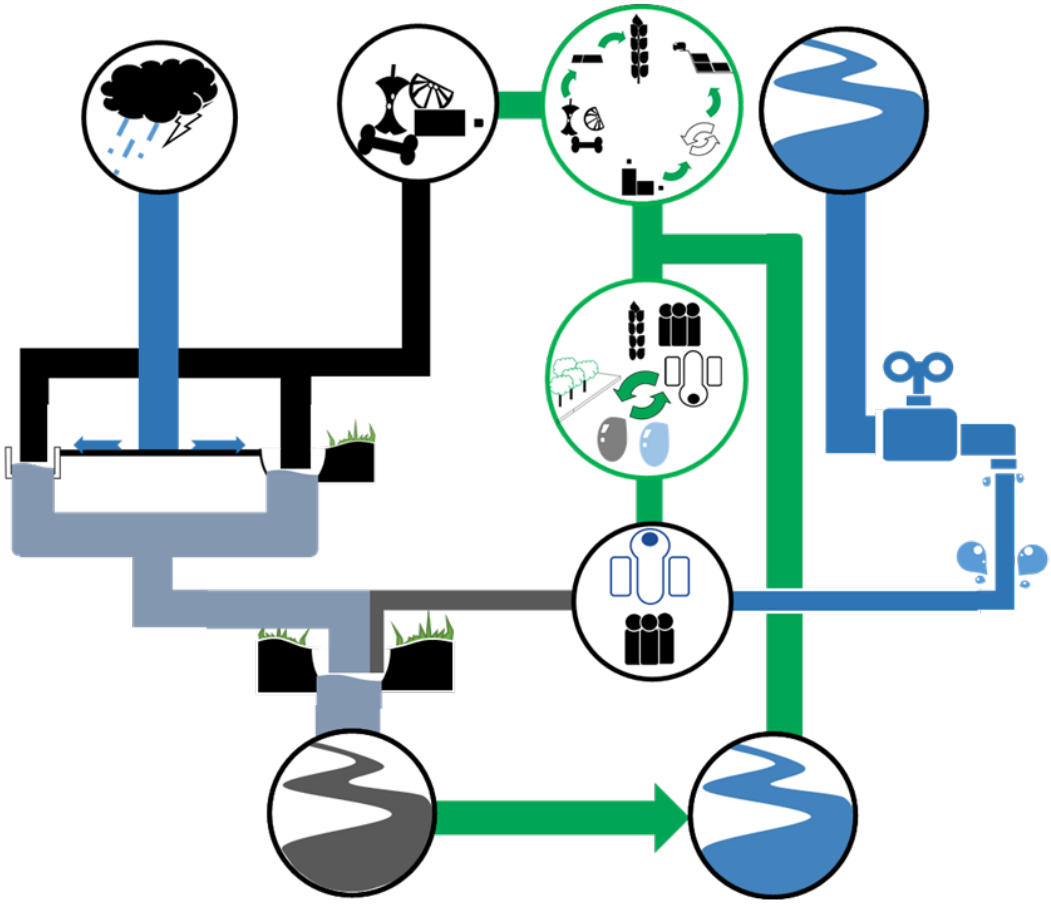
City Sanitation Plan for PURI



Preparation of CSPs for Cities of Odisha

Sanitation Action Plan

2017

Prepared By:

Consortium for DEWATS Dissemination Society

राष्ट्रीय नगर कार्य संस्थान
NATIONAL INSTITUTE OF URBAN AFFAIRS

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LIST OF ACRONYMS

%	Percentage
°C	Degree Celsius
°F	Degree Fahrenheit
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
BIS	Bureau of Indian Standards
CAPEX	Capital Expense
CDD SOCIETY	Consortium for DEWATS Dissemination Society
cm	Centimetre
CPHEEO	Central Public Health and Environmental Engineering Organisation
CSP	City Sanitation Plan
CT	Community Toilet
cu m	Cubic Metre
FSM	Faecal Sludge Management
FSSM	Faecal Sludge and Septage Management
H & UD Department	Housing and Urban Development Department
IHHL	Individual Household Latrines
JICA	Japan International Cooperation Agency
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
km	Kilometre
l	Litre
lpcd	Litre per capita per day
lts	Litres
m^3	Cubic Metre
MC	Municipal Corporation
MLA	Member of Legislative Assembly
mld	Million litres per day
MoUD	Ministry of Urban Development
MPLAD	Members of Parliament Local Area Development Scheme
NIUA	National Institute of Urban Affairs
nos	Numbers
OISIP	Orissa Integrated Sanitation Improvement Project
OPEX	Operating Expense
OWSSB	Orissa Water Supply & Sewerage Board
PT	Public Toilet
PHEO	Public Health Engineering Organization
Rs	Rupees
SAAP	State Annual Action Plan
SBM	Swachh Bharat Mission
SCBP	Sanitation Capacity Building Platform

SeTP	Septage Treatment Plant
SFC	State Finance Commission
SLIP	Service Level Improvement Plan
sq. km	Square Kilometre
SRT	Sludge Retention Time
STP	Sewage Treatment Plant
SWM	Solid Waste Management
ULB	Urban Local Body

1 MOUD CSP Self Review Checlist

1 MOUD CSP SELF REVIEW CHECKLIST

The checklist below shows all the sections that are required to be covered under the City Sanitation Planning process. The checklist, as developed by Ministry of Urban Development (MoUD), helps in the assessment of the scope of the City Sanitation Plan (CSP). The indicators in the Checklist are drawn to measure whether the key dimensions of sanitation are addressed in the contents; and ensure that the process followed in the preparation of the CSP was consultative and has full ownership of the city stakeholders.

TABLE (1): CSP CONTENT SELF-ASSESSMENT

No	Item	Yes/No	Remarks/Status
I. Baseline Data Collection & Situational Analysis in terms of identification of short term or mid – term or long term measures			
1.	Has the city carried out a baseline data collection (secondary and primary) and Situation Analysis of different aspects of sanitation viz:	**Yes**	**Stakeholder consultations and field visits were conducted during the following periods:** • 3rd Feb 2017 (Project Inception Meeting) • 10th, 14th and 15th of March 2017 (Stakeholder consultation and field visits) • 23rd March 2017 Meeting with SBM State PMU Cell at Bhubaneswar • 26th and 27th April 2017 (Stakeholder consultation, field visits, surveys, WW flow studies)
i.	Access to household level sanitation arrangements in general residential and slum areas	**Yes**	**SBM Data for number of applications for new toilets and 2011 Census Data** Information sources include • Data from SBM Cell of the city and • Census 2011 data (The city also uses the 2011 data for all its decision making) • Note: The Swachh Sarvekshan Survey was underway during the course of the project. The data once received as an outcome of this project needs to be collated with the supply demand gap calculated within the CSP. This will provide the additional demand for toilets among the population that has grown between 2016 and 2017.
ii.	Community and Public Toilets – location and status	**Yes**	• Information source- SBM Cell. • location available for existing CTs, no location for new CTs (Demand for new CTs have been calculated); location are available for existing PTs • Toilet gap has been assessed.
iii.	Safe collection and conveyance of human excreta (on-site and sewerage) – infrastructure and management (including status of de-sludging services)	**Yes**	• Information for toilet containment units is sourced from Census 2011 • Information on sewerage sourced from OWSSB (Mr. SS Nanda, Deputy Engineer). • Details and gaps in OSS and desludging services have been covered.

iv.	Treatment and safe disposal of human excreta	**Yes**	• Information source- Mr. S.S Nanda., OWSSB, Puri. • DPR shared for upcoming Fecal Sludge Treatment Plant
v.	Solid waste collection, transport and safe disposal	**Yes**	All details on Human Resources, waste collection and conveyance assets, treatment site details collected from Solid waste specialist, SBM Cell
vi.	Drainage and flooding	**Yes**	• Information sourced from Officials of the Drainage division, Odisha Water Resources Department, Puri • Information source - Mr. S.S Nanda., OWSSB, Puri.
vii.	Drinking water quantity, quality and coverage	**Yes**	• Information Source- PHED • The focus on Water Supply sector is only to the extent that it has a bearing on the sanitation of the city. Technical inputs in this sector will be limited. These three data sets were collected and presented in the Situation Assessment reports. All these 3 points are covered here. • Total water demand of population • Rate of supply (lpcd) • Coverage of supply across wards • Extent of Non Revenue Water • Water quality
viii.	Institutional arrangements and finances for capital creation and O&M management of environmental services (water, sanitation, solid waste, drainage)	**Yes**	• Information source- Puri Municipal Corporation. • Staffing situation (positions available, filled, vacant) is presented in the Situation Assessment report as well as institutional arrangements; • Municipal budget has been assessed.
ix.	Current population and socio-economic categories; and projections by different categories	**Yes**	2011 Population data was used for all assessments; Socio economic categorization was limited to the assessment of situation in slum settlements.
x.	Arrangements and practices of commercial, public and other institutions in respect of sanitation and solid wastes	**Yes**	Public Toilets data have been collected along with sample surveys at selected units to understand their O&M arrangements. Specific focus on commercial establishments was not placed in the CSP. The focus of the report was holistic and citywide.
xi.	Maps and physical features of settlements (wards, slums, etc.) and key city infrastructure (water, sewerage, drainage, roads, treatment plants, water and sewage pumping stations, etc.)	**Yes**	Map source- Monalisa, Health and Sanitation, PMC; GIS shape files from PMC and OWSSB for sewerage related projects. These have been used in the relevant sections.
xii.	Data on health-related indicators of sanitation and water supply	**No**	Health related indicators have not been evaluated in the study. However, solutions for solid waste and wastewater management have been sensitive to the public health situation in the

			city.
xiii.	Other important and locally relevant details (specify)	**Yes**	• Storm water flow and quality was studied. • Reuse potential was assessed and suggestions provided for FSM and SWM.
2.	Has the draft CSP identified specific data gaps and developed a plan for detailed data collection?	**Yes**	Supply demand gap assessment has been incorporated.
II. Institutional Roles and Issues			
3.	Has the city identified an institutional home/s for sanitation planning, implementation, monitoring and regulation?	**Yes**	The ULB anchors the implementation of CSP
4.	Has the draft CSP proposed specific actions to resolve institutional gaps and overlaps for:	**(Score overall "Yes" if at least five indicators below score "Yes", else "No")**	
i.	Planning and financing	**Yes**	• Plan has been provided with action points and their prioritization over a time frame • Costs for the same has also been highlighted in the action plan
ii.	Creation of physical infrastructure	**Yes**	Infrastructure assets to be built have been identified (costs and O&M considerations) for solid waste processing, wastewater conveyance, treatment and FS reuse
iii.	O&M Management	**Yes**	
iv.	Training and Capacity Building	**Yes**	Training and capacity building has been highlighted for toilet creation, FSM and SWM related activities.
v.	Monitoring of Outcomes	**Yes**	Monitoring activities have been suggested for water quality in the drains and solid waste management.
vi.	Communications	**Yes**	IEC activities to be undertaken have been provided for all the sectors.
vii.	Regulation	**Yes**	Regulatory provision for FSM and SWM has been included.
III. City-wide Sanitation Campaign			
5.	Does the draft CSP contain a plan for the launch of a 100% Sanitation Campaign in the city?	**Yes**	The ancillary activities such as IEC campaigns and training programs have also been suggested within the action plan.
IV. Technology Options and City-wide design			
6.	Has draft CSP detailed and evaluated different technology options (on or offsite as well for collection, transport and safe disposal – i.e. full-cycle) for sanitation?	**Yes**	Different technology options have been evaluated for: • Wastewater conveyance and treatment options • Solid waste processing facilities
7.	Do the proposed sanitation interventions (rehabilitation, retrofitting or new investments) consider the whole city? (not just a part thereof)	**Yes**	For conversion of insanitary to sanitary toilets
V. Urban Poor and Unreached			

8.	Has the draft CSP identified the locations or settlements of the urban poor and other unreached population segments with have no or limited access to sanitation?	**Yes**	Slum locations have been identified
9.	Does the draft CSP identify actions for assisting unreached/poor households with individual, community or public sanitation facilities (in that order); and efficient disposal from these facilities?	**Yes**	Information on the number of slums and their access to sanitation has been included.
10.	Has the draft CSP identified or proposed sources of financing the CSP (schemes, grants, loans, etc.) for extending access to sanitation and related behaviour change communication activities?	**Yes**	• Costs have been identified for all action points (involving asset creation, capacity creation and awareness generation) and funds available from AMRUT and SBM are known. Additional avenues for funding have not been identified.
VI. Financing and O&M Management			
11.	Does the draft CSP consider an appropriate time-frame and spatial and demographic dimensions to remain relevant (at least for the 12th Five Year Plan period, even if investment numbers are indicative or work-in process)?	**Yes**	A short term, medium term and long term timeframe has been considered while providing solutions Spatial dimension has been considered wherever necessary, such as while locating the citywide composting unit. For HH level interventions, the ULB will have to do site level feasibility to exactly determine space availability for implementations. Funds available from the SAAP and municipal budget are known for meeting the costs of the actions (involving asset creation, capacity creation and awareness generation) identified in the plan.
12.	Were the different sanitation options (hardware plus software) evaluated on the basis of financial viability? (i.e. Cost Benefit Analysis done)	**Yes**	Cost comparison and pros and cons have been reflected for different technology options meant for toilet installation, solid waste treatment options and wastewater conveyance and treatment options
13.	Whether O&M implications of each of the investment options evaluated i.e. implications on tariff increases and willingness to pay for services; personnel number and capacities etc.?	**Yes**	
14.	Has the draft CSP considered options for partnering with private sector, NGOs etc. for implementation or O&M management of sanitation facilities?	**Yes**	• For toilets and wastewater management operations, the options for partnering with private sector are being indicated in Action Plan. • For SWM, collection is outsourced already to private agencies. • Outsourcing of biomedical waste treatment plant, C&D plant, biogas plants and material recovery facilities has been suggested.
VII. Expedient and Other Actions			
15.	Has the draft CSP identified the steps for implementing improved enforcement of	**Yes**	Enforcement frameworks have been suggested for effective SWM and FSM

	existing laws and provisions? (e.g. prohibiting hazardous discharge of untreated sewage, scrutiny about sanitation arrangements before issue of building permits)		
16.	Have gaps and overlaps in existing regulations identified for resolution? (e.g. provisions in development regulations or building bye-laws to promote sanitation including safe disposal)	**Yes**	Gaps and overlaps are identified for toilets, FSM and SWM.
17.	Does the draft CSP have a plan for improving septage management?	**Yes**	See **FSM section**
18.	Whether the draft CSP includes an Implementation Plan and Timeline?	**Yes**	Action plan
19.	Whether the draft CSP has a disaster preparedness component?	**No**	
20.	Whether the draft CSP identifies Short term/Medium Term/Long Term Measures to achieve identified outcomes?	**Yes**	Action plan
21.	Does this draft CSP leads to improvement of service levels with respect of SLB related to MSW/Storm Water Drainage/Solid Waste Management?	**Yes**	If the ULB works in alignment with the action plan temporally and incrementally it will leads to improvement in service levels across the whole of the sanitation sector.
22.	Outline of expected improvements on rating as per NUSP?	**Yes**	The Action Plan reflects the expected improvements.

TABLE (2): CSP PROCESS SELF-ASSESSMENT

No.	Item	Yes/No	Remarks
	I. Stakeholder Participation		
1.	A multi-stakeholder City Sanitation Task Force has been formed and has met at least sufficient consultations have been held?	**Yes**	Discussions were conducted with corporators and municipal officials.
2.	All agencies working in the City (ULB, State Government, NGOs, private sector involved in planning, implementation, management or regulation of environmental services (water, sanitation, solid waste, drainage), representatives of different community groups, and key waste-generating segments have been consulted in the process of preparation of the draft CSP?	**Yes**	Unstructured interviews were conducted across stakeholders for assessing all sectors.
3.	Number of Area Sabhas/Mohallas/RWA's etc. consulted?	**No**	Discussions were limited to the executive members of the municipal corporation, community leaders,

			OWSSB, other project consultants and PHED
4.	Whether sufficient consultations have been held with urban poor groups in the city? Indicate the number.	**Yes**	Field visits at slum settlements and community toilets
II. Ownership of the Draft CSP			
5.	Has the draft CSP gone through an appropriate process of "appraisal" or "agreement" at the ULB and the City Sanitation Task Force?	**Yes**	Shared with the ULB. No adverse comments received.
6.	Is the draft CSP aligned to other plans of the city (CDP, Master-plan, Development Plan, etc.) and differences if any, highlighted for resolution in the CSP?	**Yes**	
7.	Are there are any current or pending/ proposed projects (under various schemes) that are in conflict with the recommendations and decisions in the CSP? Have these been highlighted for resolution?	**No**	
III. Communications			
8.	Has the CSP process formally recognized the importance of communicating with stakeholders, right from the beginning of the process, and drawn up as a Communications Plan?	**Yes**	• A project inception and stakeholder consultation was conducted across three meetings; Additionally a implementation support meeting is also envisaged • Discussions also conducted with E&Y who serve as TSU (Tech Support Unit) and activities and analysis shared with TSU. However, no citizen level communication was done.
9.	Have the basic steps of the communication plan started being implemented?	**Yes**	• A project inception was conducted with the executive staff • Implementation support envisaged beyond the CSP submission
10.	Level of awareness in the city about CSP (Indicate Yes/No)?	**Yes**	
IV. Links with Related Exercises			
11.	If the city is participating in the Service Level Benchmarking (SLB) exercise, have the relevant indicators been measured and uniformity ensured between that and the CSP?	**Yes**	SLB data has been considered while analysing the sectors

2 Introduction

2 INTRODUCTION

2.1 Background

The National Institute of Urban Affairs (NIUA) with support of Consortium for DEWATS Dissemination (CDD) Society under its Sanitation Capacity Building Platform (SCBP) is assisting the Government of Odisha to revise the City Sanitation Plans for the 4 (four) cities and towns- Bhubaneswar, Cuttack, Puri, and Baripada. City Sanitation Plans were formulated for these respective cities in overall conformity to the framework proposed within the National Urban Sanitation Policy (NUSP). The plan documents will also align the sanitation priorities of the cities with the National Missions such as Swachh Bharat Mission (SBM) & Atal Mission for Rejuvenation and Urban Transformation (AMRUT). The CSPs will be prepared and submitted within a time period of 4 months by the end of the month of May.

2.2 Approach and Methodology

The preparation of the CSP will be organised to capture information across all segments of the sanitation value chain, for which all sanitation services will be evaluated. As such, the project will undertake following activities:

I. Stakeholder consultations with officials concerning sanitation from the city:
   A. State Government personnel including Joint Secretary, Project Team Leader and other key State Government Officials
   B. Municipality Officials, mainly responsible for solid waste management. The engagement includes discussions with the Chief Health Officer[1], City Engineer, Sanitary Inspector, Chief Finance Officer, Town Planner
   C. Officials from the Swachh Bharat Mission cell within the municipality- who are responsible for IHHL and solid waste management
   D. Officials from the Odisha Water Supply & Sewerage Board (OWSSB), who are mandated with the responsibility for septage and sewerage management in the project cities
   E. Officials from the Public Health Engineering Department (PHED), who are responsible for the supply of water in the project cities.
   F. Accounts department for assessment of municipal budgets for the latest three years
   G. Elected representatives from all project cities

II. Rapid feasibility studies for solid waste management, FSM and wastewater management across all segments of the value chain:
   A. Sector wise detailed engagements (for FSM) will include:
      i. Toilets from households, community, public toilets were surveyed to get an understanding of the user charges, O&M expenditure, service level agreement and issues faced.
      ii. Understanding of the containment systems: Sample households from low-income areas (slums) and public, community and hybrid toilets were surveyed for their desludging practices and user demand

[1] Note: The Chief Health Officer is the main nodal officer at the municipality for managing the mandate of solid waste

iii. Discussions with masons to assess construction practices for toilets and containment systems
iv. Discussions with mechanical sludge emptying operators to assess their activities and frequency
v. Discussion with sewage treatment plant operators to assess treatment processes within plant, O&M practices and costs
vi. Discussions with farmers to assess reuse potential of faecal sludge/septage
vii. Discussion with brick and cement industries for the reuse potential of faecal sludge/ septage

B. Evaluate Infrastructure availability within city (for FSM)
   i. Technology and capacity of existing wastewater/ faecal sludge treatment facility
   ii. Identifying the following for prospective plants:
      - Technology concept
      - Site assessment
      - Site identification
      - Soil Testing

C. The project will adopt a micro pocket planning approach[2] to optimize the systems (human resource, infrastructure assets and processes in place) for the existing solid waste value chain in the respective cities. The sector wise detailed engagements (for SWM) will be to assess activities, frequencies and resources deployed across all segments of the chain. This will include the following study activities:
   i. The project will undertake household surveys only to validate information on solid waste disposal and collection practices retrieved from the municipality
   ii. Discussion with waste collectors to assess waste collection quantities, activities and frequencies of waste collection routines
   iii. Survey of dry resource collection units
   iv. Survey of transfer stations (if any)
   v. Survey of solid waste processing units
   vi. Exploring recycling potential for dry solid waste resources (plastics, glass etc.)
   vii. Discussion with the municipal officials for setting up composting units in large market complexes

D. Evaluate Infrastructure availability within city (for SWM)
   i. Details of existing sanitary land fill
   ii. Technology and Capacity for existing solid waste processing unit
   iii. New technologies that can be incorporated, i.e. identifying prospects for improving treatment processes. Different technology concepts will be explored in this regard.

[2] The Micro Pocket planning approach is a planning methodology pioneered in Andhra Pradesh under the provisions of the A.P. State's Government Order 279

III. Secondary data collection (old CSP document, policy documents, DPRs etc.) and review from the cities on service levels and sectoral situation for the aforementioned sectors
IV. Rapid city level surveys (at sewage outfalls, topographic analysis of city, visits to sanitary landfills and solid waste processing site) specifically to map environmental and public health issues associated with sanitation
V. Flow assessment at main outfalls were also undertaken (in Bhubaneswar, Cuttack and Puri) to understand the quality of wastewater being conveyed out of the town.
VI. Undertaking situation assessments across water supply and Storm water management in the respective cities
VII. Identifying potential technical feasibility interventions for storm water management in the project cities
VIII. Preparing financing and business models for different components of the selected interventions for access to toilets, SWM and FSM. CAPEX and OPEX should both be considered for the business model to ensure sustainability. Recommend any incentives needed for contractors and/ or waste haulers to guarantee safe disposal of sludge and solid waste
IX. Evaluating the Municipal Budgets, State Annual Action Plan (SAAP) and the Service Level Improvement Plans (SLIP) and organizing the investment planning for sanitation in the project cities in alignment with these plans

2.3 Scope of the Report

The report focusses on solutions for each of the sections. Key issues and gaps are highlighted for the complete sanitation value chain, which includes access to toilets, sewerage and FSM, storm water drainage, and solid waste management. The demand supply gap in the infrastructure provided is also assessed through for each of the sectors. Specific on-site details have also been covered in this section. The key issues for each of the sectors in sanitation are given solutions through an action plan in the short term (within 2 years), medium (3-5 years), and long term (5-10 years). The solutions would also follow an incremental approach to improvements in all the sectors of sanitation. This would mean interventions and investments which can be sustained- technically, environmentally and socio- economically over a period of time, with a gradual improvement over the three terms.

The components that have been covered under each of the sectors are as follows:

2.3.1 Access to Toilets

The section focusses on the infrastructure required for providing access to toilets to all households. The following aspects were covered to provide solution to access to toilets.

- The demand supply gap in individual, community and public toilets are assessed for the population of Puri.
- The location of the public and community toilets (including Project Samman toilets for Bhubaneswar and Cuttack) are also provided for this section. Details of some of the public and community toilets which were assessed in detail during the site visits have also been incorporated in the report. The details include information about the number of seats, user charges collected, septic tank dimensions, cleaning and desludging frequencies, and issues faced by the toilets. The selection of the toilets has been done

to cover all income segments within the municipality, and also in different areas of the city.

- The current situation and the issues/ gaps are highlighted for each type of toilet. The issues would include gaps in infrastructure, service level issues and future demand projections.
- The demand supply gap is assessed at a quantitative number where the number of toilets required is estimated. Based on the incremental approach of infrastructure provision, households with no toilets were estimated to be provided with community/ public toilets, and households with existing access to public/ community toilets were estimated to be provided with individual toilets. However, the actual number of toilets to be provided is to be finalised based on feasibility studies undertaken in the city/ town.
- An action plan for the provision of toilets is to be provided. Interventions were planned for the short, medium and long terms along the following areas- technical/ infrastructure interventions, operations, IEC and policy measures.

2.3.2 Sewerage and Storm water Drainage

- In sewerage, the current situation in generation of wastewater, conveyance and treatment are assessed. Both the existing infrastructure and upcoming projects are detailed in this section, and the gaps from each of the segments of the value chain are estimated.
- The location of the existing sewerage treatment plants (if any) are provided through a map.
- The key issues in the sewerage system are highlighted and interventions are provided for the short, medium and long terms. Since all the towns/ cities have sewerage or FSM systems or a combination of both, solutions are provided both for FSM and wastewater management in the city/ town. Cross cutting interventions are also planned out for wastewater and FSM- such as IEC campaigns to be undertaken, floating of tenders for detailed projects and the preparation of DPRs.
- For storm water drainage, the major concern areas are mapped out through the waterlogged areas. Other aspects of storm water drainage, such as coverage, major natural drains and rivers, and outfall points are mapped out in the map.
- The length of the drainage network, their slope, and the direction of the course of the storm water drains are provided to give a holistic view of the storm water drainage system in the city/ town. The details of the catchment area are also provided to give an idea of the major outfall points and waterbodies which convey greywater (or wastewater) from the town/ city.
- Water quality is assessed at various outfall points for each of the towns to provide an estimate of the chemical levels and nutrient content in the major drains conveying the wastewater from the city/ town.
- Solutions for the provision of sanitation systems in the city/ town are provided in the next part of the section. The details of implementation of decentralised systems, small bore systems, and simplified and conventional sewer line systems are provided through their main features, pros and cons of implementation. The capital cost, the water quality after

treatment and the O&M costing after implementation of the various systems are provided for each of the treatment technologies.

- Key issues in storm water management are then resolved through an action plan for short, medium and long terms, which would include both infrastructure development and also cross-cutting measures, such as IEC campaigns, policy mechanisms and the kind.

2.3.3 Faecal Sludge Management

- Since there has been an increased dependency on FSM in the project cities/ towns. The report provides an assessment of the faecal sludge management situation in the city/ town. The current situation is assessed across the FSM value chain- including containment, collection and conveyance, disposal and treatment, and reuse.
- The possible recommendation for each segment of the value chain is estimated from the assessment of the current situation and gaps.
- The action plan for faecal sludge management would include the highlighting of the key issues in FSM, definition of the major goals to be achieved for each of the issues, and the action plan over short, medium and long terms. Technical, operational, IEC and policy interventions are defined for solving each of the issues.

2.3.4 Solid Waste Management

- The report highlights the current situation based on the various components of the value chain in solid waste management.
- This would include the total amount of waste generated, amount of waste collected from households, road sweeping and drain cleaning. Details regarding the municipal and private operators responsible for the management of the solid waste are also given in the section.
- Conveyance details are provided through the number of vehicles and machines that are utilised for collection and conveying solid waste in the city/ town.
- Ward wise details of operational service providers, manpower engaged, number of dustbins utilised and the vehicle details are also provided in this section.
- Transfer station details, amount of waste treated and ultimately disposed are also provided in the section.
- Based on the above assessment, the gaps/ issues are highlighted for each segment of the value chain in SWM, followed by the possible recommendations. Gaps in policies related to SWM are also covered in this section.
- The major issues are highlighted, and goals are provided for resolution of the issues. Measures are undertaken in short, medium and long terms along the following aspects- technical, operational, IEC and policy mechanisms.
- Technical details of various technologies for the treatment of waste are also provided in the section. The feasibility of implementation of any of the solutions is to be further assessed by the town/ city.

