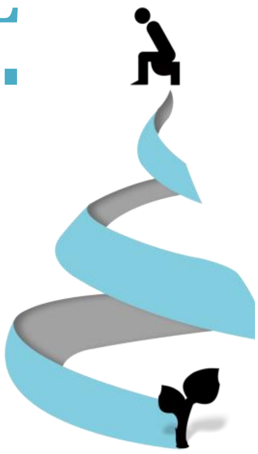
SANITECH MANUAL



Keywords: Decision support systems; sanitation systems, options, technology

Objective

To develop a decision support tool that will help cities in India to provide cost-effective and sustainable sanitation options for all, especially the urban poor, through an integrated framework for assessment of different sanitation options.

It is well recognised by sanitation researchers and strategic policy makers that there is a need for portfolio approaches to sanitation. However, there is a need to build a broader framework for decision makers whose understanding of the approach can influence how sanitation investments are prioritised. There is a need to develop a broad resource base for decision makers which will enable them to understand the sanitation needs of a city as well as provide them with information about a range of sanitation system options which can serve these needs.

This platform will allow for a rational process for demonstrating trade-offs between different stakeholders' preferences and views for addressing different key questions. All urban local bodies need to have a sanitation plan, and this tool can help in this process of planning where decision of right systems (information from different sources mentioned above has been collated) is of ultimate importance.

The Tool

In this context, the decision support tool has been developed to facilitate an integrated approach to the sanitation investment planning process for urban local bodies in India. The tool is envisioned to provide stakeholders information and knowledge of existing and new technologies in a manner that allows them to compare options, assess cost/benefits and make informed decisions. This will also help decision makers understand the relative value for money associated with decentralised options, and support an enabling policy and market environment for providers of sanitation products and services. It can also be used as a capacity building tool. The design of the tool will be generic such that it can be used for any area provided certain data are available. Field data from a city in India is being collected to demonstrate the potential of the tool. Sustainable access to sanitation would mean not only access to sanitation but also addressing the whole value chain.

The tool has a GIS-enabled user interactive interface, and allows users to create and compare scenarios and allow assessment of the impact of various sanitation options. It will provide a framework for analysis, visualisation, and self-learning where modification of system/technology inputs based on new information, addition of new parameters for a system, addition/deletion/modification of systems can be done easily, enabling iterative action plans to get the best solution by comparing scenarios. It will also help facilitate collaboration and consultation with the partners, stakeholders and decision makers within this sector. The information, research outputs of non-government organisations and knowledge partners working in the sanitation domain can be integrated into this platform, enhancing the robustness of the tool, instead of re-inventing the work done by them.

In short, this tool will aid decision making by sharing data, creating, storing and sharing scenarios, compare scenarios and identifying trade-offs, identify avenues for improvement of models, and identify the need for new models and more sophisticated models. The tool will be sufficiently robust to add new innovative sanitation systems for assessment as data from field studies become available.

Target Audience

The target audience for this tool could be elected officials and policy makers influencing sanitation infrastructure decisions, utilities and government agencies responsible for sanitation provision, technocrats and consultants, decision makers in Urban Local Bodies (ULBs), Ministry of Urban Development (MoUD), the Government of India (GoI) and its technical/capacity building departments and also technology developers.

When to Use

SANITECH will be used at the Pre-Feasibility stage of the project cycle. It will give an idea of the different systems that are suitable to the city/ward context. The user at this point can select a range of suitable technologies (scenarios) and compare them against certain key parameters like environmental compliance, costs, resource needs, etc.

Data Needs

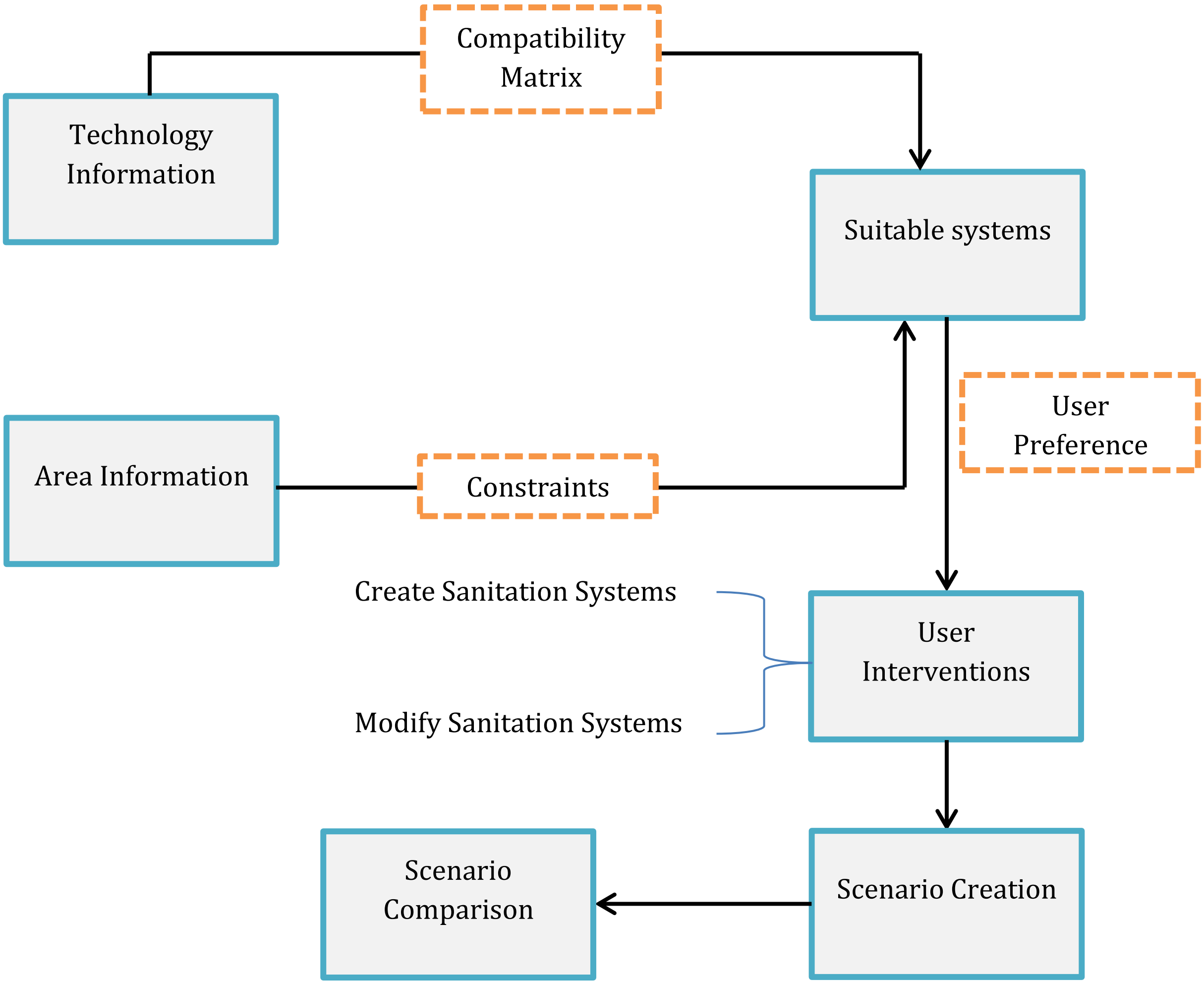
The data required for the city/ward or any other spatial unit is as follows:

CITY/WARD/ANY SPATIAL UNIT – POPULATION AND SANITATION DATA			
	Non slum	Slum	
Population			
No of households			#
No of commercial institutions			#
% of homes having toilets and septic tank			%
% of homes having toilets (but no storage/collection)			%
% of homes has sewerage system			%
% of homes having decentralised system			%
% of homes having no toilets			%

