 Public Transport Systems

As discussed a complex grid of radial and ring systems have been proposed complimenting the metro phase 1 and 2. The mass rapid transit systems proposed is as per the **Table 11-2** and as shown in **Figure 11-3**. The selection of mass transit system is based on the section load (passenger per hour per direction) for selected systems.

Table 11-2: Existing and Proposed Public Transport Systems under RMP 2031

Sl.No	Corridor	Length (kms)	System
1.	Metro Phase 1	42.4	Metro (Implemented)
2.	Metro Phase 2	81.4	Metro (Under Implementation)
3.	Metro Phase 3 (Airport Link)	29.5	Metro (18.3 km within BMA)
4.	Commuter Rail Network	106	Commuter Rail System
5.	Intermediate Ring Road (R2)	37	LRT/ Monorail/ BRTS (Medium Level)
6.	Outer Ring Road (R3)	62.6	Metro
7.	Inner Peripheral Ring Road (R4)	81.8	LRT/ Monorail/ BRTS (Medium Level)
8.	Peripheral Ring Road (R5)	106	Metro
9.	Bellary Road (A1)	13.5	LRT/ Monorail/ BRTS (Medium Level)
10.	Hennur -Bagalur Main Road (A3)	21.6	BRTS
11.	Sarjapura Road (A10)	26.3	LRT/ Monorail/ BRTS (Medium Level)
12.	Old Airport Road (A8)	26	LRT/ Monorail/ BRTS (Medium Level)
13.	Magadi Road (A20)	9.2	LRT/ Monorail/ BRTS (Medium Level)
14.	Jalahalli West Main Road (A24)	10.4	LRT/ Monorail/ BRTS (Medium Level)
Total		653.7	

11.6.3 Bus Augmentation

BMTC, at present is operating 6249 buses on 2500 routes. There are 10 TTMC's (Traffic and Transit Management Centre's) and 40 depots, new depots and TTMC/ Bus Terminals have been identified within the newly planned areas of BMA. It is assumed that the bus fleet size will be in the range of 15,000.

11.6.4 Interstate Bus Terminal

BMTC along with KSRTC provides the regional/ interstate connectivity from Bangalore to other parts of the cities and vice versa. A total of six interstate bus terminals are proposed on Tumkur Road, Mysore Road, Old Madras Road, Hosur Road, Bellary Road and Magadi Road so that intercity traffic will not get mixed with the city traffic.

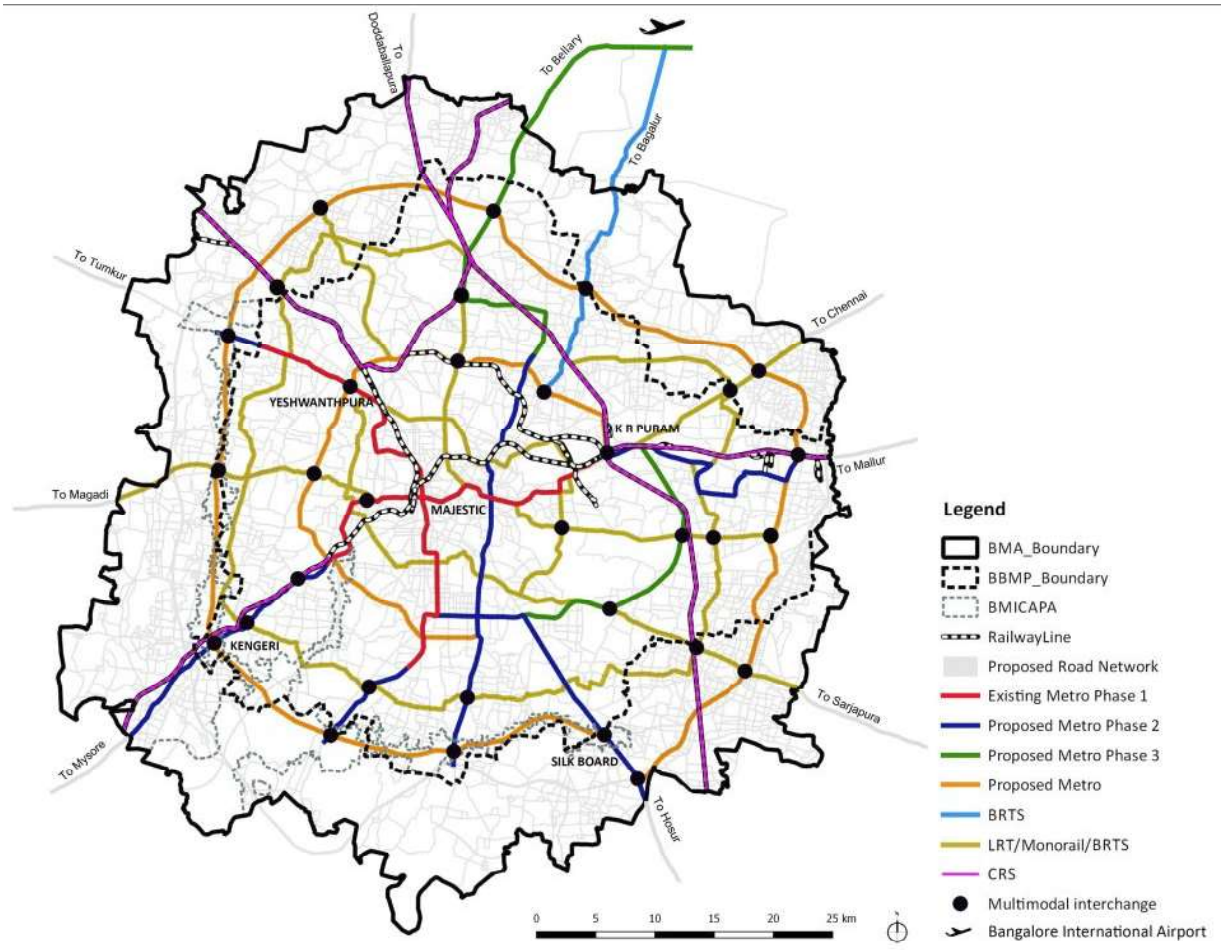
11.6.5 Intermodal Interchange

RMP 2031 has proposed 36 intermodal interchange stations intersections of two or more public transit corridors.

11.6.6 Freight/ Goods Infrastructure

In order to restrict the freight movement inside the city, eight logistic hubs of 100 acres each is proposed at the periphery of major highways. Logistic Hubs are proposed on Bannerughatta Road, Tumkuru Road (outside BMA), Mysore Road, Mallur Road, Bellary Road, Old Madras Road, Hosur Road and Sarjapura Road.

Figure 11-3: Map showing Proposed Public Transport Network of RMP 2031



12 PHYSICAL AND SOCIAL INFRASTRUCTURE

12.1 Water and Waste Water

The water availability for meeting the future demands of Bengaluru for the master plan period and beyond was one of the concerns expressed by some citizens during the public consultations. By all accounts, the availability of surface water (synonym as Cauvery water) has not affected the growth of city (in terms of population and spatial). Having said that Bengaluru is at the situation where the only surface water source available to city (River Cauvery) is legally getting exhausted and dependency on ground water is growing. Will the city continue to grow? probably yes – for the fact that Bengaluru has become self-sustaining economic growth centre in entire state of Karnataka. Even if the policy decision is taken to reduce the pressure on Bengaluru by developing counter magnets, the real impact would only be visible after decade or two, provided all policy initiatives are implemented in time bound manner.

Water would be required for future population in Bengaluru – during the master plan period (2031) and beyond. It is indeed a fact that city is to face water shortage in future even after having exhausted the only surface water source, thereby increasing the dependency on ground water much more than today. The situation is likely to persist in future, the only difference being the spatial impact. The water is likely to be available and supplied to entire of BBMP by master plan period, it is the adjoining villages with Bengaluru Metropolitan Area, that are likely to get urbanised over next 15 years. How we reduce the water demand and manage the water demand is going to be most important aspect in utilising existing resources to providing safe drinking water to fellow city residents. The implementation of dual pipeline system and use of recycled water for non-potable activities for all future developments is likely bring substantial reduction in potable water demand, thereby dependency on resources. Further, social acceptability of use of recycled yet potable water would completely change the water dynamics in the city. However, this is possible only if the of water supply and sewage system covers the entire planning area.

Located at 950 Mean Sea Level Bengaluru is only metropolitan city which is not abutting to any major surface water source (River). Bangalore Water Supply and Sewerage Board (BWSSB) formed in 1964 under BWSSB Act, 1964 is mandated to provide water supply and sewage systems primarily within the BBMP (708.5 sqkm). However in the Bengaluru Metropolitan Area (admeasuring 1294 sqkm), in addition to BBMP, there are 51 Gram Panchayat's (with 251 villages having spatial extent of 583 sqkm) served by Panachayath Raj Engineering Department (RDPR/ PRED). At present BWSSB is extending the water supply and sewage network to entire BBMP area and is expected to complete the works by 2021. However, there is no coverage of water supply and sewage network in many areas already urbanised and under process of urbanisation outside the BBMP Limits. These areas are expected to get further urbanised by 2031 with planned development as envisaged under Revised Master Plan - 2031. It is therefore recommended that BWSSSB provide support to RDPR in planning for water supply and sewerage network for entire BMA, for the fact that existing/ planned systems

within BBMP will have to be integrated/ extended to villages outside BBMP. This is to help in designing and implementing the integrated networks across BMA.

As per Census, BBMP has a population of 8.4 Million (93% of BMA) whereas the rest of 251 villages together hold 0.7 million persons, thus a total of ~9.1 million in BMA. The population projections for RMP 2031 suggests that population within BMA is expected to reach ~20 million by 2031, thereby, making Bengaluru the third most populous city in the country.

At present BWSSB is withdrawing about 19 TMC of water (1470 MLD) from Cauvery to meet city's water demand. The Plan/ work is on for getting additional 10 TMC (775 MLD) of water as accorded by the Cauvery Tribunal to meet the water demand for BBMP area alone. Thus, altogether about 29 TMC (2250 MLD) of water is available for Bengaluru from Cauvery. Though Unaccounted for Water amounts to 46%, the actual water losses (transmission, leaks, treatment and distribution) are around 15-18%. Also, network coverage (both water supply and sewage) in the city is limited and work is in progress to get entire BBMP covered by 2021.

The water demand has been established considering 135 LPCD supply to the population. Non-domestic water demand for potable purposes has been established considering 45 lpcd for estimated work force. Equal amount of non-potable water has been considered for non-domestic sector to establish the total non-domestic demand. The net water demand including water demand for non-domestic activities has been estimated at 3639MLD for the projected population of 20.3 million for BMA by 2031. The net demand of 3639MLD translates to the total gross water requirement for BMA at 4282 MLD considering 15% losses towards transmission & distribution.

As mentioned earlier, dual pipeline system for use of recycled water would reduce the overall water demand for potable water. If the water supply is split (within plot/ site) into two – potable (@90 lpcd) and non-potable (45lpcd) then the water demand for potable water can be reduced by 865 MLD. However, still there will be water shortage of about 862MLD [refer table 2]. This water shortage likely to be met through Ground Water, thereby increasing the dependency on ground water from present level 677 MLD to 862 MLD (about 27% (185MLD) higher than present levels). It may be noted that due to change of land use from Agriculture to urban activities within BMA, the water withdrawal for current agriculture activities to the tune of 100-150 MLD would be available for urban activities. This is with the assumption that present over draft will continue. Thus, the status of ground water dependence in 2031 would be of the similar scale as it is at present.