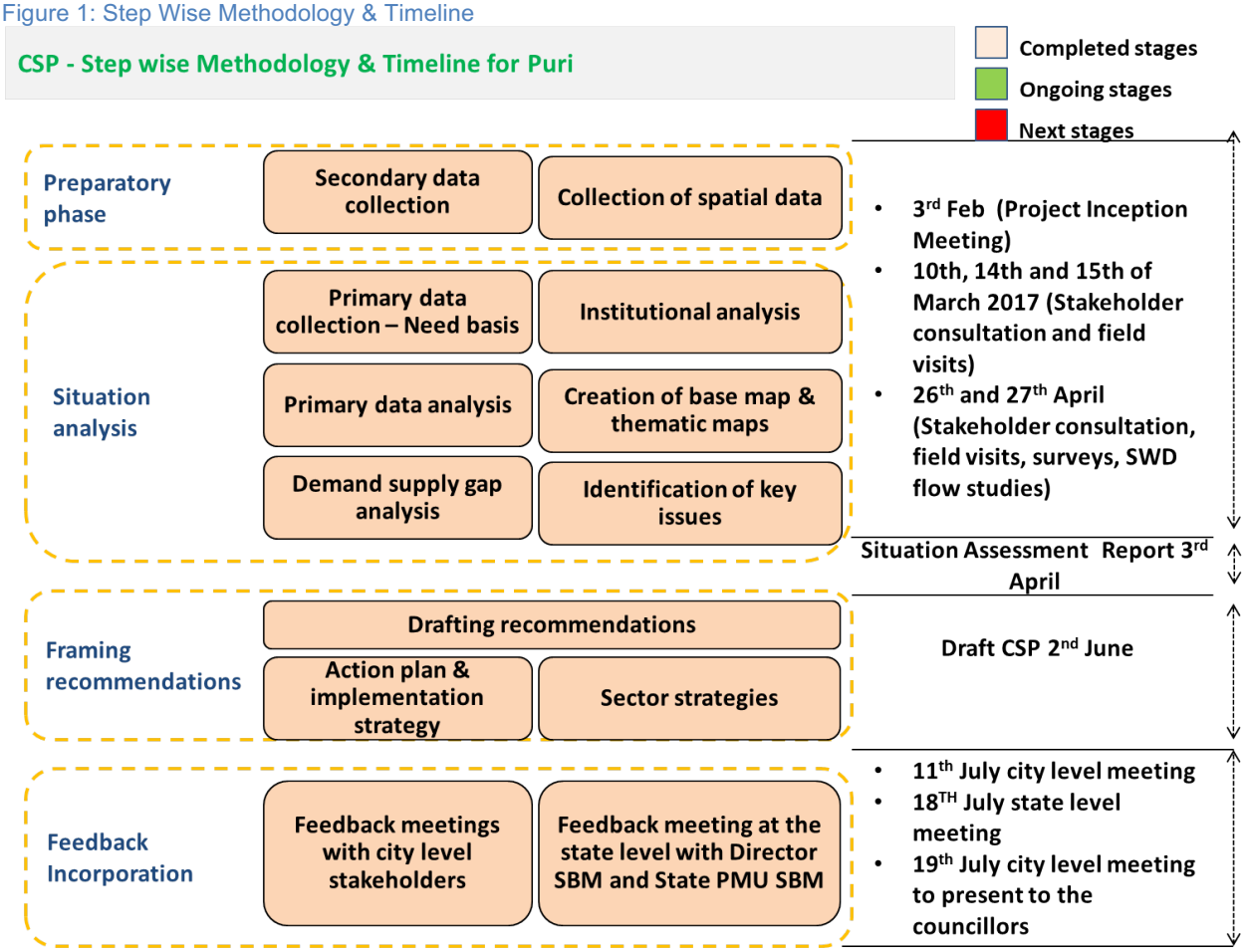
2.3.5 Institutional and Financial Interventions

- The report provides information on the responsibilities for water supply and sanitation sectors in the state of Odisha and the city/ town.

- The organogram of the municipal body is also provided, showing the responsible departments for water supply and sanitation related sectors.
- The section also provides the vacancies in the sanitation related departments, and in the overall municipal structure, allowing an estimate of the departments where capacities are to be immediately strengthened.
- The municipal budget assessment shows the financial capacity in the overall and sanitation related budgets.

2.4 Project Activities and Timeline

Figure 1: Step Wise Methodology & Timeline



The dates for the various project stages will be as follows:

- Project Inception: Feb 1st
- Project data collection: Up to March 20th
- Completion of Situation Assessment: April 3rd
- Defining solutions and technology options: By April 25th
- First Draft of CSP: 2nd June

- Final round of feedback meetings on draft CSP with city and the state-level with Director SBM and State SBM-PMU: completed on 11th and 18th July respectively. Another, meeting with the councillors on 19th July.

Tasks completed:

- Project Inception Meeting (NIUA)
- 1st city stakeholder meetings:
  - Bhubaneswar (1st Feb), Cuttack (2nd Feb) and Puri (3rd Feb)
  - Balasore (2nd Feb) and Baripada (3rd Feb)
- 2nd city stakeholder meetings:
  - Bhubaneswar (23rd Feb) and Puri (23rd Feb)
  - Cuttack (27th Feb)
- 3rd city (detailed city level consultations): 5th March to 20th March
- 4th city level consultations and completion of fieldwork: 17th April to 30th April
- 5th city level feedback meetings on the 1st draft of CSP : 11th July and 19th July
- State Level meeting to get feedback on the 1st draft of CSP :18TH July

3 City Profile

3 CITY PROFILE

3.1 About the City

Table 1: City Profile- Puri Municipal Corporation

District	Puri
Demography	
Total Population 2001 (nos.)	1,57,837
Total Population 2011 (nos.)	2,00,564
Population Density (persons per km²)	12535
Number of Households (nos.)	41,140 (Census 2011)
Avg. Household Size (nos.)[3]	5
Sex Ratio[4]	927
Slum Information	
Number of Slum settlements (nos.)	46
Slum Population (nos.)	66330
Slum Population as a percentage of total population (%)	33
Location, Climate & Topography	
Area (km²)	16.8
Agro Climatic Zone	Tropical savanna climate
Soil Characteristics	Alfisols, Ultisols, Entisols
Ground Water Table (below ground level) (m)	5 m below ground level
Avg. max Temperature (°C)	31.8°C
Avg. min Temperature (°C)	17.1°C
Annual mean Rainfall (mm)	1114

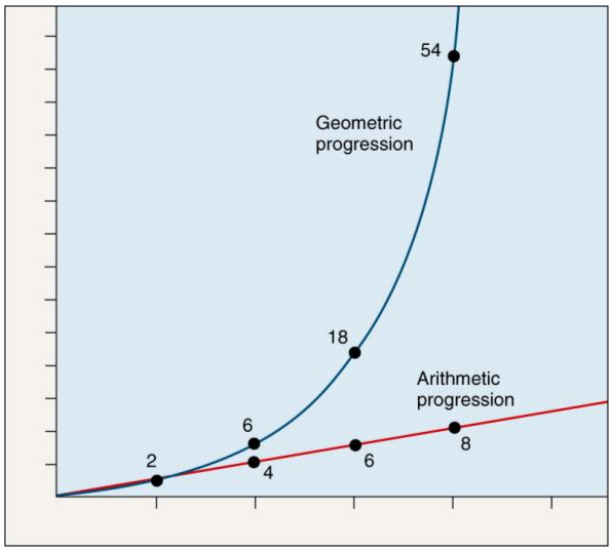
Table 2 Population Projection for Puri

Population Projection (nos)			
Progression Method	**Year**	**Population**	**Households**
Census 2011 Population	2011	200564	41140
Swachh City Plan	2019	260000	52000
	2025	310000	62000
Exponential	2019	217879	43576
	2025	231839	46367

[3] Calculated from the Census 2011 population and households
[4] Based on Census 2011 information

Towards making the population projections, the numbers available from the Swachh City Plan were taken into consideration. The exponential progression of population was also reflected on. Two reasons for adopting an exponential projection of population over the arithmetic or geometric progression methods are:

Figure 2Graphical Representation of arithmetic and geometric projections

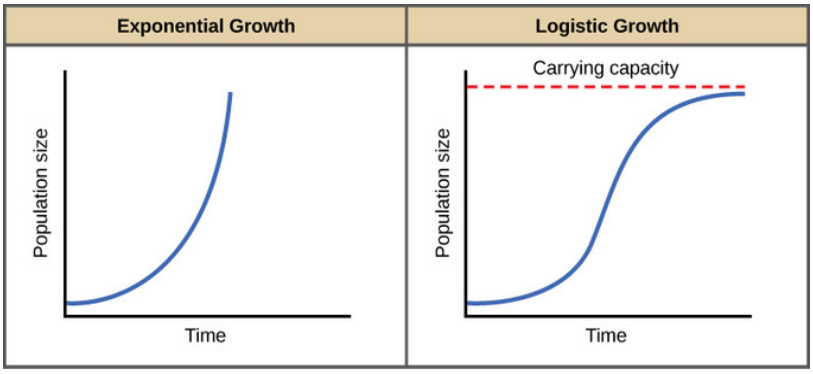


Source: McGraw Hill Companies Inc. (McGraw-Hill Online Learning Center Test)

- In a Geometric progression, the sequence of population increase for each term is by a fixed multiplier growth rate.
- In Arithmetic progression, the sequence of population increase is in a linear manner, where the same amount of population gets added to the base population every year.

Both the above cases of population projections would provide an unrealistic portrayal of the future increase in population. However, in an exponential population progression, the city's future population is proportional to the amount already present.

Figure 3 Exponential and Logical Growth

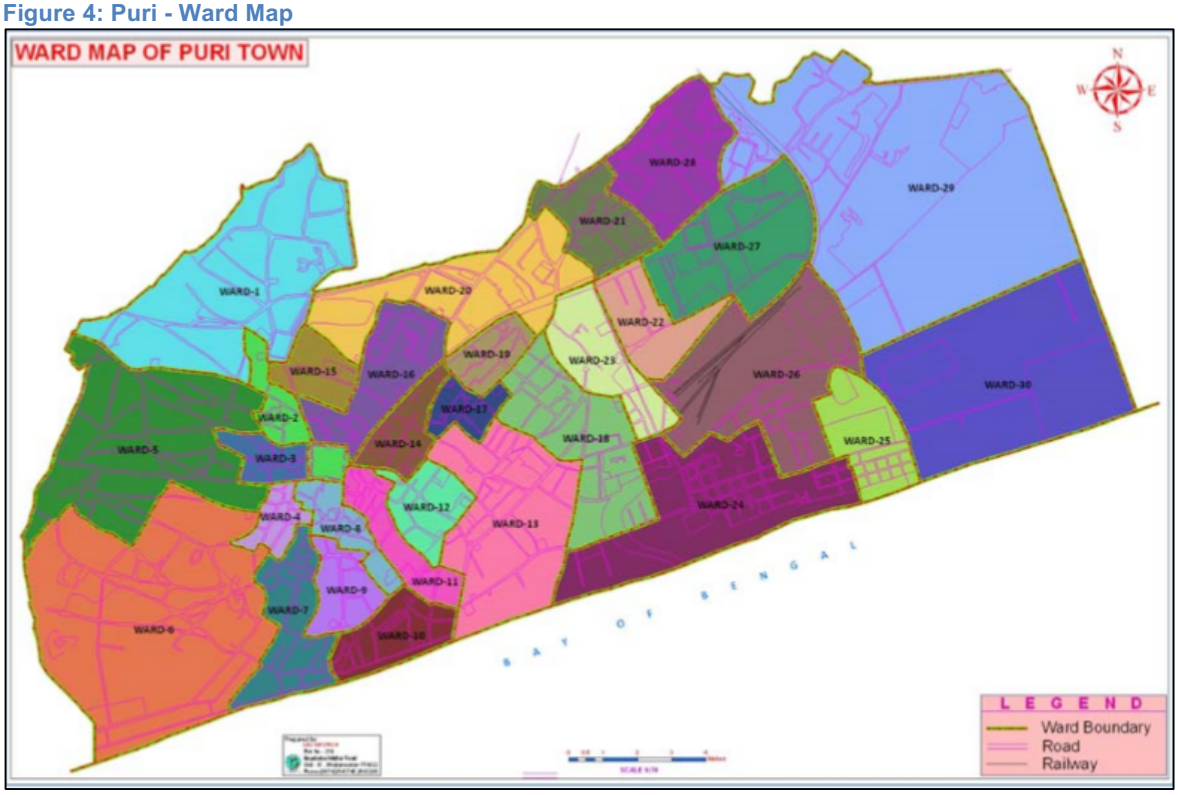


Source: (Socratic organisation)

Although growth may initially be exponential, the modelled phenomena will eventually enter a region in which previously ignored negative feedback factors like lack of regional resources become significant (leading to a logistic growth model). Moreover, there are not enough data to adopt the logistic growth model and calculate accordingly. For a logistic model, the carrying capacity of the region needs to be known after which the population growth rate becomes stagnant.

Taking all these aspects into account, the exponential approach is the most realistic approach to be adopted in this project case.

Figure 4: Puri - Ward Map



Source: Puri Municipality (2017)

4 Sanitation Interventions


Water Supply
27 MLD
Total supply:
55% lost
Non-revenue water
32 municipal wards
4 of which is partially covered
Future Demand
In 2025: 48 MLD (Swachh City Planl)
35 MLD (Exponential)

4 SANITATION INTERVENTIONS

4.1 Water Supply[5]

- Number of pumping wells and open wells: 130
- Total water demand (MLD) @ 155 lpcd (including 15% loss): 31 MLD
- Total supply of water: 27 MLD
- Water supply source is completely groundwater
- Rate of supply: 119 lpcd
- Total number of service connections: 14,639
- Total number of stand posts: 1020
- Wards fully covered under piped water supply: 28
- Wards partially covered under piped water supply: 4
- Non revenue water constitutes 55% of the total water supplied.
- Water quality[6] is reported as 100%
- Water supply is for 2 hours daily on an average

4.1.1 Future Projects:

A number of projects have been planned for Puri under AMRUT funding. The projects are as follows:

1. **Improvement in water metering**
    - There has been a project for the improvement of metering at a cost of 919 lakhs in the year 2015-16.
    - Installation of consumer meters including house connection for existing and new consumers at a cost of 6 crores in 2017-18
2. **Construction of treatment plants and ancillary works**
    - Construction of reservoirs and other ancillary infrastructure including coverage in 12 slums at a cost of 5 crores in 2017-18
3. **Improvement of water supply to uncovered areas**
    - Improvement of water supply to the uncovered areas with laying of pipelines and procurement of pipes, at a cost of 1655 lakhs in the year 2015-16
    - Improvement of water supply to 32 slums at a cost of 6 crores in the year 2017-18
    - Laying of pipelines in uncovered roads and slum areas to achieve 100% coverage planned for 6.50 crores in the year 2017-18.

[5] The information shared on the water supply sector have been sourced from the Service Level Benchmarks and the consultation with officials from the Public Health Engineering Organization

[6] The quality of water supplied is as important a performance indicator as other service delivery indicators. Poor water quality can pose serious public health hazards. Water-borne diseases are quite common in Indian cities, particularly among the urban poor. Although, in most cases, the source of water that causes such diseases/epidemics is not the municipal piped water supply, it is very important to monitor the supply. Therefore, this performance indicator must be regularly monitored, the benchmark value for which is 100 percent

4.1.2 Projection for Water Supply Demand

Table 3 Projection for water supply demand

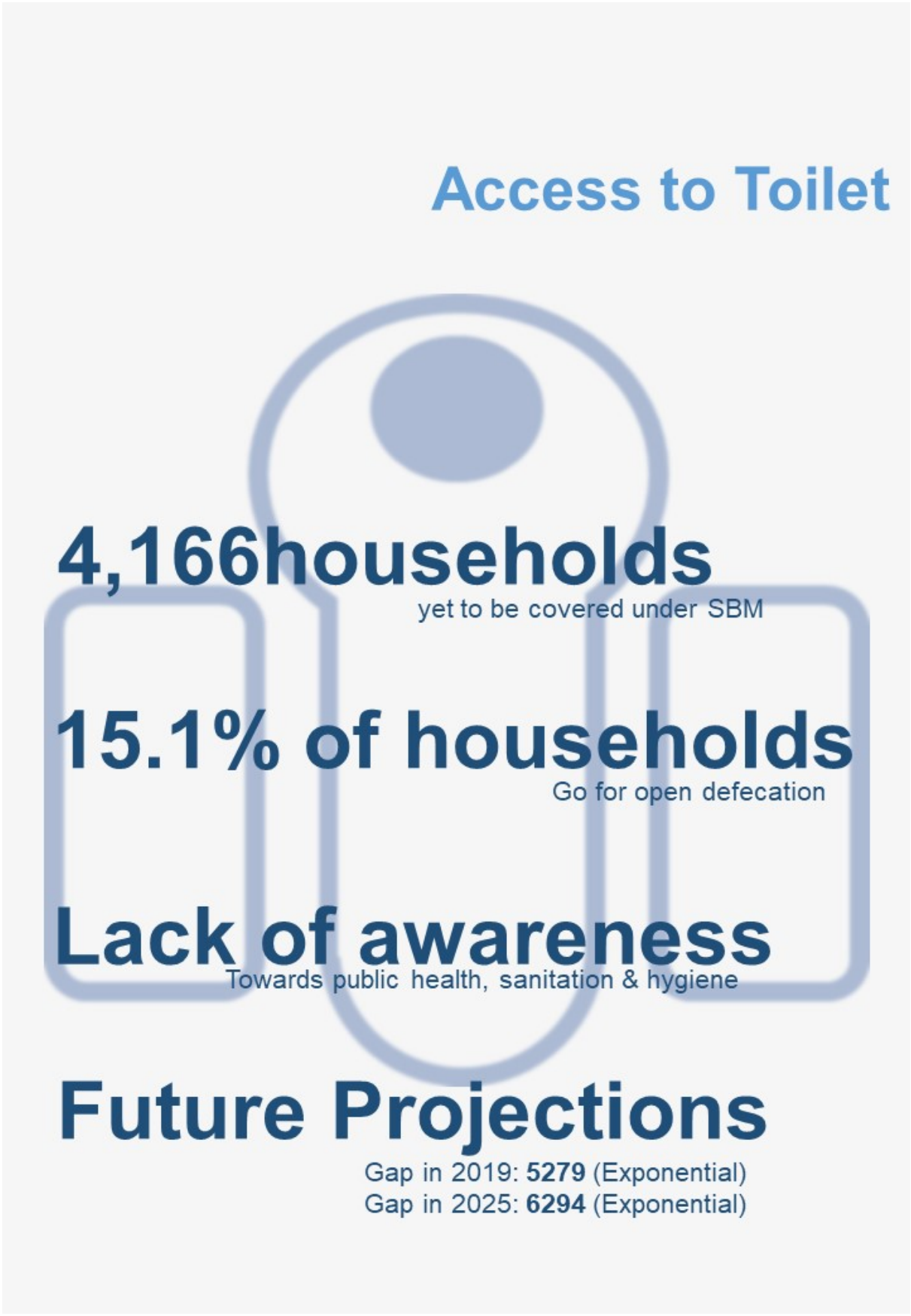
Progression Method	Year	Population	Water supply demand in MLD (approx.)	Existing supply (MLD)	Gap in water supply (MLD)
Census 2011 Population	2011	200564	31	27	4
Swachh City Plan	2019	260000	40		13
	2025	310000	48		21
Exponential	2019	217879	33		6
	2025	231839	35		8

For the purpose of projection, we are using exponential projections. (see Population Projection for Puri for details)

As per Swachh City Plan in 2019, the projected population of Puri will be 260000 and the consequent water supply demand will be 40 MLD. In 2025, the population is projected to increase to 310000 and the consequent water supply demand will be 48 MLD.

As per exponential projections, in 2019, the projected population of Puri will be 217879 and the consequent water supply demand will be 33 MLD. In 2025, the population is projected to increase to 231839 and the consequent water supply demand will be 35 MLD.

The availability of supply water in Puri is less than total demand (4 MLD Gap). In order to fill this gap, currently groundwater is extracted using private wells. This gap will be **13 MLD** (as per Swachh City Plan) **or 6 MLD** (as per exponential projection) in 2019. If the gap is not addressed by 2019, it will further increase to **21 MLD** (as per Swachh City Plan) or **8 MLD** (as per exponential projection) in 2025. This would put greater pressure on groundwater as the supply gap will be compensated using groundwater extraction. In order to avoid that, the supply gap can be met by means of reuse of treated wastewater, especially for toilet flushing, gardening, industrial and agricultural demand; and rainwater harvesting systems.


Access to Toilet
4,166households
yet to be covered under SBM
15.1% of households
Go for open defecation
Lack of awareness
Towards public health, sanitation & hygiene
Future Projections
Gap in 2019: 5279 (Exponential)
Gap in 2025: 6294 (Exponential)

4.2 Access to Toilets

Individual toilets are used by the members of one household. Shared toilets are used by a number of households living in one building or plot. Community toilets are shared by a group of households, primary in low income and/ or informal settlements/ slums, where space and/ or land are constraints in providing a household toilet.

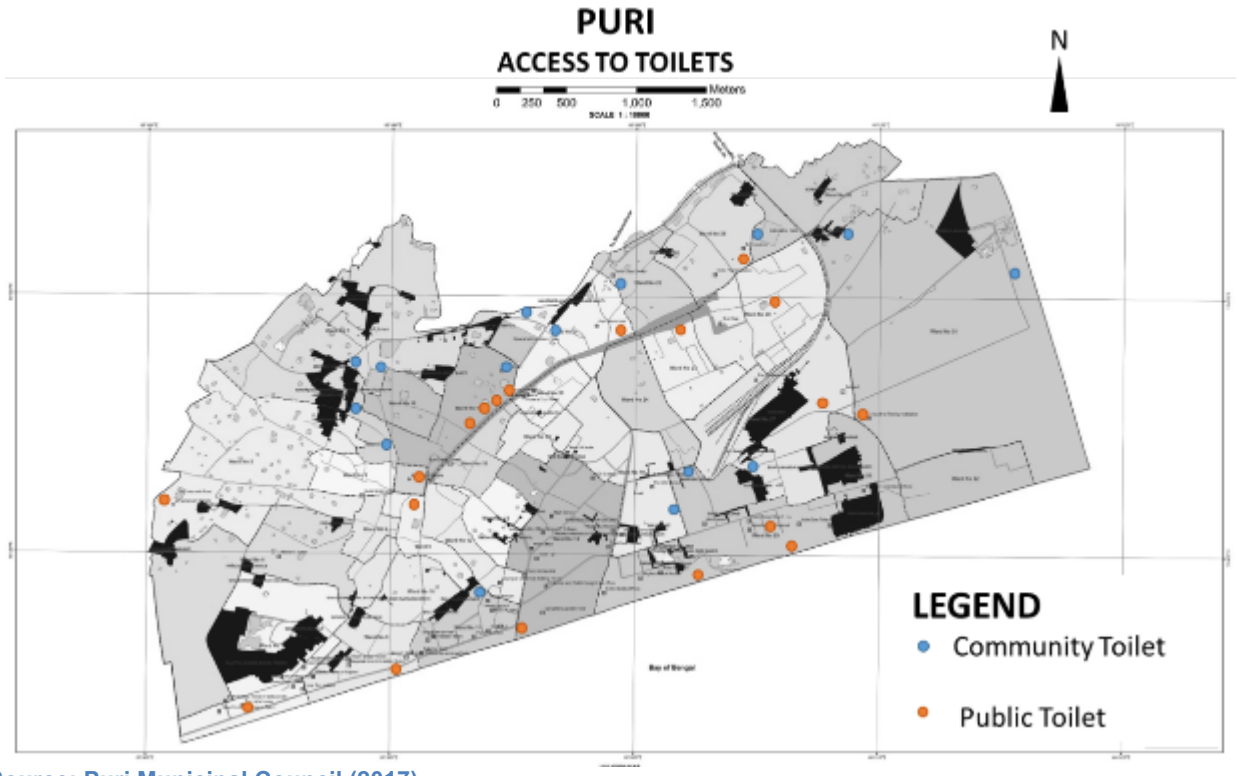
4.2.1 Public and Community Toilets

Map showing the location of public and community toilets in Puri Municipality in Map showing the location of public and community toilets in Puri Municipality below shows the location of the public and community toilets in Puri. There are 16 CTs which are located mostly near slums and 21 PTs are mainly located around the high footfall areas of the Grand Road and the beach area.

The map does not show the location of the hybrid toilets, since they are mostly under construction. The following toilets have also not been marked since they are located outside the municipal boundary, as given in the map:

1. Community toilet near Baliapanda STP
2. 3 public toilets which are located in Malatipatapur, Batamangala and Charinala

Figure 5: Map showing the location of public and community toilets in Puri Municipality



Source: Puri Municipal Council (2017)

Public Toilets

Figure 6: Public Toilet and its containment system in Puri

- **Near Holiday Resort Beach**
  The toilet is operated by Sulabh International. The toilet is used by 15-20 people daily. The daily collection of user charges is around Rs. 50-60. There are 4 seats for gents, and 2 seats for ladies. The charges undertaken are Rs. 5 each for latrine and bathroom. There is 1 caretaker and no helpers. The salary of the caretaker is Rs. 4000. The septic tank for the toilet is a Sintex tank, which has a capacity of 1500-2000 litres. The idea of using a plastic containment is because the percolation rate is high near the beach, where the toilet is located, and therefore a plastic container provides a better collection system. The toilet is more under use during Rath Yatra.
- **Diggvarani Sauchalaya, near Puri beach**
  There are 200-300 people who use the toilet daily. Mostly used by tourists, the toilet is also used by 100-150 local people on a regular basis. There are 7 seats for men and 5 seats for women. User charges are undertaken at the rate of Rs. 5 each for latrine and bath. There are 4 caretakers and 5 sweepers who are in charge of maintaining the toilet, who have a monthly salary of Rs. 4000 each. The daily collection from the toilet is Rs. 1500-1600. The toilet is cleaned around 7-8 times daily. The septic tank is triangular in shape, and has the dimensions of 10 feet*10 feet*15 feet. The septic tank is desludged once a year, and around Rs. 70,000- Rs. 80,000. The high rate for cleaning the septic tank is due to a high amount of sand deposition of sand on top of the septic tank, which requires extra effort to clean up.

Figure 7: Community toilet in Puri

Community Toilets

1. **Near URDC Park office**

The toilet is used by 50-100 people daily. There are 10 seats for men, while there are 10 seats for women. There are no user charges for using the urinals, while Rs. 3 is charged for using the latrine. The septic tank is of the size 8m*4m. The toilet is currently closed since the last three months since the septic tank is full and has not been cleaned.

4.2.2 Current Situation and Gaps

As per Census 2011, 18% households (7405 households) either have no toilets or have access to public/ community toilets. Of this, 15.1% (6212 households) undergo open defecation and 2.9% (1193 households) are dependent on community/ public toilets.

Additionally, 8 % households (3171 households) are having insanitary latrines which include single pit latrines (with and without slabs), service toilets (by humans and animals) and toilets directly connected to drains.

4.2.2.1 IHHL Gap

For the purpose of IHHL construction the Puri Municipality is using the 2011 Census data for planning and estimating the number of IHHL required. For implementation, they rely on application for IHHL and physical verification of the same to construct the toilets with the SBM funds

In the present report, therefore, in the absence of reliable estimates of the numbers exist for 2016, the figures from Census 2011 have been used for the purpose of defining the gaps in the total number of toilets. The individual toilets sanctioned to be constructed under SBM have been considered while calculating the gap in individual toilets. Once the total number of households with no access to individual toilets and those with insanitary toilets are calculated (10576 households), the toilets approved for construction under SBM have been deducted (6400 IHHL). Thus, **4176 sanitary IHHL is the gap is left** after the SBM interventions, as on 8th of August 2017. Ideally, all these households should be provided IHHL. However, given the money and space constraints for many slum households, community toilets will be a better option. (see Projection for IHHL Gap)

4.2.2.2 Community Toilet Seats Gap

In the State level feedback meeting on the first draft on this report, it was suggested that NULM data needs to be referred to for the purpose of slum population based on which the CT requirement can be estimated. However, after discussion with the city officials, it was learnt that NULM uses the same slum population data based on 2011 Census as provided by the city. (SBM co-ordinator of Puri, 2017)

For the purpose of CT seats requirement estimation for this report, the total CT seat estimation has been done for the entire slum population. The demand has been calculated for the entire slum population (66330) as 1 toilet seats every 35 men and 1 toilet seat for every 25 women. Based on this calculation, the total community toilet seat demand is 2336. (refer Slum list, Puri). From this, the existing number of functional CT seats is to be subtracted and thus the gap can be assessed.