CITY/WARD/ANY SPATIAL UNIT – Constraints			
Part of the value chain	**Constraint**	**Choices**	**Definition**
User Interface	Water Available	(High/Medium/Low)	<25lpcd 25-60lpcd >60lpcd
	Land Availability	(Yes/No)	>3m^2/HH is needed to build toilets
Containment or Storage	Ground Water Level	(Shallow/Deep)	>1.5m below pit bottom is deep
	Predominant Soil Type	(Clayey/ Silty/ Sandy)	
Emptying and Conveyance	Vehicular Accessibility	(Yes/ No)	
	What is the slope of the region	(High/Low)	Is it >1% (1m/100m)
	Predominant Soil Type	(Rocky/Not Rocky)	
Treatment	Land Availability	(Low/Medium/High)	
	Ground Water Level	(Shallow/Deep)	>1.5m below pit bottom is deep
	Technical Skill Availability	(Yes/No)	
	Energy Availability	(Yes/No)	

Decision Flow

Sanitech has two repositories of information that are used to carry out analyses on the sanitation situation of any area. These repositories contain information on the spatial unit (city or ward or similar) and on the technologies (across the sanitation value chain) respectively. The following chart shows the decision flow in the tool:



The compatibility matrix and constraints are crucial in determining what technologies under each component is compatible with the technologies in the subsequent component and which technologies are compatible with the area under consideration.

Constraints and Indicators

What are constraints?

While considering the different sanitation options for an area, certain factors may have a limiting impact on the choices available. For example, lack of space at a household would take away the possibility of providing individual household toilets. These factors are collectively called constraints. These are applicable at every part of the Sanitation value chain, although the exact constraint would vary from component to component.

Which constraints have been considered?

Sanitech takes into account 11 constraints, which are distributed over 5 components of the sanitation chain. They are given as follows:

1. Constraints on User Interface:

Water Availability: A limitation in water availability would raise problems if water intensive technologies are used (such as cistern flush toilets, which traditionally are more water intensive than manually pouring water for flushing). Water availability is categorised into: low (less than 25lpcd), medium (25-60lpcd) and high (more than 25lpcd).

Land Availability: In order to build a toilet within a dwelling, a minimum about of space (3m2) is required. If this area is not available, users would need to consider building public or community toilets instead.

2. Constraints on Storage:

Groundwater Level: While choosing a sanitation system, it is important to keep the ground water level of the area in mind. Aquifers are often a source of freshwater for household use, especially drinking and bathing. It is therefore important to ensure that aquifers don't get contaminated by wastewater. The risk of contamination is higher, closer the aquifer is to surface as any leachate from a sanitation system could flow into it. Further, storage technologies are generally underground, therefore the distance between the bottom of the storage unit and the aquifer is lowered. The risk of groundwater contamination can be lowered by watertight storage units or lining them with impermeable material. Here, the distance to the ground water is measured from the bottom of the pit. A deep groundwater would be 1.5m or more below pit bottom while shallow groundwater would be less than 1.5m below pit bottom.

Soil Type: The performance and suitability of onsite systems and storage components depends heavily on local geography. Like groundwater, the type of soil is an important factor as it will influence soil permeability - a feature of the soil that is often used in the design of sanitation technologies.   Soak pits, for example, require perform best in soil with good absorptive properties and thus clayey soil would not be the ideal choice. Sanitech allows users to choose the soil type in a region (silty, sandy, and clayey). In case of mixed soil, users should choose the predominant soil type.

3. Constraints on Emptying and Conveyance:

Vehicular Accessibility: Most onsite and decentralized system require removal or movement of the faecal sludge that is collected by some form of storage technology. For this purpose, vehicles (big or small trucks) need to be able to move across the spatial unit. Users can choose whether the area under consideration can be accessed by faecal sludge transport vehicles. The possible conveyance options will be highlighted accordingly.

Slope: In case of a sewerage network, the presence of a natural gradient will allow the wastewater to flow simply by the force of gravity. If the surface is flat, additional digging work and/or pipes adapted for flat areas might be needed. In the constraints, "high" denotes slopes greater than 1% (1m/100m) and "low" denotes slopes less than 1%.

Soil Type: A rocky layer near the surface would make it difficult to lay pipes for a sewerage network. For this constraint, users can define the spatial unit as either “rocky” or “not rocky”.

4. Constraints on Treatment:

Groundwater Level: Similar to the constraint for storage.

Energy Availability: This constraint relates the energy intensiveness of the technologies to the availability of energy in the spatial unit. Some technologies (membrane bioreactor) especially the highly mechanized ones will be highly dependent on a constant source of energy for operation while others will have little to no dependence on energy.

Land Availability: This constraint relates the land use intensiveness of the technologies to the availability of land in the spatial unit. Many technologies require a large area to perform effectively. In regions where space available is limited, it will be difficult (and expensive) to implement such technologies.

Technical Skill Availability: Depending on the type of technology, the skill level needed will differ. Technical skill availability is associated to depth of technical knowledge required for operation of any technology. Generally, the know-how required initially, is more available for "Old" techniques like composting or drying, which are easy to understand. For energy-intensive technology, the maintenance – repair especially, will be more challenging.

What should be kept in mind while using constraints?

It is important to remember that **many technologies can be improved in order to overcome the limitations set by the constraints**. The tool however, assumes that the technologies being used are **not improved and/or adapted to local needs**. If users feel that a pre-existing constraint for the spatial unit can be overcome, they can change the constraints through the list available on the left hand side of the tool. Any additional expense that may occur due to the improvement of the technology design will not be taken into account by the tool.

What are indicators and why are they important?

Indicators are relevant, intuitive outputs of the tool which help in illustrating the differences between:

a) Base scenario and user-defined scenario (“improved scenario”)

b) Two or more user-defined scenarios.

Indicators can be viewed at two levels. For comparing base case to improved scenario, the indicators are in numeric form under the “Interventions” tab. For comparing two or more scenarios, indicators are in graphical form under “Compare Scenarios”.

2. Which indicators have been considered?

Sanitech allows users to view three categories of indicators, Cost, Coverage and Environmental Performance Rating. These categories may contain one or more indicators.

Cost indicators:

Capital costs: The total capital cost for a scenario is calculated from the costs of individual systems applied in the scenario and the capacity of each of these systems. Capital costs are based on estimates from literature reviews and expert opinion. **These values are not exact. The tool does not use cost functions.** The units are Rs./MLD.

Operating costs: Like capital cost, operating costs are also estimates calculated from operating costs of systems and system capacity. These costs are expressed as Rs./MLD/year.

Net Present Value (NPV): The money in the present is worth more than the same money in the future. Hence the earnings from the project are discounted over the lifetime of the project to measure the value of future cash flow. The project is considered profitable if NPV of the project is greater than one.

Internal Rate of Return (IRR): is a metric to measure the profitability of potential investments. It is the rate at which the net present value of all the cash flows from a project or investment equal zero. The project is considered financially attractive as the value of IRR increases.

Revenue: The revenue that can be collected from the sale of manure from faecal sludge management and treated water. Usually, there is no revenue generated from the effluents of FSM systems, therefore this is a value-add for new sanitation systems.

Coverage indicators:

The coverage indicator gives the distribution of different types of sanitation systems in a scenario (or the lack thereof). Four categories of population make up 100% - unsafe systems (households practising open defecation and households having toilets but no storage), onsite systems, decentralized systems and networked systems.

EPR:

EPR denotes the Environmental Performance Rating for a ward/spatial unit. The EPR is calculated on the basis of system performance in terms of some form of removal efficiency (here Biochemical Oxygen Demand removal is used). The total removal efficiency of a system is first calculated (based on individual technologies in the system), which is then assigned a weightage based on the calculated value:

0%	0
0-20%	1
20%-40%	2

40-60%	3
60-80%	4
80-90%	5
>=90%	6

The lowest weigh is 0 and the highest is 6. This is the EPR of a system (EPRS)

A weighted average based on the population distribution will give the EPR for a ward (EPR).