To meet the future water demand following are the master plan suggestions:

- **Providing Infrastructure across the Planning Area:** Being a public utility, providing water to the public has a vital interest in its functioning and wellness of the society. More than 27% of water supplied by BWSSB is among the BPL and EWS of the society and is provided free of charge. BWSSB has coverage of 575 sq.km area out of 710 sq.kms of BBMP. The rest 135 Sq.km under 110 villages is expected to be covered by 2021. However, rest of the planning are outside BBMP are not covered by BWSSB, and it is imperative to improve the coverage to not only within BBMP but also in villages outside BBMP falling within BMA. It is therefore recommended to institutionalise the planned water supply and sewage network out BBMP as well to reduce the dependency on ground water.

- **Dual pipe line for drinking and other purposes** for the newly planned areas and additional population. On implementation of Dual pipeline, Government has to take measures to supply Cauvery water for all the purposes for population expected to be living in the BBMP in existing establishments and for only potable purposes for the population residing in any new developments in BBMP area which need to be developed on the basis of zero liquid discharge policy. Similarly, dual pipeline system shall cater to additional population expected to be residing in 251 villages of BMA with only potable water demand being supplied by Government infrastructure. This initiative could minimize additional water requirement significantly but it is difficult to make an assessment of the same at master plan level. As per IS 1172, out of a total per capita demand of 135-200 lpcd, a flushing water requirement of 45 lpcd may be taken for flushing requirements and the remaining quantity for other domestic purposes. However, other non-potable water uses may include gardening, washing etc. Recycled water has to be made available for non-domestic purposes and non-drinking purposes in the 251 villages where the new supply network is planned. Even after realising 865mld of treated recycled water and additional about 2000mld recycled water would be available, which can be utilised for revival of lakes and valley system. Using innovative systems like artificial aquifer recharge would help in improve the ground water levels.
- **Water Conservation:** Over 50% of the population of the project population of 2031 has been assumed to be supplied potable water @135lpcd; however there is a strong potential for reducing this demand of 135lpcd through promoting awareness for water conservation, implementation of decentralised sewerage treatment plants for the local area, which can be utilised for gardening, horticulture purposes and other activities like car washing. This would lead to reduction in potable water demand to 120lpcd, which translate to saving of about 166MLD. Thereby bringing down the dependence on ground water below the present level.
- **Treating Recycled Water to Potable Level:** The fact that Cauvery will not be adequate for city and relishing water from other sources is still to determined, it is proposed to recycle the sewage water with tertiary treatment technologies available in the market and supply to the city for all the purposes.
- **Evaluation of Proposals of Thyagaraja Committee:** For long term purposes some of the major interventions proposed by the Thyagaraja Committee to explore new sources have to be considered by the state government on priority basis.
- **Rejuvenation of Lake and Valley System:** The lake and valley system has been historically water supply source, however due to limited sewage network coverage; most of the lakes are filled with sewage. The improved coverage of sewage network is expected to improve the quality of water flowing into lakes. In addition to that recycled water shall be used to rejuvenate the lakes along with dredging of some of large lake to improve the holding capacities and aid ground water percolation. Adequate sewage network and infrastructure shall be developed to contain the sewage flow into lakes and streams.

Towards provision of land for water and sewage infrastructure, the Master Plan has incorporated the proposals provided by BWSSB for BBMP area and are appropriated depicted in proposed land use maps.

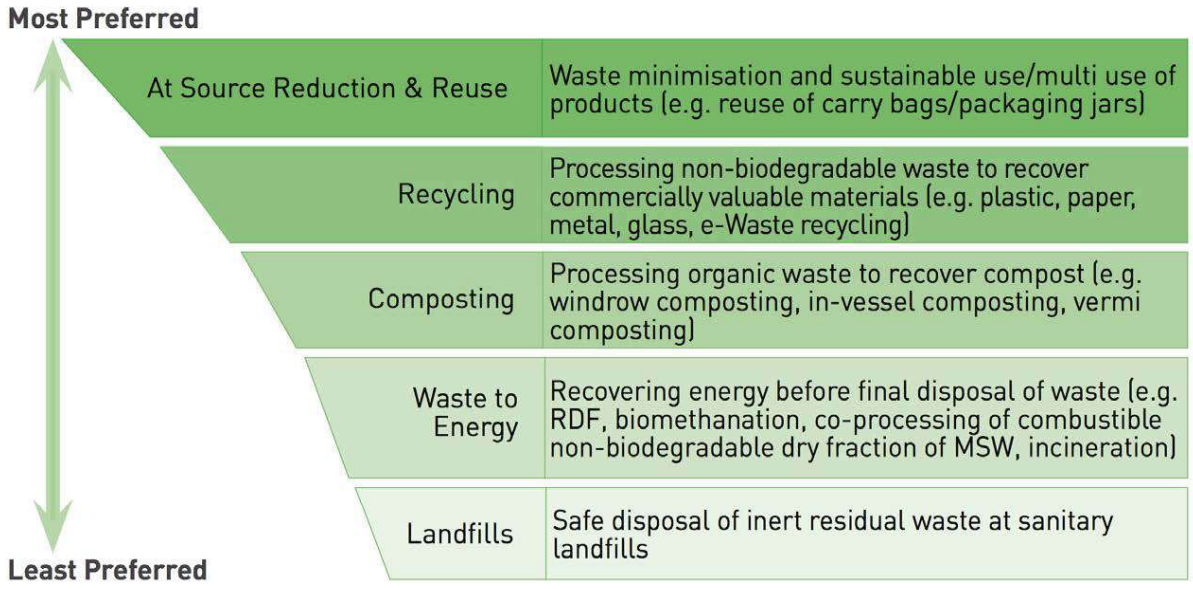
12.2 Municipal Solid Waste

Solid Waste Management (SWM) is an obligatory function of the BBMP and is governed by the Solid Waste Management Rules, 2016 ("SWM Rules") and several court directives. In BMA, which comprises of BBMP and around 50 Gram Panchayats, there is no single unified authority for the waste management. BBMP is looking after the waste management within its jurisdiction, while the rest of the area, which is administered by different Gram Panchayath's, concerned Gram Panchayath is responsible for waste management in their respective jurisdictions.

BBMP is in the midst of transforming its waste management system from centralised to a decentralised one. Going forward with the decentralized approach, in BBMP area, SWM facilities have been substantially provisioned at the ward, zone and city level. BBMP looks after the collection, transportation, segregation, processing, treatment and disposal of solid waste in the city of Bengaluru. BBMP has established dry waste collection centres, enhanced solid waste collection and transportation activity, mechanical sweeping, bulk waste management and waste processing units using modern technologies like bio-methanation waste to energy plants and vermi-composting facilities.

Essentially, BBMP is aiming at The Integrated Solid Waste Management (ISWM) System – a waste management hierarchy (refer Figure 12-1), to ensure reduction in the amount of waste being disposed (Landfill waste) and maximise resource recovery and efficiency.

Figure 12-1: Integrated Solid Waste Management System Hierarchy



Source: BBMP

In Panchayath areas within BMA, reliable information about the management of waste is not readly available. However, the comprehensive socio-economic household survey suggests that 14% of the households in these villages have access to waste collection system. Hence, the existing Status on Solid Waste is limited to BBMP. However, forecasts and demand estimates are for the entire BMA

(including part of BMICAPA). In view of the above, to attain a sustainable solid waste management system in Bengaluru, BBMP has adopted the following Approach and Strategies within its jurisdiction.

a) The Approach:

Reduce – Reuse – Recycle (3R approach): The 3R Approach is aimed at optimising SWM management from all the waste-generating sectors and involving all the stakeholders (waste generators, service providers, informal sector, regulators, government, and community or neighbourhoods). The adoption of 3R minimizes the waste being handled by the local bodies (BBMP/GPs), minimizing public health and environment risk associated with it.

b) Strategies:

- Decentralised SWM Systems: In order to reduce the burden of unscientific handling of large volumes of MSW, the city has opted to shift its focus from a centralised 'single stream' collection and 'Landfill disposal' system to a decentralised 'multiple stream' collection and scientific 'Processing' system.

- Separating Bulk Generators: Bulk Generators contribute to 25% of the city's waste and have been separated from the regular collection cycle. They include domestic generators - apartment complexes with more than 50 units and Commercial bulk generators viz. hotel/ restaurant, clubs, factory, choultry, mall, shopping complex, marriage halls, convention hall, place of worship, institution, office establishment, railway stations, bus stand or any other commercial or public entity which accumulates MSW of a quantity not less than 10 kg per day. These generators are being mandated to set up in-situ systems or link with BBMP empanelled vendors to manage their waste.

- Micro plan: A Micro Plan is a process of creating a solid waste management plan for the smallest unit of management, by splitting the ward into blocks (750 Households + shops). City-wide implementation of the micro SWM plan is already being rolled out in the BBMP area.

The master plan proposes that similar approach and strategies be followed by respective Gram Panchayats in consultation with various stakeholders including ward committees and SWM experts within LPA of BDA for better synchronisation synergies and optimisation of resources. With this background, the RMP 2031 has analysed the existing status of SWM within BMA and has formulated the proposals for allocation of land for SWM facilities in consultation with BBMP.

12.2.1 Municipal Solid Waste Generation

As per the assessment and quantification of municipal solid waste generation carried out by BBMP in the year 2016, the waste generation rate in BBMP area is approximately 564 grams/capita/day (gcpd). In addition, the villages administered by the Gram Panchayath's are expected to get further urbanised/ populated by 2031 with planned development as envisaged by RMP-2031 and therefore, similar estimates have been made for areas outside BBMP.

RMP 2031 has considered waste generation growth rate at 1.3% per annum on the base of 564 gcpd to estimate per capita waste generation by 2031. RMP 2031 estimates that about 13911 tonnes per day of Municipal Solid Waste (MSW) will be generated in BMA by the year 2031 (**Table 12-1)**.