At Puri, there are 16 community toilet blocks. Since the Puri Municipality couldn't provide data of the number of seats in these toilet blocks, the exact gap cannot be calculated. (see Projection for CT seat gap)

4.2.2.3 Public Toilet Seats Gap

The floating population for Puri is 10028, as per 2011 Census. Assuming the male to female ratio in the floating population is 1:1, 23 CT seats for male (1 per 100 persons up to 400 persons; for over 400 persons, adding at the rate of one per 250 persons or part thereof) and 53 CT seats for female (2 for 100 persons up to 200 persons; over 200 persons, add at the rate of one per 100 persons or part thereof) will be required. This equals to a requirement of **76 public toilet seats**.

There are 21 PT blocks in Puri. Since the Puri Municipality couldn't provide data of the number of seats in these toilet blocks, the exact gap cannot be calculated. (see Projection for PT seat gap)

Table 4 Access to toilets: situation, gaps and recommendations

Current Situation	Issues/ Gaps	Possible Recommendations
• The Census data (2011) shows that around 18% of the households (7405 households) do not have latrines and they either use public toilets or community toilets or defecate in the open. • Additionally, 8% of the households (3171 households) are having insanitary latrines which includes single pit latrines (with and without slabs), service toilets (by humans and animals) and toilets directly connected to drains. • Apart from the individual household latrines (IHHL), there are 16 Community toilets (CTs) in Puri. • 6400 toilets have been approved for construction under SBM as on 8th of August 2017. • During Rath Yatra time, there is high influx of people from various parts of the country and there are additionally few mobile toilets provided by municipality	• **Gap as per 2011 Census**: ○ **4176** sanitary household toilets need to be constructed. • **Public lacks awareness** towards sanitation, public health and hygiene. In most of the cases people, mostly male population prefer to defecate in open even if they have individual toilet at home. This was validated based on discussions with municipal officials and during visits to slum settlements. • During Rath Yatra time, there is high influx of people from various parts of the country and there are additionally few mobile toilets provided by municipality but there was no proper plan for tackling the issues related to access to toilets during the same time. • Public lacks awareness towards sanitation, public health and hygiene. In most of the cases people, mostly male population prefer to defecate in open even if they have individual toilet at home. This was validated based on discussions with municipal officials and during visits to slum settlements. • There is delay in verification of toilet construction under IHHL and release of funds for the same which is de-incentivizing the process of construction of toilets • Beneficiaries receive full amount i.e. Rs. 5300 only after the toilet and containment system is fully constructed by beneficiary. The amount as subsidy is very less when compared to the expenditure that is incurred in construction of toilet and septic tanks.	• **As per 2011 Census:** ○ 4176 remaining sanitary toilets are to be constructed. Depending on the space and funds availability, the remaining toilets would be constructed for individual households. There might be an additional extra number of toilets from the population that has grown between 2016 and 2017. • The municipality should plan for mobile toilets during the time of festivals, such as Rah Yatra festival. • IEC campaigns for household communities on the importance of usage of toilets, and health and hygiene • Review of the process of verification of the applications for individual toilets in the municipality. • Increase the incentive given to households in order to meet the expenditure incurred in building toilets through other sources of funding. (Refer Funding Models for financing Construction of Toilets)

4.2.2 Requirement based on population projection

For the purpose of projection, we are using exponential projections. (see Population Projection for Puri for details)

4.2.2.1 Gap projection for IHHL[7]

Table 5 Projection for IHHL Gap

Progression Method	Year	Population	Household	Households with either no toilet and dependent on PT/CT	Insanitary Toilets	SBM Coverage till 2017	Gap for IHHL (if SBM coverage doesn't increase beyond 2017)	SBM Coverage till 2019 (End of SBM)	Gap for IHHL (if SBM coverage increases at 8754 IHHL per year till 2019- end of SBM)
Census 2011 Population	2011	200564	41140	7405	3171	6400	4176		
	2019	260000	52000				5279	10667	1011
Swachh City Plan	2025	310000	62000				6294		1206
	2019	217879	43576				4424		156
Exponential	2025	231839	46368				4707		166

As per Swachh City Plan in 2019, the projected population of Puri will be 260000 and the number of households will be 52000. In 2025, the population is projected to increase to 310000 and the number of households will be 620000.

As per exponential projections, in 2019, the projected population of Puri will be 217879 and the number of households will be 43576. In 2025, the population is projected to increase to 231839 and the number of households will be 46368.

For calculating the gap two approaches have been used:

1. If IHHL approvals under SBM continue till 2017
2. If IHHL approvals under SBM continue upto 2019 (the terminating year of SBM) at the same rate.

[7] The number might vary depending of the actual changes on the ground such as people taking initiative to construct individual household latrines owing to increased awareness.

If the IHHL approval continue only till 2017, the number of households lacking access to **sanitary IHHL** (this includes households with insanitary toilets) **will be 5279** (as per Swachh City Plan) **or 4424** (as per exponential projection) in 2019. If the gap is not addressed by 2019, it will further increase to **6294** (as per Swachh City Plan) or **4707** (as per exponential projection) in 2025.

If the IHHL approval continues at the same rate till 2019, **1011** (as per Swachh City Plan) **or 1206** (as per exponential projection) households will still lack access to **sanitary IHHL** (this includes households with insanitary toilets) in 2019. The gap will further increase to **156** (as per Swachh City Plan) or **166** (as per exponential projection) in 2025. .

4.2.2.2 Gap projection for Community Toilet Seats[8]

Table 6 Projection for CT seat gap

Progression Method	Year	Population	Slum population	Requirement for CT seats male	Requirement for CT seats female	Total Requirement for CT seats
Census 2011 Population	2011	200564	66330	976	1360	2336
Swachh City Plan	2019	260000	75000	1260	1747	3007
	2025	310000	105000	1497	2082	3579
Exponential	2019	217879	72057	1060	1475	2535
	2025	231839	76674	1124	1569	2693

As per the Swachh City Plan, the slum population will be **75000** in 2019 and **105000** in 2025.

For calculating the exponential projection, it is assumed that the slum population as a percentage of total population remains constant at 33%. Hence, the slum population will be **72057** in 2019 and **76674** in 2025.

For the purpose of CT seats requirement estimation, the total CT seat estimation has been done for the entire slum population. Assuming the male to female ratio in the slum population is 1:1, the number of CT seats is calculated as 1 community toilet seat for 35 male and 1 community toilet seat for 25 female. The total of these seats gives the total requirement of CT seats. (Guidelines for Swachch Bharat Mission-urban, 2017). From this, the existing number of functional CT seats is to be subtracted and thus the gap can be assessed.

[8] The number will vary depending of the actual changes on the ground such as construction of more community toilet seats and change in slum population.

There is a requirement of **3007** (as per Swachh City Plan) **or 2535** (as per exponential projection) community toilet seats in 2019. This will further increase to **3579** (as per Swachh City Plan) or **2693** (as per exponential projection) in 2025.

At Puri, there are 16 community toilet blocks. Since the Puri Municipality couldn't provide data of the number of seats in these toilet blocks, the exact gap cannot be calculated.

4.2.2.3 Gap projection for Public Toilet Seats[9]

Table 7 Projection for PT seat gap

Progression Method	Year	Population	Floating population	Requirement for PT seats male	Requirement for PT seats female	Total Requirement for PT seats
Census 2011 Population	2011	200564	10028	23	53	76
Swachh City Plan	2019	200000	15000	33	77	110
	2025	310000	20000	43	102	145
Exponential	2019	217879	10894	25	57	82
	2025	231839	11592	26	60	86

As per the Swachh City Plan, the floating population will be **15000** in 2019 and **20000** in 2025.

For calculating the exponential projection, it is assumed that the floating population as a percentage of total population remains constant at 5%. Hence, the floating population will be **10894** in 2019 and **11592** in 2025.

Assuming the male to female ratio in the slum population is 1:1, the number of PT seats is calculated as 1 per 100 persons up to 400 persons; for over 400 persons, adding at the rate of one per 250 persons or part thereof and PT seats for female has been calculated 2 for 100 persons up to 200 persons; over 200 persons, add at the rate of one per 100 persons or part thereof. The total of these seats gives the total requirement of PT seats. From this number, the number of existing PT seats is to be deducted to arrive at the gap. (Guidelines for Swachch Bharat Mission-urban, 2017)

There is a requirement of **110** (as per Swachh City Plan) **or 82** (as per exponential projection) in public toilet seats 2019. This will further increase to **145** (as per Swachh City Plan) or **86** (as per exponential projection) in 2025.

[9] The above projections will vary depending of the actual changes on the ground such as the increase in number of high footfall areas in the cities and construction of more public toilet seats.

There are 21 PT blocks in Puri. Since the Puri Municipality couldn't provide data of the number of seats in these toilet blocks, the exact gap cannot be calculated.

4.2.3 Site specific conditions to be considered

- Sewered areas: The core area is being covered under sewer network. The toilets in these areas can be connected to the sewer network once the network is in place.
- Unsewered area: The unsewered areas, as indicated in Drainage utilities map will remain unsewered for some years. Hence, ccontainment systems need to be built as appropriate for the site-specific conditions such as Groundwater table and soil conditions. If building a containment system is challenging for each toilet, alternate conveyance and treatment systems such as simplified (shallow) sewer lines with decentralised treatment systems and community septic tanks with soak pits can be implemented.

4.2.4 Fund Mobilisation for IHHL

With regard to the public funding for individual toilets, it is largely left to the SBM Funds. That apart, there are various approaches for making available the investment towards construction of new toilets have been explored in this part of the report. The selection of the investment strategy is the discretion of the Puri Municipality. To begin with, 3 possibilities of funding toilet construction can be considered:

Table 8 Funding Models for financing Construction of Toilets

Financing Source	Options
Bipartite Model	Municipality's contribution
	Government of Odisha's contribution
Tripartite Model	Beneficiary Contribution
	Municipality's contribution
	Government of Odisha's contribution
Quadripartite model	Beneficiary Contribution
	Municipality's contribution
	Government of Odisha's contribution
	Aid Organisation/ Not-for-Profit that can bring funding and/or for-profit entities involved in Corporate Social Responsibility

Note: Within these models also, BC could range from 12% to 50% depending on the income segments.

The following aid organisations and for-profit entities involved in Corporate Social Responsibility should be contacted by the municipality for mobilizing funds for increasing the incentives for construction of IHHL.

Table 9 Aid agencies

Name	Scope of work	Relavance
Sulabh International Social Service Organisation	Cost-effective sanitation, liberation of scavengers, social transformation of society, prevention of environmental pollution and development of non-conventional sources of energy.	They undertake CSR activities of various organisations like SAIL, IOCL, etc. for household level, community level toilets.
Gram Vikas	water and Sanitation, Livelihoods, Social Housing, Community Health, Education, Renewable Energy	Initiated as a support volunteer group during the cyclone in Odisha, and since then, has been one of the NGOs that get things done; lead by Joe Madiath who's known in the sanitation sector
WaterAid	Safe water, sanitation, hygiene, Menstrual hygiene, Urban WASH, School WASH, WASH in health, CC & DRR	An international aid agency in WASH sector
CareToday	Construction of Clean toilets	It is a part of India Today group and has been active in construction of household toilets under Clean Toilet Initiative

Table 10 For-profit entities involved in Corporate Social Responsibility

S.N	Name	Scope of Work	Relavance
1	**Mahanadi Coalfields Limited**	Healthcare;, Sanitation	They have done similar kind of projects based on water supply as well as building toilets in the schools.
2	**National Aluminium co. Ltd.**	Drinking water; Sanitation & Health	They have been involved actively involved in SBM in Korapat and Angul districts; in setting up drinking water treatment plant in villages etc.
3	**M/S Indian Farmers Fertilisers Co Op.Ltd**	Building toilets, cleaning of ponds, providing water cooler/ filter	They are very active in constructing the bio-toilets in villages and also care about water purification
4	**Paradeep Phosphates Ltd.**	Health, Drinking water & sanitation	Their objective and work focuses on providing healthcare and sanitation.

5	**M/S. Jindal Stainless Limited**	Health care, Rural Development	They have been focusing on health care and being part of Swatch Bharat Mission
6	**Infosys Limited**	Healthcare, Sanitation, safe drinking water	Their focus areas include promoting healthcare and sanitation as per their CSR policy
7	**M/S Cybertech Software and Multimedia Pvt Ltd**	Sanitation	One of their project include working under Swachh Bharat Mission
8	**M/S Hindustan Aeronautics Limited**	Drinking water, Healthcare, Developing Infrastructure	They have installed BioToilets on ,any public spaces in Koratpur district
9	**M/S Sail Rourkela Steel Plant**	Water Sanitation Project	SAIL has actively involved in Swachh Vidhyalaya
10	**OCL India Ltd Rajgangpur**	Health, Drinking water	Have spent 34 Lakhs in making a village ODF in Sundergadh district
11	**Tata Sponge Iron Ltd**	Health, Drinking Water	Have invested in water and sanitation projects

4.2.5 Action Plan

The key action points to improve access to toilets is in terms of construction of new toilets (both individual latrines and community, public toilets and mobile toilet) and upgrading the insanitary toilets to sanitary toilets; creating a policy mechanism for scheduled desludging and IEC campaign for improving toilet usage.

Table 11 Action plan for Access to toilets

Issue 1		**Individual Toilets**
Key Issue		1. To provide toilets to those who either have access to community toilets or have no toilets; or upgrade household toilets of those having insanitary latrines. 2. Behavioural block of resorting to open defecation even when toilets are there.
Goal		➢ To provide 100% toilet access to the city ➢ To improve the understanding of health and hygiene amongst individuals and communities
Actions	**Short term (within 2 years)**	• The focus on improving access to toilets is not only to construct new toilets but also upgrade insanitary toilets to sanitary toilets. • Constructing **5279 IHHL** (as per Swachh City Plan projection) **or 4424 IHHL** (as per exponential projection) by 2019. • The household toilets can be connected to the sewerage network in the sewered areas. Ensuring last mile connectivity to the sewer line is hence of prime importance in these areas.

	To Medium term (3- 5 years)	• For unsewered areas, the cost of construction of one individual toilet connected to septic tank and soak pits. In such cases, regular deluding of the septic tanks need to be done tanks at least once every 2 or 3 years and transported off-site for treatment prior to disposal. Municipal utility or private contractors are required for desludging of septic tanks and to ensure safe disposal of septage at a treatment plant. However the responsibility for O&M of the septic tank itself lies with the owner of the property. • In unsewered areas, localised wastewater treatment systems can also be put in place. (Refer • Approaches for wastewater management for unsewered pockets and newly constructed multi-storeyed buildings) • Detailed design of the individual toilets are given in Toilet Designs • Increase the incentive given to households in order to meet the expenditure incurred in building toilets through other sources of funding. (Refer Funding Models for financing Construction of Toilets) **IEC** • Households and community members should be made aware for the need for the use of toilets. Awareness programs focussed on the environmental and health issues faced due to open defecation should be highlighted. • Training should be conducted on the O&M mechanisms for individual toilets. **Policy** • Policy measures which would discourage individuals to go for open defecation should be formalised- this would include penalties, incentives for construction of individual toilets, and others. Upgradation of households with public/ community toilets to individual toilets. If funds and conditions are viable, households should be encouraged to construct individual toilets.
	Long term (5-10 years)	Constructing **1015 IHHL** (as per Swachh City Plan projection) **or 1587 IHHL** (as per exponential projection) by 2025.
Issue 2		**Mobile Toilets**
Key Issue		Lack of toilet facilities in high footfall areas during Rath Yatra festival
Goal		Mobile toilets with a safe collection and conveyance system should be planned in areas of high footfall during Rath Yatra and other major festivals.
Actions	**Short term (within 2 years)**	**Technical** • Portable toilets are manufactured by a range of companies in India and thus differ in terms of design, seize as well as the number of WCs and urinals and are available in a variety of options – from A/C luxury toilet vans to economical products. Apart from the toilets itself, mobile toilets are usually equipped with wash basins, water tanks and a wastewater collection tank. **Figure 8 Pictorial representation of mobile toilet**

- The design is considered by the Punjab Municipal Infrastructure Development Company for a mobile toilet with 6 seats
  - 6 WCs (3 per side)
  - 2 wash basins
  - Toilet size: 4' x 3'- 6" x 6'- 6" (approx.)
  - Capacity of wastewater tank: 750 litres (approx.) of SS material
  - Capacity of freshwater tank: 750 litres (approx.) of SS material

Operations

- Cleaning required twice a day
- Collection of user charges for the use of the mobile toilet
- Adequate water supply should be provided within the toilet

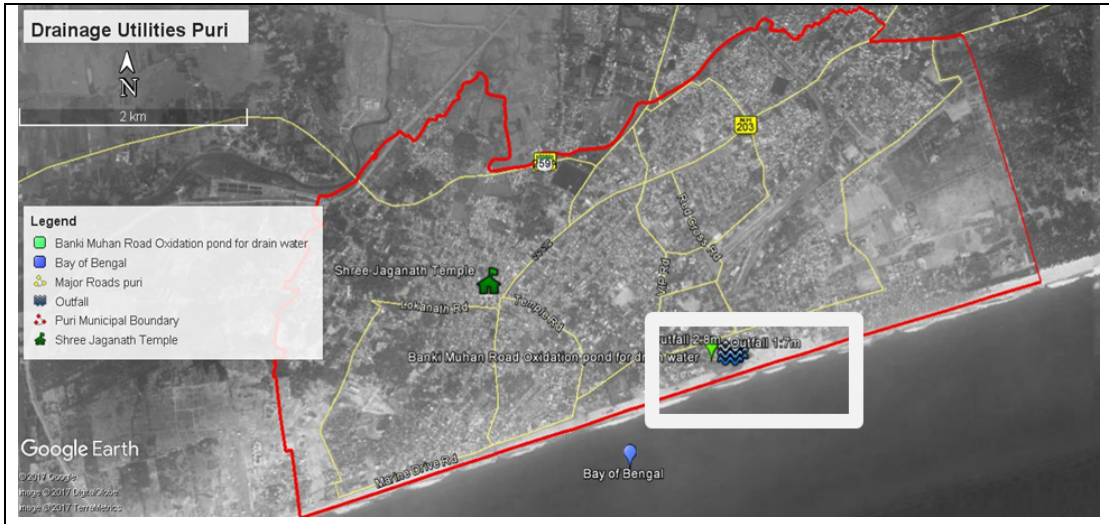
IEC

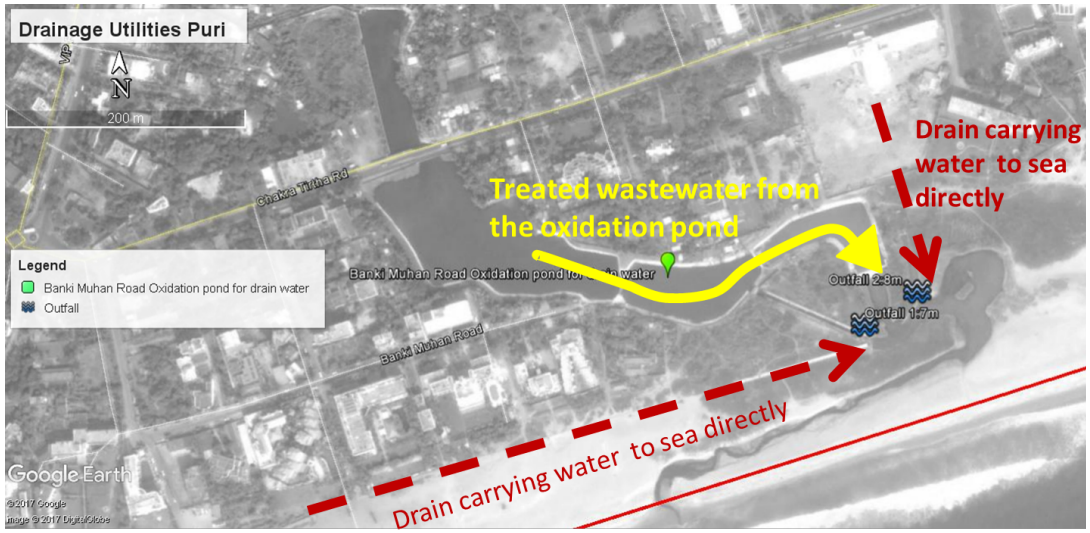
- Private operators in charge of the mobile toilet should be made aware of proper collection and conveyance mechanisms. This can be done through awareness campaigns and training sessions.


Stormwater Management
304 km
of drains: 179 kutcha
125 km pucca
10 MLD
of Blackwater
Drain Coverage
67% deficit in stormwater drain coverage
Direct Discharge
From toilets

4.3 Storm water Management

Figure 9 Drainage utilities map





Preparation of CSPs for Cities of Odisha

Consortium for DEWATS Dissemination Society

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4.3.1 Storm Water Drainage network

- There are 179 km of kutcha drains and 125 km of pucca drains, out of a road length of 372 km. Thus 81% of the city is covered by pucca drains (Service Level Improvement Plan , 2015).
- The drains in the city serve as combined sewers, as 10,000 – 12,000 toilets of households are directly connected to the drains (Officials of Drainage Division, 2017).
- **Gap-** Inadequate drain network
- **Recommendation-** Construction new drains to improve drain coverage

4.3.2 Catchment area

- There are 3 outfall of the drains located in adjacent to each other. The water from the outfall ends up into the sea.
- 45% of the drain water is connected to the Bankimuhan oxidation pond for treatment and from there into the sea. The rest 55% is currently connected directly into the sea (see 4.3.4.0). This 55% is flowing through the new drains that have bypassed the seas. This attracted warning from the National Green Tribunal. (Green tribunal rap for Puri pollution, 2017). The OWSS is therefore planning to connect these drains into the oxidation pond.

4.3.3 Natural Drains of Puri

There are 179 km of kutcha drains in Puri out of 304 km of total drains i.e. 56% of the drains. This is an asset to the city for natural drains and the vegetation and wetland around them are playing a key role in naturally treating the wastewater in the drains. The vegetation in these system not only take up the nutrients in the water, but also slow down the velocity of water thereby controlling flooding in the downstream areas. However, these systems are constantly under threat from human activities like construction and littering. Therefore, these natural systems need to be protected.

Solutions

- Demarcating drain using pillars or fencing and protecting them from encroachment by maintaining buffer zones (such as 50m, 25m and 15m from the primary drains, secondary and tertiary drains respectively) as mentioned in the Wetland Rules (Conservation and Management) 2010. (National Green Tribunal)
- Maintaining the vegetation around the natural drains: Bush cutting along the drains and clearing the vegetation in the drain at the beginning of monsoons in order to increase the water carrying capacity of the drains for the season and allowing vegetation growth towards the end of the monsoon so that it can treat the dry season flow.
- Clearing solid waste at regular intervals from the drains.
- Concretisation of natural drains should be avoided.

Factors that need to be taken into consideration to maintain natural drains and create new constructed kuchha drains are:

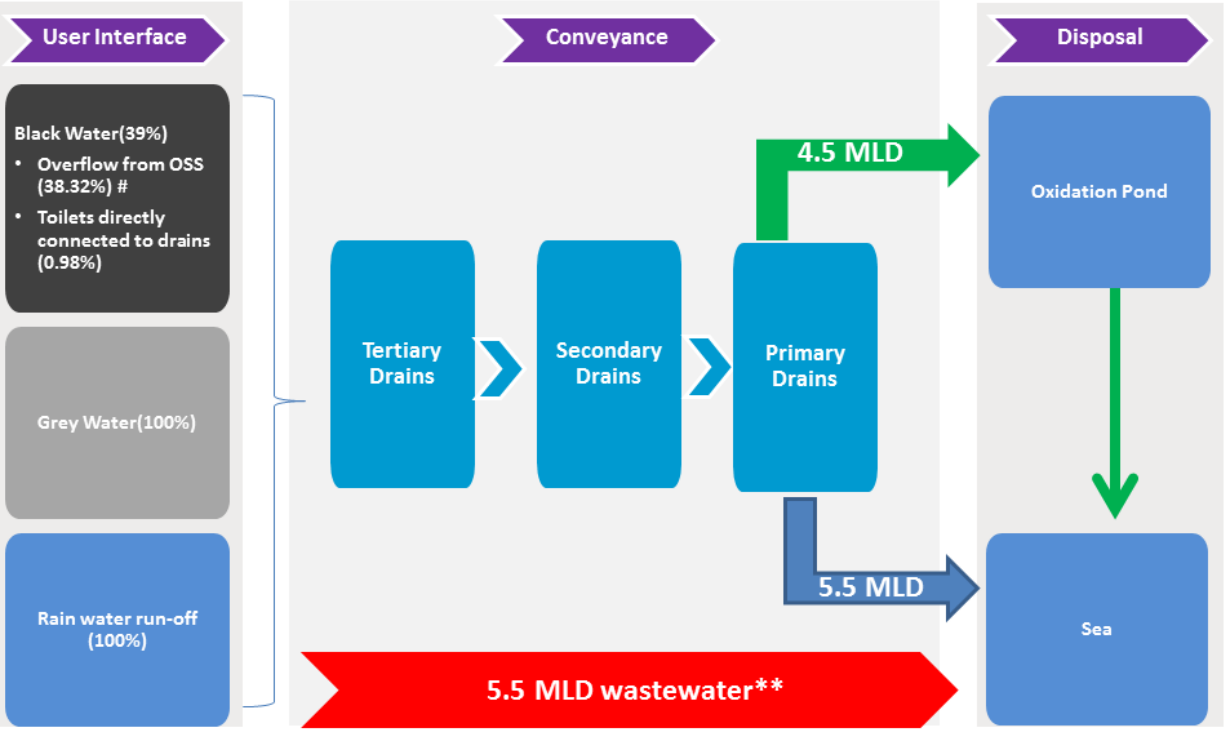
- In areas with less population density avoiding concretisation.
- Settlement pattern- areas with scattered population are ideal for natural drains
- Road width

The OWSSB is taking measures like recharge pits and sand traps for better maintenance of the natural drains and these needs to be promoted

4.3.4 Water quality in the drains

10 MLD of water is flowing through the storm water drains in Puri. Of this 4.5 MLD is getting treated in an oxidation pond and 5.5 MLD is getting into the sea directly. The sources of wastewater into the drains include overflow from septic tank in absence of soak pits[10]; black water from toilets directly connected to drains and greywater.

Figure 10: Storm water management snapshot of the city of Puri



**As per the information from OWSSB Puri

Source: Prepared from information received from Puri Municipality and OWSSB office, Puri

[10] This figure has been arrived at based on the assumption that 50% of septic tanks do not have soak pits. The Census definition of toilets with septic tanks refers to only the containment system and doesn't distinguish between septic tank with soak pit and septic tank without one (Latrine facility, 2017) . However, it is well known that overlfow from septic tanks is one of the key reasons for pollution of water bodies. (Biswas & Jamwal, 2017). Since the exact number or percentage of septic tanks without soak pits is not known, therefore we are assuming that have of the septic tanks are not having soak pits. This is supported by the field observations and conversations with the sanitation staff of urban local bodies. This number doesn't include unhygienic/ insanitary toilets. (SBM_Guideline, 2017)

4.3.4.1 Analysis of water samples from drains

In the filed visit undertaken as a part of the current project, drain and flow measurements at 3 locations and water samples were taken at 3 locations to get a glimpse of quantity and quality of water flowing through the drains.