The EPR is calculated for the base case and each selected scenario (for scenario comparison). It is then plotted against the Minimum Time Taken for Installation for a ward (MTTFI). The MTTFI is the largest installation time among all technologies introduced in a scenario.

The EPR v/s MTTFI graph starts at MTTFI =0 and EPR = Base case EPR. The final value is the MTTFI calculated for a scenario and its corresponding EPR

EOQ

In situations where the average effluent water quality is known for a region, this value can be used to estimate the impact of different technologies on output quality for four water quality parameters, BOD, COD, TSS and TN. EOQ functions by determining the overall efficiency of all the system chosen for a scenario and calculating the output quality. The lowest (best) and highest quantity of the parameters are shown in a bar graph with different water quality standards projected on the graph. In order to help users understand whether the output quality is likely to be similar to the best or worst case, a weighted average for the scenario is shown.

It should be noted that EOQ is a demonstrative indicator, to give an idea of the impact each scenario can have on effluent quality and not accurately predict the quality. Further, the weighted average bar is present merely to show where, in the range from best to worst case output quality, the majority will be present. It has no actual significance otherwise.

3. How should these indicators be interpreted?
The indicators are estimates aimed to assist users in choosing a scenario and viewing the possible pros and cons of choosing one scenario over another. There is no cost modelling involved in the tool and the EPR and EOQ are estimated on the basis of the theoretical efficiency of different technologies applied. Moreover, the minimum time taken may be very different from a real-life observation; this may be due to lack of data on installation time as well as difficulty in accurately predicting the time that would realistically be required.

Using the Tool

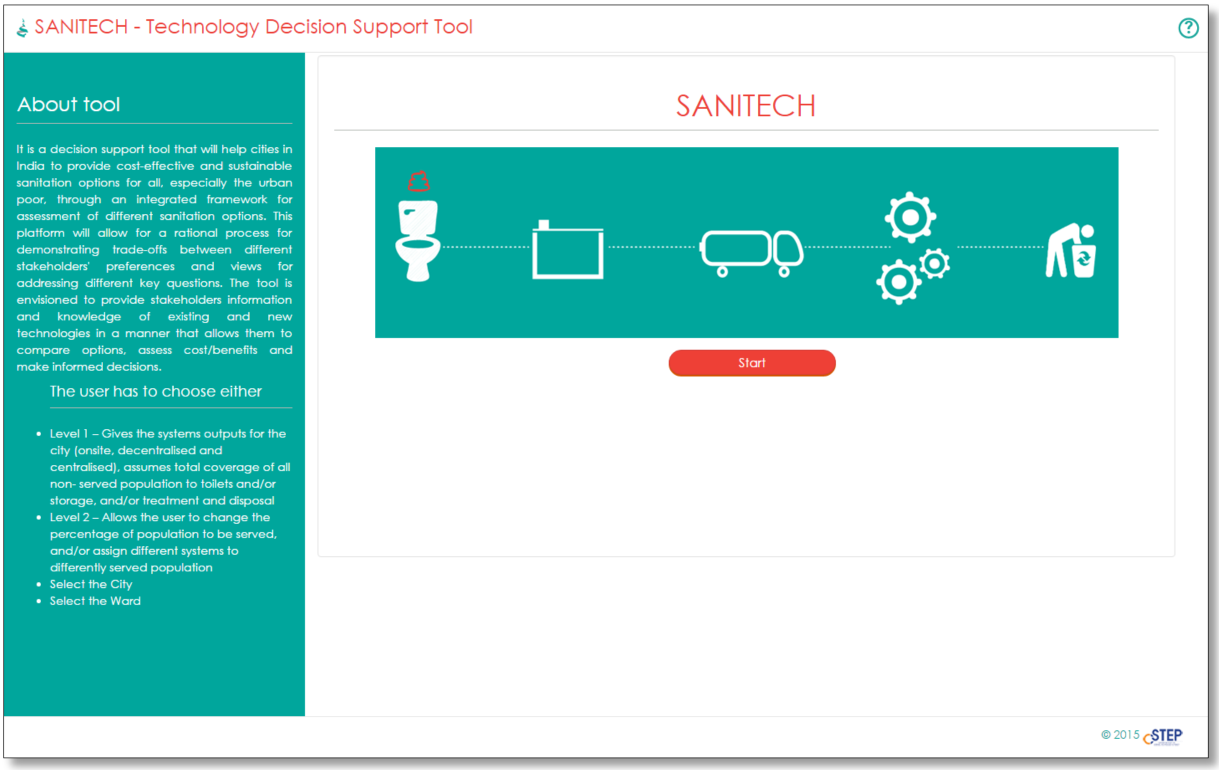
Functionality of the tool

- Visual representation of the base-case scenario in a zone (ward-level)
- Ability to view and select areas in a city (depending on GIS data availability)
- Suggestions for appropriate systems
  - based on features of the systems and the ward (constraints)
  - ability to create systems based on constraints and the compatibility matrix for technology options
- Ability to take actions ("interventions") on the current situation
  - Modifying systems
  - adding systems
- Viewing the result of a set of interventions ("scenarios") in the form of outputs and indicators.
- Comparing scenarios
- Downloading outputs of a scenario as Saniplan input.

Using the tool

Step 1: Launch of the application

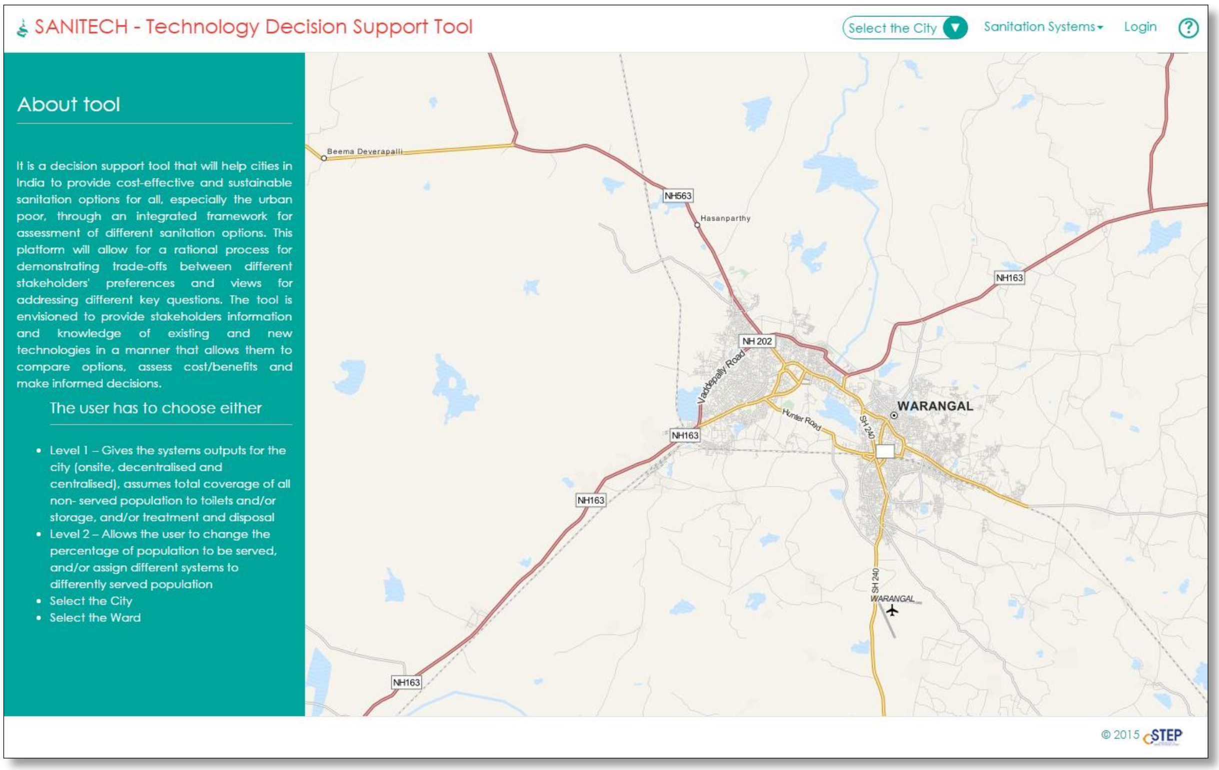
To access SANITECH click on the link mentioned below:
http://darpan.cstep.in/sanitech