Table 12-1 Waste Generation Estimates for BMA

Year	MSW gpcd @ 1.3% growth p.a.	BBMP Area (8 zones; 198 wards)		Outside BBMP Area (50 Gram Panchayath's; 251 Villages)		BMA (BBMP area + Villages)	
		Projected Population	MSW generation (TPD)	Projected Population	MSW generation (TPD)	Projected Population	MSW generation (TPD)
2016	564	10207062	5757	844837	476	11051899	6233
2021E	602	12164520	7318	1386925	834	13551445	8153
2026E	642	14026694	9002	2590119	1662	16616813	10664
2031E	685	15480378	10597	4840427	3314	**20320805**	**13911**

Source: BBMP

-gpcd: gram per capita per day (as per 2016 waste assessment carried out by BBMP)
-gpcd for BMA is calculated as per gpcd considered for BBMP area
-TPD: Tonnes per day
-Municipal Solid Waste (MSW) comprises of: Residential HH; Small commercial establishments, Bulk generators; Street Sweeping
-MSW excludes Construction & Demolition Waste [estimated to be around 1500 to 2000 TPD (2016 assessment)
E-estimates

12.2.2 Waste Streams & Composition – BMA

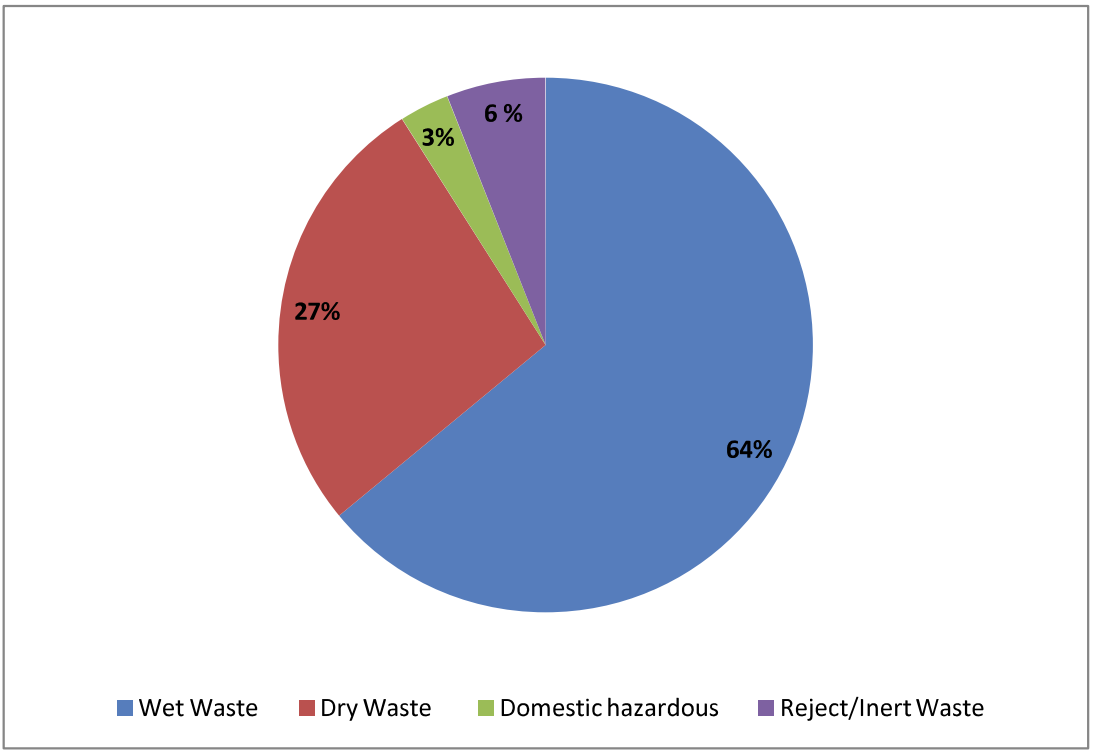
In line with the SWM Rules 2016 and micro assessment carried out by BBMP, the 4 basic streams of waste identified are as follows. Subsequently, the waste composition for BMA (assuming same for outside BBMP area) is depicted in Figure 12-2.

- Wet Waste: Any organic material that can be degraded by micro-organisms into simpler stable compounds. It includes household kitchen waste, food waste from small hotels and bakeries and garden waste.
- Dry Waste: Waste other than food waste and inert and includes recyclable waste, non-recyclable waste, combustible waste and sanitary waste
- Domestic Hazardous Waste: comprises sanitary and bio-medical waste. This includes hygiene products like sanitary napkins and baby or adult diapers contaminated with blood, urine and faeces; and bandages and sharp objects like syringes and needles
- Inert/Reject Waste: includes street sweeping inert (like silt from drains) and post processing rejects from the wet waste processing units or dry waste collection centres. It does not refer to mixed waste or construction and debris waste.

In addition, other waste streams that are being addressed in terms of segregating, collecting and processing are:

- Coconut Waste: This includes the exterior shell of tender coconut left over after the water is consumed
- Leaf/Garden Waste: This is all horticulture waste and includes leaf litter, garden pruning, and branch cuttings.

Figure 12-2: Waste Composition - BMA



The waste composition is the basis of projections-stream wise projections for entire BMA. Table 12-2 provides the estimated quantum of wet, dry, domestic hazardous and reject waste generation in the year 2031.

Table 12-2: Projected Composition of Total solid waste for 2031 - BMA

Waste Streams	Waste Composition	Quantum of Waste Generated (TPD)
Wet Waste	64%	8903
Dry Waste	27%	3756
Domestic Hazardous Waste	3%	417
Rejects/Inert waste	6%	835
Total	100%	**13911**

12.2.3 Waste Segregation, Collection & Transportation

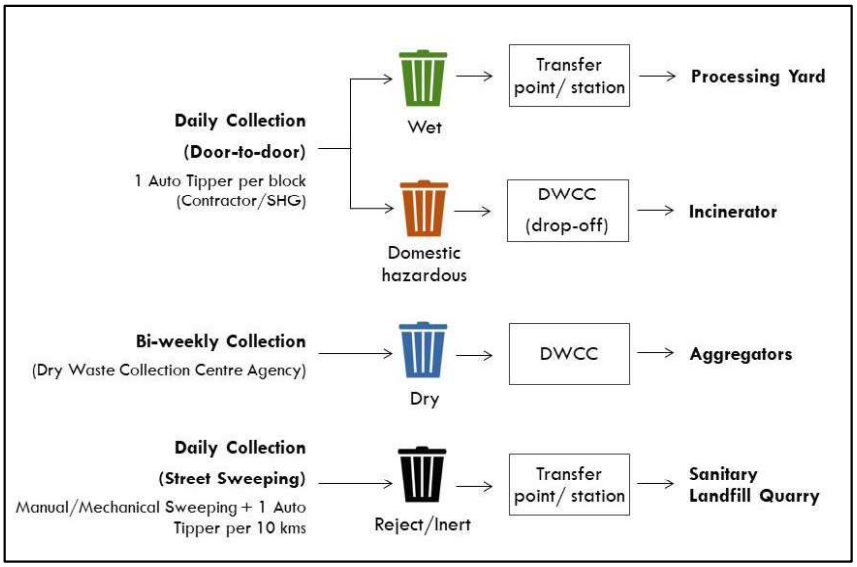
As per the High court directive dated 17 December 2015, 3-way segregation at source (wet, domestic hazardous & dry) for domestic generators and 2-way segregation for commercial generators was mandated and is being implemented.

Figure 12-3: Waste Segregation Guidelines

Source: BBMP

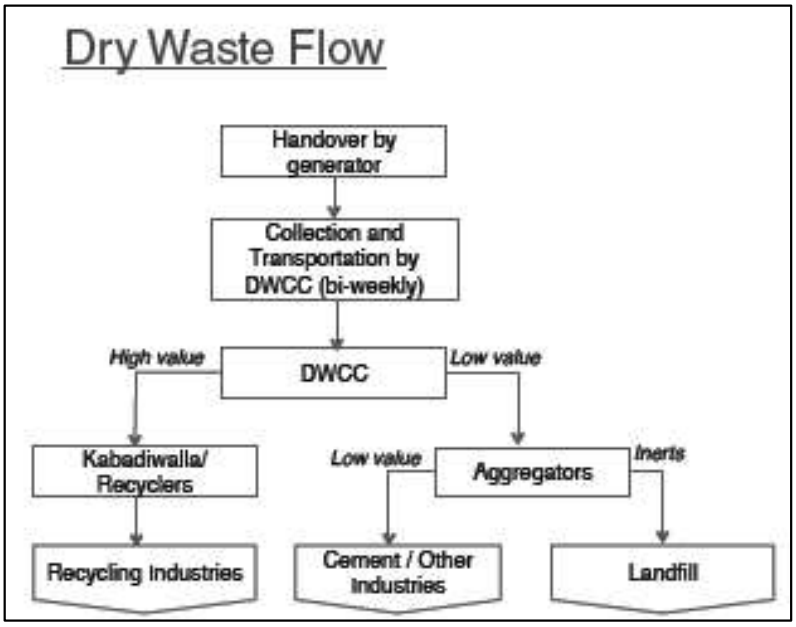
Primary collection & transportation involves three activities - wet and domestic hazardous waste collection (daily), dry waste collection (bi-weekly) and street sweeping (frequency based on road width)

Figure 12-4: Waste Collection & Transportation Process



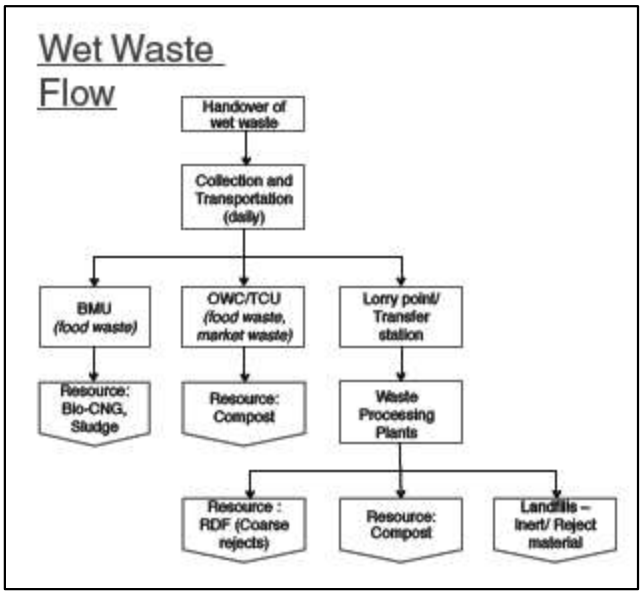
- **Dry Waste:** For recycling of Dry waste in the city, at present there are 196 Dry Waste Collection Centers (DWCC), 1 per ward and large aggregators as per zonal requirement. Out of 27% of dry waste generated in the city, only 36% of it is currently processed. **Figure 12-5** presents the Dry waste flow.

Figure 12-5: Dry Waste Flow



- **Wet Waste:** For city level processing of wet waste, at present there are 11 bio-methanation units (BMU), 7 organic waste converters (OWC) as per ward requirement – small hotels and markets and windrow composting in 9 integrated waste processing plants (IWPP) at the zone level. At present, out of 64% of the total wet waste generated in the city 92.5% is processed in IWPP, 7% in BMU and 0.25% in OWC's.

Figure 12-6: Wet Waste Flow



- **Domestic Hazardous Waste:** At present, out of 3% of the total domestic hazardous waste generated in the city, only 1% of the waste is processed by existing biomedical waste processing agencies.
- **Inert/Reject Waste:** At present, 6% of the total waste generated in the city is inert waste, meaning waste that cannot be further processed or utilized in any other form. This waste is usually termed as Landfill waste as it is disposed of in a sanitary landfill.
- **Facilities required by 2031: Table 12-3** presents the facilities required with BMA for Waste Segregation, Collection & Transportation.

Table 12-3: Proposed Units for processing of Dry waste generated

Particulars	No.s
DWCC (3 TPD to 5TPD) @240 to 480 sqm	470
Aggregators (50 TPD @ 1200 sq.m)	19
BMU (5 TPD @ 600 sq.m)	12
OWC (1 TPD @ 220 sq.m)	85
IWPP (500 TPD @ 97125 sq.m)	8

Source: BBMP and RMP 2031

12.2.4 Waste Disposal

Although Inert waste comprise 6% of the total waste generated at present and the waste to be landfilled should be approx. 10-12% of the total waste however, taking into account post-processing rejects from the wet waste processing units or dry waste collection centres including unprocessed dry waste (~17%) along with construction and debris waste altogether, make up to over 25-30% of the waste going to Landfill.