Table 12: Drain water sampling and flow tests

Date	Sample Points	Sample ID	Time of sampling	Wastewater generation	Avg Daily Discharge	Quality					
						TSS, mg/l (CPCB Standard 20)	pH (CPCB Standard 6.5-9.0)	TDS, mg/l	BOD, mg/l (CPCB Standard 10)	COD, mg/l (CPCB Standard 50)	VS, mg/l
26 April 2017	Outfall 1 (marked in as Outfall 1:7 m in Drainage utilities map)	*143(C)*	10.00 am	15 MLD	9.5	78	7.2	1050	50	208	228
	Out fall 2 (marked in Drainage utilities map as Outfall 2:8 m)	*143(D)*	12.00 pm		18.14	86	7.1	810	40	151	182
	Oxidation pond outlet (marked in Drainage utilities map as Banki muhan oxidation pond for drain water)	*143(E)*	10.30 am			18	7.3	7300	44	170	1236

Table 3: Picture table for outfalls- Puri Municipality

Place	Description	Pictures
Outfall 1 (marked in Drainage utilities map as Outfall 1:7 m)	Outfall directly connected to sea	
Outfall 2 (marked in Drainage utilities map as Outfall 2:8 m)	Outfall directly connected to sea	
Oxidation pond outlet (marked in Drainage utilities map as Banki muhan oxidation pond for drain water)	Treated wastewater from the oxidation pond	

4.3.4.2 Inferences

The flow measurements and water analysis results were taken at the outfalls of two drains directly connected to the sea (marked as Outfall 1 and Outfall 2) and the outlet of from the Banki Muhan Oxidation Pond. The level of pollution at these locations is:

- The parameters of pollution at these locations are:
  - BOD mg/l
    - 50 at Outfall 1; 40 at Outfall 2 and 44 at the outlet of the oxidation pond
  - COD mg/l
    - 208 at Outfall 1; 151 at Outfall 2 and 170 at the outlet of the oxidation pond.
  - TSS mg/l
    - 78 at Outfall 1; 86 at Outfall 2 and 18 at the outlet of the oxidation pond.
  - PH mg/l
    - 7.2 At Outfall 1; 7.1 at Outfall 2 and 7.3 at the outlet of the oxidation pond.
- The result shows that the wastewater is low in concentration at the outfalls of two drains directly connected to the sea (marked as Outfall 1 and Outfall 2). However, the water at the outlet from the Banki Muhan Oxidation Pond is high.

- The OWSSB plans to divert the water from Outfall 1 and Outfall 2 into the Oxidation Pond for treatment. However, before doing that it is recommended that the functioning of the treatment facility is reviewed.

4.3.4.3 Recommendations for improving water quality in drains

1. **Stopping entry of wastewater into storm water drains**:
   A major portion of wastewater in storm water drain comes from domestic wastewater. In order to keep this wastewater out of the drains, all the domestic wastewater should be safely disposed. Since 43% of the city is already covered under sewerage network, ensuring that all the households are connected to sewer network and maximising the collection efficiency of wastewater will address the issue. In unsewered areas this issue can be addressed by mandating construction of septic tanks with soak pits.
2. **Reviewing the functioning of the oxidation pond:** Since the characteristics of the treated wastewater from the oxidation pond is much higher than the set standards, the functioning of the treatment facility needs to be reviewed and sources of pollution needs to be found before the additional flow from the Outfall 1 and Outfall 2 are connected to the system.
3. **Maintaining the natural drains of Puri:**
   As said in section Natural Drains of Puri, natural drains due to their ecosystem act as a treatment system to treat limited quantities of wastewater. Maintaining the drain ecosystem is the major part of this. The vegetation in the drains should be minimised at the beginning of monsoons in order to increase the water carrying capacity of the drains for the season. Thereafter, the vegetation should be allowed to grow towards the end of the monsoon so that it can treat a limited dry season flow.
   There are 179 km of kutcha drains in Puri out of 304 km of total drains i.e. 56% of the drains. This is an asset to the city for natural drains and the vegetation and wetland around them are playing a key role in naturally treating the water in the drains. Hence, this asset must be maintained.

4.3.5 Upcoming Projects

The OWSS is planning to connect the drains bypassing the oxidation pond back into the pond.

4.3.6 Action Plan

The key action points for improvement in storm water drainage are in terms of reviewing the functioning of the oxidation pond, wastewater from entering the drains and maintaining and increasing the coverage of natural drains and constructed kuchcha drains and stopping and maintaining the vegetation in the drains are essential to improve upon storm water drainage system.

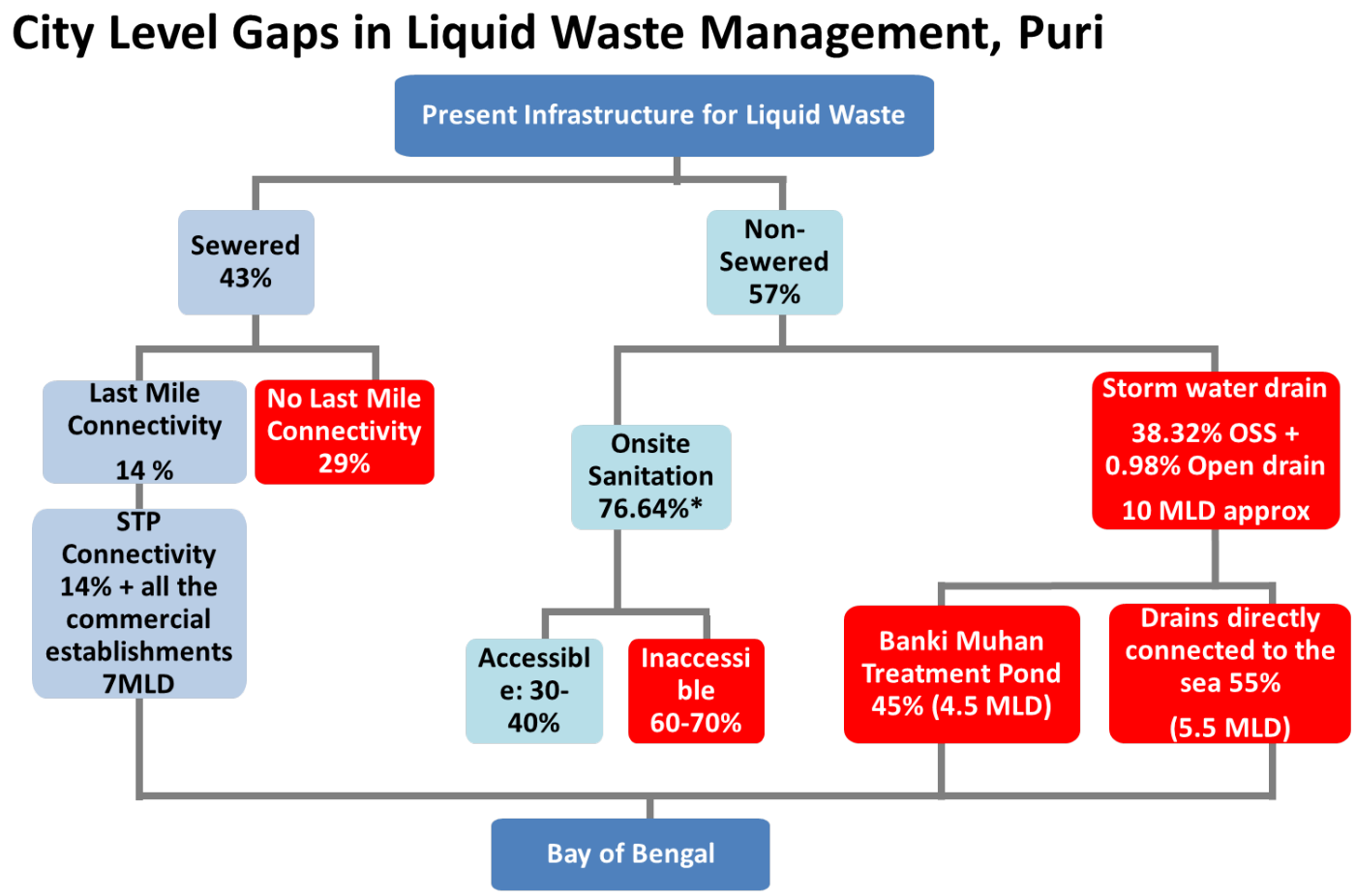
Table 13 Action plan for storm water drains

Issue 1		**Inadequate drain coverage**
Key Issue		19% deficit in stormwater drain coverage
Goal		To improve drain coverage
Actions	**Short term (within 2 years)**	Construction of 125 km of drainage
Issue 2		**Wastewater into storm water drains**
Goal		To improve the water quality in the drains
Actions	**Short term (within 2 years)**	• **Stopping the entry of sewage into the storm water drain** • **Reviewing the functioning of the oxidation pond.** • **Maintaining and increasing the number of natural drains**


Wastewater Management
15 MLD
Wastewater Generation
57% non-sewered
With a capacity of 15 MLD
Future Projections
In 2025: 23 MLD (Swacch City Plan)
In 2025: 17 MLD (Exponential)
Unwilling residences
High expenses for sewer connections

4.4 Wastewater Management

Figure 11 City Level Gaps in liquid waste management, Puri



Sewered/Non-sewered: Total road length covered by sewer lines
Last Mile Connectivity: How many buildings are actually connected to the sewer lines
All the percentages are based on the above mentioned percentages.
*This is taken from the 2011 Census Data,

Table 14 Wastewater Management- Current Situation, gap and recommendation

SN	Aspects	Details	Gap	Recommendations
1	Generation	The sewage generation is 15 MLD. Of this 7MLD is conveyed through the existing sewer lines.		
2	Conveyance	**Existing Network** • 129 km sewer network. • About 17,652 of households are covered in the sewered areas. The key challenge in this regard is household connectivity because households are unwilling to take connections because toilets are usually located at the back of the households while the sewer line is in the front and connecting the two would require excavation under the house to connect with the resulting in an expenditure of Rs. 10,000 – 15,000. **Invalid source specified.Invalid source specified.**. • All the commercial/ institutional set-ups are connected to the sewerage network. • No more extension of sewer network is planned. **Invalid source specified.**	• Domestic connection of sewer line is low resulting in discharge from septic tanks and toilets into drains. • Some pockets will not be covered by sewer network (marked as Areas not covered under sewer network in Puri wastewater utilities map)	• Strong enforcement to take sewer connections by incentivizing the households to do the same or subsiding the cost of connections • Localised wastewater treatment or FSM solutions for unsewered areas.
3	Treatment	**Existing situation** • Sewage Treatment Plant (STP) of a capacity of 15 MLD, using aerated lagoon system, treats the sewage. (Service Level Improvement Plan , 2015) • There is an oxidation pond at Banki Muhan of 10 MLD capacity to treat the water in the storm water drains.		

Figure 12: Puri wastewater utilities map

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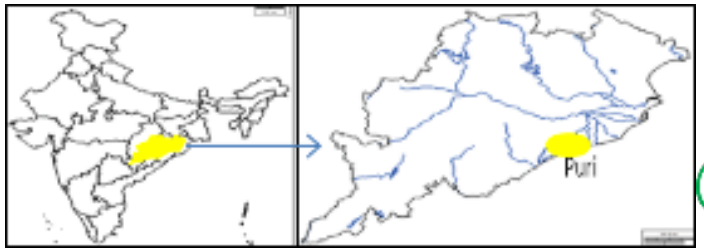

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4.4.1 Projections for Wastewater Generation

Table 15 Wastewater generation projection

Progression Method	Year	Population	Water demand in MLD (approx.)	Wastewater generation in MLD (approx.)
Census 2011 Population	2011	200564	31	15
Swachh City Plan	2019	260000	40	19
	2025	310000	48	23
Exponential	2019	217879	33	16
	2025	231839	35	17

For the purpose of projection, we are using exponential projections. (See Population Projection for Puri for details). Assuming that the per capita wastewater generation remain constant, the projections for wastewater generation have been made. The total capacity of the upcoming of the wastewater treatment infrastructure is 25 MLD (Banki Muhan and Matgajpur facilities). Considering this, the STPs will be able to cater to the wastewater demand till 2025. However, in order to avoid the need for putting more STPs beyond this point, unsewered areas and bulk wastewater generators such as new multi-storeyed buildings (more than 50 households or hotels and commercial complexes) and new areas should be mandated to have localised treatment plants. This policy legislation has been instituted in the city of Bangalore. It would allow gated communities to be self-sufficient in terms of their wastewater treatment and thus not create a negative impact on the environment. The earlier such measures are taken, the lesser would be the pressure to create new centralised STPs. Also, the earlier such mandates are passed, the greater is the likelihood of compliance as the city as maximum number of new buildings can go for decentralised solutions.

4.4.2 Action plan

The key action points for improvement in wastewater management focuses on the intervention in the unsewered areas and wastewater management for bulk generators of wastewater.

Table 16 Action plan for wastewater management

Issue 1		**Residences unwilling connect to the sewer network**
Key Issue		Domestic connection of sewer line is low resulting in discharge from septic tanks and toilets into drains.
Goal		➢ To ensure residences no blackwater from household is released into drains.
Actions	**Short term (within 2 years)**	• IEC activities for citizens to connect to the sewer network • Legal enforcement for mandating connections in sewered areas • Incentivising or subsiding the sewer connection cost to households.
Issue 2		**Areas out of sewer network**
Key Issue		Domestic connection of sewer line is low resulting in discharge from septic tanks and toilets into drains.
Goal		➢ To ensure residences no blackwater from household is released into drains.
Actions	**Short term (within 2 years)**	**FSM Solutions** ➢ Detailed survey to assess the FSM demand and supply gap. ➢ Implementation of the FSM solutions as highlighted in the FSM sections. **Localised Wastewater solutions** ➢ Implementation of localised conveyance and treatment solution in, clusters left out of the sewered areas as suggested in the ➢ Approaches for wastewater management for unsewered pockets and newly constructed multi-storeyed buildings
	Medium term (3- 5 years) To Long term (3- 5 years)	• Identifying potential reuse options • Bulk generators of wastewater such as apartments and institutions; and any new multi-storeyed buildings can be mandated to treat their wastewater at source.

4.4.3 Approaches for wastewater management for unsewered pockets and newly constructed multi-storeyed buildings

Decentralized sanitation systems: Considering the future infrastructure development in the town, the cluster approach for wastewater treatment can be proposed for the town. This requires the clustering the town based on the contours available and provide conveyance system along with wastewater treatment. This allows the usage of low energy for conveyance system and low construction cost.

Table 17 Different conveyance systems options[11]

Options	Features	Pros	Cons	Cost per running meter
Small bore systems	A solids-free sewer is a network of small-diameter pipes that transports pre-treated and solids-free wastewater (such as Septic Tank effluent).	➢ Does not require a minimum gradient or flow velocity ➢ Can be used where water supply is limited ➢ Lower capital costs than conventional gravity sewers; low operating costs ➢ Can be extended as a community grows	➢ Space for interceptors is required Interceptors require regular desludging to prevent clogging ➢ Requires training and acceptance to be used correctly ➢ Requires repairs and removals of blockages more frequently than a conventional gravity sewer ➢ Requires expert design and construction Leakages pose a risk of wastewater exfiltration and groundwater infiltration	➢ Rs 2400
Simplified sewer systems	A simplified sewer describes a sewerage network that is constructed using smaller diameter pipes laid at a shallower depth and at a flatter gradient than conventional Sewers	➢ Lower capital costs than Conventional Sewers; low operating costs ➢ Can be extended as a community grows ➢ Greywater can be managed concurrently ➢ Does not require onsite primary treatment units	➢ Requires repairs and removals of blockages more frequently than a Conventional Gravity Sewer ➢ Requires expert design and construction ➢ Leakages pose a risk of wastewater exfiltration and groundwater infiltration and are difficult to identify	➢ Rs 2800
Conventional sewer lines	Conventional gravity sewers are large networks of underground pipes	➢ Less maintenance compared to Simplified and Solids-Free Sewers ➢ Greywater and possibly storm water can be managed	➢ Very high capital costs; high operation and maintenance costs ➢ A minimum velocity must be maintained to prevent the deposition of solids in the sewer	➢ Rs 4800

[11] The cost estimates couldn't be calculated in the absence of road length data for the uncovered areas

	that convey blackwater and greywater	concurrently ➢ Can handle grit and other solids, as well as large volumes of flow	➢ Requires deep excavations ➢ Difficult and costly to extend as a community changes and grows ➢ Requires expert design, construction and maintenance	

One of the most challenging aspects of a sustainable wastewater treatment system (either centralized or decentralized) design is the analysis and selection of the treatment processes and technologies capable of meeting the requirements. The process is to be selected based on required quality of treated water. While treatment costs are important, other factors should also be given due consideration. For instance, effluent quality, process complexity, process reliability, environmental issues and land requirements should be evaluated and weighted against cost considerations

Table 18: Wastewater treatment technologies

Sl.No	Parameters	Activated Sludge Process (ASP)	Sequential batch Reactor (SBR)	DEWATS	Membrane Bioreactor (MBR)	Moving bed Bioreactor (MBBR)[12]
1	**Capital Cost (Rs. Lacs/MLD)**	**80**	**125**	**300**	**220**	**130**
	Civil Construction/Prefab (% Capital Cost and Electrical and Mechanical)	55	30	100	20	40
2	**Area Required (Sq.m/MLD)**	**800**	**400**	**4750**	**200**	**400**
3	**Performance of Technology-Effluent**					
	BOD (mg/l)	<20mg/l	85-98%	<20mg/l	<2mg/l	92-97%
	COD (mg/l)			<50mg/l	15-20mg/l	94%
	TSS (mg/l)	<30	85-98%		NA	
4	**Operation and Maintenance cost**					
	Energy Cost					
	Total Power required(Treatment Process) (KW/day)	184	172.5	0	302.5	202.5

[12] ASP cost esitmates based on Ganga River Basin Management Plan
SBR, MBR and MBBR cost estimates based on Kavali STP DPR.
DEWATS cost estiamtes based on CDD Society quotation.

	Yearly Power cost (Rs.Lacs PA/MLD)	2.65	2.48	0	4.36	2.92
	Recurring cost (Rs in Lacs PA/MLD) (List of chemicals, safety equipments will be attached)	5.3	0.2	0		0.4
	Annual Maintenance Cost (Equipments)					
	Civil Parts Maintenance Cost (% Of civil works cost) (List of equipments will be attached)	1.94	1	3.72	1	
	Electrical and Mechanical parts Maintenance cost (% Of civil works cost)	3	2.5	0		3
	Other Repair Cost Rs.Lacs	3.2	2.34			3.2
	Annual Human Resource Cost, in Lacs PA/MLD					
	Plant Manager	4.8	4.8	0	4.8	4.8
	Operator	1.44	1.44	0.6	1.44	1.44
	Chemist/Engineer	2.4	2.4	0	0	2.4
	Total O&M cost in Lacs PA/MLD	24.73	17.16	4.32	11.6	18.16


Faecal Sludge Management
6
cesspool vehicles
Unregulated Dumping
of untreated faecal sludge
68.9% of households
Connected to a containment system
Direct Discharge
Into open drains

4.5 Faecal Sludge Management

4.5.1 Faecal Sludge Generation Details:

With a population of 200,564 people (as per Census 2011) and a per capita accumulation rate of faecal sludge per year of 0.25 m³, the faecal sludge generated per year is about 50,141 m³. Daily, about 137.37 m³ of faecal sludge are generated in Puri.

Table 19 Faecal Sludge Management- Current situation, gaps and recommendations

Faecal Sludge Management cycle in Puri **Containment → Collection and Conveyance → Disposal and treatment → Reuse**				**Possible recommendations**
Aspect/Parameter		**Details**	**Gaps**	
1	**Containment**	As per the Census 2011, the toilets of the majority of the households in Puri - 68.9% are connected to septic tanks (with and without soak pits). - 8% of the households have toilets connected to pits - 2.2% have their toilets connected to other containment units. The average size of the containment systems that were found during the household survey in Puri is 8 m³ for septic tanks and 7 m³ for lined pits.[13] The average filling time for the containment units is about 8 years and the desludging frequency is generally 8-12 years.[14]	- No enforcement of standard pit/septic tank design and size (mostly depends on space available within the house) - Unhygienic Toilets, i.e. pits/Septic Tanks are un-scientifically constructed resulting in frequent overflow and leakages - Lack of understanding - O&M of containment units. - Grey water is entering the septic tanks, - Majority of the containment systems in the city are inaccessible for cleaning. - Many containment units' outlets are directly opened into the drains.	- Enforcement of standard containment size code regulations strictly - Increasing the incentive mechanisms/amount for converting the insanitary to sanitary - Awareness/IEC campaigns on open defecation and other aspects
2	**Collection and Conveyance**	• Septage collection and transport in Puri is done with the help of cesspool vehicles handled and operated by the ULB.	- There is no proper mechanism for monitoring and tracking the cesspool vehicle esp. the private players.	- Gulpur/small cesspool vehicles where the existing cesspool vehicles cannot access

[13] These average figures are not indicative for the entire city and the size of containment units mostly depend on space and money availability.
[14] These are based on the field visits and may not be indicative for the entire city.

		• The ULB has 2 own cesspool vehicles of capacities of 3000 and 4000 litres to handle the desludging requests from the local citizens by charging nominal prices. The cesspools are present and functional and the ULB receives about 1 – 2 requests for undertaking desludging operations per day. • Apart from the existing cesspools, the ULB received 4 new trucks of 3500 litres from OWSSB, which has procured the cesspools centrally. The new vehicles tendering will be allotted on PPP mode and charge Rs. 790 per trip. • The Municipality takes around 2-3 days to provide their services whereas private operators supply immediately on demand. • No private operators offer desludging services in the city but in a few instances, private operators from Puri provide desludging services to clean the hotels/commercial establishments in Puri. • About 60-70% of the septic tanks in Puri are inaccessible by cesspool vehicles. These are the places which show a high incidence of manual scavenging. The places include *Harichandi Sahi, Mati Mandap Sahi, KalikaDevi Sahi, Mishra Sahi, Udayagiri Gali, Suara Sahi, Patra Sahi, Yamuna Lane, Hada Gadia Sahi.* • The working hours of desludging operators are usually from 10am to 5pm. The ULB provides services within the city as well as within Puri Sadar in a radius of 30 km. • The pricing model of the desludging services is based on the type of entity; the service is being provided to, the capacity of the truck as well as the location (within city limits or under Puri Sadar area). • There are a few areas, where desludging services are provided by the ULB for free of cost. These	- About 60-70% of the septic tanks in Puri are inaccessible by cesspool vehicles. These are the places which show a high incidence of manual scavenging. - Lack of data on private operators involved in desludging the hotels/other institutions. - The private operators are not regulated. - Desludging of septic tanks is not carried out regularly (once in every 2-3 years). - Proper safety gears are not used	- Make GPS and other ICT interventions mandatory for both private and government vehicles. - Licensing the private operators - Form to be filled by the customer availing the desludging service which has to be submitted at the MC/during the disposal. - Separate account for handling cesspool vehicles account. - 24 hrs call center for desludging services - Mechanisms to reduce the manual scavenging activities - Scheduled desludging should be implemented by incorporating user fee or property tax incorporation

		include all the community latrines, officer quarters and office and government guesthouses.		
3	**Disposal and treatment**	• Faecal sludge from municipal vehicles is being disposed indiscriminately. • The site allocation of a faecal sludge treatment plant of a capacity of 50 m³ at current STP site has been completed. • There is no proper monitoring of the disposal practices of faecal sludge in Puri	- Unsafe faecal sludge/septage disposal practices currently (SeTP is due in Oct/Nov,2017) - The distance of the disposal point/treatment plant site from the city center. - Incentive mechanism/regulation to promote the disposal at treatment site is not yet available. - No designated disposal sites available as of now until SeTP is constructed	- Once constructed, disposal at the SeTP to be mandatory - IEC campaign with the cesspool operators both private and government
4	**Reuse**	No reuse/reuse plan is present in the form of usage of waste water and sludge in few areas in the agriculture	One should explore the potential of reuse of dried sludge/co-compost.	- Exploring of technologies for enhancing the nutrient value in the dried sludge and also to reduce the helimenth eggs which may be prevalent in the dried sludge. - Reuse plan for selling the dried FS - Converting the dried FS into co-compost for enriching the nutrient content - Exploring it to sell for cement industries/ brick factories - To encourage reuse among the farmers through IEC campaigns

4.5.2 Catering to future demand

In order to meet to the future demand, the city can rely increasingly on localised wastewater treatment. This way the septage generation of the city can be limited, thereby reducing the pressure on the SeTP.

4.5.3 Action Plan

Implement a holistic faecal sludge management program spread across 3 years targeting construction of FSTP in 2017 and alongside streamlining collection and conveyance of faecal sludge operations.

Table 20 Action Plan for FSM

Issue 1		Containment	Costs
Key Issue		• No enforcement of standard pit/septic tank design and size (mostly depends on space available within the house) • Unhygienic Toilets, i.e. pits/Septic Tanks are un-scientifically constructed resulting in frequent overflow and leakages • Lack of understanding - O&M of containment units. • Grey water is entering the septic tanks, • Septic tanks are inaccessible for cleaning.	
Goal		• Complete conversion of existing insanitary toilets to sanitary toilets • New constructions or toilets construction in the pipeline are to be completely standardized • Creating capacities to undertake O&M of containment units • Implementation of rules and regulations which would standardize the existing and upcoming containment systems	
Actions	Short term (within 2 years)	**Technical** • Enforcement of standard size/designs of the septic tanks which needs to be incorporated in the house construction design which needs to be in accordance with the provisions of the o National Building Code of India, 2005; o Bureau of Indian Standards, Code of Practice for Installation of Septic Tanks; o Manual on Sewerage and sewage treatment systems, CPHEEO, 2013; o Swachh Bharat Mission Guidelines, 2014 **IEC** • Awareness/IEC campaigns on open defecation and other aspects • Masons training for building the containment systems **Policy** • Enforcement of Odisha Urban Septage Management Guidelines, 2016.	