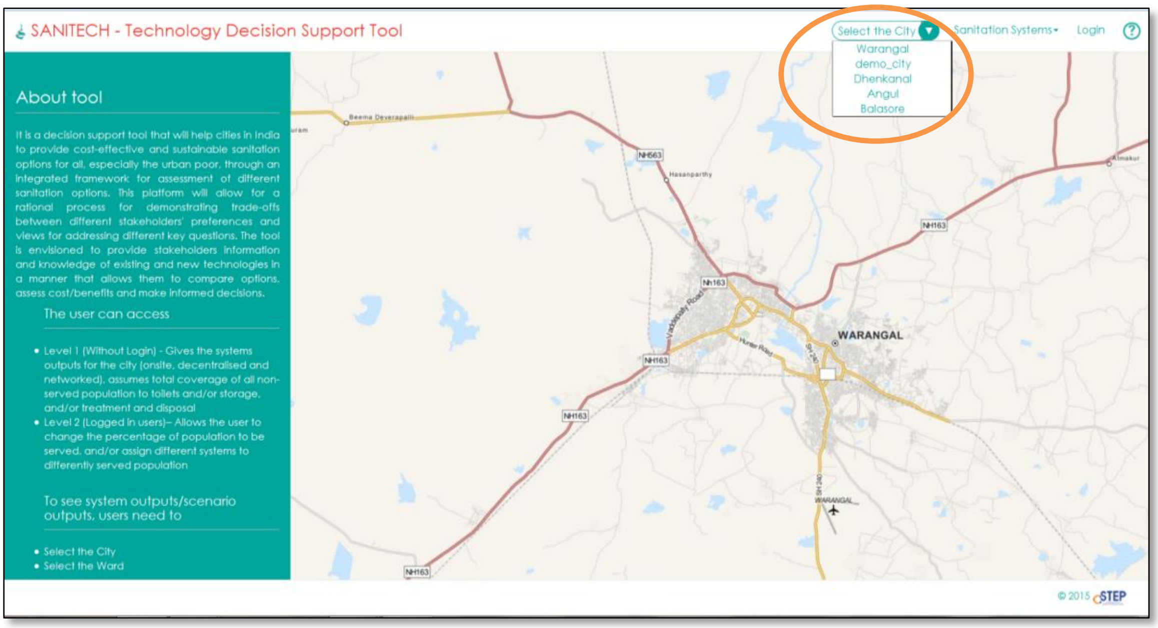
1. [Find out whether Sanitech is a relevant tool for you (use without login)]- limited functionality
2. [Use a demo version of the tool]
3. To use Sanitech for your city
    a. [request City Admin details]
    b. [Add city details]
    c. [Login as respective city user]

NOTE: The data needed has been outlined in the previous chapter. The data would need to be uploaded by the city admin as shown here.

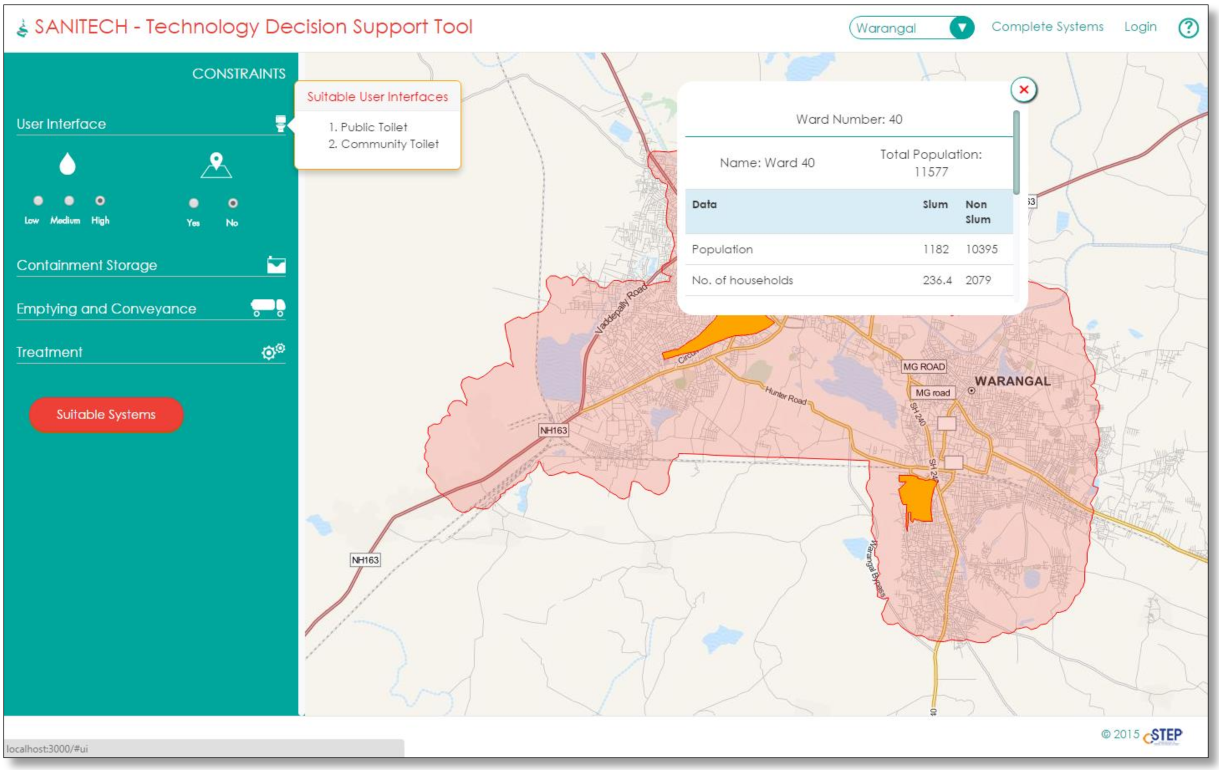
Step 2A: Application overview without login details