(a) Processing of Domestic Hazardous Waste generated:

The segregated domestic hazardous Waste (including sanitary waste) will be collected from drop-off locations/points (DWCCs) and further processed by existing biomedical waste processing agencies. The facilities include incinerators, Autoclaves, Shredders and Effluent Treatment Plants to scientifically dispose this waste. There are 3 units to manage bio-medical waste in Bengaluru: 1) SembRamky Environmental Management Pvt. Ltd. 2) Maridi Eco Industries Pvt. Ltd. 3) Anu Autoclave

(b) Lorry Point/Transfer Stations:

A Lorry Point is a point where the transfer of waste takes place from the Primary to the Secondary vehicle, within a ward. These are usually located by the side of the road, vacant sites and in front of decentralised waste facilities. At present, there are 340 lorry points throughout the city. As these Lorry points are informally located within wards, they result in several issues such as garbage on

ground, creation of black spots, resident opposition, etc. Therefore, the city aims to move from multiple informal points to a single built transfer station per ward.

(c) Disposal of Inert/Rejects (Landfill Waste):

BBMP has identified 3 abandoned quarries, which are currently been designed as Sanitary Landfills. It will receive only the following types of waste:

- Comingled waste (mixed waste) not found suitable for waste processing
- Pre-processing and post-processing rejects from waste processing sites
- Non-hazardous waste not being processed or recycled

As per BBMP, the three Landfills available have a total capacity of approx. 1460 TPD. Significantly, this capacity can address the quantum of waste to be landfilled upto 2031. However, this is a far-fetched assumption as this is only feasible if the rejects/inerts to be landfilled are 10-12% of the total waste generated, which in its entirety is dependent on factors such as:

- 100% Segregation of waste
- Waste processing/treatment achieved as per ISWM hierarchy, SWM rules 2016
- High recycling and waste diversion rate
- Processing and disposal of Construction & Debris Waste as per C&D rules, 2016

Moreover, keeping in view the fact that finding new sanitary landfill sites in Bengaluru is becoming extremely difficult, there is no option, but to resort to the strategy (decentralized) as developed by BBMP at the micro-level. This in turn, has led to the need for a new approach in Solid Waste Management as the city plans its shift towards 'A Future with No Landfills'.

Landfill area requirement: Considering active period of the Landfill as 20 years, it is estimated that about 220 ha of land (25% additional services) will be required to landfill the rejects generated in BBMP area. These estimates have been made by taking into consideration the waste being landfilled at 25% of the total waste during (2011-2018) after which computations have been made keeping in view the ongoing interventions (decentralized approach), if successful will yield only 12% of rejects from the total quantum of waste generated.

12.3 Construction & Demolition (C&D) Waste

Wastes generated from building materials, debris and rubble resulting from construction, re-modelling, repair and demolition operation is termed as C&D waste. It excludes steel, aluminium, wood and other components currently being salvaged for reuse or recycling. In exercise of the powers vested under section 256 of Karnataka Municipal Corporations Act , 1976 (Karnataka Act, 14 of 1977) and enabling provisions U /s 257 and 260 of the said Act, a public notification regarding separate collection and disposal of Construction and Demolition Waste or Debris within the BBMP area , w.e.f. 01-03-2016 along with the guidelines have been issued.

As per BBMP and other studies it is estimated that around 1500-2000 TPD of C&D waste is generated daily in Bengaluru as of 2016. To manage the C&D waste BBMP has identified seven C&D waste management site for BBMP zones.

Table 12-4: Approved C&D waste management sites designated by BBMP for each zone

Sl No.	Name of the location	Address	Extent of area in acres	Nearby zone
01.	Mallasandra	Sy. No. 33, Mallasandra grama, Yeshwanthpura hobli Bangalore, North Taluk	30	R.R. Nagar/West
02.	Kadu Agrahara	Sy. No. 34, Kadu Agrahara grama, Bidhrahalli hobli, Bangalore East Taluk	18	Mahadevpura
03.	Srinivasapura & Kogilu	Sy No. 15, Srinivasapura & Kogilu grama, Yelahanka Hobli, Bangalore North Taluk	10	Yelahanka
04.	Gollahalli	Sy No. 58, Gollahalli grama, Uttarahalli Hobli, Bangalore South Taluk	60	Bommanahalli & South
05.	Kannur	Sy. No. 50, Kannur grama, Bidhrahalli hobli, Bangalore East Taluk	50	East
06.	Guddadahalli	Sy.No. 43, Guddadahalli grama, Hesaraghatta hobli, Bangalore North Taluk	46.31	Dasarahalli
07.	Mittaganahalli	Sy.No. 02, Mittaganahalli grama, Bidhrahalli hobli, Bangalore East Taluk	10	East/Mahadevpura

Source: BBMP

12.4 Power Infrastructure

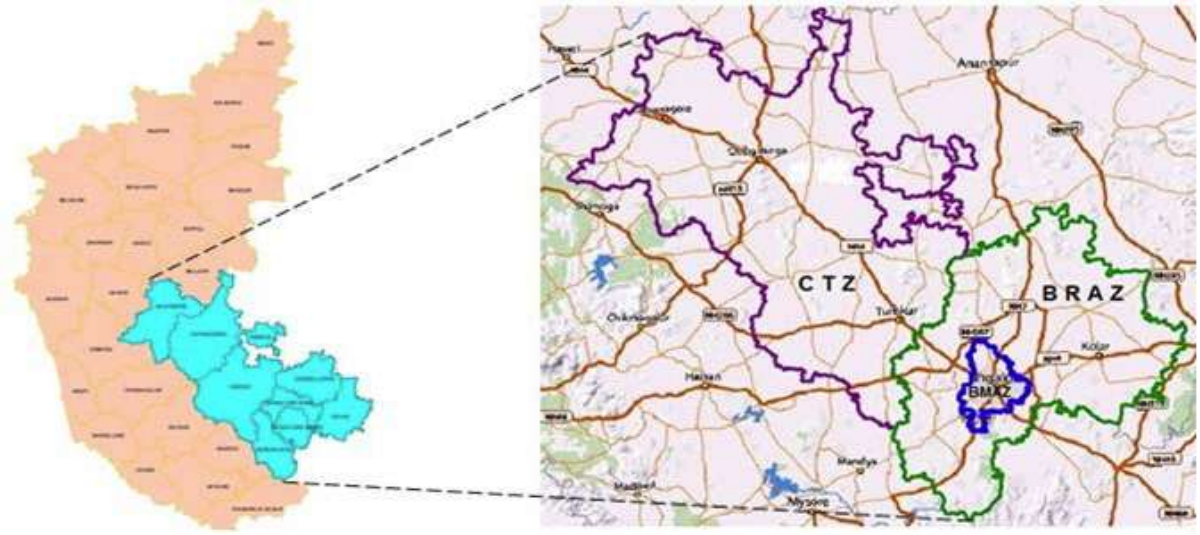
12.4.1 Existing Situation and Trends

Bengaluru, with almost one third of state's demand/ consumption is the largest power consumption centre in Karnataka. With the rapid change and growth in Bengaluru the demand for power supply is also ever growing. Karnataka Power Transmission Corporation Limited (KPTCL) and Bangalore Electricity Supply Company Limited (BESCOM) are responsible for powering Bengaluru city. While KPTCL is responsible for transmission (upto and including 66kv lines), BESCOM is responsible for distribution and supply (below 66kv lines).

BESCOM has 3 operating Zones – Bengaluru Metropolitan Area Zone (BMAZ), Bengaluru Rural Area Zone and Chitradurga Zone. BMA is covered by BESCOM BMAZ and BRAZ. BMAZ of BESCOM is divided into twelve divisions which includes – i) Indiranagar, ii) Shivajinagar, iii) Vidhanasoudha, iv) Hebbal, v) Malleshwaram, vi) Peenya, vii) H.S.R. Layout, viii) Jayanagar, ix) Koramangala, x) Kengeri, xi) Rajajinagar and xii) Rajajeshwarinagar.

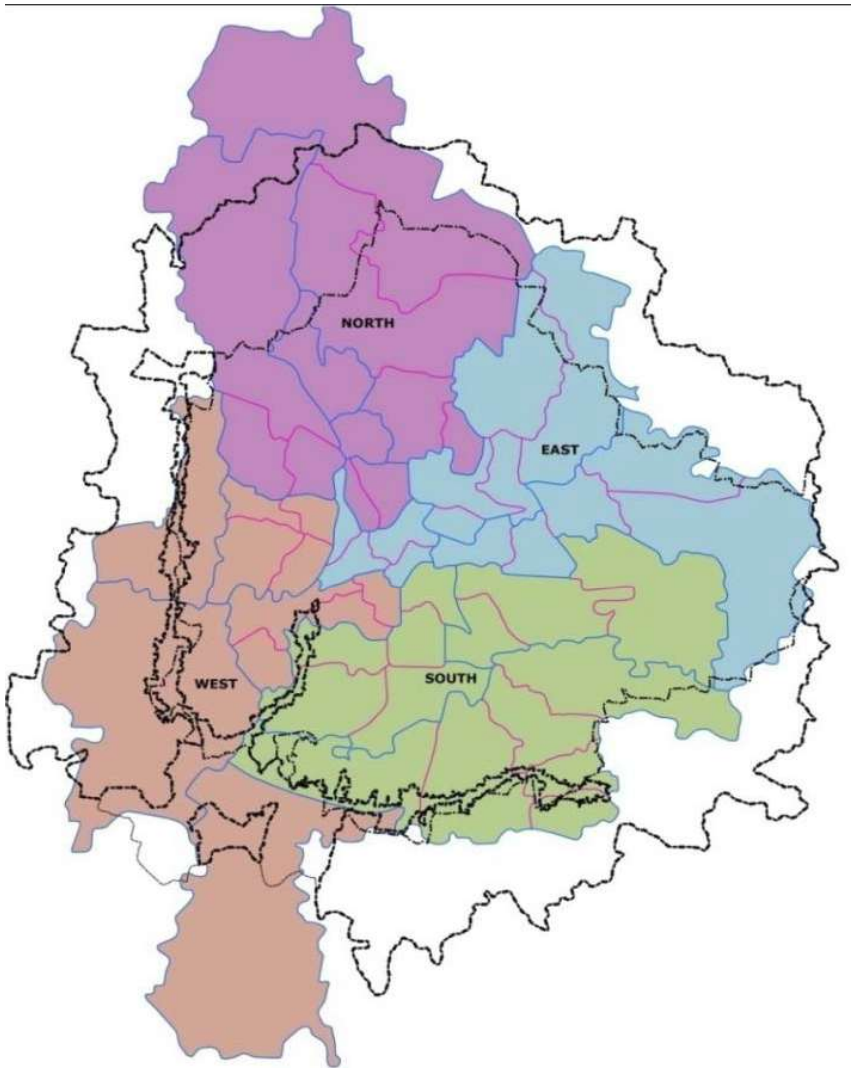
Figure 12-7 presents the BESCOM administrative zones, whereas **Figure 12-8** presents overlay of the BESCOM BMAZ and BMA.

Figure 12-7: BESCOM Zones



Source: BESCOM

Figure 12-8: BESCOM BMAZ and Bengaluru Metropolitan Area Overlay



Bengaluru is powered by the same southern grid that supplies to the entire state. The sources include hydel, thermal and non-conventional sources like wind and solar. Karnataka state gets power from Central Generating Stations (CGS), Hydel Power Stations and Thermal Power Stations within the state. There are no dedicated power plants/ generation centres for Bengaluru.