	Medium term (3- 5 years)	**Operations** • Increasing the incentive mechanisms/amount for converting the insanitary to sanitary **IEC** • Behaviour change campaigns and workshops periodically in the newly developing areas	• Rs 8,000 – Rs 10,000 increase in incentive for every toilet converted from insanitary to sanitary toilet (based on other states implementation of incentives under SBM plan)
Issue 2		**Collection and Conveyance**	
Key Issue		• There is no proper mechanism for monitoring and tracking the cesspool vehicle esp. the private players. • Accessibility is an issue in few areas and unscientific method • Manual handling of faecal sludge is a significant issue (as per the discussion with private cesspool operators) • The private operators are not regulated. Lack of data on private operators involved in desludging. • Desludging of septic tanks is not carried out regularly (once in every 2-3 years). • Proper safety gears are not used while desludging both by government and private operators	
Goal		➢ 100% collection of FS/Septage generated in the city and 100% conveyance to the treatment/disposal site ➢ No manual scavenging/ manual handling of FS ➢ Use of safety gears and proper equipment while desludging ➢ Regulating the private operators through licensing and periodic renewal	
Actions	**Short term (within 2 years)**	**Technical** • Monitoring of private and government cesspool vehicles by mandating GPS and other ICT interventions. • Safety gears to be given to government operators and are to be made compulsory for the government and private operators **Operations** • Separate account for handling government cesspool vehicles account. • Maintain the database of private operators • Mechanisms to fill the form by the customer availing the desludging service which has to be submitted at the municipality /during the disposal. **Training** • Training the operators on standard practices and safety measures for collection and conveyance • Training of ULB officials on monitoring of cesspool vehicles	For ICT technology interventions: CapEX and OpEx is approx. Rs 1.2 Lakh per vehicle per year. It becomes

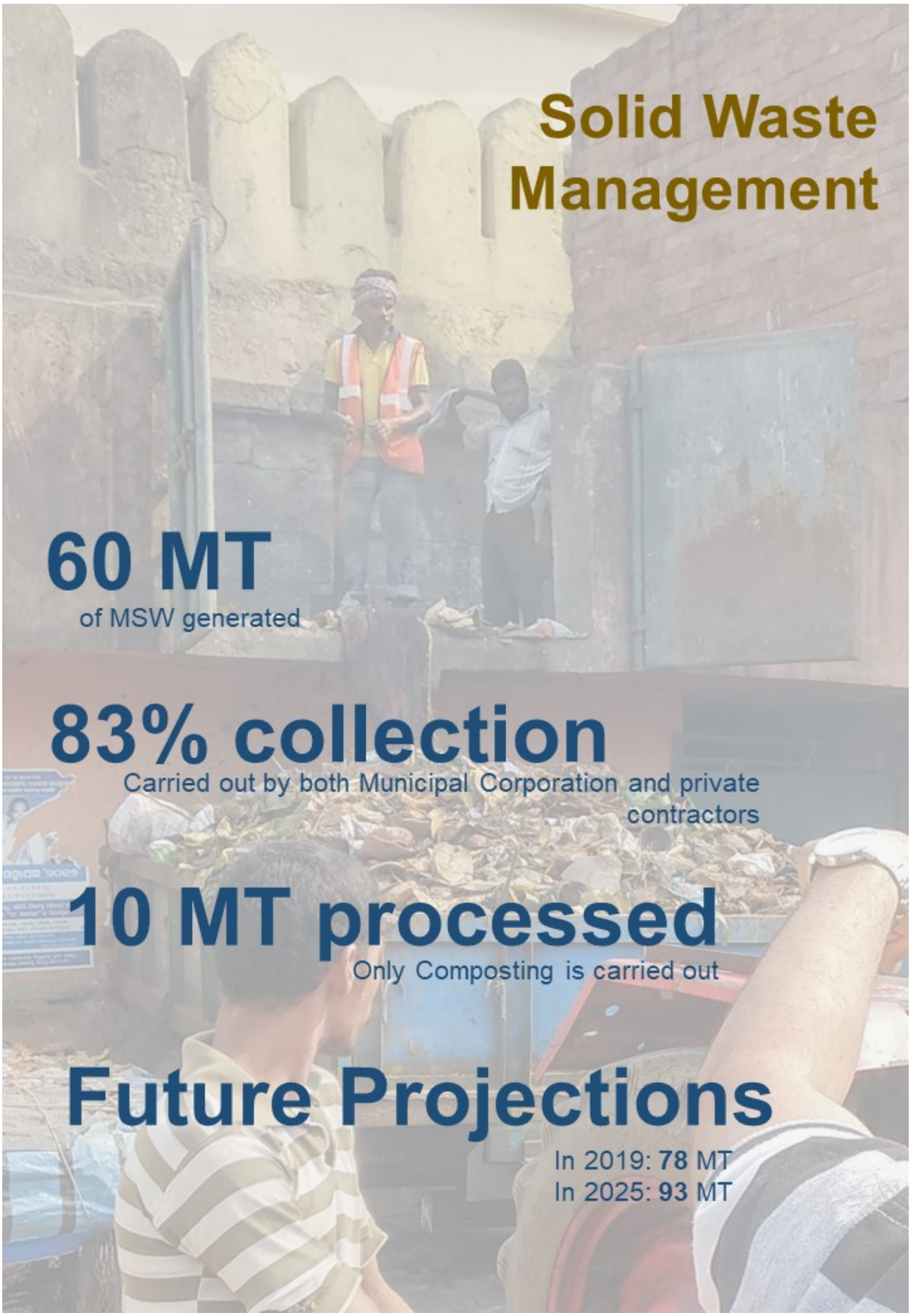
		Policy • Licensing the private operators and periodic renewal • Enforcement of Odisha Urban Septage Management Guidelines, 2016.	
	Medium term (3-5 years)	**Technical** • Procure 3-4 Gulper machines /small cesspool vehicles where the existing cesspool vehicles cannot access **IEC** • Behaviour change campaigns and workshops periodically in the newly developing areas	**For Gulper machines/small cesspool vehicles:** - Rs 32 Lakh for 4 vehicles as CapEx and Rs 2.8 Lakh for OpEx of vehicles(which will not include the fuel costs) - HR salaries will be around Rs 14.4 Lakh per year for 8 people employed(2 per vehicle)
	Long term (5-10 years)	**Operations** • Assess between the demand generated for collection and supply of FS collection in the city and accordingly procure cesspool vehicles if necessary **Policy** • Scheduled desludging should be implemented by incorporating user fee or property tax incorporation	**For procuring of new cesspool vehicles:** Rs 28 Lakh for 1 cesspool of 4.5 Kld Rs 20 Lakh for 1 cesspool of 3 Kld
Issue 3		**Disposal and treatment**	
Key Issue		• Unsafe faecal sludge/septage disposal practices currently (SeTP is due in Oct/Nov,2017) • The distance of the disposal point/treatment plant site from the city center. • Incentive mechanism/regulation to promote the disposal at treatment site is not yet available. • No designated disposal sites available as of now until SeTP is constructed	
Goal		➢ 100 % disposal of FS generated at the treatment plant ➢ 100% of the FS generated is to be treated ➢ Scientific disposal sites are made available	
Actions	**Short term (within 2**	**Technical**. • Complete SeTP by end of 2017 • Outsource the operations and maintainence of the SeTP to third party	

	years)	**IEC** • Capacity building of ULB and operators for handling the SeTP • IEC campaign with the cesspool operators both private and government for behaviour change regarding the disposal **Policy** • Licensing the private operators and periodic renewal and disposal to be made mandatory at the designated sites • Enforcement of Odisha Urban Septage Management Guidelines, 2016.	
	Medium term (3-5 years)	**Technical** • Different business models assessment for the SeTP and work on sustainability of the operations of treatment plant **Operations** • Outsourcing of O&M of the plant to third party by releasing tenders **Policy** • Inclusion of property tax as part of making the operations of SeTP sustainable	• Tender Handling charges: Rs 2.5 Lakh approx. for design of tender • Business models for possible reuse options are provided in Business Models for FSM
	Long term (5-10 years)	**Technical** • Integrating the solid-liquid waste treatment at the same location **Operations** • Plan for ODF++ declaration **Policy** • Policy resolution leading to 100% disposal and treatment of the FS generated	
Issue 4		**Reuse**	
Key Issue		• No reuse is present or formally institutionalized in the city	
Goal		• Reuse of treated sludge	
Actions	**Short term (within 2 years)**	**Technical** • Co-compost plan for enhancing the nutient value • Explore other technologies for reuse **Operations**	• Cost of setting up co-composting unit[15] = Rs 0.7 Crore/70 Lakhs • The OpEx costs

[15] Based on case study of FSTP Devenahalli, the Co-composting unit CapEx will cost 25% of the FSTP cost

		• Collaborate with chemical fertilisers companies • Reuse plan for selling the dried FS and to be outsourced • Converting the dried FS into co-compost for enriching the nutrient content **IEC** • To encourage reuse among the farmers through IEC campaigns **Policy** • Reuse policy to be formulated for the city	would be approx. = Rs 7 Lakh per year assuming 10% of CapEx. • For the compost to be sold in the market, it should pass the FCO (2013)[16] norms.
	Medium term (3-5 years)	**Technical** • Exploring possibilities of using Black soldier flies usage of solar energy at the SeTP **Operations** • Exploring possibilities to sell for cement industries/ brick factories	

[16] Fertiliser (Control) Order 2013 Norms, brought out by the Department of Agriculture and Cooperation


Solid Waste Management
60 MT
of MSW generated
83% collection
Carried out by both Municipal Corporation and private contractors
10 MT processed
Only Composting is carried out
Future Projections
In 2019: 78 MT
In 2025: 93 MT

4.6 Solid Waste Management

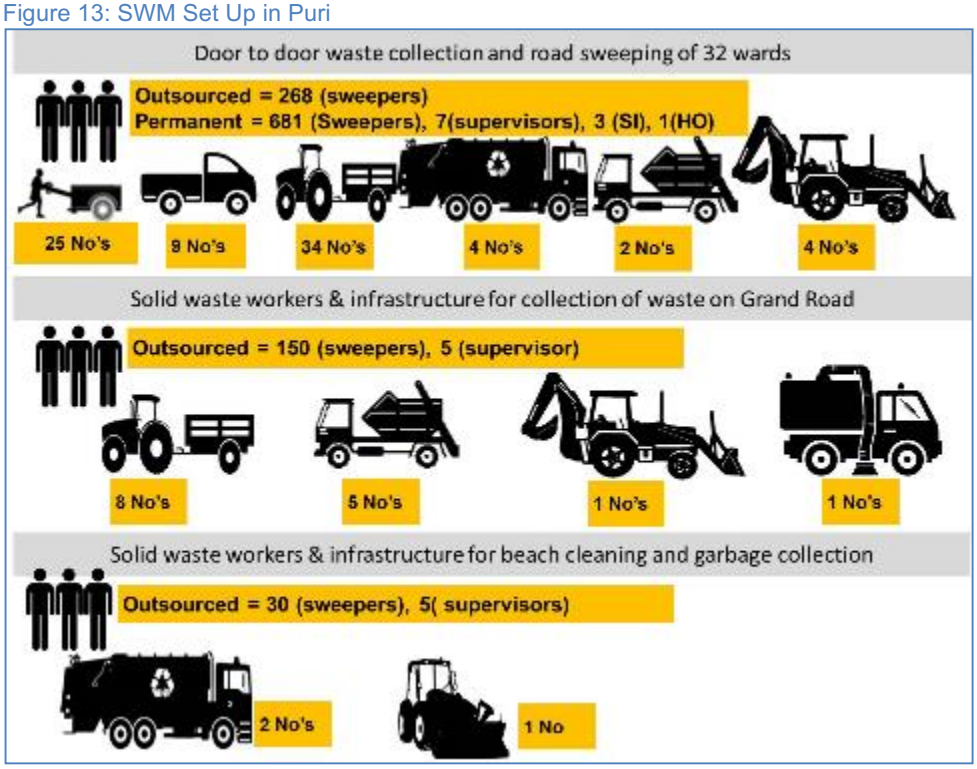
4.6.1 Generation of Municipal Solid Waste

As per Swachha City Plan, Puri generates around 60 MT of municipal solid waste per day.[17]

4.6.2 Collection & Conveyance of Solid Waste

Household collection - In Puri, solid waste is collected through both door to door collection and collection from secondary and community bins. Door to door waste collection is carried out through private service provider. Even though it is mentioned that all the areas are covered under door to door collection, frequency of collection varies. In few areas waste is collected once a week. During field visits solid waste open dumping was visible in few open lands. To cater all these problems and to increase door to door collection efficiency 4 private agencies have been appointed for collection of door to door solid waste. M/s. U Tech services, F.M Welfare club, Sabyasachi Mahakul and Green Circle Environment Pvt. Ltd. Work order to these private agencies is not issued yet.[18] Even after issuing these work orders and commencement of door to door solid waste collection, 5 wards I.e. 22,23,30,31 and 32 will not be covered under this door to door collection process. [19] As per Swachha city plan out of 60 MT generated on daily basis, only 50 MT is collected per day (83%).[20]

Figure 13: SWM Set Up in Puri



[17] Puri Municipal Council (2017)
[18] Puri Municipal Council (2017)
[19] Puri Municipal Council (2017)
[20] Puri Municipal Council (2017)

During field visit to Puri, openly dumped solid waste was visible in many open plots. Also discussion with residents revealed that frequency of solid waste collection is low i.e. once a week.

Figure 14: Open dumping of Solid Waste in Puri.

4.6.3 Solid Waste Treatment & Disposal

- There is no transfer station in Puri, all the collected waste is transported to composting plant at Baliapanda.
- The composting plant is maintained by Krishirasayan Udhyog. 14 no. of staff are currently working at composting plant. The capacity of the composting plant is 100 MT per day.
- At the composting plant, all the transported waste is dumped at unscientific dumping yard next to the composting plant. As observed during the site visit, there is heaps of garbage surrounding treatment plant. After a weeks' time biodegradable waste gets reduced to compost and this waste is then mechanically segregated using different sized sieves and conveyer belt. In the final stage this compost is mixed with coconut husk.
- As per discussions with plant operators, per day 6-10 MT of compost is produced. Earlier this compost was sold in Kolkata, but at present they are selling it only in and around Puri at Rs. 3 per kg since there is no demand from Kolkata. Temple waste is taken to separate location (2-3 acres) since it is considered sacred and is not allowed to mix with other waste.[21]

[21] Puri Municipal Council (2017)

4.6.4 Salient features of current Solid waste system

Solid waste Management cycle in Puri

Generation → Collection → Transportation to Dump site

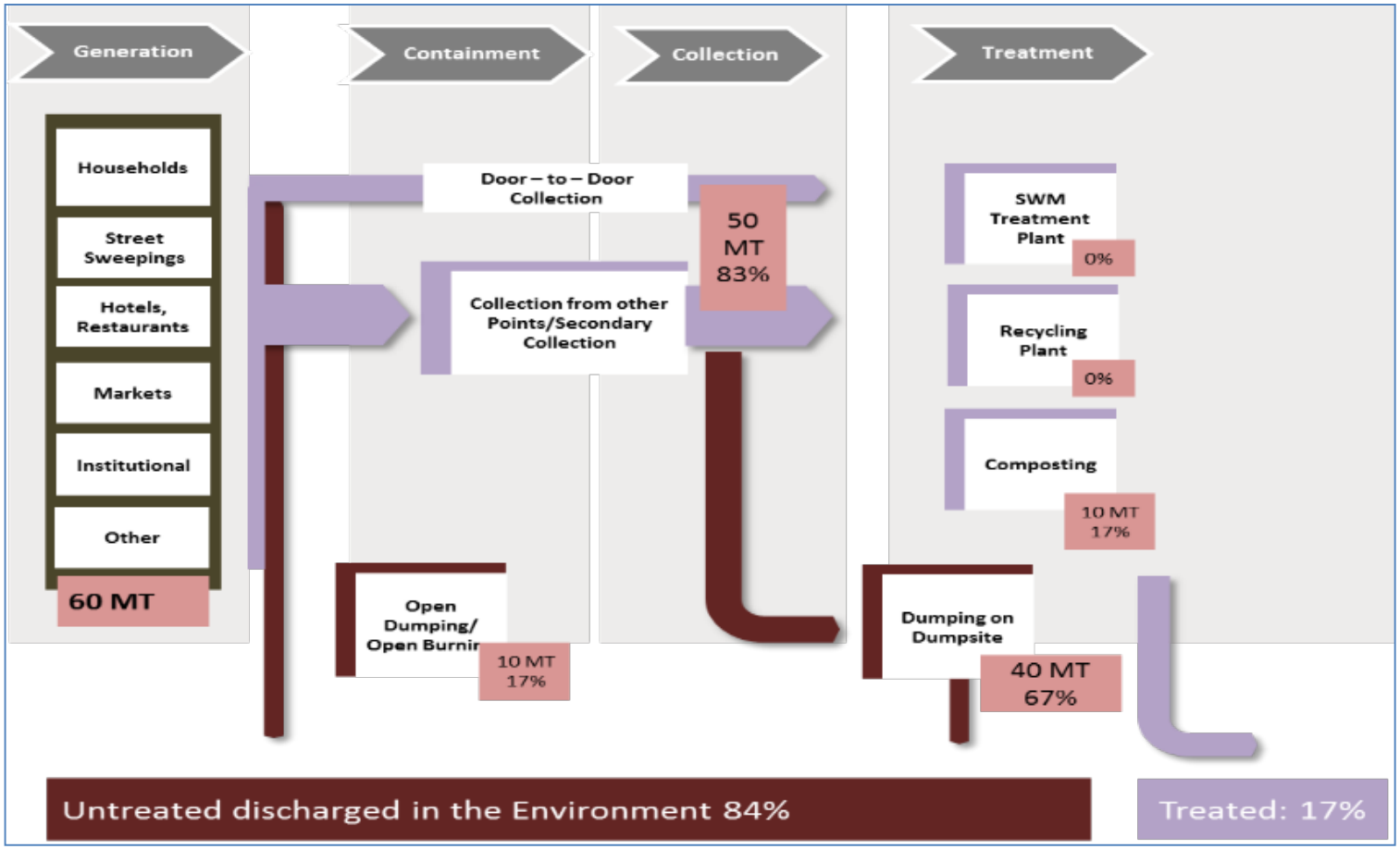


Table 21 Solid Waste Management- Current Situation, gaps and recommendations

	Aspects/ parameters	Current situation	Pictures	Issues/ Gaps	Possible Recommendations
1	**Generation**	Total waste generated= 60 MT per day			
2	**Collection and transportation**	• Waste collection is carried out by both Municipal Corporation and Private Service providers. • As per Swacch Bharat City plan, out of 60 MT waste generated only 50 MT (83%) of waste is collected. • Waste collection services don't cover all the wards in Puri. Also the frequency of collection is less.		1. Collection of waste is not 100% 2. No door to door waste collection services in 5 wards even after issueing of new waste collection work orders. 3. Frequency of waste collection is low. In sme places it is once a week. 4. Segregation of waste is not managed at source 5. Labourures are differentiated for door to door waste collection, street sweeping and drain cleaning. 6. Increase in collection cost due to collection of unsegregated waste	**Solid Waste collection using Micro-pocket planning approach.** For efficient handling of the sanitation and solid waste management function, Municipality is required to bundle the related activities (door to door collection, into three major work units based on the size and work load quantities. Work packages can be classified as follows:- •Residential Micro Pocket •Commercial and Bulk Solid Waste Handling •Mechanical Sweeping of Main Roads The SWM activities within one micro-pocket is supposed to be handled by one or two set of dedicated personnel who will work as a team and takecare of all the activities in the given micropocket. (Refer Micro Planning)

3	**Segregation**	No household segregation happening		No incentives given to promote segregation at source	• Provision of incentives in the form of property tax rebates or rebate on solid waste collection charges under polluters pay principle. • IEC campaign for awareness generation towards segregation of waste.
4	**Treatment/ Processing**	• Waste collected from town is taken to dumping site at Baliapanda. • Composting plant is also located next to dumping site at Baliapanda. • Composting plant is 20 years old with 100MT daily composting capacity but produces only 6-10MT of compost.[22] • Waste is composted when it is in mixed condition i.e. all the plastic and other recyclables are still present in the compost which is taken out at later stages.		• Although there is some treatment for wet waste, 100% of wet waste generated in town is not getting treated. • Quality of compost as waste is composted in mixed condition. • Loss of resources in the form of recyclable materials (plastic, metals, glass, paper etc.) and compostable materials. • No scientific landfill for safe disposal of inert materials • No separate treatment happening for Bio medical waste and sanitary waste.	• Material Recovery facility for recovering recyclable materials • Biogas plant at source reduction for bulk waste generators like vegetable Market and temple. • Wet waste composting at the composting plant • Separate incineration treatment facility for Bio medical and sanitary waste to be constructed under PPP mode.[23] • Installation of Organic waste Converter (OWC) machine at public parks for source reduction of waste • **Management of waste at source for bulk waste generators**
5	**Policy**			1. No holistic Soild waste	• Preparation of Solid waste management DPR for

[22] CDD Society field visit (2017) Discussion with Krishirasayan Udhyog composting plant operators.

[23] All the above waste technologies are suggested based on general characteristics of Municipal Solid Waste in India. Swachha Bharat Mission (2016) Municipal Solid Waste Manual, Page-43, Government of India.

				management DPR prepared which is a mandate under Swaccha Bharat Mission	claiming funds under Swachha Bharat Mission

4.6.5 Projections for Solid Waste Generation

Table 22 Projection for solid waste generation

Progression Method	Year	Population	Solid waste generation (MT) (approx.)
Census 2011 Population	2011	200564	60
Swachh City Plan	2019	260000	78
	2025	310000	93
Exponential	2019	217879	66
	2025	231839	70

For the purpose of projection, we are using exponential projections. (see Population Projection for Purifor details)

The solid waste generation has been calculated with the assumption that the per capita waste generation of the city will remain constant. The total capacity of the proposed centralised composting plant at Baliapanda is 100 MT. However the plant is facing repair and maintenance issues, which if resolved can resolve the solid waste challenge in Puri. In order to ensure proper functioning of the plant and to make sure it caters greater number of years, the action plan focusses on maximum segregation to promote recycle.

4.6.6 Action Plan

The key action points for improvement in solid waste management pertain to improvements in various segments in the value chain. At the user interface, policy and IEC interventions for household segregation are suggested. For the collection system, micro-pocket approach in which the city is divided into multiple micro-pockets and all the solid waste collection activities - door-to-door collection, road sweeping and drain cleaning- is assigned to one or two individual workers who will take care of all the activities. This will lead to increased accountability of workers and easy monitoring of their work. For treatment, it is suggested that the city must have dry resource collection centre/s in order to ensure that there is a place where the segregated dry waste collected is received and processed (or sent for processing from this facility). For bulk generator of wet waste, it is suggested that treatment units are made mandatory in order to manage the solid waste at source itself.

Table 23 Action Plan for SWM

Issue 1	Collection of waste	Cost Estimates
Key Issue	1. Collection of waste is not 100% 2. No door to door waste collection services in 5 wards even after issueing of new waste collection work orders. 3. Frequency of waste collection is low. In sme places it is once a week. 4. Segregation of waste is not managed at source 5. Labourures are differentiated for door to door waste collection, street sweeping and drain cleaning.	
Goal	100% collection of solid waste generated in the city and 100%	

		conveyance to the treatment/disposal site.	
Actions	**Short term (within 2 years)**	**Micro-pocket planning approach.** For efficient handling of the sanitation and solid waste management function, Municipality is required to bundle the related activities (door to door collection, drain cleaning and road sweeping) into three major work units based on the size and work load quantities. Work packages can be classified as follows:- •Residential Micro Pocket •Commercial and Bulk Solid Waste Handling •Mechanical Sweeping of Main Roads The SWM activities within one micro-pocket is supposed to be handled by one or two set of dedicated personnel who will work as a team and takecare of all the activities in the given micropocket. (refer Micro Planning) Steps involved: • Clear demarcation of residential, commercial and main road sweeping pockets for carrying out the sanitation and solid waste management activities • Clearly defining of job responsibilities and key performance indicators for the service providers • Making realistic estimates of resource requirements in rationalized and standardized manner (manpower, transportation vehicles, tools, implements and conservancy materials) • Develop clear resource inputs and results-outputs correlations to achieve standard service delivery results across the ULBs in a uniform manner. • Identifying and developing clear wok quantities, key performance indicators and performance monitoring mechanisms, in the event of outsourcing complete work packages to private agenciesClear demarcation of areas and tasks for waste collectors. • secondary bins should be removed from all the areas except high floating population areas. **Training** • Training for solid waste collection workforce for both Govt. and private waste collectors about waste collection process in micro pockets **IEC**	

		• Household awareness campaigns about segregation of waste to be carried out by waste collectors • Getting local self-help groups (SHGs) and community based organisations (CBOs) involved in the IEC campaign for household segregation of waste **Policy** • Policy amendment for Provision of incentives in the form of property tax rebates or rebate on solid waste collection charges under polluters pay principle.[24]	
Issue 2		**Treatment/ Processing of waste**	
Key Issue		1. Although there is some treatment for wet waste, 100% of wet waste generated in town is not getting treated. 2. Quality of compost as waste is composted in mixed condition. 3. Loss of resources in the form of recyclable materials (plastic, metals, glass, paper etc.) and compostable materials. 4. No scientific landfill for safe disposal of inert materials 5. No separate treatment happening for Bio medical waste and sanitary waste.	
Goal		**Management of waste at source for bulk generators**	
Actions	**Short term (within 2 years) Medium term (3- 5 years)**	**Technical** • Carry out waste composition study to know the actual content of wet and dry waste and composition of different materials like, biodegradable, paper, metals, glass etc. [25] • Mandating all bulk waste generators whose waste characteristics are mainly wet waste eg vegetable market, public parks etc. to treat waste at source by means of using technology opetions such as bio gas digestors and Organic waste converter to be outsourced to private service providers	• Carring out Prefeasibity study, waste compostion study, and a preparation of holistic solid waste management DPR= **Rs.7.5 lakhs** • Biogas digestor= **Rs.15-16 Lakhs per tonne** • Onsite composting (windrow)= **Rs.3-4 lakhs per tonne** • Onsite Composting (Vermicompostin g)= **Rs. 5 lakhs per tonne**

[24] This model is being implemented In State of Andhra Pradesh.

[25] Waste composition study should be carried out according to this given reference- Swachha Bharat Mission (2016) Municipal Solid Waste Manual, Volume II, Page-47, Government of India.

			• Organic waste converter machine = Rs.4-5 lakhs per unit
Goal		➢ 100% treatment of waste generated in Puri.	
Actions	**Short term (within 2 years) To Medium term (3- 5 years)**	**Technical** • Construction of new treatment facilities at city level: ○ Material Recovery Facility ○ C & D Waste Plant Exisiting SWM facility such as the Baliapanda dumpyard –cum conmposting sitecan be used to locate the plants. **Training** Training for supervisors and helpers.	**Material Recovery Facility=** Assuming 40% of the total waste generated is Dry waste Total waste to be treated is= 20 MT Capital cost = Rs. 20 -30 Lakhs
Goal		➢ 100% treatment of Bio-medical and domestic sanitary waste.	
Actions	**Short term (within 2 years) To Medium term (3- 5 years)**	**Technical** • Construction of incinaration facility to treat biomedical and sanitary waste. Exisiting SWM facility such as the Baliapanda dumpyard can be used to locate the plants. **Financial** O & M cost to be recovered from hospitals and clinics depending upon no. of beds.	Bio medical waste treatment plant= Rs. 40 Lakhs per tonne
Goal		To achieve 100 % scientific disposal of inert waste by 2020.	
Actio	**Short term (within**	**Technical** • Construction of construction of scientific landfill.	

	2 years)	**Operational** • For operations, there shold be 1 full time technical person, 2 supervisors, 4 helpers permanently stationed at sanitary landfill site. **Financial** • SBM, 14th Finance Commission Grants, State Government Grants. **Training** • Training for supervisors and helpers.	

5 MT Treatment plant

Following are 3 technological options for treatment of 5 MT of waste to be installed at bulk waste generators, to achieve treatment of waste at source:

Table 24 Technology options for 5 MT Solid Treatment Plant

Technology options	Cost assumption	CapEx	OpEx	Odour issues	Space required
Biogas digestor	Rs.15-16 Lakhs per tonne	Rs.15-16 Lakhs (1 tonne) Rs.45-48 Lakhs (3 tonne) Rs.75-80 Lakhs (5 tonne)	O & M operations to be outsourced.	Low	9 sq.mt for 1-5 MT (System can be also buried under ground in places of space constraints.)
Onsite composting (windrow)	Rs.3-4 lakhs per tonne	Rs.3-4 Lakhs (1 tonne) Rs.9-12 Lakhs (3 tonne) Rs.15-20 Lakhs (5 tonne)	Less than Rs.2 per kg	High	6- 10 sq.mt for 1 – 5 MT (depends on height of the windrow)
Onsite Composting (Vermicomposting)	Rs.5 lakhs per tonne	Rs.5 Lakhs (1 tonne) Rs.15 Lakhs (3 tonne) Rs.25 Lakhs (5 tonne)	Less than Rs.2 per kg	Medium	5 Sq.mt(1 tonne) 15 sq.mt (3 tonne) 25 sq.mt (5 tonne)

- The above costs are calculated for a prototype facility of 1 tonne, 3 tonne and 5 tonne capacities for one bulk waste generator like vegetable market, Hotels, Hostels etc.
- Technology option should be selected based on space availability, odour issues and availability of funds.
- Advantages of biogas over windrow and vermicomposting is low space requirements, low odour issues and biogas generated can be converted into electricity and used for lighting of market

premises and for cooking in case of bulk generators like hotels, hostels and restaurants.

- Total cost of installation of below 5 MT treatment plants should be calculated depending upon type of technology selected and number of bulk waste generators at which these facilities will be installed.

Table 25: Investment Plan for SWM interventions

Proposed Work	Cost assumption	Amount (CapEx)	Amount (OpEx)
Carring out Prefeasibity study, waste compostion study, and a preparation of holistic solid waste management DPR		7.5 Lakhs	
Biogas digestor	Rs.15-16 Lakhs per tonne	Rs.15-16 Lakhs(1 tonne) Rs.45-48 Lakhs(3 tonne) Rs.75-80 Lakhs(5 tonne)	O & M operations to be outsourced.
Onsite composting (windrow)=	Rs.3-4 lakhs per tonne	Rs.3-4 Lakhs (1 tonne) Rs.9-12 Lakhs (3 tonne) Rs.15-20 Lakhs(5 tonne)	Less than Rs.2 per kg[26]
Onsite Composting (Vermicomposting)	Rs.5 lakhs per tonne	Rs.5 Lakhs (1 tonne) Rs.15 Lakhs (3 tonne) Rs.25 Lakhs (5 tonne)	Less than Rs.2 per kg[27]
Organic waste converter machine		Rs.4- 5 lakhs (per unit)	Rs.0.1 lakhs per year
Material Recovery Facility (20 MT dry waste)		Rs. 20- 30 Lakhs	O & M cost to be borne by private agencies
Windrow composting (36 MT wet waste)	Rs.3-4 lakhs per tonne	Rs.1.1- 1.4 Crore	Less than Rs.2 per kg
Bio medical waste treatment plant	Rs.40 lakhs per tonne	To be calculated as per requirements.	O & M cost to be bound by
IEC Campaigns		Rs.3.10 lakhs	

[26] Amount may change according to place.
[27] Amount may change according to place.

4.6.7 Contractual amendments to solid waste service contracts for incorporating advantages of micro-pocketing planning approach in the collection and conveyance process

1. **Outsourcing of work as opposed to outsourcing of labourers**: This implies that the contract with private agencies for collection and conveyance of solid waste should be based on the work that needs to be done. The supervision and management of the labourers should be with the private agency and not the municipality. The municipality would be monitoring and evaluating only the work under taken.