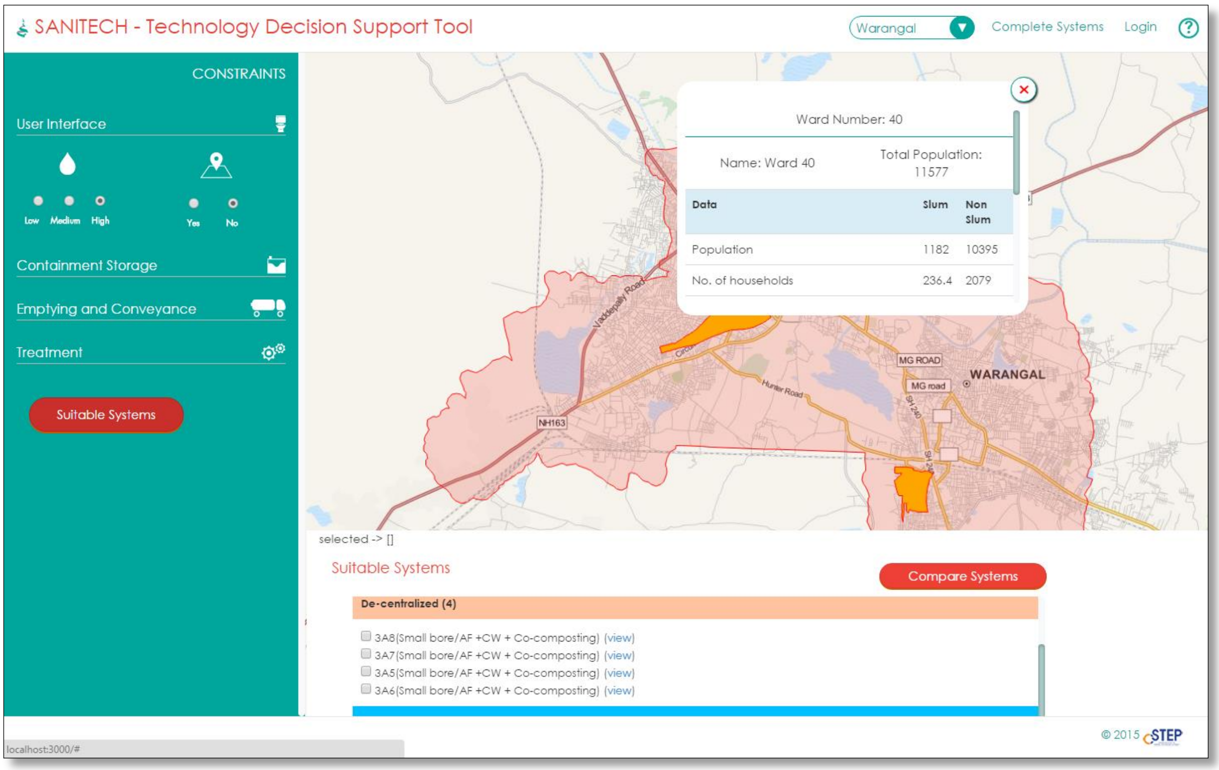
- Select the city



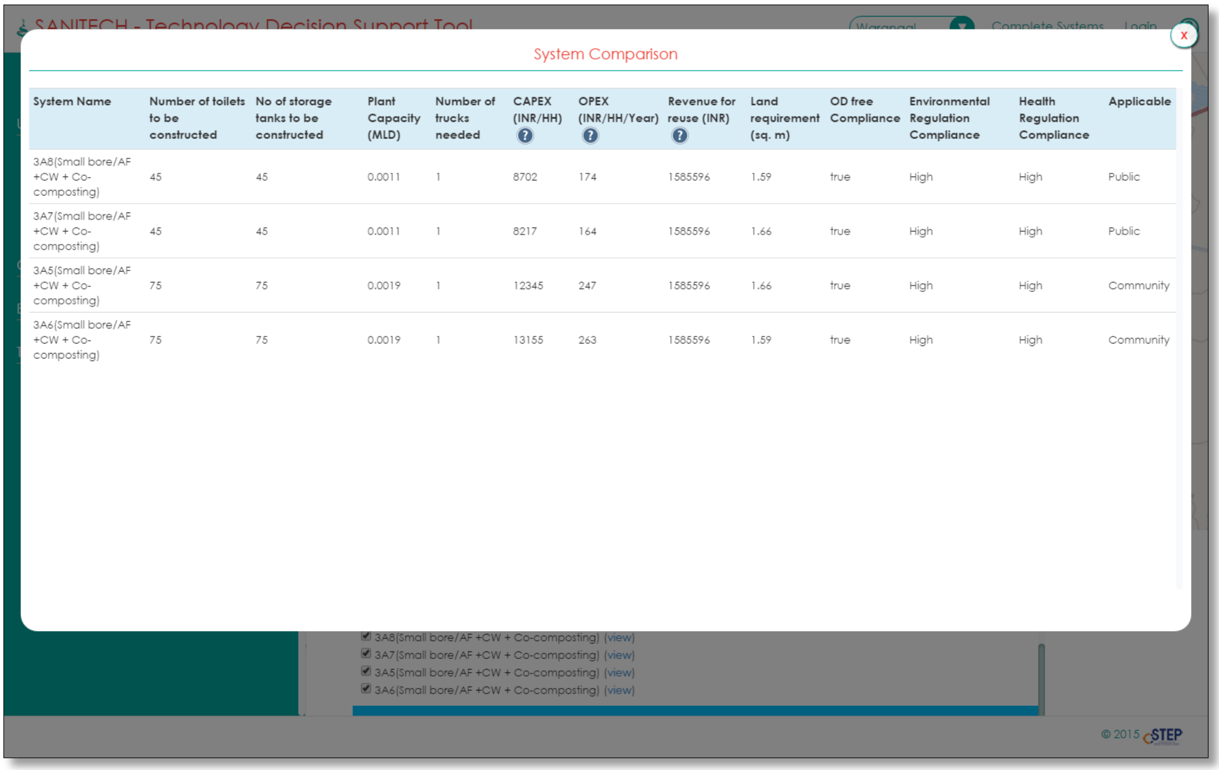
- Select the ward (if applicable) by clicking on the map



- Hover on the constraints heading image to see the disaggregated components

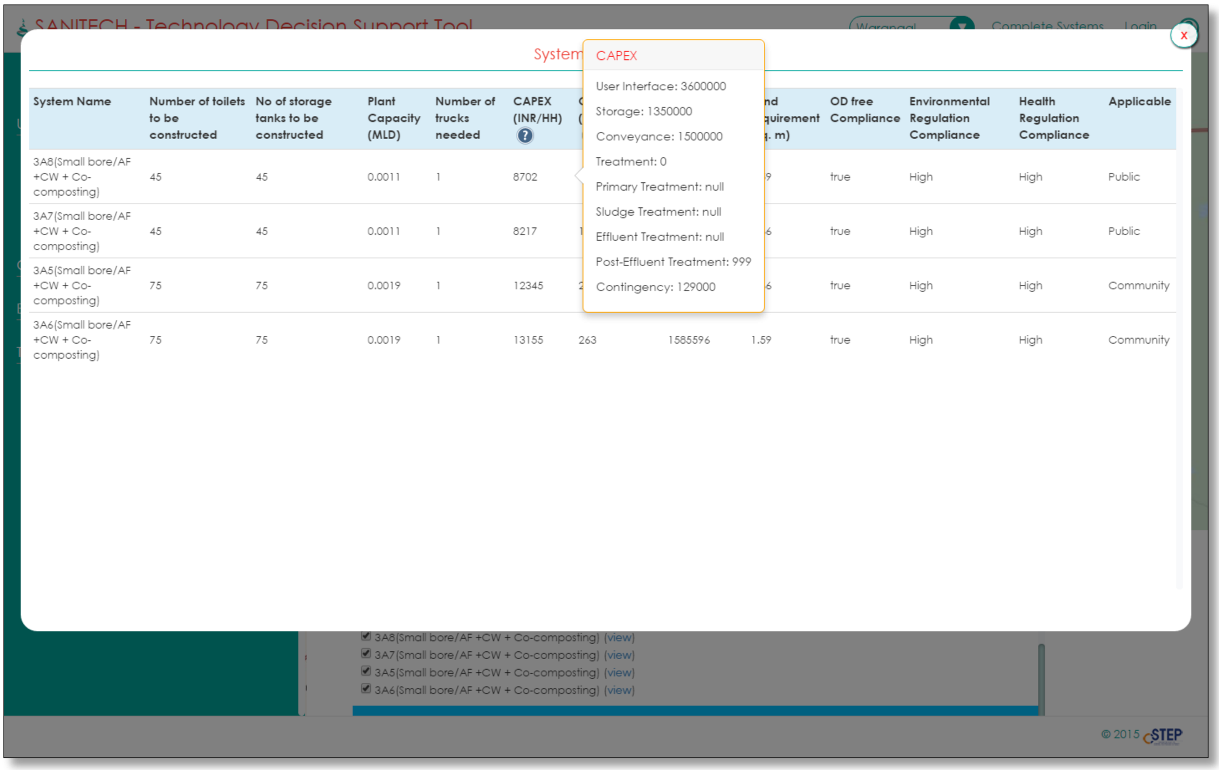


- Click on the suitable system button to see the list of suitable system
- Select the systems by checking the check boxes
- Compare the system click on compare systems button