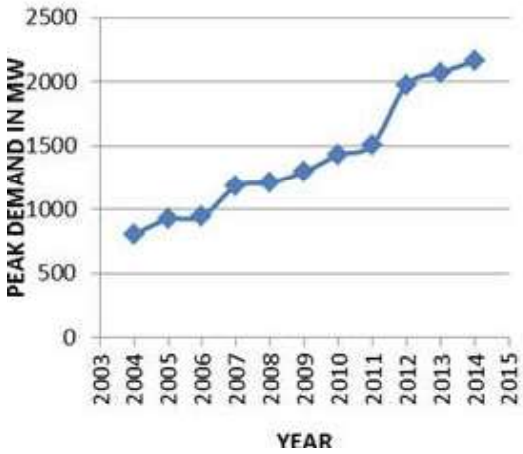
The total peak power demand for Bengaluru (BMAZ) stood at 2579 MW (2015-16) and the energy consumption is at 13885 MU. The average growth in peak demand during 2004 to 2015 has been 11.6% per annum (CAGR), while the Energy Demand has increased by 9.5%. The Per capita energy consumption has increased from 827 units in 2005 to 1219 units in 2014 with CAGR of 4.4%.

Table 12-5: Summary of Power Consumption Trend for BMAZ

DESCRIPTION	Growth Rate (2004 TO 2015)
Peak Demand	11.6%
Energy Demand	9.5%
Per Capita Consumption	4.9%

Source: 19th EPS, KPTCL

Figure 12-9: BMAZ Peak Demand (2004-2015)



YEAR	BESCOM Peak Demand in MW	BMAZ Peak Demand in MW
2004	1608	804
2005	1843	921
2006	1888	944
2007	2364	1182
2008	2418	1209
2009	2592	1296
2010	2856	1428
2011	3019	1510
2012	3953	1977
2013	4144	2072
2014	4321	2161

Source: 19th EPS, KPTCL

BESCOM BMAZ has over 45.26 lakhs consumers (as on March 2014) of which domestic and commercial constitutes 92% (80.2% and 11.8% respectively) whereas industrial and agricultural consumers are negligible. Consumers of electricity in BMA include low-tension (LT) consumers – domestic, commercial, agriculture, industries and miscellaneous categories and high tension (HT) consumers – residential apartments, industries, commercial, irrigation, water supply.

The power supply to Bengaluru is made through four 400/220kV power stations located at Hoody, Nelmangala, Bidadi and Somanahalli. Further, electric supply to different parts of the city is made through 220/66kV sub stations, which are equally distributed to all parts of the city. The power

supply to consumer is supplied after being stepped down voltage through substations; primarily at 11kV, however 33kV power is also supplied to bulk consumers/industries. BMAZ has 4 of 400/220kV Substations, 25 of 220/66kV Substations and 52 of 66/11kV Substations having total installed capacity of 13245 MVA. There are 2801 numbers of Distribution Transformers within BMAZ. Further, KPTCL has planned 18 sub-stations of different capacities (400kV, 220kV, 66kV sub-stations) in BMA Zone of BESCOM.

In general, the present transmission and distribution infrastructure is inadequate to meet the un-restricted peak hour demand given the fact that around 25 out of 62 substations would require immediate augmentation along with associated distribution network.

12.4.2 Power Demand/ Forecast and Land Demand

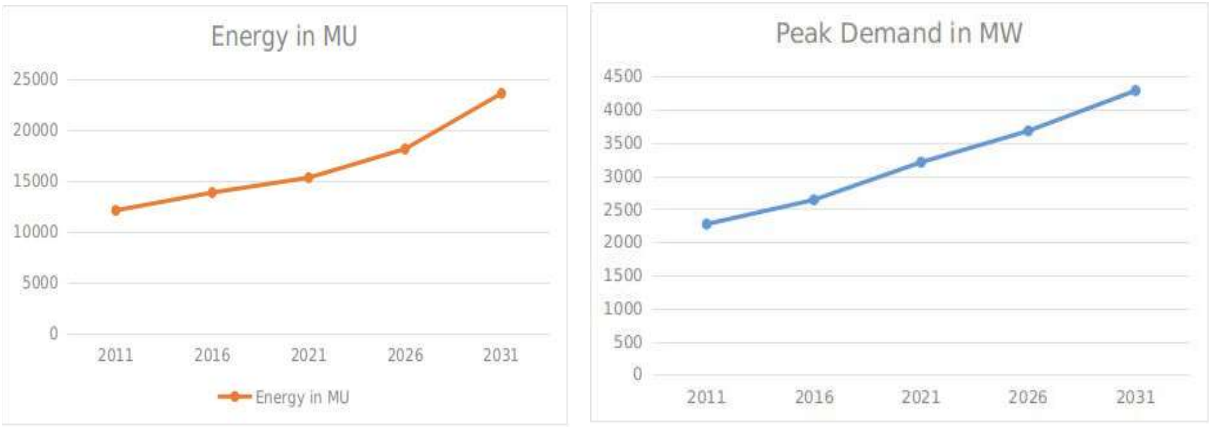
Based on the 19th Electricity Power Survey, Central Electricity Authority (CEA), requirement of power for Bengaluru in the year 2026 as projected by the KPTCL is 3680 MW, the estimated peak demand for 2031 is 4288 MW (say 4300MW). To meet the additional requirement of 1720MW, the KPTCL & BESCOM need to augment the power supply and improve the transmission and distribution system. The additional power requirement is expected to be met from allocated share from the grid system and generation at state level.

Table 12-6: 19th Electric Power Survey Forecast for Energy and Peak Demand for BMAZ

YEAR	2011	2016	2021	2026	2031 (extended forecasts)
Energy in MU	12129	13885	15349	18174	23638
Peak Demand in MW	2273	2639	3207	3680	4288

Source: KPTCL

Figure 12-10: 19th Electric Power Survey Forecasts for BMAZ



Source: KPTCL

In order to meet the future power demand, it is recommended that The Government of Karnataka enter into power purchase agreements with power generating companies and/ or establish power generation plant for effectively meeting Bengaluru's long term power demand. The power

infrastructure and land required for power infrastructure has been planned based on CEA planning norms recommending planning for 200% of peak demand. Accordingly, it is estimated that in addition to existing infrastructure, 2 of 400/220 KV, 39 of 220/66KV and 68 of 66/11KV substations are required. It may be noted that some of the additional requirement are already in the process of being implemented. **Table 12-7** provides the summary of required sub-stations.

Table 12-7: Details of Existing and Additionally Required Sub-Stations

Description	No. of Substation Existing in 2016-2017	No. of additional Substation Required by 2031
400/220kV	4	2
220/66kV	14	39
66/11kV	80	68

Note: Additional substation required also includes substation proposed by KPTCL

It is estimated that about 7.2 hectares of land is required for 400/220kV substation, 13.5 hectares of land is required for 220/66kV substation and 12.34 hectares of land is required for 66/11kV substation. The land estimates has been done with the assumption that all future sub-stations would be GIS based, thus reducing the land requirement. **Table 12-8** presents the land requirement considered for each substation.

Table 12-8: Land Requirement of Sub-stations

Substation	Land required for GIS (ha)	Land required for AIS (ha)
400/220kV Substation(GIS)	3.64	16
220/66kV Substation(GIS)	0.48	4
66/11kV Substation(AIS)	0.202	0.25

It is proposed that major transmission network would be developed within the Right Of Way of proposed master plan roads and would follow short route method in agriculture zone. The grid sub-stations has been identified and land has been allocated in the master plan and shown at Planning District level proposals. The safe distance for developments along the transmission lines should adhere to Indian Electrical Rules, 1956. The vertical & horizontal clearances from buildings along transmissions lines shall be as given in Table below.

Table 12-9: Indian Electric Rules, 1956 prescribed Safe Distance for Buildings

BUILDING CLEARANCE	66kV	230kV	400kV
Vertical Clearance	3.969(13')	5.488(18')	7.318(24')
Horizontal Clearance	2.14(7')	3.66(12')	5.489(18')

Source: Indian Electric Rules, 1956

In addition to existing 4 and 2 planned 400/220kV substations, 2 more such sub-stations are required for BMA and some of them are required to be established outside BMA and within other local planning area of Bengaluru Metropolitan Region (BMR). Potential Locations for establishing

these sub-stations are Devanahalli and Jiganii. It is therefore required that BMRDA and KPTCL coordinate for allocation of Land in other LPAs within BMR for establishing 400/200kV sub-stations.

12.4.3 Use of Renewal Energy

In order to reduce the dependency on fossil fuels and attend energy efficiency it is critical to attend the following:

- Non-conventional energy sources like recovering energy from municipal waste, sewerage, solar energy, etc. should be used for street lighting, lighting at public spaces, open areas, traffic signals, hoardings, etc.
- To supplement part of the estimated growing power requirement, nonconventional sources / solar energy and other actions proposed are as follows:
    - Solar energy should be encouraged for all establishments with floor area of more than 300 sq.mt.
    - All public buildings to install roof top solar panels and use CFL blubs.
    - Solar Panels for public advertising, lighting in open areas, public utilities, streets, etc.
    - As alternate mandatory arrangement during power cuts to replace generators/inverters etc.
    - Interim solutions of single point connection in unauthorized developments and slums.
    - Incentivizing energy savings and use of energy efficient gadgets.
    - Promotion of Battery Operated Vehicles and Non-motorized Transport.

It is proposed that a Government of Karnataka prepares a detailed Renewal Energy Master Plan for Bengaluru and implements the same for long term energy savings.

12.5 Social Infrastructure

RMP 2031 envisages good quality of life in the city with accessible social infrastructure for all citizens. As the city grows rapidly, there will be need to expand the number of social infrastructure facilities like educational infrastructure, healthcare infrastructure, recreational infrastructure, safety and security infrastructure, and other necessities like neighbourhood amenities, opens spaces etc.

12.5.1 Educational Infrastructure

Primary and Secondary Educational Infrastructure: Bengaluru has very good educational infrastructure in comparison to the rest of the state. For the purpose of administration, the education department categorises schools under various educational districts. Table 12-10 shows the number of government and private schools across various categories in Bengaluru Urban District, whereas Figure 12-11 presents the spatial spread.

Table 12-10: Number of existing government and private schools in each category

Sl. no.	Category of School	Classes	No. of Gov. Schools	No. of Private Schools/ Others	Total No. of Schools
1	Primary , Upper primary and secondary	*1 to 10*	15	894	909
2	Primary , Upper primary, Secondary, Higher Secondary	*1 to 12*	9	777	786
3	Primary	*1 to 5*	670	493	1163
4	Primary , Upper Primary	*1 to 7/ 8*	712	1116	1828
5	Secondary	*9,10*	146	448	594
6	Secondary and Higher Secondary	*9 to 12*	14	18	32
7	Upper primary, Secondary, Higher Secondary	*6 to 12*	1	6	7
8	Upper primary, Secondary	*6 to 10*	4	11	15
9	Upper Primary	*6 to 7 / 8.*	0	8	8
	Total		**1571**	**3771**	**5342**

Source: E-Governance Unit, Department of Public Instruction (2014-2015) and Consultants Analysis, 2015

Figure 12-11 Spatial spread of schools within Bengaluru Metropolitan Area

A gap analysis study shows that most inhabited areas in BMA have access to a primary school within 1 km radius. The schools also face challenges like traffic safety and congestion during the schools hours.