2. **Different the pockets for solid-waste collection based on area wise and not on activities i.e. collection of waste, street sweeping and drain cleaning.** Refer to 7.2 for the detailed micro-pocket plan

3. **Incentivizing segregation process** – Building an incentive structure in the contract for waste collectors to advocate and push for more segregation at the HH level
4. **Waste collector has to double up as advocates for segregation in their respective micro-pockets**. For this appropriate capacity building has to done to enable this.

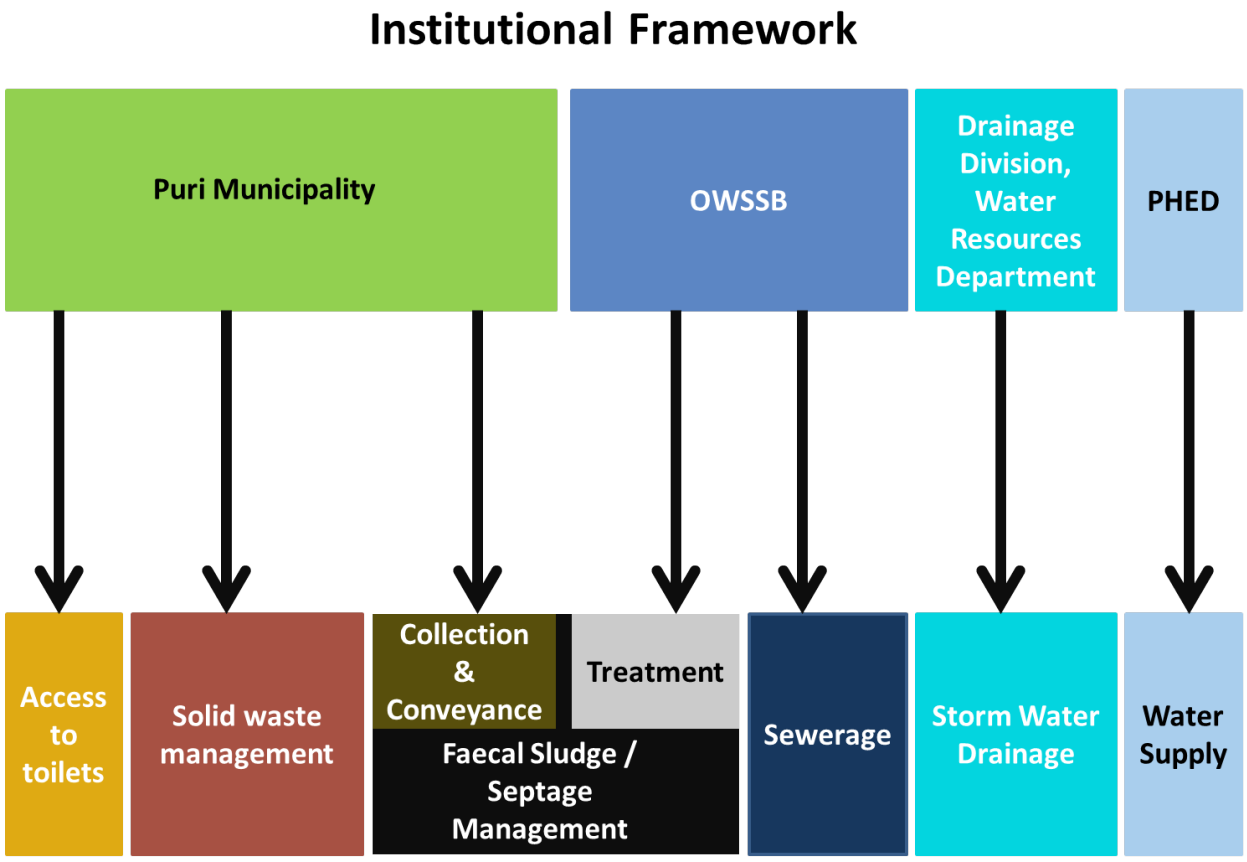
5 Institutional & Financial Capacity

5 INSTITUTIONAL & FINANCIAL CAPACITY GAPS

5.1 Institutional Framework

The institutional framework for sanitation sectors in Puri is illustrated below.

Figure 15Institutional Framework for sanitation in Puri



Source: Consultation meeting with city level officials at Puri Municipality, Drainage division of water resources department, OWSSB and PHED

A number of organisations are handling the sanitation infrastructure in Puri.

Puri Municipality handles toilet construction (IHHL, CTs and PTs) through the SBM Cell which also handles solid waste management initiatives. The SBM also supervises collection and conveyance of faecal sludge as it manages the operations of the cesspool vehicles maintained by the Puri Municipality.

Orissa Water Supply and Sewerage Board (OWSSB) is currently handling the treatment of faecal sludge since the construction of the Faecal Sludge/Septage Treatment Plant (FSTP/ SeTP) is with them.

Sewerage (construction of sewer network and sewage treatment plants; and managing household connections to the sewer) is also handled by the OWSSB.

Public Health Engineering Department is responsible for water supply (construction of sewer network and water treatment plants; managing household connections to the water supply; and connections to public stand posts).

Drainage Division of State Water Resources Department is primarily responsible for storm water drainage.

5.2 Capacity Assessment

In sanitation related positions, there are 1 health officers, 3 sanitary inspectors and 7 sanitary supervisors. Currently there are 704 sanitation workers working in the Municipality.

5.3 Capacity Building Interventions

5.3.1 Access to Toilets

Workshop on introduction on hygienic sanitation

The one day workshop would be planned to provide a basic understanding of access to toilets to the officials of the cities. Workshop should me aimed to complete following training modules:-

- ✓ Introduction to current sanitation situation in India
- ✓ Importance of Swachh Bharat Mission and access to toilets
- ✓ Importance of Public health and hygiene
- ✓ Benchmarks
- ✓ Hygienic and unhygienic user interface
- ✓ Types of containment units.
- ✓ Public and community access to sanitation.

Target Group: Commissioners, Municipal Engineers, health officer, public representatives who are involved in provision of sanitation services and improvement in access to sanitation.

Workshop on Training for Toilet Builders on Onsite Sanitation Systems

Masons play a vital role in the overall faecal sludge value chain in construction of toilets and containment systems for the individual users in every city. The success of faecal sludge management in any city relies heavily on it's on –site sanitation systems which includes the toilets, septic tanks, pits, etc. To ensure the sustainability of the activities, capacity building of the masons who are responsible for the construction of these facilities is mandatory.

The workshop is planned to create awareness on the significance of toilets in sanitation and its impact on environmental protection, to provide Mason's with technical knowledge and skills on the design and principles of the Onsite Sanitation Systems (OSS) as specified under Swachh Bharat Mission, to familiarise the participants with the construction norms and the specific

requirements for construction of OSS Systems and to stress on the importance of O& M of these OSS Systems in order to understand the role played by the elements of the OSS relevant to O&M.

Target Group: Masons working in the Puri who have been building toilets under the Swachh Bharat Mission

5.3.2 Faecal Sludge Management

Appropriate and adequate management of faecal sludge from on-site containment systems is imperative for the protection of human and environmental health. Through these various capacity building activities, we intend to strengthen the knowledge and skills of the officials working with the various town municipalities on various aspects of Faecal Sludge Management.

We propose various capacity building activities through workshops which would address the current knowledge elements of this rapidly evolving field, and present an integrated solutions approach that includes technology, management and planning. It will focus on the planning and organisation of the entire faecal sludge management service chain, from the collection and transport of sludge and treatment options, to the final end-use or disposal of treated sludge.

In addition to providing fundamentals and an overview of technologies, the workshop will go into details of operational, institutional and financial aspects, and will provide guidance on how to plan a city-level faecal sludge management project with the involvement of all stakeholders.

The objectives of these proposed workshops is to:

- To provide participants with technical and practical knowledge and skills on the concept and principles of design and implementation of FSM in Indian context.
- To enable participants to gain knowledge and skills for systematic planning and implementation of a series of activities for collection, containment, transportation, treatment and safe disposal/reuse in FSM.

3 workshops are proposed as part of capacity building activities and both of them have different target groups and are aimed to achieve the objectives. The details of the workshops are discussed below.

Introduction on FSM

The one day workshop would be planned to provide a basic understanding of FSM to the officials of the cities. Upon completion of the one day workshop the participants will be able to appreciate the need of FSM in their city.

Target Group: Commissioners, Engineers & Planners of the cities who are involved in the management of sanitation infrastructures.

Introductory Workshop & Exposure visit on FSM

The two day workshop is planned to provide customised inputs towards the potential of the FSM activities in the city. The workshop would provide in-depth understanding of the methodology

involved in planning FSM for a city and the participants will be able to get first-hand experience about operations of a FSTP.

Target Group: City Commissioners and State level officials who are involved in the planning of sanitation in state and city levels.

Location: Bangalore

Training for cesspool vehicle operators on using of technology integrated with faecal sludge transport and conveyance

A good quality, reliable faecal sludge transport and conveyance systems are required to ensure end-to-end Faecal Sludge Management services are provided by the city. The cesspool vehicle operators play an important role in the faecal sludge management.

The two day workshop is planned to provide overview of the technology integrated with faecal sludge transport and conveyance. The activities are designed in such a way that the cesspool operators get hands on experience with the technology which would strengthen the faecal sludge management. They will be provided with customised inputs towards the potential of the FSM activities in the city and how using the technology will help in addressing the key issues faced. The workshop would provide in-depth understanding of the technology and various aspects of undertaking a business/service in the form of desludging services for Puri.

Target Group: Cesspool operators working in the Puri who have been handling desludging services and also potential desludging services in order to develop the team.

5.3.3 Solid Waste Management

Suitable and acceptable solid waste management techniques are necessary for the protection of human and environmental health. Through these various capacity building activities, we intend to strengthen the knowledge and skills of the officials working with the various town municipalities on various aspects of solid waste management right from waste collection to waste treatment and reuse.

We propose various capacity building activities through workshops which would address the current knowledge elements of this rapidly evolving field, and present an integrated solutions approach that includes technology, management and planning. It will focus on the planning and organisation of the entire solid waste management service chain, from the waste collection to waste treatment and reuse options.

Training should be carried out for following groups

1. Public representatives (ward counsellors, corporators, ward members)
2. Engineers, health officers and managers
3. Sanitary supervisors, sanitary inspectors and contractors supervisors
4. PH workers, sweepers and waste collectors
5. Household and commercial waste generators

Workshop on Introduction on Solid waste Management

The one day workshop would be planned to provide a basic understanding of SWM to the officials of the cities. Workshop should me aimed to complete following training modules:-

- ✓ Introduction to SWM in India
- ✓ Importance of SWM Rules 2016
- ✓ Best Practices in SWM
- ✓ SWM System -Implementation STEPS
- ✓ Infrastructure requirements for the short-term and long-term ISWM
- ✓ Benchmarks
- ✓ Ensuring proper records of daily work output
- ✓ Maintaining Cordial Relations with community
- ✓ Maintain complaints and feedback for waste generators.
- ✓ Handling the Workforce (Labour Management – challenges – welfare)

Target Group: Commissioners, Municipal Engineers, health officer, public representatives who are involved in the management of Solid waste infrastructures.

Training for waste collectors on sanitation and public health awareness.

The one day workshop would be planned to provide a basic understanding of SWM to the solid waste collectors. Workshop should me aimed to complete following training modules:-

- ✓ Introduction to SWM in India
- ✓ Importance of SWM Rules 2016
- ✓ Best Practices in SWM
- ✓ Trainings on proper waste collection process.
- ✓ Trainings on micro pocketing, steps to increase efficiency of waste collection.
- ✓ Training on handling different types of wastes.

Target group- Sanitary supervisors, sanitary inspectors, contractor's supervisors, PH workers, sweepers and waste collectors responsible for collection and transportation of waste.

Training for waste generators on sanitation and public health awareness.

The one day workshop would be planned to provide a basic understanding of SWM to the solid waste generators i.e. general public and commercial establishment owners. Workshop should me aimed to complete following training modules:-

- ✓ Introduction to SWM in India
- ✓ Importance of SWM Rules 2016
- ✓ Best Practices in SWM
- ✓ Awareness creation about solid waste management and public health.
- ✓ Trainings on process of segregation of waste, storage of waste and handing over of waste to waste collectors in prescribed manner.
- ✓ Trainings of household treatment of waste eg. Composting, biogas etc.

Target group- General public, commercial establishment owners, and bulk waste generators.

5.4 Financial Capacity

This section provides a measure of the financial capacity of Puri to maintain the new infrastructure built in Puri. In maintaining new facilities like Public Toilets, and operating a city FSM, or water supply related activities such as increasing metering or the number of connections, the MC would have to undertake the operating expenses related to running these infrastructures, and so the existing gap in the water supply and sanitation budget is bound to increase. As such, the new interventions are proposed to make the MC as self-sufficient as possible. The income and expenditure patterns under sanitation have been calculated for Puri Municipality by analysing the revised budgets for the years of 2012-13, 2013-14 and 2014-15 respectively[28]. The revenue and grant budgets have been taken into consideration for the budget assessment. It has been observed that Puri registers a **surplus** of about 15.35% in 2012-13, 26.88% in 2013-14 and 36.03% in 2014-15. The maximum revenue generators are compensation in lieu of Octroi.

Water Supply

In Puri, provision of water supply is the responsibility of the Public Health Engineer Organisation (PHEO), who handles the construction of the water supply related infrastructure, and is also responsible for the provision of connections and collection of revenue from the consumers. However, in this section, water supply revenue and expenditure components from the municipal budget is undertaken. Since there are no different budget heads for water supply, there can be investments for water supply under other budget components, which has also not been included.

In Income Heads and Percentage for Water Supply in Puri Municipality (all figures in Rs.), it can be observed that JNNURM grant for piped water supply form the major income component from water supply for 2012-13 and 2013-14. For 2014-15, it has been seen that there has been no revenue or capital income for water supply and drainage.

Table 26: Income Heads and Percentage for Water Supply in Puri Municipality (all figures in Rs.)

Income Heads for Water Supply	2012-13	2013-14	2014-15
Water Tax	16, 27,107 *(0.91%)*	16, 27,107 *(0.23%)*	-
Water Connection Charges	-	6,468 *(0.001%)*	-
JNNURM-Piped Water Supply	17, 54, 55,000 *(98.46%)*	69, 41,11,000 *(99.56%)*	-
Grants for Drinking Water Programme	11, 25,000 *(0.63%)*	14, 35,000 *(0.21%)*	-
Total	**17,82,07,107**	**69,71,79,575**	**-**

Source: Assessment of the Municipal Budgets for Puri Municipality (2012-13, 2013-14, 2014-15)

Piped water supply projects under JnNURM form the major expenditure component from water supply and drainage for the years 2012-13 and 2013-14. For 2014-15, it has been seen that there has been no revenue or capital expenditure for water supply and drainage.

[28] Source: Assessment of the Municipal Budgets for MC Puri (2012-13, 2013-14 and 2014-15)

Table 27: Expenditure Heads and Percentage for Water supply in Puri Municipality (all figures in Rs.)

Expenditure Heads for Water Supply	2012-13	2013-14	2014-15
JNNURM-Piped Water Supply	21, 61, 76,000 *(100%)*	14, 21, 11,000 *(100%)*	-
Grants for Drinking Water Programme	-	-	-
Total	**21, 61, 76,000**	**14, 21, 11,000**	**-**

Source: Assessment of the Municipal Budgets for Puri Municipality (2012-13, 2013-14, 2014-15)

The above table shows that there is a deficit in 2012-13, and a high surplus in 2013-14. However, the huge disparity reflects on certain heads in water supply which may have been combined with other sectors of expenditure, Therefore, there is a need for a separate revenue and expenditure assessment for water supply within Puri Municipality, which would also be overseen by PHEO, who is responsible for water supply in Puri Municipality.

Storm water Drainage

Storm water drainage is the responsibility of the Public Health and Engineering Organisation (PHEO). However, this section deals with the revenue and expenditure for storm water drainage in Puri's municipal budget, and does not include components from the PHEO.

In Expenditure Heads and Percentage for Storm Water Drainage in Puri Municipality (all figures in Rs.), it can be observed that grant for storm water drainage is the only income component from storm water drainage for 2012-13 and 2013-14. For 2014-15, it has been seen that there has been no revenue or capital income for water supply and drainage.

Table 28: Income Heads and Percentage for Storm Water Drainage in Puri Municipality (all figures in Rs.)

Income Heads for Storm Water Drainage	2012-13	2013-14	2014-15
Grants- SWD	3, 47, 21,000 *(100%)*	39, 74,700 *(100%)*	-
Total	**3, 47, 21,000**	**39,74,700**	**-**

Source: Assessment of the Municipal Budgets for Puri Municipality (2012-13, 2013-14, 2014-15)

In Expenditure Heads and Percentage for Storm Water Drainage in Puri Municipality (all figures in Rs.), it can be observed that repair and maintenance of storm water drainage, expenditure of grants on storm water, and expenditure on open drains form the major expenditure component in 2012-13, 2013-14 and 2014-15 respectively.

Table 29: Expenditure Heads and Percentage for Storm Water Drainage in Puri Municipality (all figures in Rs.)

Expenditure Heads for Storm Water Drainage	2012-13	2013-14	2014-15
R&M- SWD	44,359 *(52.35%)*	28,700 *(0.77%)*	1, 99,886.00 *(8.42%)*
Open Drains	40,378 *(47.65%)*	-	21, 73,749.00 *(91.58%)*
Grants- SWD	-	36, 86,200 *(99.23%)*	-
Total	**84,737**	**37,14,900**	**23,73,635**

Source: Assessment of the Municipal Budgets for Puri Municipality (2012-13, 2013-14, 2014-15)

From the above tables, one can observe that there is a surplus in both 2012-13 and 2013-14. Therefore, new projects can be undertaken in storm water management from the municipal budget allocated under storm water management.

Sewerage and Waste Water Management

In Puri, execution of sewerage and wastewater projects is the responsibility of the OWSSB. However, maintenance of existing sewerage projects is the responsibility of the Municipality. In this section, sewerage and wastewater revenue and expenditure components from the municipal budget are taken into consideration. There are no different budget heads for sewerage and wastewater in the municipal budget, and there may be some budget heads with a sewerage and wastewater component in its combined figure. However, those heads have not been included since it is not possible to differentiate the components.

In Income Heads and Percentage for Sewerage and Wastewater Management in Puri Municipality (all figures in Rs.), it can be observed that grants for renovation of dying water bodies form the major revenue component from sewerage and waste water management for 2012-13 and 2013-14. State grant for the construction of public toilet forms the major revenue component for 2014-15.

Table 30: Income Heads and Percentage for Sewerage and Wastewater Management in Puri Municipality (all figures in Rs.)

Income Heads for Sewerage and Wastewater Management	2012-13	2013-14	2014-15
Conservancy/ Latrine Tax	8, 61,664 *(3.69%)*	8, 61,664 *(0.44%)*	-
Septic Tank Cleaning Charges	1, 84,000 *(0.79%)*	1, 77,250 *(0.09%)*	2, 96,100 *(0.89%)*
ILCS- State Grant	-	16, 04,000 *(0.83%)*	-
Sewerage cleaning charges	-	53,300 *(0.03%)*	31,000 *(0.09%)*
Grants for Construction of Public Toilets- State Grant	-	-	3, 29, 93,000 *(99.02%)*
Grants for Renovation of Dying Water Bodies	2, 23,30,000 *(95.53%)*	19, 11,17,500 *(98.61%)*	-
Total	**2,33,75,664**	**19,38,13,714**	**3,33,20,100**

Source: Assessment of the Municipal Budgets for Puri Municipality (2012-13, 2013-14, 2014-15)

In Expenditure Heads and Percentage for Sewerage and Wastewater Management in Puri Municipality (all figures in Rs.) , it can be observed that expenditure from grants for renovation of dying water bodies form the major expenditure components in sewerage and wastewater management for the years 2012-13 and 2013-14 , while public toilets form the major expenditure component for 2014-15.

Table 31: Expenditure Heads and Percentage for Sewerage and Wastewater Management in Puri Municipality (all figures in Rs.)

Expenditure Heads for Sewerage and Wastewater Management	2012-13	2013-14	2014-15
ILCS- State Grant	32, 99,400 *(24.81%)*	-	-
Public Toilet	-	-	6, 35,916 *(59.55%)*

R&M- Public Toilets	-	-	4, 31,909 *(40.45%)*
Grants for Renovation of Dying Water Bodies	1, 00, 00,000 *(75.19%)*	14, 10, 79,000 *(100%)*	-
Total	**1,32,99,400**	**14,10,79,000**	**10,67,825**

Source: Assessment of the Municipal Budgets for Puri Municipality (2012-13, 2013-14, 2014-15)

From the above tables, it can be observed that for all the years, Puri registers a surplus in wastewater and FSM. However, this includes revenue and expenditure components as included in the municipal budget. Since Puri is undergoing the construction of the SeTP and the FSM conveyance process to deposit sludge at the SeTP is yet to be formalised, there will be no returns on the investment from the infrastructure unless it is fully constructed. The OWSSB should work with Puri to have an efficient revenue system for the sewerage and FSM infrastructure constructed.

The reuse potential from the FSM and wastewater sector needs to be taken into special account to consider any serious revenue from the sanitation sector in the long run. However, the revenue from public amenities like public toilets can only be taken into account for the operation and maintenance of these facilities.

Solid Waste Management

In Puri, solid waste management is the responsibility of the Municipality. Solid waste management has a separate component in the budget document.

In Income Heads and Percentage for Solid Waste Management in Puri Municipality (all figures in Rs.), it can be observed that funds from the express cleaning and state grants for SWM the major revenue component from sewerage and solid waste management for 2013-14 and 2014-15 respectively. For 2012-13, it has been seen that there has been no revenue or capital expenditure for water supply and drainage.

Table 32: Income Heads and Percentage for Solid Waste Management in Puri Municipality (all figures in Rs.)

Income Heads for Solid Waste Management	2012-13	2013-14	2014-15
Express Cleaning	-	1, 49,300 *(100%)*	3, 21,000 *(0.45%)*
Grants for SWM- State Grant	-	-	3, 73, 33,000 *(52.60%)*
Total	**-**	1, 49,300	**7,09,74,100**

Source: Assessment of the Municipal Budgets for Puri Municipality (2012-13, 2013-14, 2014-15)

In Expenditure Heads and Percentage for Solid Waste Management in Puri Municipality (all figures in Rs.) it can be observed that garbage and clearance expenses form the major expenditure components in sewerage and solid waste management for the years 2012-13 and 2014-15. Cleaning of garbage by private agencies was the major expenditure component in 2013-14

Table 33: Expenditure Heads and Percentage for Solid Waste Management in Puri Municipality (all figures in Rs.)

Expenditure Heads for Sanitation	2012-13	2013-14	2014-15
Garbage and Clearance Expenses	5,90,393 *(62.89%)*	64,240 (34.98%)	24, 92,647 (100%)

Cleaning by private agencies	85,860 *(9.15%)*	1, 19,400 (65.02%)	-
Transfer to SWM account	2,62,526 *(27.96%)*	-	-
Total	**9,38,779**	**1,83,640**	**24, 92,647**

Source: Assessment of the Municipal Budgets for Puri Municipality (2012-13, 2013-14, 2014-15)

In solid waste management, Puri Municipality registers a deficit in all the three years. However, the huge disparity reflects on certain heads which may have been combined with other sectors of expenditure, Therefore, there is a need for a separate revenue and expenditure assessment for SWM within Puri Municipality, which would also be overseen by the SBA cell, who are in charge of the operations in Puri Municipality. The solid waste sector also eventually needs to collect the cost for collection of solid waste (there are plans to begin charging collection of solid waste in Puri Municipality), which would be a substantial cost for the solid waste management sector.

The Puri Municipality budget calculates revenue and grant budget accounts. The revenue income budget has heads on taxes and fees, rent, own source income. The developmental income budget includes SFC and grants awarded to the municipality. The revenue expenditure budget has heads on own income expenditure, delegated functions, maintenance/ repair/ depreciation of assets and other expenditure heads. The developmental expenditure budget has expenditure from the SFC and grants awarded.

Budget components from other organisations related to water supply and sanitation, such as OWSSB and PHEO will be detailed in the next phase when the solutions are formulated. The following table provides a comparison of the income in the municipal budget for the various components of sanitation, and the total SAAP amount planned for the year 2014-15. Depending on this budget, the various options given in the earlier sections of the report would be finalised. The municipal income figures of 2014-15 have been used for the assessment.

Table 34: Comparison of Municipal Income and SAAP figures

Sector	Income in Municipal Budget
Access to Toilets	-
Storm water management	23,73,635
Wastewater management	3,33,20,100
Solid waste management	7,09,74,100

Source: Assessment of the municipal budgets of Puri

In the above table, the municipal budget of 2015-16 shows the total income for all the sanitation sectors as Rs. 10.67 crores. The total allocation under SAAP is Rs. 12.56 crores. Therefore, depending on the discretion of the municipality and suitability of technological options, interventions can be planned for Puri.