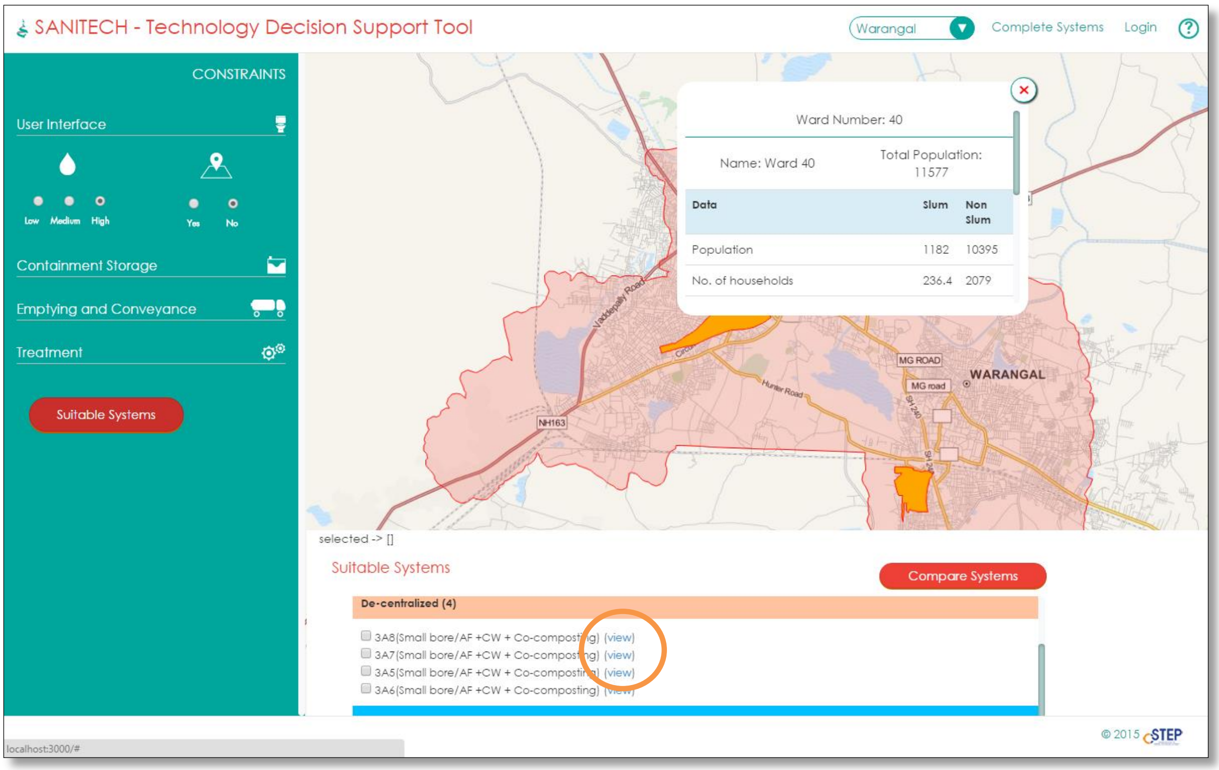


System Comparison

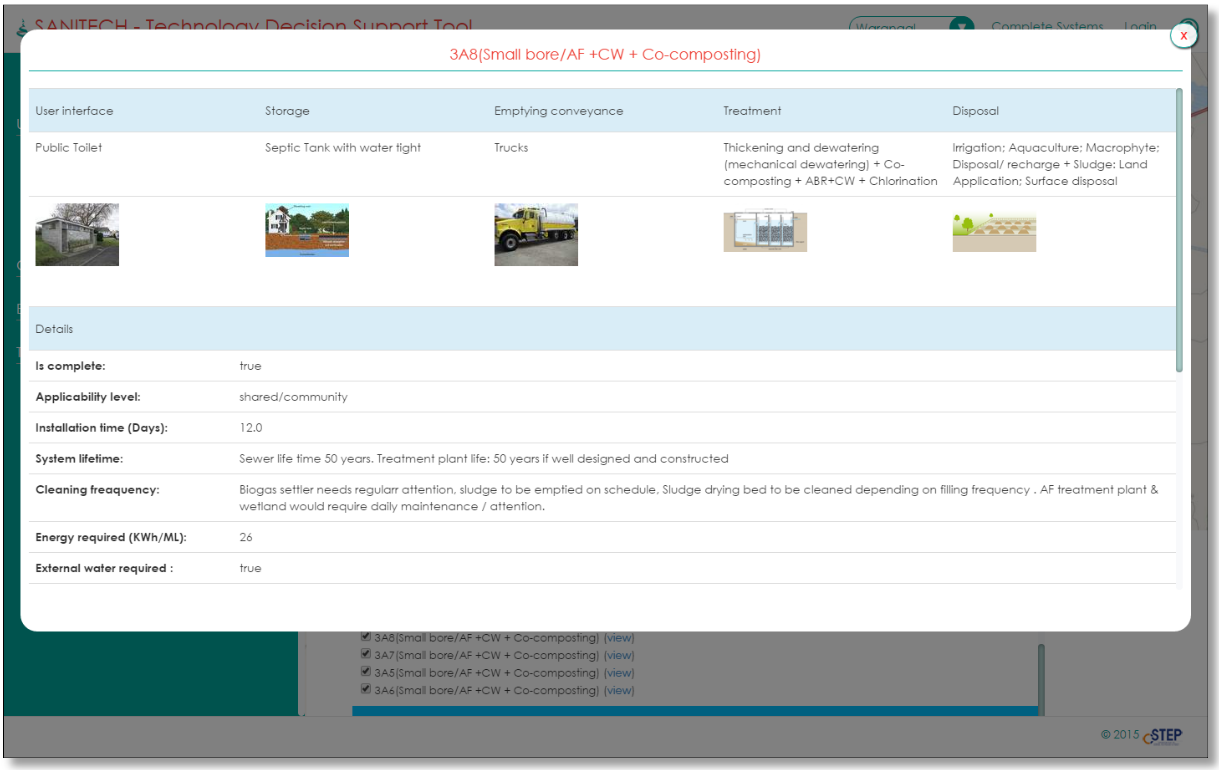
System Name	Number of toilets to be constructed	No of storage tanks to be constructed	Plant Capacity (MLD)	Number of trucks needed	CAPEX (INR/HH)	OPEX (INR/HH/Year)	Revenue for reuse (INR)	Land requirement (sq. m)	OD free Compliance	Environmental Regulation Compliance	Health Regulation Compliance	Applicable
3A8(Small bore/AF +CW + Co-composting)	45	45	0.0011	1	8702	174	1585596	1.59	true	High	High	Public
3A7(Small bore/AF +CW + Co-composting)	45	45	0.0011	1	8217	164	1585596	1.66	true	High	High	Public
3A5(Small bore/AF +CW + Co-composting)	75	75	0.0019	1	12345	247	1585596	1.66	true	High	High	Community
3A6(Small bore/AF +CW + Co-composting)	75	75	0.0019	1	13155	263	1585596	1.59	true	High	High	Community