The RMP 2031 envisages development of new schools in the transitional periphery zone of BMA. The educational infrastructure in the inner and outer core may be reinforced by provision of playground spaces wherever possible. Presently there are no gaps, and all areas are adequately covered by schools. There is less concentration of schools outside the outer ring road presently. However the city needs more government schools to be more inclusive. It is expected that land areas of government schools is met by the land ceded to the BDA under C.A site.

Higher Education Infrastructure: Bengaluru plays a role of primacy in the state of Karnataka, in the education sector. Bengaluru Metropolitan Area (BMA) has a fair share of institutes of higher education and professional institutions. Bengaluru is a hub of higher education in the country with a high number of colleges and professional institutes.

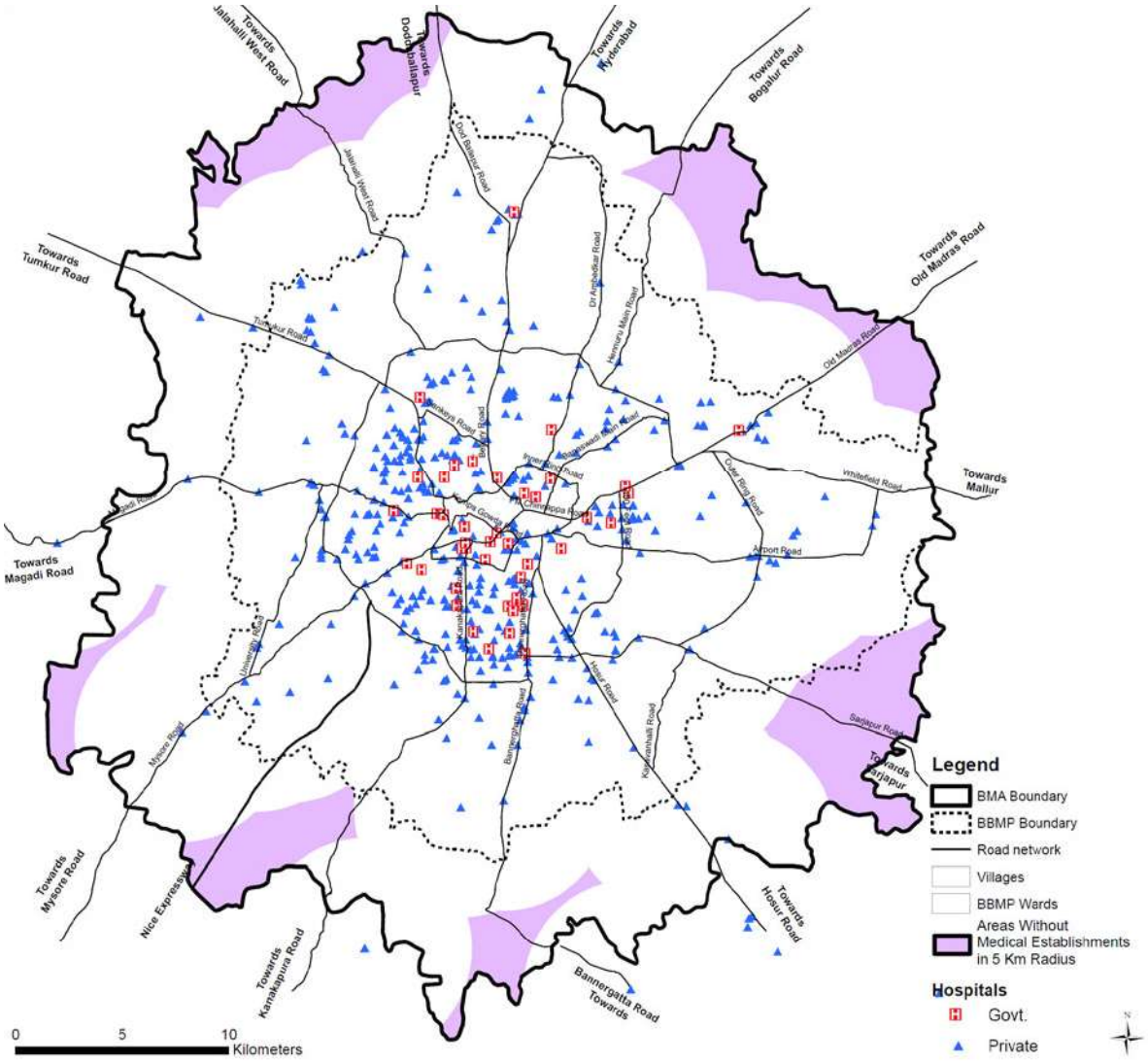
12.5.2 Healthcare Infrastructure:

Accessible health infrastructure is a necessity for welfare of the residents. The city of Bengaluru has a high concentration of healthcare facilities in the BBMP area. Bengaluru serves as a tertiary healthcare centre for the surrounding region with several tertiary and referral hospitals in the city. Bengaluru has many super speciality and multispecialty facilities which also make it a healthcare tourism destination. The BBMP runs several government hospitals, maternity centres, and healthcare centres within the erstwhile BBMP areas. The rest of the BMA is served by healthcare infrastructure run by the department of health and Family Welfare. Private healthcare facilities are spread around the city. Most of the large referral and tertiary care hospitals are located within BBMP and concentrated in the core areas within the outer ring road

Gaps: There are several pockets in the peripheral areas of BMA, which are more than 5kms away from a healthcare facility. With the increasing traffic congestion, and reducing vehicle speeds in the city, the accessibility to medical facilities has reduced even in some of the core areas in Bengaluru, especially for people living far away from healthcare centres. The access to tertiary healthcare is a major gap in the peripheral areas of BMA.

RMP 2031 proposes that government run public healthcare facilities be opened in some of peripheral areas of the city outside the BBMP so that no area is more than 3 Kms away from a government healthcare unit.

Figure 12-12: Healthcare Facility Accessibility



Source: RMP 2031, District Health Officer, BBMP,

12.5.3 Public Open Spaces

Bengaluru has public open spaces like Cubbon Park, Lalbagh, several city level and neighbourhood level parks, as well as other accessible open spaces. The loss of green cover in the city in the last decade is a major cause of concern. While there are large city level parks and neighbourhood parks in the core areas of the city, there is a lack of playgrounds in the city. The peripheral areas which lack large parks or playgrounds, give an opportunity for the same to be developed in a systematic way, owing to availability of vacant lands and buffer areas along the lakes and streams. RMP-2031 proposes regional parks and city level public open spaces. These open spaces shall conserve the greenery, lake buffers and eco-sensitive areas, while also providing recreational benefits to the residents of the city. The RMP 2031 also envisages development of playgrounds and sports centres in the city, in the peripheral areas, which are easily accessible to the public. The need of playgrounds

in the neighbourhood is stressed upon, and neighbourhood level parks along with playgrounds are to be developed in all proposed residential areas.

Table 12-11 outlines the various categories of Parks and Open spaces and the nature of each type of open space.

Table 12-11 Categories of Parks and Open spaces

S.No.	Park Categories	Approx Area	Examples in Bangalore	Broad nature of the environment	Active Recreation spaces	Passive Recreation Spaces
1	Regional Parks	200 – 400 Acres	Cubbon Park ~ 300 acres Lalbagh ~ 240 acres	Largely natural, in eco sensitive areas, with riparian buffers.	Very limited, in areas other than no development zones.	Prominently more
2	City Parks – Planning District Park	50 – 150 Acres	Freedom Park ~ 21 Acres	A combination of natural areas and activity areas like playground, running tracks.	Several active recreation spaces available	Passive recreation spaces available.
3	Sporting Facilities	10 to 50 Acres	Kanteerava stadium	Mostly intense activity areas with some amount of natural landscaping and lawns.	Prominently more	Very limited passive recreation facilities
4	Multipurpose Grounds / Play grounds	5 to 10 Acres5 acres and above	Several local level grounds present	Mostly intense activity areas with some amount of natural landscaping and lawns.	Should facilitate active recreation when necessary	Should facilitate passive recreation like jogging and walking etc.

Regional Parks: 8 Regional/ Large Parks and are proposed to be developed as natural areas to provide recreational space and also safeguard the fragile lake and stream system.

12.5.4 Sports Complex (city level sports facilities)

Sports facilities proposed in the revised RMP 2031 would be public spaces supporting active recreation and catering to a range of activities and games including badminton, tennis, cricket, football, basketball, table tennis, fitness, gymnastics etc. These facilities may be provided as standalone sporting facilities or as additional sporting facilities to larger parks open spaces and multipurpose grounds. RMP 2031 proposes development of 4 large sports complexes across BMA.

12.5.5 Fire Stations

Fire stations are critical infrastructure that needs to be present in every planning district. An optimum distance for fire station is 10.5 sq km radius, but the frequency of fire stations need to be more in high density areas due to increase of risks. Bengaluru has 19 fire stations, mostly located in the core areas.

As per the requirement of Karnataka Emergency and Fire Services Department 16 new fire stations have been incorporated in RMP 2031. In addition, RMP 2031 has identified additional fire stations and defined in Proposed land Use map as Public and Semi-public use.

12.5.6 Art and Cultural Infrastructure

Bengaluru is an important centre of art and culture with several prominent art schools, performance spaces and cultural hubs. Bengaluru is the capital of the Kannada cinema industry, and an important theatre and drama hub in the country. The city has several art installations, and hosts street art festivals along with formal events like art exhibitions, book fairs etc. Formal and informal spaces must be provided for art and culture to thrive city. Informal spaces include street pavements, plazas, open spaces, parks and open spaces etc. Formal spaces like art galleries, museums, performance spaces, outdoor spaces like open air theatres, cinema halls etc must be provided in all planning districts.

12.5.7 Markets

Markets, both formal and informal, are needed at accessible distance. While the core areas of the city have very good market facilities, such facilities must be provided in the outer areas. Each market must also have space for informal vendors and vendors who sell occasionally or seasonally. It is proposed to develop markets along with logistic hubs and in the planning districts which are devoid of markets.

12.5.8 Cemetry and Graveyard

Bengaluru has limited number of cemeteries and graveyards. Most of the graveyards in the city have reached the threshold. More number of graveyards is required in the city and the outer areas. RMP2031 proposes development of burial grounds, cremation ground/ cemetery in each planning district.

12.5.9 Night Shelters

RMP 2031 proposes that adequate number of night shelters be developed based across BBMP depending on the requirement by BBMP for the urban poor.

12.5.10 Women's Hostels

Bengaluru attracts many people from other parts of the state and the country who come here to study and work. Women, especially from poorer families find it very difficult to find a safe place to stay while they work or study in the city. RMP 2031 proposes development women's hostels for working women and female students in each planning district that would provide affordable and safe accommodation to women.

13 DISASTER AND HAZARD MANAGEMENT

13.1 Introduction

Bengaluru has been experiencing very high rates of urbanisation and population growth. Parts of the city are vulnerable to several natural and manmade disasters in varied degrees. Urban flooding, wide spread pollution and scarcity of water are some of the challenges the city faces presently. Certain hazards like droughts, earthquakes etc in other parts of Karnataka also have impact on the city. Hazard and Disaster Management as part of the revised master plan is an attempt to understand the hazards, reduce their impact and decrease the vulnerability of the city to these hazards.