6 Implementation & Rollout Plan

6 IMPLEMENTATION AND ROLL-OUT PLAN

Table 35: Indication of Phases

Phase	Time Period	Characteristics
Short Term	Upto 2 years	Urgent improvements that require some planning steps
Medium Term	3- 5 years	Recommendations with a significant impact; needs more elaborate planning steps and requires substantial funding
Long Term	5- 10 years	Recommendations for the sustainable functioning of the system and adaptation to future developments

Table 36: Phase-Wise Implementation of Actions

Phase	Activity
Water Supply	
Short Term	• Implementation of the ongoing projects to improve water supply
Improvements in Toilet Access	
Short Term	• Constructing **5279 IHHL** (as per Swachh City Plan projection) **or 4424 IHHL** (as per exponential projection) by 2019. • Mandating connections to sewer network in sewered areas and to septic tanks or localised treatment systems in case of unsewered areas. • **Awareness programs** focussed on the environmental and health issues faced due to open defecation for households and other communities. • Training on the O&M mechanisms for individual toilets. • Increasing the incentive given to households in order to meet the actual expenditure incurred in building toilets IHHL. In order to achieve this, other sources of funding apart from SBM needs to be approached. (Refer Fund Mobilisation for IHHL) • Policy measures discouraging individuals to go for open defecation should be formalised- this would include penalties, incentives for construction of individual toilets, and others
Medium Term	• Upgradation of households with public/ community toilets to individual toilets. If funds and conditions are viable, households should be encouraged to construct individual toilets.
Long Term	• Constructing **1015 IHHL** (as per Swachh City Plan projection) **or 1587 IHHL** (as per exponential projection) by 2025.
Storm water Management	
Short Term	Refer Recommendations for improving water quality in drains • **Stopping the entry of sewage into the storm water drain** • **Reviewing the functioning of the oxidation pond.** • **Maintaining and increasing the number of natural drains**
Wastewater Management	

Short Term	• **Implementation of localised conveyance and treatment solution** in clusters left out of the sewered areas as suggested in the
	• Approaches for wastewater management for unsewered pockets and newly constructed multi-storeyed buildings
	• **Ensuring last mile connectivity for the sewer network** in areas covered under sewer system
	  ○ IEC activities for citizens to connect to the sewer network
	  ○ Legal enforcement for mandating connections in sewered areas
	  ○ Incentivising or subsiding the sewer connection cost to households.
	• Training of operators

Medium Term	• Identifying potential reuse options
Long Term	• **Bulk generators of sewage** such as apartments and institutions; and any new multi-storeyed buildings can be mandated **to treat their wastewater at source** in order to reduce the pressure on the centralised sewer infrastructure.
Improvements in Faecal Sludge Management	
Short Term	• **Implementation of standard containment size code regulations** • **Awareness/IEC campaigns on open defecation** and other aspects, training the operators on standard practices and safety measures for collection and conveyance • **Masons training** for building the containment systems • Adhering to **Odisha Urban Septage Management Guidelines, 2016.** • **Monitoring of private and government cesspool vehicles** by mandating **GPS and other ICT** interventions. • **Mandating safety gears** to be given to government operators private operators • Separate account for handling government cesspool vehicles. • Maintain the **database of private operators** • Mechanisms to fill the form by the customer availing the desludging service which has to be submitted at the MC/during the disposal. • **Licensing the private operators** and periodic renewal • **Capacity building of ULB and operators for handling the SeTP** • **IEC campaign with the cesspool operators** both private and government for behaviour change regarding the disposal • Co-compost plan for enhancing the nutrient value • **Plan for selling the dried and co-composted FS to farmers** and through collaboration chemical fertilisers companies to sell it as a part of their product. • Converting the dried FS into co-compost for enriching the nutrient content • To encourage reuse among the farmers through IEC campaigns • **Treated FS Reuse policy** to be formulated for the city
Medium Term	• **Procure 3-4 Gulpur machines /small cesspool** vehicles where the existing cesspool vehicles cannot access • **Different business models assessment for financial sustainability** of the SeTP. • **Inclusion of property tax as part of making the operations of SeTP sustainable** • **Policy resolution leading to 100% disposal and treatment of the FS generated** • Exploring possibilities of using Black soldier flies usage of solar energy at the SeTP • Exploring possibilities to sell for cement industries/ brick factories
Long Term	• **Scheduled desludging should be implemented** by incorporating user fee or property tax incorporation
Solid Waste Management	

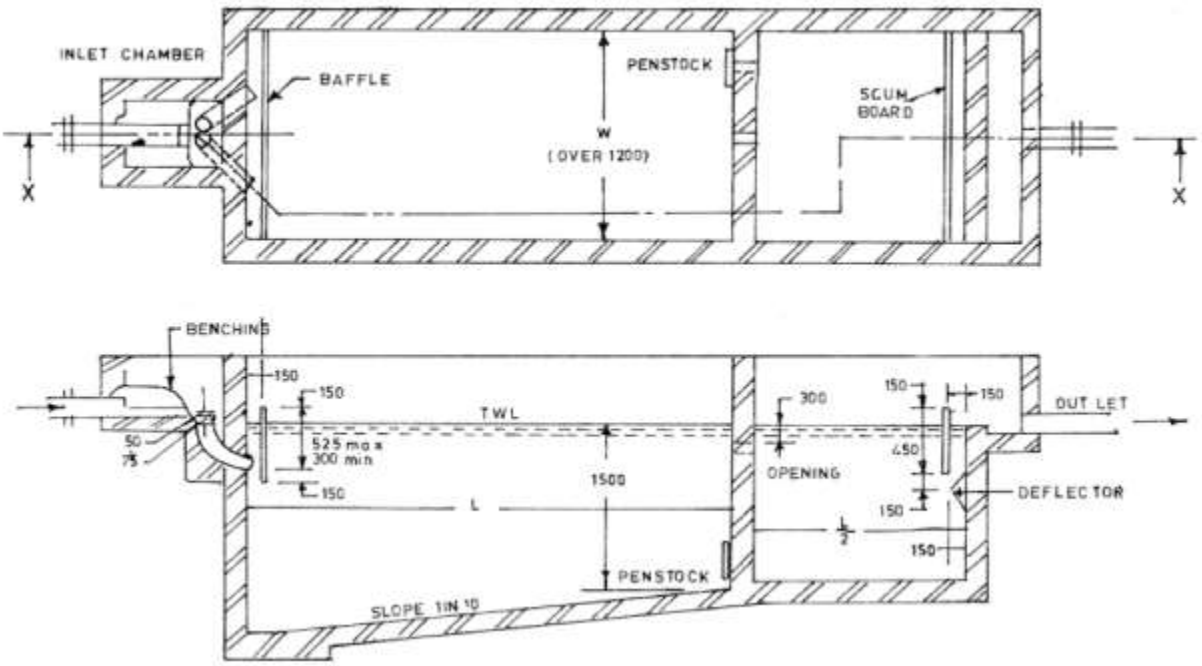
Short Term to medium term	• Implementation of **Micro-pocketing approach** for solid waste collection (Refer to Micro Planning) • **Household awareness campaigns about segregation of waste** to be carried out by waste collectors • Policy amendments for provision of incentives in the form of property tax rebates or rebate on solid waste collection charges under polluters pay principle. • Carry out waste composition study to know the actual content of wet and dry waste and composition of different materials like, biodegradable, paper, metals, glass etc. • **Mandating all bulk waste generators** whose waste characteristics are mainly wet waste eg vegetable market, public parks etc. **to treat waste at source** by means of installation of biogas digester/ onsite composting system/ Organic waste Converter (OWC) machines in the bulk waste generation sites. • Identify and Demarcate land parcel for construction of Material Recovery Facility (MRF) for recyclable dry waste, composting for wet waste and C & D waste plant at Balia Panda dumpyard. • Repair of the composting unit at Balia Panda. This will cater to the wet waste from residential micro-pockets. • **Construction of new treatment facilities at city level**: o Material Recovery Facility o C & D Waste Plant o Incineration facility for biomedical waste o Scientific landfill for inert waste • **Training for solid waste management personnels-** from the gound level worker to the officials implementing the systems.

7 Annexure

7 ANNEXURE

7.1 Toilet Designs

Figure 16: Typical sketch of a two- compartment septic tank for 5 users (dimensions in mm)



Source: Manual on Sewerage and Sewage Treatment Systems, 2013, Part A: Engineering

7.2 Slum list and community toilet seats estimation

Table 37 Slum list, Puri

Data received						Inferred data		
S NO	SLUM NAME	WARD NO	HOUSEHOLDS	DU	POPULATION	No of Community toilet seats required		
						Male	Female	Total
1	Matitota	1	134	80	529	8	11	19
2	Gokha Sahi	1	304	223	1152	17	24	41
3	Mangala Ghat	1	618	293	2101	31	43	74
4	Khuntia Bagicha Bhoi Basti	1	159	68	417	6	9	15
5	Jagannath Basti	1	247	153	865	13	18	31
6	Markandeswara Sahi Harijan Basti	01&02	307	190	1040	15	21	36
7	Tridev Nagar	5	352	234	1536	22	31	53
8	Leporsy Colony	5	106	114	349	5	7	12
9	Hati Sala Bhoi Basti	5	96	78	307	5	7	12
10	Bijaya Nagar (Balia Panda)	7	1689	1066	6027	87	121	208
11	Para Nolia Sahi	6	83	60	287	5	6	11
12	Gouda Bada Nolia sahi	7	258	146	882	13	18	31
13	Akshya Dham Basti	7	70	70	315	5	7	12
14	Tiadi Sahi Harijan Basti	8	39	28	110	2	3	5
15	Bali Harijan Sahi	09,10, 11	272	126	463	7	10	17
16	Bali Mochi Basti	10	106	158	524	8	11	19
17	Bali Nolia Sahi	11	1173	788	3988	57	80	137
18	Gadi Khana (Mochi) Basti	13	60	74	260	4	6	10
19	Mochi Sahi	13	68	60	317	5	7	12
20	Indira Marga Colony	14	96	41	288	5	6	11
21	Old Sadar Thana Bhoi Basti	14	32	28	112	2	3	5
22	Jagannath Ballav Matha Bhoi Basti	17	32	24	114	2	3	5
23	V.I.P Road Banki Muhan Basti	19	239	74	559	8	12	20
24	Banki Muhana Nala Basti	19	96	37	227	4	5	9
25	Gola Pucca Basti	20	56	43	146	3	3	6

Data received						Inferred data		
SNO	SLUM NAME	WARD NO	HOUSEHOLDS	DU	POPULATION	No of Community toilet seats required		
						Male	Female	Total
26	Kumbharapara	21,22	711	387	2535	37	51	88
27	Narendra Kona Harijan Basti	21	232	141	796	12	16	28
28	Mangala Sahi(N.S. Depot)	01,21	198	137	752	11	16	27
29	Gopabandhu Colony	21	78	41	140	2	3	5
30	Ramachandi Balikuda	23	1707	918	5462	79	110	189
31	Ghoda Bazar	24	710	429	2414	35	49	84
32	Gora Kabar	25	343	177	914	14	19	33
33	Dhoba Sahi	25	316	146	839	12	17	29
34	Youth Hostel Back side Basti	25	104	40	282	5	6	11
35	Jali Sahi Telgu Basti (A)	25	233	159	792	12	16	28
36	Chakra Tirtha Nolia Basti	26	1231	671	3620	52	73	125
37	Penthakata (B)	26	1320	750	4290	62	86	148
38	Jali Sahi (B) (Rama Mandir)	27	116	86	577	9	12	21
39	Railway Adibasi Basti	27	165	192	959	14	20	34
40	Matiapara	28,29, 30	550	266	1536	22	31	53
41	Tikarapara	29,30	102	83	403	6	9	15
42	Chasa Sahi	30	161	94	510	8	11	19
43	Chamara Sahi	31	63	41	182	3	4	7
44	Binabha Nagar	31	288	158	883	13	18	31
45	Kumuti Patana	30	167	95	556	8	12	20
46	Penthakata (A)	32	2996	1815	10346	148	207	355
47	Mashani Chandi	1	106	91	479	7	10	17
48	Bhagabati Nagar	5	100	67	328	5	7	12
49	Panchabati Sriram Nagar	6	62	34	204	3	5	8
50	Gourang Khuntia Basti	6	60	32	185	3	4	7
51	Maheswar Nagar	7	316	918	1084	16	22	38
52	Zilla School Front	19	68	32	207	3	5	8
53	Manibaba Colony	25	50	32	162	3	4	7
54	Banki Muhana Nuaa Sahi	25	133	79	408	6	9	15

Data received						Inferred data		
SNO	SLUM NAME	WARD NO	HOUSEHOLDS	DU	POPULATION	No of Community toilet seats required		
						Male	Female	Total
55	Mangala sahi	25	40	23	119	2	3	5
56	Bijayananda Nagar	27	56	51	229	4	5	9
57	Gangamata Bhoi Sahi	29	32	32	100	2	2	4
58	Kumbharapara Baada Sahi	29	42	40	204	3	5	8
59	Mangala Patana	31	72	29	209	3	5	8
60	Gouda Bada Malik Sahi	7	32	28	149	3	3	6
61	Sahajoga Sahi	25	69	41	217	4	5	9
62	Rama ballabha Colony	14	43	21	167	3	4	7
63	Mahabir nagar	27	54	31	176	3	4	7
	TOTAL		19818		66330	976	1360	2336

7.3 Solid Waste Management Technology Options

7.3.1 Micro Planning

For efficient handling of the sanitation and solid waste management function, MC Puri

is required to bundle the related activities into three major work units based on the size and work load quantities. Work packages can be classified as follows:-

- Residential Micro Pocket
- Commercial and Bulk Solid Waste Handling
- Mechanical Sweeping of Main Roads

Further all these above packages should include sweeping of streets and cleaning of drains within the package boundary.

Steps involved:

I. Clear demarcation of residential, commercial and main road sweeping pockets for carrying out the sanitation and solid waste management activities
II. Clearly defining of job responsibilities and key performance indicators for the service providers
III. Making realistic estimates of resource requirements in rationalized and standardized manner (manpower, transportation vehicles, tools, implements and conservancy materials)
IV. Develop clear resource inputs and results-outputs correlations to achieve standard service delivery results across the ULBs in a uniform manner.
V. Identifying and developing clear wok quantities, key performance indicators and

performance monitoring mechanisms, in the event of outsourcing complete work packages to private agencies

Strategies for handling work packages:

1. Residential micro package

A household is defined as a domestic living accommodation of any type such as: a) any type of a dwelling structure; b) a slum house; c) a multi-floor housing complex of not more than 20 units and also small shops and petty commercial units situated in residential areas. For solid waste collection purpose, each of these households will be counted as one unit. Single residential micro package should consist of a continuous area with 300- 350 of waste generating units.

Residential micro packaging include:-

i. Collection of source segregated solid waste (wet, dry and hazardous waste separately) at the gates / doors of the households, shops, vendors and public places - Daily
ii. Manual sweeping of streets, footpaths, pavements and open spaces and removal of any litter in these areas, and removal of animal carcasses - Daily
iii. Cleaning of and removal of garbage, litter, silt or blocks from the street side shallow surface drains – Daily
iv. Sweeping of main and arterial roads and all the abutting road surfaces, foot paths and paved areas – Daily
v. Sweeping and Litter Collection in Parking Lots, Foot Over Bridges, Bus Shelters, Sub Ways, Traffic Islands, and any other structure abutting the main roads – Daily
vi. Cleaning of Shallow Surface and Storm Water Drains (other than underground sewerage drains)
vii. Observe the places of water logging and water stagnation and clear the clogging garbage and silt for ensuing free flow of water.
viii. Disinfectant spraying, shrubs cutting, removing earthen heaps and or any other vector control activities as specified by the ULB.
ix. Transfer of the collected waste from all the above activities to the points of designated locations such as Transfer Stations, Compost or Material Recovery Yard, Landfill Facility - Daily

2. Commercial and bulk waste handling package

A Bulk Waste Generating Unit is an independent building structure or a building complex which houses a Commercial or Institutional unit(s); a high rise building or a gated community of more than 20 units used for either residential, commercial or mixed purposes. For example, any entity such as a restaurant, bank, chit fund office, educational institution, government or private office, religious place, hostel, hotel, training institute, function hall etc., which generate waste in bulk volumes can be classified as a bulk waste generating source. A group of more than 20 dwelling units located in the same complex used for either residential or commercial purpose will also be classified as a bulk waste generator.

For enumerating bulk waste generating units, each gate at which the waste can be handed over to the waste collector should be considered as one unit. Bulk waste will be collected at the gates

of the buildings. It is the responsibility of the building owner on whom the property is registered, to arrange for handing over the waste at the gate of the building to the waste collector. Roadside vending units are to be considered as bulk waste generators and to be enumerated in the respective roads and streets in which they are located. Mobile vending carts are also to be enumerated in the respective streets / roads in which they normally cart for maximum time.

Depending on the size of the commercial activities and the physical spread of these commercial and institutional establishments in the ULB, a ULB can have more than one Commercial bulk waste zone.

3. Mechanized road sweeping

Based on the conditions of the roads and the financial capacity of the MC to bear the costs, specific road stretches can be swept by mechanical sweeping. MC Puri shall deploy power driven mechanical sweeping machines for specific stretches

Outsourcing work packages:

Instead of taking workers on contract basis for deployment in Solid waste collection activities, MC Puri is required to shift to a system of outsourcing complete work packages to any registered legal entity/ society / contractor / agency that are covered by income tax and other statutory regulations. The system of outsourcing complete work packages is meant for getting the following benefits to the MC as measurable operational results such as better delivery of services; compliance to MSW rules & NGT directives; availing better technology, management methods and capital through private, social sector & CSR participation and overall positive impact on the living environment by mitigating pollution and environmental hazards.

Outsourcing of residential Micro Pocket Work Packages:

For outsourcing micro pocket Work Packages, MC is required to adopt the following steps.

I. The available permanent PH workers on the rolls of the MC are to be fully allocated for all micro pocket management activities in the wards that are identified as high density low public movement and low density low public movement areas. They should be allocated for the activities such as micro pocket management – (Gate-to-gate solid waste collection, street sweeping, litter collection, drains cleaning, disinfectant spraying, vector control, removal of weeds and unwanted vegetative growth, berms cutting, removal of animal carcasses from residential areas and the main and arterial roads that are part of the micro pocket.), as loaders for secondary transportation and gang Work
II. The remaining micro pockets and the respective wards should be earmarked for outsourcing. The micro pockets that are earmarked for outsourcing are to be bundled into 2-3 work packages, covering the rest of the MC area other than those micro pockets and wards that are identified for services by the MC permanent staff. As an illustration, each work package for outsourcing may contain 80-100 micro pockets. However, MC can decide on the number of micro pocket work packages that can be outsourced, not exceeding three.

Outsourcing of Commercial, Institutional and Bulk Solid Waste and C&D Collection and Transportation

I. Commercial, institutional and bulk solid waste collection and transportation activity shall be outsourced as a complete work package.
II. MC shall suitably make the RFP, following the model RFP and shall procure the services of a competent bidder.
III. Based on the size and spread of the commercial activities in the MC, the required number of packages can be worked out. Municipal Corporations and larger Special Grade ULBs may have 2-3 Commercial and Bulk Waste Wok Packages, whereas other smaller ULBs may have one work package for commercial, institutional and bulk waste collection and transportation. For deciding upon the work packages, MC shall consider the financial viability on the part of the MC to outsource this activity as a permanent arrangement.
IV. As the approximate quantities of C&D waste that need to be lifted and transported to designated places cannot be determined based on some norms, lifting of this component is to be outsourced to the successful contractors as an additional work on rate contract basis. As and when the C&D wastes are to be lifted, the MC will notify the contractors and make payments separately according to the work executed by them. To this effect, MC shall set up a process to enable citizens to approach MC for service at a quantity based fixed rate. The citizen can make the specified amount through a challan and this amount will be transferred to the contractor after completing the lifting.

Outsourcing Mechanical Sweeping

Mechanical Sweeping of the select road stretches based on the road conditions (well paved longer roads) can be outsourced as a complete work package.

MC can follow the decision matrix as given in the following table:-

Table 38: Decision Making Matrix for Outsourcing of Work

Residential Area and Main Roads Sanitation, Solid Waste Collection and Drains Cleaning	Commercial and Bulk Waste Collection and Transportation	Mechanical Sweeping
1. Adjust all the available permanent workers to as many micro pockets as possible 2. Outsource the remaining micro pockets	Outsource	Outsource

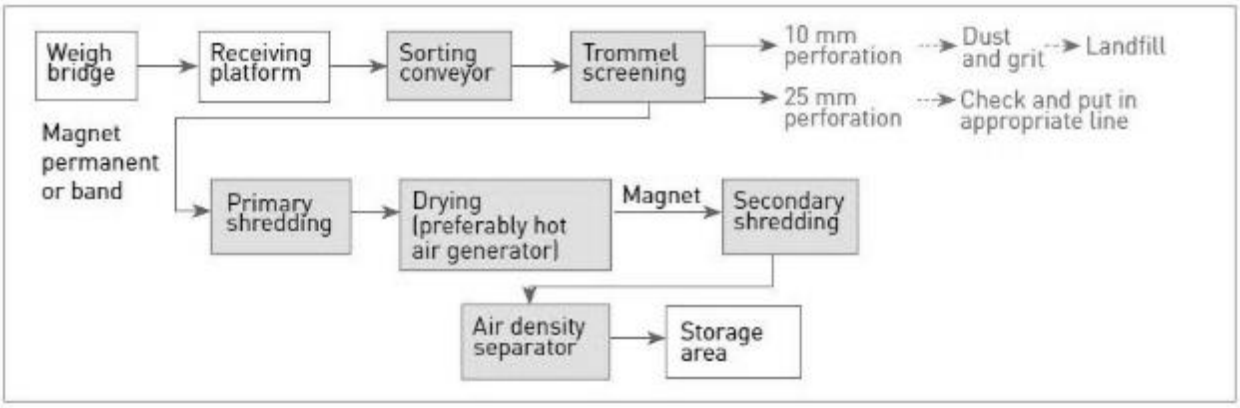
1. In case, where outsourcing the works as independent work packages is not possible, create one package for outsourcing after adjusting the existing permanent workers to as many micro pockets as possible.
2. Where Mechanical Sweeping is not feasible, this package need not be considered as the sweeping and litter collection in the major road areas will be carried out by the respective micro pocket workers

- MC should issue separate government orders / guidelines for levy of user fee in the form of SWM Cess.
- MC is required to identify suitable locations for depositing the collected waste from the processes as detailed above by the contractors / MC sanitation workers teams.
- Ongoing monitoring of the field activities that are carried out by the MC staff and the outsourced agencies by the senior officials of MC under the management and supervisory guidance of the Commissioner is an important component.
- Municipal Commissioners are required to ensure implementation of the guidelines issued for micro planning, micro pocket management, bulk waste handling, street sweeping etc. without fail.
- Penalties will be levied on the citizens / repeat violators, if they
  - Fail to handover waste, despite the visit of the service provider Fail to handover waste in segregated manner
  - Resort to public littering.
- Municipality should conduct training and capacity building for responsible personnel and agencies for solid waste management. Community IEC should also be conducted on regular basis.

7.3.2 Solid Waste Treatment Options

Material Recovery Facility

Figure 17: Indicative Material Recovery Facility and Pre-sorting Facility dedicated to Dry waste



Source: Swachha Bharat Mission (2016) Municipal Solid Waste Manual, Volume II, Government of India.

Salient features of Material Recovery Facility

- Depending on the scale of operations and the level of mechanisation in the facility, MRFs may be classified as manual or mechanised.
- Usually small- scale units, manual MRFs largely employ manual sorting practices and are typically owned, managed, and operated by the informal sector.
- Mechanised MRFs are large facilities with sophisticated systems and equipment that enable efficient separation of large quantity of material into different fractions.
- Dry segregated material is received in a mixed form consisting of a combination of fibres (paper, card board, mixed paper, magazines, etc.) and commingled containers (plastic, glass, metal, etc.), among other materials.
- The first stage of processing typically uses manual labour or equipment that separate material into various streams (fibre, paper, plastic, containers, etc.).
- Land Requirements:
  - 500 m for facilities dealing with 100 TPD or more of MSW
  - 400 m for facilities dealing with 75–100 TPD of MSW
  - 300 m for facilities dealing with 50–75 TPD of MSW
  - 200 m for facilities dealing with 10–50 TPD of MSW
  - No buffer zone for facilities dealing up to 5 TPD of MSW
  - No buffer zone for decentralised plants handling less than 1 TPD of MSW (but adequate environmental controls are required)
- Different process or stages and equipment employed in material recovery facility are shown in table below.

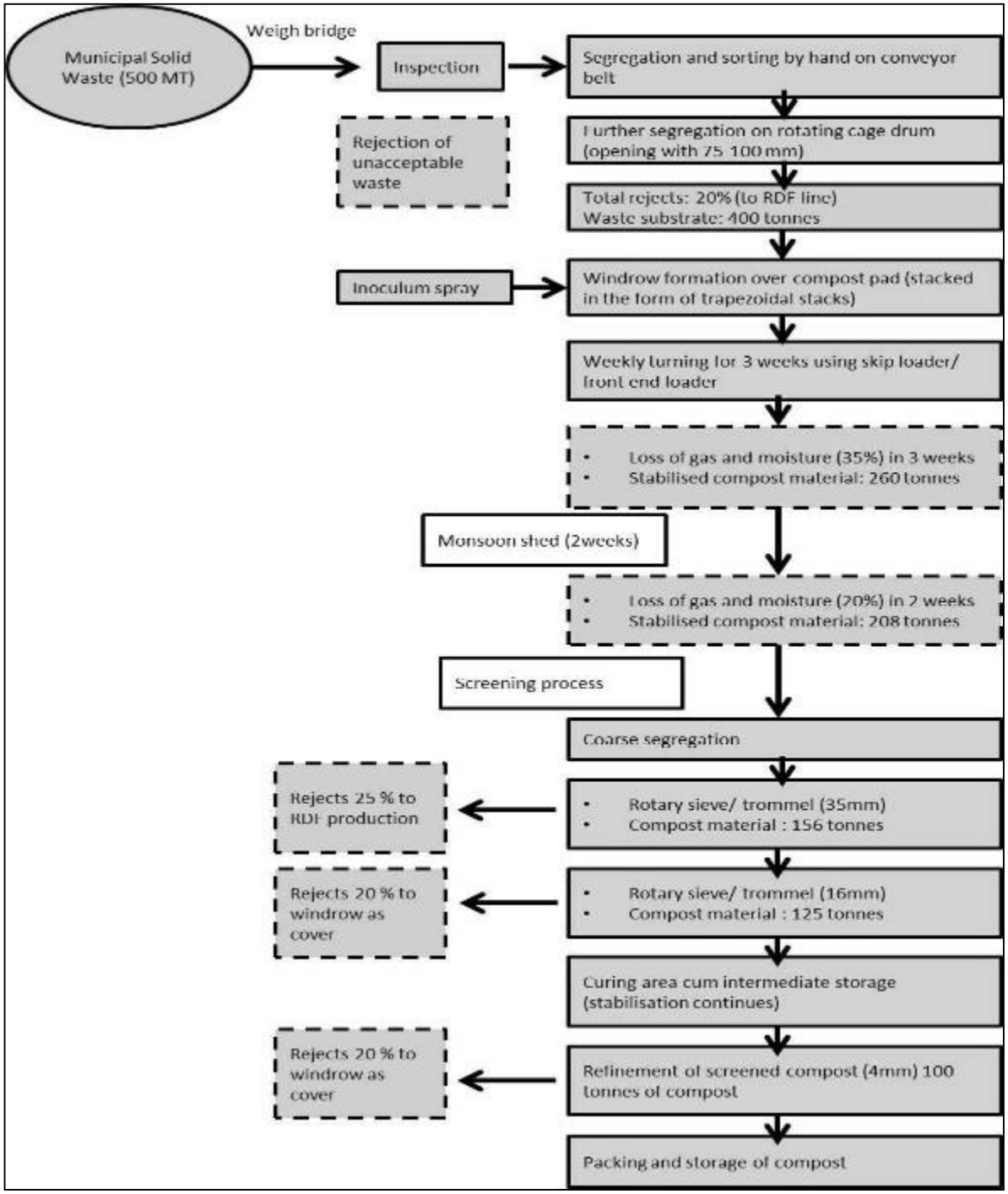
Table 39 Stages of Material Recor Facility

PROCESS OR STAGES	EQUIPMENT
Pre-sorting material handling equipment	• Belt conveyor • Screw conveyor • Apron conveyor • Bucket elevator • Drag conveyor • Pneumatic conveyor • Vibrating conveyor
Ferrous metal separation	• Magnetic separator and screening
Screening	• Disc Screening • Trommels
Air classification	• Horizontal air classifier • Vibrating inclined air classifier • Inclined air classifier
Non-ferrous metal separation	• Rotating disk separator • Eddy current separator
Size reduction	• Can densifier • Can flattener • Glass crusher • Plastic granulator • Plastic perforator
Pollution control	• Dust collection system • Noise suppression devices • Odour control system
Other fixed equipment	• Fixed storage bin • Live-bottom storage bin • Floor scale for pallet or bin loads • Truck scale

Source: Swachha Bharat Mission (2016) Municipal Solid Waste Manual, Volume II, Government of India.

Windrow Composting

Figure 18: Process Flowchart and mass balance for anaerobic windrow composting of 500 MT per day of waste of waste



Source: Swachha Bharat Mission (2016) Municipal Solid Waste Manual, Volume II, Government of India.

Salient Features of Windrow Composting: -

- Land Requirements:
  - 500 m for facilities dealing with 100 TPD or more of MSW
  - 400 m for facilities dealing with 75–100 TPD of MSW
  - 300 m for facilities dealing with 50–75 TPD of MSW
  - 200 m for facilities dealing with 10–50 TPD of MSW
  - No buffer zone for facilities dealing up to 5 TPD of MSW
  - No buffer zone for decentralised plants handling less than 1 TPD of MSW (but adequate environmental controls are required)
- Composting in coastal/high rain- fall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation.
- Land requirement: - For 300 TPD of segregated/pre-sorted MSW: 5 ha of land including buffer zone is required.
- Upto 500MT of waste can be managed by a single facility.
- High requirement of segregation prior to technology
- If only composting is done the about 30% of rejects including inert materials are obtained. If RDF facility is located in same plant then percentage of rejects can be reduced to 15%.
- Capital cost comes up to 15-20Cr for a 500 TPD plant. i.e. around 3-4 lakhs per tonne.
- Quality of compost should be compliant with FCO 2013. It has a good market potential.
- Windrow composting is labour intensive. It required technically qualified and experienced and semi-skilled staff.
- Atmospheric pollution is low. Only odour issues.
- In high rainfall areas, the windrow need to be covered either temporarily or permanently to control leachate generation. However, the design of the shed should be such that good natural ventilation is maintained.
- Fire and safety issues should be taken care of.[29]

Vermi Composting

- Vermicomposting is the process of composting the biodegradable fraction of MSW with the help of earthworms, resulting in the production of vermicompost which can be used in agricultural fields as a soil conditioner and nutrient supplier.
- Vermicomposting draws better market price as compared to compost. Additionally, sale of worms can bring in additional revenue.
- Vermicomposting is typically suited for managing smaller waste quantities.
- Land Requirements:
  - 500 m for facilities dealing with 100 TPD or more of MSW
  - 400 m for facilities dealing with 75–100 TPD of MSW

[29] Source: Swachha Bharat Mission (2016) Municipal Solid Waste Manual, Volume I, Government of India.