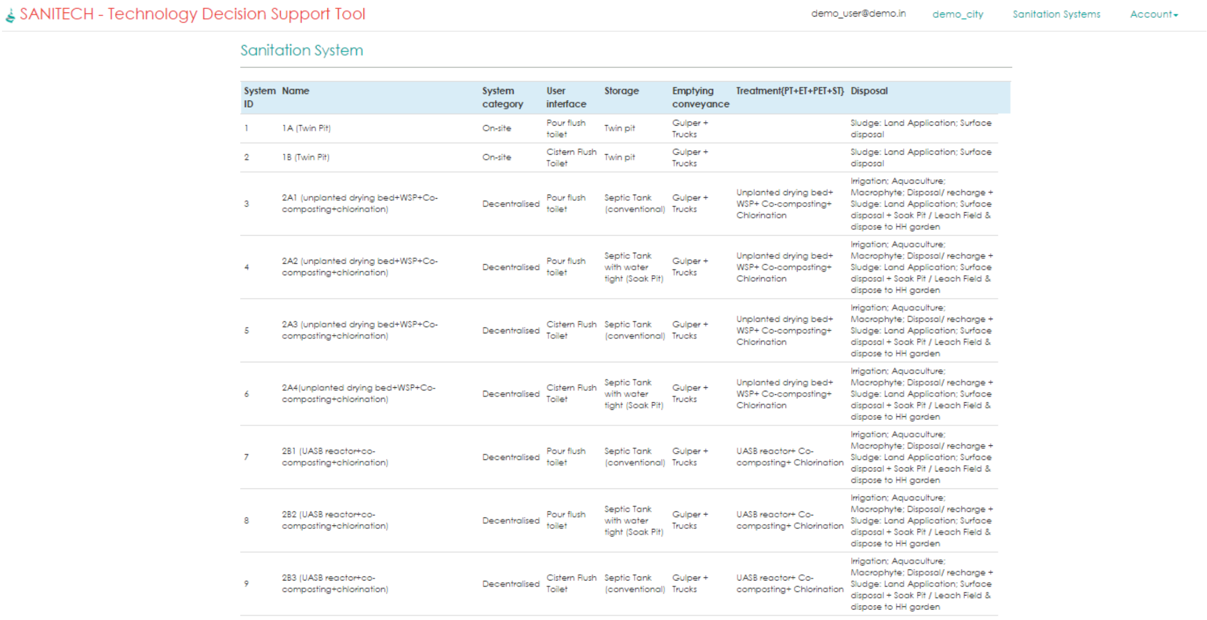
- Hover over Capex, Opex, Revenue values to see the disaggregated values



- Press view to see the complete details about the system



- Click on the sanitation systems to display complete system details and component details



SANITECH - Technology Decision Support Tool demo_user@demo.in demo_city Sanitation Systems Account

Sanitation System

System ID	Name	System category	User interface	Storage	Emptying conveyance	Treatment{PT+ET+PET+ST}	Disposal
1	1A (Twin Pit)	On-site	Pour flush toilet	Twin pit	Gulper + Trucks		Sludge: Land Application; Surface disposal
2	1B (Twin Pit)	On-site	Cistern Flush Toilet	Twin pit	Gulper + Trucks		Sludge: Land Application; Surface disposal
3	2A1 (unplanted drying bed+WSP+Co-composting+chlorination)	Decentralised	Pour flush toilet	Septic Tank (conventional)	Gulper + Trucks	Unplanted drying bed+ WSP+ Co-composting+ Chlorination	Irrigation; Aquaculture; Macrophyte; Disposal/ recharge + Sludge: Land Application; Surface disposal + Soak Pit / Leach Field & dispose to HH garden
4	2A2 (unplanted drying bed+WSP+Co-composting+chlorination)	Decentralised	Pour flush toilet	Septic Tank with water tight (Soak Pit)	Gulper + Trucks	Unplanted drying bed+ WSP+ Co-composting+ Chlorination	Irrigation; Aquaculture; Macrophyte; Disposal/ recharge + Sludge: Land Application; Surface disposal + Soak Pit / Leach Field & dispose to HH garden
5	2A3 (unplanted drying bed+WSP+Co-composting+chlorination)	Decentralised	Cistern Flush Toilet	Septic Tank (conventional)	Gulper + Trucks	Unplanted drying bed+ WSP+ Co-composting+ Chlorination	Irrigation; Aquaculture; Macrophyte; Disposal/ recharge + Sludge: Land Application; Surface disposal + Soak Pit / Leach Field & dispose to HH garden
6	2A4(unplanted drying bed+WSP+Co-composting+chlorination)	Decentralised	Cistern Flush Toilet	Septic Tank with water tight (Soak Pit)	Gulper + Trucks	Unplanted drying bed+ WSP+ Co-composting+ Chlorination	Irrigation; Aquaculture; Macrophyte; Disposal/ recharge + Sludge: Land Application; Surface disposal + Soak Pit / Leach Field & dispose to HH garden
7	2B1 (UASB reactor+co-composting+chlorination)	Decentralised	Pour flush toilet	Septic Tank (conventional)	Gulper + Trucks	UASB reactor+ Co-composting+ Chlorination	Irrigation; Aquaculture; Macrophyte; Disposal/ recharge + Sludge: Land Application; Surface disposal + Soak Pit / Leach Field & dispose to HH garden
8	2B2 (UASB reactor+co-composting+chlorination)	Decentralised	Pour flush toilet	Septic Tank with water tight (Soak Pit)	Gulper + Trucks	UASB reactor+ Co-composting+ Chlorination	Irrigation; Aquaculture; Macrophyte; Disposal/ recharge + Sludge: Land Application; Surface disposal + Soak Pit / Leach Field & dispose to HH garden
9	2B3 (UASB reactor+co-composting+chlorination)	Decentralised	Cistern Flush Toilet	Septic Tank (conventional)	Gulper + Trucks	UASB reactor+ Co-composting+ Chlorination	Irrigation; Aquaculture; Macrophyte; Disposal/ recharge + Sludge: Land Application; Surface disposal + Soak Pit / Leach Field & dispose to HH garden

Step 2: Launch of the application (with login details)

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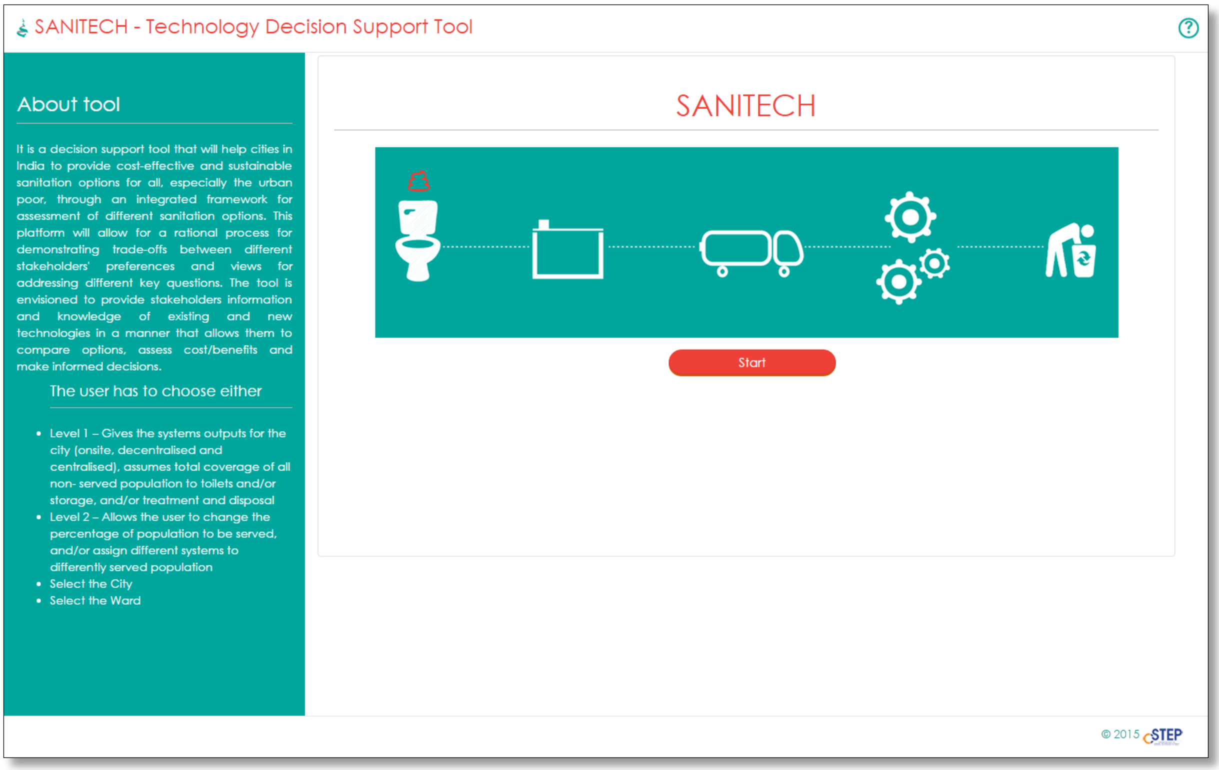