13.2 Hazard Risk Assessment

Hazard Risk Assessment includes identification of the major hazards (natural & manmade) affecting the Bengaluru metropolitan area, understanding the risk the city faces from the hazard, and profiling the hazard and its vulnerabilities. Identification of the major hazards in BMA has been done through past occurrences, frequency and impact levels. The physical, social, economic and environmental vulnerabilities of the hazards have been assessed to prepare strategies to reduce vulnerabilities.

13.3 Hazards Affecting Bengaluru

Bengaluru, owing to its location, is not affected by hazards like volcanoes, tsunami and coastal cyclones. The climate in Bengaluru is favourable and it is not affected by extreme temperatures. However, the city is affected by several natural and manmade hazards in varying degrees. Some hazards like earthquake, floods and drought outside BMA/planning area but primarily limited to Karnataka may also affect the city in various ways like in migration from other parts of the state, water scarcity, agricultural scarcity, energy deficit, water deficit and loss of critical supplies to the city. The Hazards affecting the city may be classified into natural and man-made hazards.

13.3.1 Earthquake

Earthquake is a major natural hazard with severe impact and high vulnerability. Bureau of Indian Standards [IS 1893 (Part I):2002], has grouped the country into four seismic zones, viz. Zone II, III, IV and V with zone V being the most seismically active region while zone II is the least. Bengaluru region is located in low seismicity zone (Seismic zone 2). The intervention of the Master Plan is restricted to guidelines that may help reduce vulnerability to an earthquake.

Vulnerability: Since Bengaluru is in a region, prone to low and moderate earthquakes earthquake related environmental vulnerability is less significant. In the event of a medium intensity earthquake in the region, there will be some physical damage to buildings and infrastructures. Economic activities in the city are expected to be disrupted for a short while. There may be loss to life and property depending on the intensity of the earthquake.

Mitigation: To reduce the physical damage, buildings, communication towers and public utility centres, and other critical infrastructure need to withstand damage during an earthquake. Construction rules need to be followed to resist vulnerable condition. All multi-storey buildings must be designed and constructed adopting the norms prescribed in the National Building Code.

13.3.2 Urban Floods in Bengaluru

Urban flooding is a natural hazard triggered by climatic events, and aggravated by human activities and urbanisation. Flooding of major roads, hinder the functioning of smooth traffic in the city, leads to congestion. In the recent past, incidences of flooding have been reported in 2005, 2007, 2010 and 2013 and very prominently in 2017.

The areas which are particularly prone to flooding include parts of the city which lie within the natural floodplains of the river and drainage channels. Several slums and unauthorised developments in low lying flood prone areas make a large population of the city directly vulnerable to urban flooding. Urban flooding occurs due to natural and manmade factors. Some of the major reasons identified for flooding in BMA are as following.

a. **Heavy and incessant rains:** Heavy rainfall event leads to urban flooding. As per the Karnataka State Action Plan for Climate Change, the climate change is expected to affect the rainfall pattern and may lead to several heavy rain events in the future.

b. **Increased urbanisation:** Increased urbanisation has led to significant changes in the hydrologic flow of storm water runoff from developed areas. Effects of urbanisation like increased peak flow; reduced ground water infiltration and diminishing base flow of streams have impacted urban flooding.

c. **Breached water bodies:** The loss of retention basins such as lakes and reservoirs has led to increase in the urban flooding. The breached network of natural water bodies and tanks, which play a major role in storm water drainage and runoff within the city, is leading areas getting flooded during heavy rainfall events. It may be noted here that many of the low lying areas are the locations where slums have developed, leaving a large group vulnerable to floods and epidemics. The loss of lakes and streams this also increased the vulnerability of these areas to urban flooding Also, at several locations, storm water drainage system have been broken/ lost due to developmental activities, which is also contributing to urban floods.

13.3.3 Environmental Pollution

Environmental Pollution includes pollution of air, water and noise within the Planning Area.

Air Pollution: Air pollution is a major hazard that has been growing steadily in Bengaluru. The increased number of vehicles on road, industrial activity, construction activity, poor quality of roads and dust on road add to the suspended particulate matter in air. There are more than 67 lakhs vehicles registered in Bengaluru (March 2017). Old vehicles with worn out engines, adulterated fuels, and slow moving traffic lead to increased emissions. The total emissions in 2015 due to vehicular traffic is estimated at 196 tonnes of CO per day, 50 tonnes of HC per day, 9 tonnes of SPM

per day, and 321 tonnes of NOX per day[23]. Reducing the number of private vehicle trips, and increasing public transport share is expected have a positive impact in reducing the emissions due to vehicular traffic. The vulnerabilities of air pollution include people living along the major roads, travellers, pedestrians and especially children and the elderly.

Water Pollution: Pollution of surface and groundwater is prevalent in Bengaluru. The rivulets Arkavathy, Vrishbhavathy, along with the lakes and the natural streams are highly polluted due to inflow of sewage, industrial effluents and municipal waste. The Dissolved oxygen (DO) level in lake waters is decreasing indicating organic pollution load leading to a phenomenon called eutrophication. Untreated Sewage flowing into lakes cause the lake to decay, and loss of aquatic life. The people living around the polluted lakes are very vulnerable as the area in the vicinity of the lake is covered in foul smell emanating from the lake. The froth and smell affects the commuters and the water pollution has led to ground water getting polluted in the area. Ground water in BMA is polluted due to sewage pollution and industrial pollution, over exploitation of ground water resources and high Nitrate concentration in ground water.

Noise pollution: The sources of noise pollution in BMA are a) vehicular traffic, b) flying aircrafts near airports, c) drilling of bore wells, d) industrial sound, e) construction activities, f) DG sets, g) public address systems, etc. Noise sensitive areas like hospital area, schools and also residential neighbourhoods are witnessing heavy noise pollution due to traffic and unnecessary honking.

13.3.4 Water Scarcity

Bengaluru faces a major challenge in the availability and access to reliable good quality water supply. Water is supplied in the BMA from Cauvery River catchment pipeline systems linked with water storage and replenish-able groundwater resources, all of which are rain fed. The Karnataka State Action Plan on Climate Change[24] has estimated change in rainfall patterns in the future that may have an impact on water availability. Further detailed studies are required in regards to the impact on climate change on the water availability in BMA to fully comprehend this future challenge.

Drinking Water: Peripheral areas in BMA, where Cauvery water is not supplied, is facing acute shortage of good quality drinking water. Considering the demand in BMA and the requirements of Non-Domestic and industrial supplies, total water shortage at present in BMA could be established as 876 MLD. However, with envisaged tapping of additional 10 TMC of Cauvery water, the current demand could be met. Unaccounted flow of water (UFW) has been observed as 46% which is predominantly due to leakages in the old system of the core city area. UFW needs to be moderated to 15 – 20 % on priority. Availability of water in the future shall depend on the population distribution, and reducing losses.

Ground Water: Ground water table in BMA is depleting, increasing the risk of unavailability of drinking water in the future. Urbanisation has increased in the last two decades leading to wiping out of many tanks and lakes that were helpful in maintaining the ground water level. Increased

[23] Estimation is based on Urban Transport Modal built for RMP 2031.

[24] Karnataka State action plan on climate change: by Department of Forest Ecology and Environment-Government of Karnataka.

dependency on water tankers as well as bore wells especially in areas where BWSSB supply is not present. Groundwater levels have fallen steadily as a result of withdrawal for private self-supply and supply through private water tankers. Over exploitation of ground water has led to decrease in water tables and reduction in ground water quality.

As per CGWB net annual groundwater availability in Bangalore Urban district is 11723 ham, total ground water draft for irrigation, domestic and industrial uses is 3794 ham and existing gross ground water draft for all uses is 16,703 ham. Thus, draft exceeds the total available ground water resources leaving absolutely nil ground water resources for future use. In view of the stage of the ground water development to the tune of 128- 176% and over exploitation of ground water resources water level has gone deeper thereby leaving the only solution of building up of ground water resource through artificial recharge and rainwater harvesting. The stage of ground water development in all the four Taluks of the district is above 100% and are in the over exploited category as per the Central Ground Water Authority. Increase in paved areas due to urbanisation and encroachment of catchment areas has led to drying of aquifers.

Drought: Bengaluru is prone to droughts and several years in the past few decades have been declared as drought years for the Bangalore urban district. Droughts occur at approximately fixed intervals, the phenomenon referred to as 'stationarity' in hydrology. Due to changing climate and varied rainfall patterns, it has become difficult to predict a drought by stationarity and hence it is difficult to be prepared for drought. Bengaluru has been declared drought hit several times. Bengaluru is dependent on Cauvery River for drinking water, which is a rain fed, and drought in other regions is likely to have an impact on Bengaluru. Drought in BMA will deplete the ground water resources and lakes, reservoirs, leading to shortage of drinking water. In the outer areas of BMA, drought may affect the availability of water for irrigation, and cattle fodder may also be affected. The people, whose livelihood is based on agriculture and other allied activities in BMA, would be worst hit during a drought. Due to depletion of water resources, there would be shortage of drinking water, which may turn into a health hazard.

13.3.5 Hazards Associated with Waste

Municipal Waste: Solid waste disposal is a challenge in BMA. It is difficult to manage the quantum of waste that is produced in Bengaluru. As per the BBMP, the total waste generated in the BBMP area is about 6233MT, with wet waste contributing upto 64% and 27% of dry waste. Waste mixed with rain water, is a hub of diseases. Stray animals often feed on the waste, further resulting in the spread of diseases. Improper disposal of waste in the landfills leads to Leachate seeping into the soil, which may enter the human food chain and lead to diseases.

Electronic waste: Bengaluru is the IT Capital of India and employs over 8,30,000 people in IT industry with more than 1300 IT/ ITES companies (as per ENVIS news letter dated June 2011) working from Bengaluru. The number of computers and consumption of electronic goods is directly linked to software professionals and rising income which mostly leading to higher generation of e-waste in the city than perhaps any other city in the country. It is estimated that Bengaluru generates close to

199768 MT/ annum (547 MT/ day) of e-waste, which is huge. Of which 45438.5MT/ annum (less than quarter of e-waste generated), is recycled through organised / authorised e-waste recyclers[25].

The majority of e-waste management/ handling and recycling is through informal sector and hence un-regulated. The informal sector handling of e-waste is not always environmentally safe and is leading to environmental pollution and health hazards.

13.3.6 Hazards due to Traffic Congestion

Traffic congestion may be defined as a hazard, considering the impact on human health, productivity, and economy. Traffic congestion gives rise to several other hazards like accidents, road rage, air pollution and also financial losses due to loss of productive time. The average speed of vehicles in the city has decreased due to increased congestion. Reasons of traffic congestion are increased number of vehicles, inadequate or non-uniform road width, poorly designed junctions, poor road surface, and improper traffic management. Rash driving without concern for others on the road leads to traffic grid locks and ultimately congestion. Sometimes, vehicle breakdowns, festivals or rallies etc are responsible for congestion. Congested corridors are also hubs of air pollution due to suspended particulate matter, leading to several health hazards. There is a huge economic loss on account of congestion in BMA.