- 300 m for facilities dealing with 50–75 TPD of MSW
- 200 m for facilities dealing with 10–50 TPD of MSW
- No buffer zone for facilities dealing up to 5 TPD of MSW
- No buffer zone for decentralised plants handling less than 1 TPD of MSW (but adequate environmental controls are required)

- Composting in coastal/high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation.
- Land Requirement: - For 20 TPD of segregated/pre-sorted: 1.25 ha.
- 1 TPD – 20 TPD quantity of waste can be managed in single facility. Higher capacities can be also planned but then the land requirements become very high.
- Very high requirement of segregation prior to technology
- 30% of the rejects including inert materials are rejected.
- Capital cost comes up to 1Cr per 20 TPD plant. i.e. around 5 lakhs per tonne.
- By-product has Good market potential in urban and rural areas.
- Vermi-composting is labour intensive. It required technically qualified and experienced and semi-skilled staff.
- Very low leachate problems.[30]
- Following are some vermin-compost problems, possible causes and solutions.

Table 40 Problems and solutions of vermicimposting

PROBLEMS	POSSIBLE CAUSES	SOLUTIONS
Foul odour	Overfeeding	Remove the excess food, remove meat or dairy products if any
	Not enough air circulation or anaerobic	Fluff up or loosen bedding
	Bed too wet	Add bedding to absorb moisture
Flies	Waste exposed	Bury the waste completely
Ant infestation		Immerse the base or feet of the vermi bed in water
		A barrier of chalk or petroleum jelly may repel the ants
		If bedding seems dry, add water
Mite infestation		Avoid adding foods with high moisture content
Worms are dying or crawling away	Bed too wet	Do not water till it reaches appropriate moisture
	Bed too dry	Sprinkle water till it turns moist
	Excess temperature, not enough air, not enough food	Sprinkle water till it turns moist and temperature drops, add waste appropriately
	Bed packed tightly	Turn bed and make it fluffy

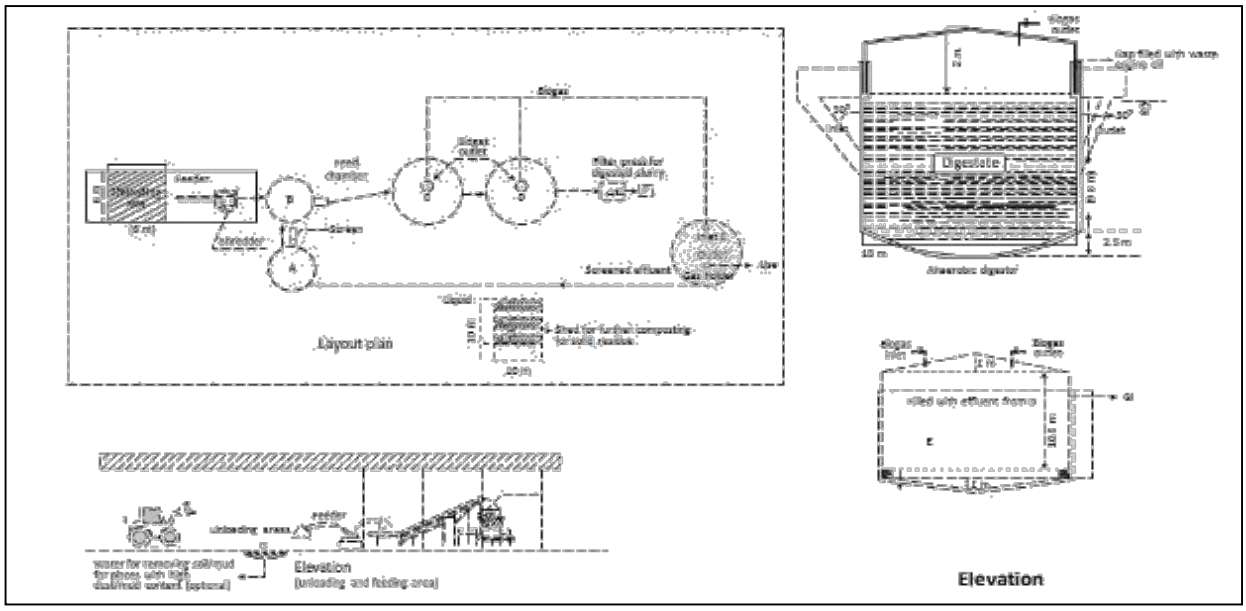
Source: Swachha Bharat Mission (2016) Municipal Solid Waste Manual, Volume II, Government of India.

[30] Source: Swachha Bharat Mission (2016) Municipal Solid Waste Manual, Volume I, Government of India.

Bio- Methanation

- Land Requirements:
  - 500 m for facilities dealing with 100 TPD or more of MSW
  - 400 m for facilities dealing with 75–100 TPD of MSW
  - 300 m for facilities dealing with 50–75 TPD of MSW
  - 200 m for facilities dealing with 10–50 TPD of MSW
  - No buffer zone for facilities dealing up to 5 TPD of MSW
  - No buffer zone for decentralised plants handling less than 1 TPD of MSW (but adequate environmental controls are required)
- Land Requirement: - For 300 TPD of segregated/pre-sorted: 2.5 ha.
- 1 TPD can be managed at small scale 500 TPD can be managed at larger scale.
- Very high requirement of segregation prior to technology
- 30% of the rejects from mixed waste are rejected.
- There is a potential for direct energy recovery
- Capital cost comes up to 75-80Cr for 500 TPD plant. i.e. around 15-16 lakhs per tonne.
- Biogas generated can be used for generation of electricity which can be used for illumination of market premises and other bulk wet waste generators which supply raw materials for the plant
- Biomethanation is less labour intensive which require only technically qualified and experienced staff.
- Leakage of biogas and fire and safety issues to be taken care of. [31]
- General plan and elevation for 50 TPD is shown below, however it is only for illustration purpose and will change according to quantity and type of waste.

Figure 19: Biomethanation plant for 50 TPD of waste



Source: Swachha Bharat Mission (2016) Municipal Solid Waste Manual, Volume II, Government of India.

[31] Source: Swachha Bharat Mission (2016) Municipal Solid Waste Manual, Volume I, Government of India.

7.4 Reuse Options for FSM

Co-composting Technologies

Two main types of composting systems are generally distinguished: 1) open systems such as windrows and static piles and 2) closed 'in-vessel' systems. These in- vessel or 'reactor' systems can be static or movable closed structures where aeration and moisture are controlled by mechanical means. Such systems usually require an external energy supply, either by electricity or through decentralized electricity generators, whereas the latter is often provided by diesel engines. In general, in vessel or reactor systems require higher investment compared with static systems and are also more expensive to operate and maintain. Static composting systems on the other hand, require much lower investments and are hence the preferred option for composting in developing countries. Among them, windrow composting is the most commonly applied system.

The identification of the best-suited option for composting depends on numerous parameters. The main choices to be made are related to a) scale (household, community, commercial), b) input materials, c) business models (public, private or combined), d) demand and market situation, e) Investment and operation cost, f) technology option and equipment, f) standards and legal framework and g) environmental and health concerns as shown in Figure 5. Decision-making has to be done on a case-by-case basis aiming at the highest possible cost- and co-benefits and sustainability level for the operator, community, stakeholder and the environment.

Different technological options are available to establish a specific composting project, as presented in Table below:

Table 41Composting Technologies - their advantages and disadvantages

Key Features	Advantages	Disadvantages
Static Pile		
Static piles are the simplest form of composting Typically larger than heap size whereas heaps are usually not turned Generally ideal for feedstock with larger particle size and higher porosity	Requires minimal management and equipment Aerobic conditions can be achieved if the porosity in the initial pile is high (>60%) and if there is a high proportion of bulking materials to keep pores open for air exchange	While simple, this method takes longer to produce matured compost; the final product is often quite heterogeneous due to the lack of mechanical treatment and physical breakdown of feedstock during the process. Anaerobic conditions can occur in the core of the heap which can also result in odor emissions
Trench and Pit composting		
Characterized by heaps which are partly or fully contained under the soil surface Structuring the heap with bulky material or turning is usually the	Requires low capital investment Requires less moisture, thus suitable for dry areas	Control of leaching is difficult in trench or pit composting Monitoring the composting process is difficult The process is labor-intense,

choice for best aeration In some cases, composting materials are completely buried in the trench which then serves as a planting bed		especially digging of the pit and emptying it
Aerated static pile/heap		
Aerated static pile (ASP) composting is comprised of forcing (positive) or pulling (negative) air through the pile. In a static aerated pile, a 15-30 cm thick layer of finished compost or wood chips is placed all around the MSW pile to provide insulation. This arrangement minimizes odor generation and also leads to uniform sustained heating of waste leading to destruction of plant pathogens and weed seeds The ASP can be used together with other composting technologies at the curing stage	The land requirements for this method are lower than that of windrow composting The technology allows for capturing and treating air to reduce odor generation Large volumes of feedstock can be treated with the help of aeration systems	The primary disadvantage of using this technology is the lack of mechanical agitation, which slows down physical breakdown of materials Usually suitable for feedstock of similar consistency and homogeneity The compost pile/heap can dry out quickly and therefore requires regular monitoring The aeration system may require capita-intensive installations
Windrow composting		
The material is piled up in heaps or elongated heaps (called windrows) Suitable for outdoor composting in piles that rely on passive, manual or mechanical aeration Some portions of waste piled up in the windrows may not be exposed sufficiently to a temperature of over 55 °C for a period of 7-10 days	Can be low cost Windrow composting produces the highest volume reduction compared to static piling (passively aerated with minimum turning) and forced aeration (static aerated pile) Introducing air mechanically speeds up the composting process and greatly reduces emissions of methane Methane emissions from windrow composting are comparably lower, e.g. passively aerated piles produce higher methane emissions (x100) than windrow turned piles whereas forced aeration piles produced even 1,000 times greater methane emissions	Anaerobic conditions could occur in the core of large piles or windrows, and together with a larger emitting surface, could result in odor generation Such plants often experience resistance from the community where they are set up ƒ Should be sited with consideration of the risk of odor Workers are in close contact with material during composting The minimum windrow/pile size must be 3 m3
In vessel- enclosed composting		
Refers to a group of composting systems, which range from enclosed halls to tunnels and containers, rotary drum or bins	Allows easy collection and discharge (through a chimney) or treatment of air (e.g. biofilter) to minimize emissions of odors and greenhouse gases	More costly than other units and, in addition, more equipment maintenance is required Skilled labor required for

Often have one exhaust air outlet	Operating temperature is uniform, more efficient in sterilizing the compost compared to open composting techniques *ƒ* Production of leachate is low (can be recycled if any) Requires less processing time (2-3 weeks) and less labor Less land requirement Effect of weather on the composting process is limited Public acceptance of the facility is higher	operation and maintenance Comparable higher investment cost and energy consumption Additional cost for operation and maintenance There is a need to treat exhaust air
Vermi-composting		
A non-thermophilic, bio oxidative process that uses earthworms and associated microbes to transform organic waste into rich humus, similar to compost Local varieties of both surface and burrowing earthworms can be used In broad-scale vermiculture, the earthworms are introduced to organic waste piled in elongated rows that are covered with protection layers to prevent water logging Appropriate process indicators are survival rate, biomass production and reproduction of earthworms	Both pathogens and weed seeds can be destroyed in the intestines of worms during vermicomposting. Protozoa and fungi are important parts of their diet The earthworms mix, grind, aerate, fragment and digest waste Vermicomposting hastens the decomposition process by 2-5 times Produces much more homogeneous materials compared to thermophilic composting It is particularly suited to urban agriculture because it can be applied in a variety of settings and at different scales	A pre-composting may be required before earthworms are added to the mixture Tolerates temperatures between 0 and 40 °C with pH of 7, while optimal growth is at temperatures from 25-40 °C Optimal moisture content: 40-45%. Higher moisture content may result in the death of earthworms Organic matter is rich in nitrogen Sorting is required after composting to allow removal of earthworms Earthworms may die when conditions are unfavorable; e.g. anaerobic They may be affected by pests/mites

All composting technologies allow production of a safe recycling product but require variable processing time, process control, human and financial resources while having different impacts on the environment and health. The degree of compost stability attained within a certain time is a key indicator which can be used to compare different composting techniques. Decomposition of organic matter through composting can be achieved in the presence or in the absence of oxygen. Therefore, different composting methods involve either aerobic (with oxygen), anaerobic (without oxygen) phases and sometimes even alternate between the two during the decomposition process. Under anaerobic conditions, composting is often achieved at mesophilic temperatures with the disadvantage that the process temperature may be too low to efficiently eliminate pathogens that are especially present if organic input materials from municipal waste management, manures and fecal sludge are utilized for composting. Anaerobic conditions may also generate strong odors which could pose a major nuisance in urban areas. Conversely,

under aerobic conditions, composting is achieved at thermophilic temperatures due to the accelerated growth rate of bacteria that results in a higher biodegradation rate of the waste. As a result, pathogens are more quickly eliminated. A composting facility which is not well managed could generate odor that can expand over a radius of 2 to 3 kilometers (km) around the plant and bother residents.

So one should use/undertake implementation of co-composting technologies based on above discussed points.

Other reuse technologies which can be explored apart from co-composting are Biochar and Black Soldier Flies (BSF)

Biochar

The term charcoal refers to the carbon-rich material obtained from heating wood or plants anaerobically. Biochar is charcoal produced for mixing into soil. Technically, biochar is nothing but a new term for charcoal that is intended for application to soils as a soil amendment and or carbon sequestration

Process

There is a cycle in nature wherein plants use solar energy to covert carbon dioxide into biomass. Biomass is then transformed into biochar thereby producing energy and other co-products. Approximately 50% of the carbon remains in the form of biochar acting as a soil conditioner and delaying release of carbon into atmosphere by 1000 to 2000 years.

Biomass can be transferred to biochar through three processes: slow pyrolysis, fast pyrolysis and gasification. The plant takes faecal sludge along with carbon rich materials like coffee husks. They are subjected in the ratio of 7:3 for a smooth charring process. The faecal sludge has a lot of moisture content in it. It is dried down to a moisture content of 30-35% with the help of using the energy deriving from the carbonizer. In carbonizer a direct pyrolysis happens at temperatures of 300-600°C. Direct pyrolysis here refers to no steering through external heating of the chamber but through the heat generated from the pyrolysis process only.

The material is fed into a reactor after being transferred from a drying belt with the material flow being vertical and the ember remaining on top of the added material.

The hot fumes that originate from the process are redirected from the carbonization chamber and for further processing in a catalyst chamber, where the gases, for example carbon monoxide (CO) is burned.

Simultaneously, cooling of the whole system is maintained by circulating water through the drying component of the plant and thereby, drying the sludge at a temperature of 40-55°C.

The output of the plant, 30 kg per 100 kg of the mixed input material (70% Sludge, 30% carbon rich material), is a fine crumbled charcoal, with a carbon content of 55%.

The carbonizer unit faces problem of sand content. Directly drying faecal content on sand bed is thereby not an option as it was in co-composting. However, a geotextile or filter bag can be sandwiched between sand and the put in the bottom to separate the sand from the drying material if we choose to use drying beds for dewatering.

The plant is equipped with sensors for temperature and can be steered via computer and monitored via Wi-Fi. The plant needs to be under constant surveillance to be able to remove disturbance, such as stones getting stuck in the spiral conveyor.

Outputs

The biochar process results into three outputs:

Biochar (Solid): The charcoal as the main product is currently not sold, but the price is estimated to be in the range of Rs. 9 to 13 per kg. Slow pyrolysis results into high amounts of biochar in comparison to other processes.

Bio-oil (Liquid): Bio-oil is a synthetic fuel being worked upon as a potential substitute for petroleum. It is a kind of tar with high level of oxygen. Fast pyrolysis gives 60% gas and 20% biochar and syngas each. Bio-oil is not a ready to use product. It requires further up gradation into a special engine fuel or syngas and then bio-diesel for making it usable (Zafar, 2015).

Syngas (Gaseous): Also called synthesis gas, syngas is a mixture of fuel gas consisting primarily of carbon monoxide, hydrogen, and very often some carbon dioxide. It is mainly used in electricity generation. Being combustible, it can be used as fuel of internal combustion engines.

Leachate: The leachate obtained from the dewatering process is a valuable output too. If treated properly and applied in adequate doses, it can be an excellent fertilizer. On the contrary discharging it into water bodies would lead to eutrophication.

Costs

The cost of the whole plant is estimated to be around Rs. 30, 48,000 per annum, including two labourers and the energy costs. The energy needed is 4 kW; 1 kW for each of the two exhausters alone, in addition to the consumption in feeding and transporting mechanism (spiral conveyors, belt) and the steering equipment. The cost of a similar machine used in India for pyrolysis of tires is Rs. 55, 00,000.

The salary of composting workers is around Rs. 9,000 to Rs. 10,000. The plant can scale up through adding more carbonization chambers with one chamber being able to process 70kg of solids per hour. The plant size is suitable for towns with a population of 30,000-40,000 people.

Snake and scorpion bites: Charcoal attracts reptiles like snakes and scorpions and can pose a threat to life of farmers. It might result to increased deaths, effect on saving and income due to medical expenditure and reduced productivity.

Benefits

Farmers

- **Higher pH of soil:** Biochar can be used as a buffer for acidic soils, improving the pH and thus increase nutrient uptake for plants. It brings down the minute cost incurred for liming agents.
- **Increased resistance against crop diseases:** Biochar can buffer the soil and increase their resistance against crop diseases.
- **Enhance microbial population:** Biochar has a significant impact on population of healthy microbial organisms in the soil. It also results create a suitable environment for earthworms.
- **Absorption of harmful elements:** Biochar is known to absorb harmful chemicals like phytotoxins and nitrification inhibiters.
- **Increased plant uptake of fertilizer:** Soil requires at least 3% carbon in them to make fertilisers use adequate enough to recover the initial investment. Biochar can act as a substrate for nutrients and raise efficiency of plants to uptake the fertilisers used. This will bring down the overall cost of fertiliser and reduce the damage caused by fertilisers on the soil.
- **Increased nutrient holding capacity:** Compost increases the **cation exchange capacity (CEC)** of soil increasing the nutrient holding capacity of the soil. The increased supply of nutrients to the soil reduces the expense on additional artificial fertilizer to fulfil those requirements.
- **Lower expenditure on Fertilizers:** Farmers are highly dependent on fertilizer for agriculture production. This has led to a surge in fertilizer prices since its introduction in India. Using biochar, the fertilizer requirement will come down due to better absorption from the current supply of nutrients.
- **Improved germination of seedling:** Biochar is known to have positive effects on germination of seedling.
- **Higher water retention capacity:** Biochar altered soil increases the capacity of soil to hold water, thus reducing cost of irrigation and letting crops survives in drought like situation.

The table below describes various effects that biochar has on property of soil as a result of certain property of biochar.

Effect of Biochar on Soil, Plant and Environment

Property	Effect	Biochar property
Soil		
Organic matter	Increased	High C content
Water-holding capacity	Increased	Porous structure
Porosity	Increased	Porous structure
pH	Increased	Alkaline nature
Cation exchange capacity (CEC)	Increased	Specific surface area
Plant		
Crop yield	Increased	Soil organic matter, pH, bulk density, CEC, high porosity
Plant productivity	Increased	Colour, P and K cycling
Environment		
CH_4 emissions	Decreased	Porous structure, pH
N_2O emissions	Decreased	Recalcitrant, porous structure
Carbon sequestration	Increased	Recalcitrant or stable C; black carbon (BC) resists decomposition
Nutrient leaching	Decreased	Porous structure, surface area and negative surface charge

Public

- **Reduced Green House Gases:** The biochar results in retention of as much as 50% of the carbon from escaping into the environment. The carbon gets locked down for 100s to 1000s of years. Lower CO_2 results in lowering of global warming and all the problems caused by it. It reduces the risk of many diseases caused by increased temperature and CO_2 in the air. Every 1% increase in retained Soil Organic Matter (SOM) through biochar, 100 tons of atmospheric CO_2 will be taken out from environment. Other than CO_2, biochar also reduces emission of nitrous oxide (N_20) by 50-80%, Nitrogen Oxide (NO_X) and Methane (CH_4) from soil. Gases like nitrous oxide are 310 more potent as a greenhouse gas then CO_2.
- **Reduced groundwater contamination:** Increased quantities of biochar in soil will lead to higher absorption of agriculture chemicals and other fertilisers and thus reduced groundwater contamination.

- **Reduced eutrophication and bioaccumulation:** Eutrophication is a result of fertilisers being washed off in rain to river bodies. Biochar will help absorb a great part of the fertilisers applied and thus result in less eutrophication. Biochar is the best method when it comes to absorbing nutrients in all the three methods and thus has the greatest impact.
- **Energy generation:** Biochar production produces bioenergy in two forms: syngas and bio-oils. These can be further processed and upgraded into biodiesel and gasoline substitute thereby reducing pressure on fossil fuels. Syngas can be put into use directly in gas turbines or be processed to produce ammonia, synthetic natural gas and other energy sources. Syngas also has the potential to replace petroleum as a material to create certain products and chemicals from it. Bio-oil is a substitute for heating oil or fuel oil. It also has the potential to be used in a bio-refinery where valuable chemicals and compounds are extracted and the remainder is upgraded to fuel or syngas.

Government

- **Aid in solving energy crises:** The government can take care of the energy crises through biochar while taking care of faecal sludge at the same time. It proves to be a better alternative on this aspect than compost since its energy producing outcomes is greater in quantity.

Limitations

- **Skilled labor required:** Operating a biochar plant requires people with in-depth technical knowledge of the field. The search cost and the salary paid would be higher in comparison to what was paid earlier.
- **Further processing:** Bio-oil cannot be used directly and needs to be processed further to be made usable. This would require further cost and labor charges.
- **Only long term benefits:** Biochar does not reveal short term benefits and thus, can be used only by farmers who are financially able enough to experiment with it and afford to take long term benefits.

Black Soldier Flies (BSF)

Black Soldier Flies in their pupae stage uses organic waste and produce some compost as a result that can be used in small scales in farms or gardens.

Process

An adult BSF has a sole objective of reproduction. It lays its eggs in decomposing organic matter and dies right after. The male would have already died right after mating. The larva stays in the mix while slowly progressing in its growth stages. After some time they burrow into the mix to complete their development into adults. When the larvae are ready to pupate (around 2 to 4 weeks after eggs are laid), they secrete their digestive system, lose their mouth, and produce an antibiotic coating. Therefore, unlike house flies, they cannot carry disease between wastes and foods we plan to eat. This also makes them safe to feed to our animals.

Each day BSF larvae can digest up to 15 kg of waste per m^2 of feeding surface area (2 lbs/ft^2). The input used in the current facility in Tamil Nadu for experimental purpose is 10 tons of dry sludge along with 3.5-4 tons other organics.

Outputs

- **Feed for hens and fish:** The BSF larvae or pupae that remains at the end has proved to be a good source of balanced lipids, complete protein and calcium and thus can be fed to one's chickens. They can also be fed to fish and livestock. The larvae are approximately 34% – 45% protein, 42% fat, 7% fiber, and 5% calcium. The protein is priced at Rs. 40 per kg and is the main source of income. It will cover a huge amount of expenditure incurred.
- **Compost:** There is a very little amount of compost left after the process. For every 100 kg, 5 kg of compost is made generally.
- **Biodiesel:** One of the products that can be generated on further processing the larvae is biodiesel which has various energy applications. The pupae obtained from it can be further fractionated into their two parts: protein for animal feeds and fats converted into biodiesel.

Costs

- **Capital and Operating and Maintenance expenditure:** The capital expenditure required to establish a BSF plant is Rs. 3, 71, 80,000. The operation and maintenance expenditure along with other supplementary expenses amount to Rs. 1, 05, 36,000.
- **Pathogen infection:** It has been found through various experiments that black soldier flies is inefficient in eliminating pathogens like Enterococcus spp. and A. suum ova. It might run a health risk for farmers and consumers of the final produce. It can be taken care of with additional expenditure incurred in treating the compost with ammonia sanitization.

- **CO_2 emission:** BSF during composting release a very negligible amount of CO_2. It is not a major concern in comparison to the actual CO_2 emission it is saving.

Benefits

Farmers

- **Nutritious feed:** BSF pupae are a very protein rich feed for chicken and fish. They will result into decreased expense on chicken feed and increased productivity in terms of eggs. Alternatively, it can be sold in market or directly to farmers as chicken feed or fish food. It will be obtained in the range of 16-40% of the input.
- **Compost:** The process yields small amount of compost that can be used in small area of farming. Thus, a small scale of nutrient recycling happens when using black solider flies for composting. It is generally obtained as a 5% of the input supplied. However, in the plant in Tamil Nadu, the plant operators were able to obtain up to 30% of the input.

Public

- **Biodiesel:** The larvae can be used to produce biodiesel. Although the process will get a lot more complicated but might result into bringing in profit and making the whole operation sustainable.
- **Reduced houseflies:** BSF larvae acts as a repellent for many pests and problematic flies like houseflies. Houseflies are responsible for serious diseases like typhoid. Typhoid costs were 100 and 29 US $ to public sector and private sector respectively.
- **Wound dresser:** BSF shells left can be used as a wound dresser for no healing wounds.
- **Reduced CH_4 and CO_2 emissions:** BSF have an advantage over other methods like composting when it comes to methane and carbon dioxide production. It prevents anaerobic bacteria from transferring waste into carbon methane and mesophilic and thermophilic bacteria from producing huge amount of CO_2 from waste.

Government

- **Aid in solving energy crises:** The government can take care of the energy crises through biochar while taking care of faecal sludge at the same time.

Limitations

- **Small quantity of compost:** Agriculture is not the main purpose of using black soldier flies because compost produced through BSF is very low and thus, does not serve the purpose of an entity looking for a technology to produce commercial compost.
- **Winter season:** BSF are inactive during the winters and thus, might not provide a round the year solution for all the places. They might be made active by creating a warm environment through consumption of electricity.

7.5 Business Models for FSM

This write up discusses aspects of effective financial models complementing sustainable sanitation solutions such as revenue/business models, sales channels, equity models which can be implemented at various parts of the sanitation value chain and also to strengthen the faecal sludge management.

1. PPP: Public private partnership Model

Also known as P3 model, is a long term contractual agreement between the government and private entity to provide public services.Under this model the government shares the burden of cost through partnership with private entities. Such financial models have been successful project such as “Bhakra Nangal Dam”, “Akshaya Patra”, “Mars orbital project”, “Kerala tourism” etc.

Table 42 Available Options under PPP Model and their details

Type of Model	What is it?	Potential Strength	Drawback
Lease contracts	Private player is responsible for overall service chain, leases the component from public sector based but capital investment done by government	High incentives for operators	Very risky since Private player is responsible for any loss
Concessions	Private player is responsible for entire capital expenditure, operations and maintenance expenditure and public entity only sets norms and monitors	Highly incentives for operators ,effective and efficient systems can be established	Complex contracts, government needs to have better monitoring process and resources for the same.
Build Operate Transfer Model (BOT)	The private player generates capex to build the facility and owns it for the definite time period to generate the returns then transfers the entity to gov.	Reduced commercial risk for private player since only one type of customer is present	Less impact on operations and output
Management contracts	The investment is provided by the government but working capital is provided by private players.	Without transferring the asset to private player operational gains be leveraged.	No autonomy of authority for private player required to efficient returns.

Service contracts	The government contracts out certain parts of its operations/services to private players majorly done for a time period of 1-3 years.	Building of managerial strength and provide quick impact on operations efficiency. Can be monitored easily	Since operator does not source capex, is not effective of other sources of fund such as government funds etc. not available

Other models under PPP are BOO model, DBO model etc. and in the long run the PPP models tend to be more effective.

2. Hybrid Annuity based PPP model

Hybrid version of the BOT model. 40% of project cost paid by the government and 60% of the project cost paid by private party. Private player bears the operations and maintenance and is paid periodically for the service rendered by government and to meet the costs government issues taxes and tariffs. Service level standards are set and based on the delivery and adherence to the standards the government pays the private players. Major benefits being; reduced initial investment, private player manages the operations, pay only if services are delivered by private party.

Governance and management:

With proper monitoring protocols, regulations and standards supported by effective policies and resolutions, better return on investment is probable in terms of positive social impact. This approach allows creating sustainable business models around each of the components which results in inclusive socio-economic uplift. It is paramount to look at human excreta as a potential resource for the agricultural and energy industry, rather than a problem. With this approach the realization of real sustainable sanitation services is possible.

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