13.3.7 Fire Hazards

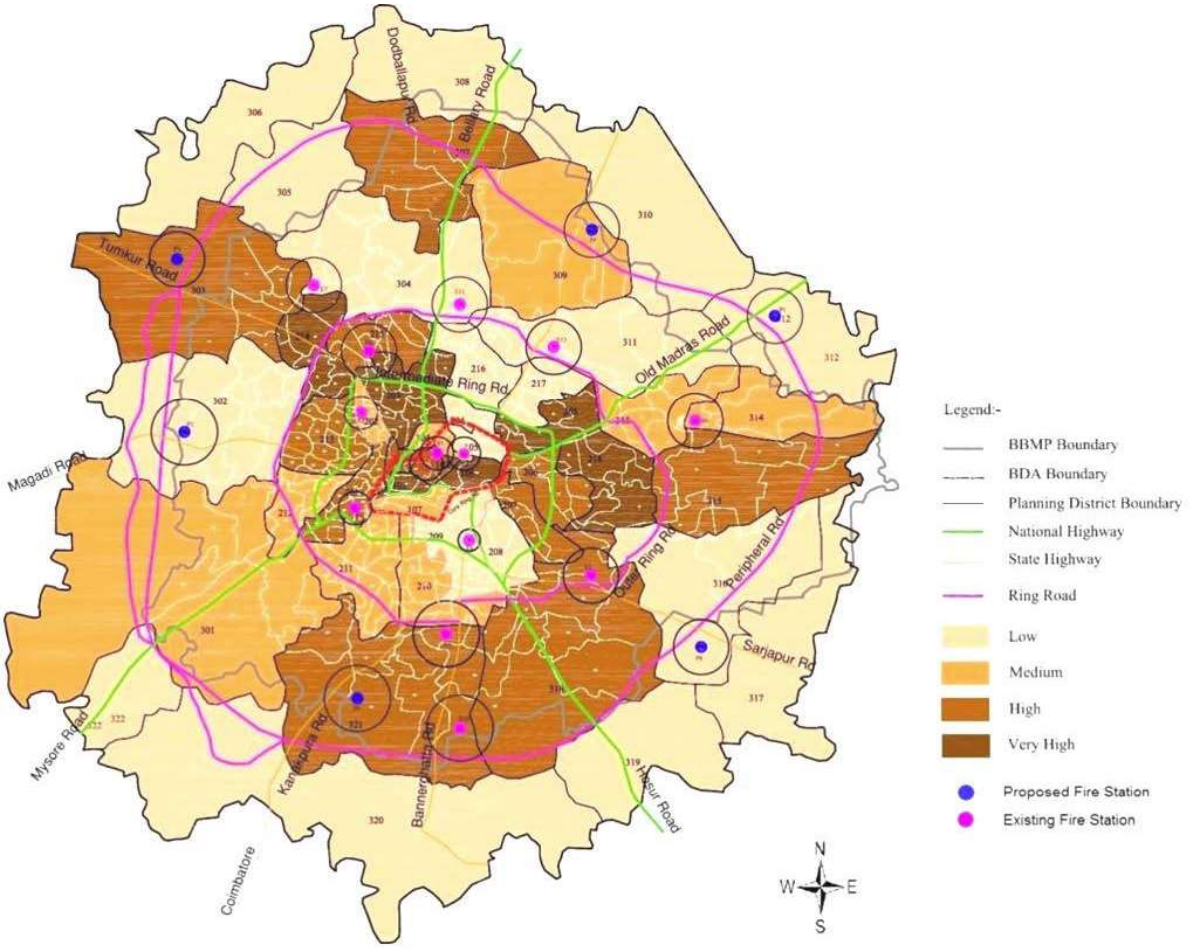
Fire Hazard: The Karnataka Fire and Emergency Services Department (KFES) has carried out an fire risk assessment for entire planning area of Bengaluru, classifying BMA in four fire risk zones – Very High Risk, High Risk, Medium Risk and Low Risk zones, formulated considering factors like population density, concentration of commercial, public assembly, industrial areas and high rise buildings, and major accident hazard units as well as Planning District boundaries of RMP 2015. **Figure 12-1** shows the Fire Hazard risk zones within BMA as per KFES. It can be seen that seven zones are classified under “Very High Risk (Petta, Richmond Town, Malleshwaram, Baiyyappanahalli, Peenya, CV Raman Nagar, Byatarayanapura), 12 as “High Risk”, 10 “Medium” and remaining 9 as “Low Risk” zones. Overall 14 percent of total area is classified as Very High Risk. Thus, many areas in Bengaluru are vulnerable to fire hazards. Fire can easily spread in highly congested areas. Narrow and congested roads also make accessibility for fire tenders difficult in the area. The central market area in Bengaluru, namely the Petta area is susceptible to fire hazards. Markets selling easily inflammable goods are more vulnerable than others. People living or working in high rise buildings, or enclosed spaces, are more vulnerable to fire hazards

Hazards from Electricity: In several places in the city, safety norms as prescribed by Karnataka Power Transmission Corporation Limited (KTCPL) guidelines on safety buffer zones along the HT corridors have not been enforced and developments have been within safety buffer zones of the HT Line. Many buildings have been constructed not only in close proximity but beneath the HT lines, posing a great risk to human life and property. As may be observed, HT lines run over buildings and

[25] http://www.cpcb.nic.in/Ewaste_Registration_List.pdf

unauthorised development under HT lines needs to be checked. Exposed electric wires in several areas pose a high risk in several areas.

Figure 13-1: Areas of High Fire Risk within BMA



Source: Fire Hazard Response and Mitigation Plan for Bengaluru City, KFES

13.3.8 Industrial and Chemical Hazards

Industrial Hazard may be defined as any incident connected with an uncontrolled development (such as leak, fire and / or explosion) of an industrial activity involving a serious immediate or delayed hazard to man and / or the environment. A chemical disaster may take place due to accidental leakage from a facility, accident during transportation of hazardous material through population centres or due to indiscriminate use of chemical agents. Industrial and chemical accidents mostly are a result of human activity and error, though there are several possibilities of Industrial hazards occurring as a result of natural phenomena, such as earthquakes.

a. **Hazardous Industries**: Some of the clusters of hazardous industries are also accident prone. Peenya has a high concentration of Hazardous factories, and major accident hazards. It is noteworthy that Peenya also has several hazardous waste recyclers. The areas, with risk of industrial hazards, have also been considered in the risk assessment for fire safety by the KFES.

b. **Quarrying in urban limits:** Several stone quarry sites are located in BMA which are in close proximity to forest areas such as the Bannerghatta National Park and residential areas. Quarrying activities add to air and noise pollution. Fine solid particles from drilling, blasting and mining are scattered across wide areas and habitations by the wind. Transportation of ore by road adds to the problem significantly. Activities like drilling, blasting, loading and transportation, results in significant noise. Human habitations located adjacent to quarries are especially subjected to high levels of noise. Abandoned quarries are safety hazards for humans. Several unauthorised sites are left abandoned without any precaution, causing risk to humans.

c. **Hazardous Material transportation/ Oil and Gas Installations:** Transportation of Hazardous materials like Oil and gas through pipelines or by tankers on road is a risk and may lead to industrial accidents. Spur lines carrying gas are being laid in Bengaluru that will distribute gas in the BMA. Oil and Gas installations are hazardous in nature and may pose risk to traffic, properties and economic activities in case of burst/ fire in pipelines. Further, highly inflammable liquids and gas storage is done at Devanagonthi, outside BMA. Several oil and gas tankers use roads within BMA, to transport the oil from Devanagonthi depot. Quality of road surface and narrow road widths pose great danger on these roads leading to Devanagonthi from BMA.

13.4 Probabilistic Hazard Assessment

A probabilistic assessment of hazard occurrence for BMA over next 25 to 50 years has been done for natural hazards only as it is not possible to assess the possibilities of occurrence for manmade hazards. The assessment is the compilation of assessment done by various government agencies.

a. Earthquake: Bengaluru lies in a low intensity seismic zone (Seismic Zone II) and is at minimal risk of an earthquake. However, there have been a few incidents of low to medium intensity earthquakes in the region that have affected Bengaluru. There may be a possibility of an earthquake in the Bengaluru region in the next 100 years. Such earthquake may lead to a damage to physical infrastructure, and lead to economic loss. Strict adherence to codes will help reduce vulnerability to earthquakes in the future.

b. Heavy Rainfall Events leading to Urban Flooding: Urban flooding may take place in the future due to heavy rain events in BMA. The clearing of blockage in the rainwater drainage system shall help mitigate some of the urban flooding events. The present infrastructure need to be upgraded to handing very heavy rain events, as such events may cause extensive flooding especially in the identified low lying areas in BMA.

c. Drought: Drought conditions may affect Bengaluru, and will have some impact on availability of water. The change in rainfall pattern in the future shall affect the occurrence of drought. The areas with limited access to the water supply network will have a higher impact from the drought.

Table 13-1 gives a probability matrix of the major hazards that BMA may face in the future. Some events like Earthquakes cannot be predicted. With change of climate and rainfall patterns, it has become difficult to predict droughts too. The probability matrix, gives the risk from each hazard. A general probability analysis for the various natural hazards is given for 25 years, 50 years and 100

years horizon. It may be noted that it is difficult to predict other man made / technological hazards due to the dynamic nature of the associated risks. With newer technology, it is expected that some of the technological hazards may have lower impact in the future.

Table 13-1 Probabilistic Hazard Risk Assessment

	Hazard Identification	Probability				
	Hazard	**Risk to BMA**	**Level of Impact**	**25 years**	**50 years**	**100 years**
1	**Urban Floods**	High	Moderate to High	High Possibility	High Possibility	High Possibility
2	**Earthquake**	Low	Low to moderate	Low to moderate possibility	Low to moderate possibility	Low to moderate possibility
3	**Drought**	Low	Low	Low to moderate possibility	Low to moderate possibility	Low to moderate possibility

Source: Consultant's Analysis.

13.5 Institutional Framework for Disaster Management in BMA

Disaster monitoring Centre: Karnataka State Natural Disaster Monitoring Centre (KSNDMC), an autonomous Body affiliated to Department of Science & Technology, Govt. of Karnataka, monitors natural Hazards and disasters and issues early warnings in BMA as well as for the whole state. KSNDMC issues alerts for heavy rain events, heavy wind etc and monitors rainfall patterns in the state as well as BMA.

Disaster Management Cell: The Disaster Management Act 2005 mandates every district to establish a District Disaster Management Authority under the chairmanship of the deputy chairman or collector and to be co-chaired by the elected representative of the local body.

Bangalore Urban District has a Disaster Management Cell overseen by the Deputy Commissioner of the district. The cell coordinates between various government agencies, organisations, stakeholders and hospitals, in the event of any disaster and manages available resources and manpower to tackle emergencies. Some of the agencies with which coordination is involved during emergency situations are the Karnataka Fire and Emergency Services (KFES), BESCOM, BBMP, and the Bengaluru City Police. In addition, several organisations and service providers have their own disaster management cells that manage the disasters in their respective sectors and services.

13.6 Hazard Mitigation and Disaster Management

The Masterplan recommends the following actions to mitigate the hazards and to reduce vulnerabilities in BMA.

- Effective implementation of National Building Codes for fire safety of buildings.

- Rejuvenating the lake and stream system to their intended volume and flow.
- Using open spaces, parks and playground as a flood protection strategy.
- Strengthening of the public transportation system which will address congestion and air pollution.

To understand the Hazards in detail, the masterplan recommends an in-depth study that shall establish the mitigation measures for all the hazards and disaster that are likely to affect BMA in near future.

As part of strengthening the institutional capacity, the masterplan recommends the District Disaster Management cell to be upgraded to a District Disaster Management Authority and it shall be responsible for preparation of the 'District Disaster Management Plan' and upgrade it regularly in coordination with all the stakeholders, subject experts, government bodies, elected representatives, and citizen groups.