Step 2: Login with demo details

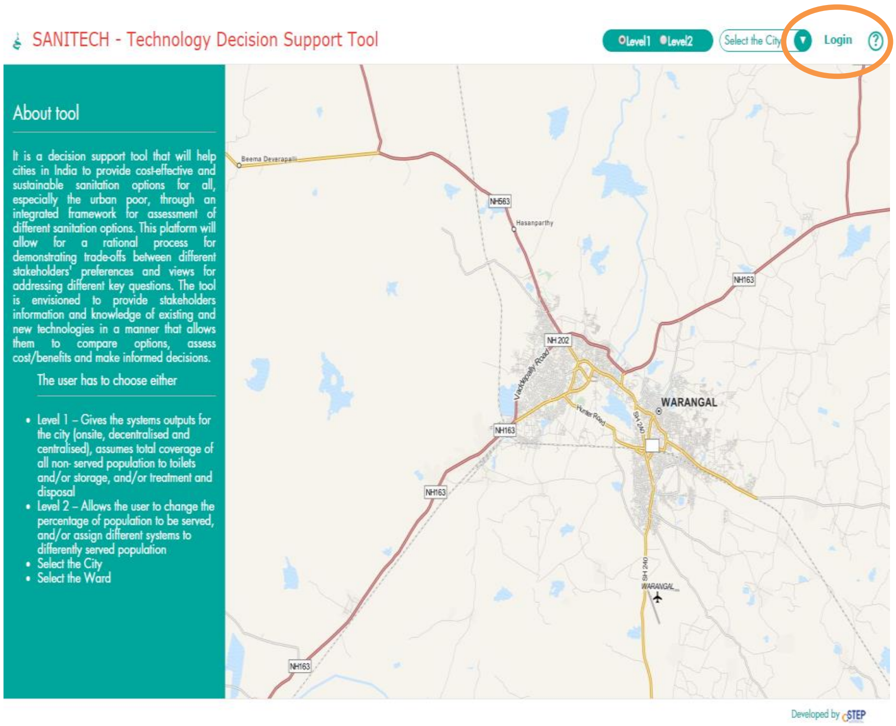
To see the full potential of the tool, use the following login credentials:

username: demo_user@demo.in

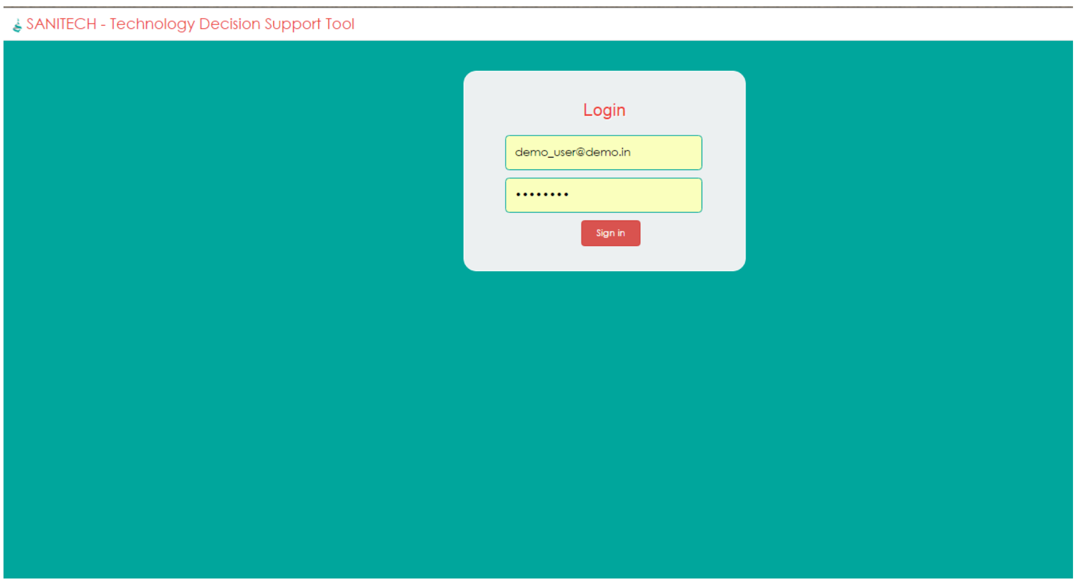
password: demo@123

If you have city user credentials, please use them in place of the credentials given above

NOTE: to use the tool for a specific city, the city must be added to the CSTEP repository. Please follow the instructions given here.



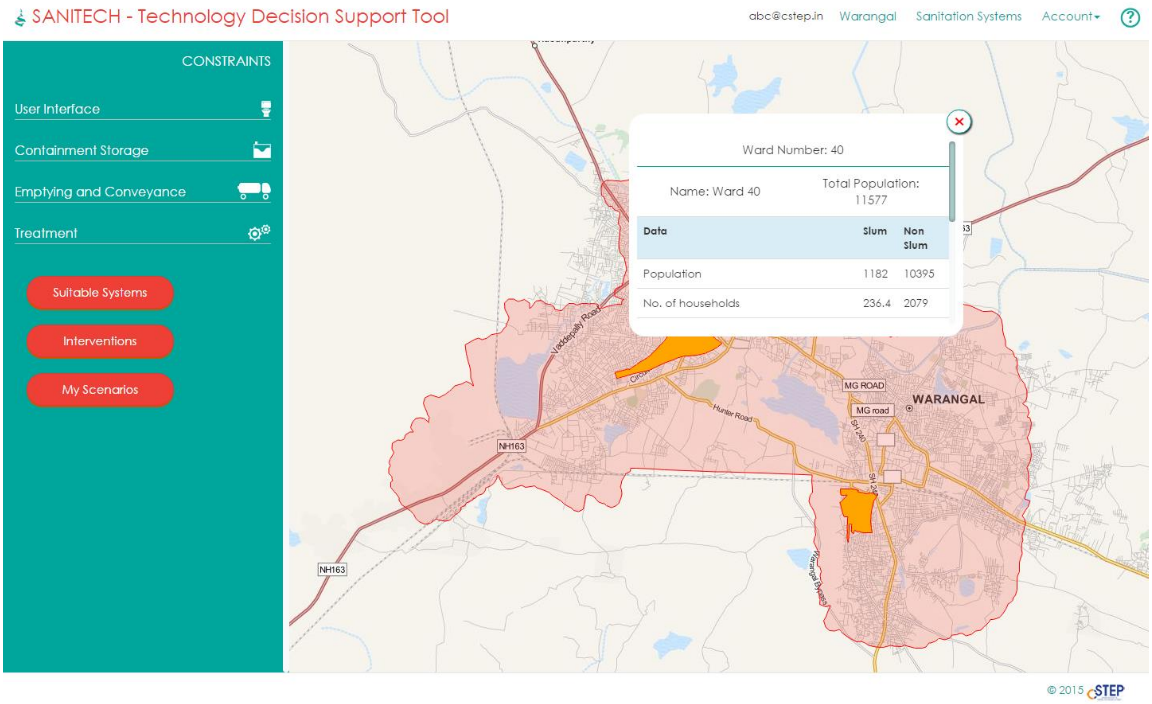
- Click on Login



- Login with demo user details (or city user details if available)

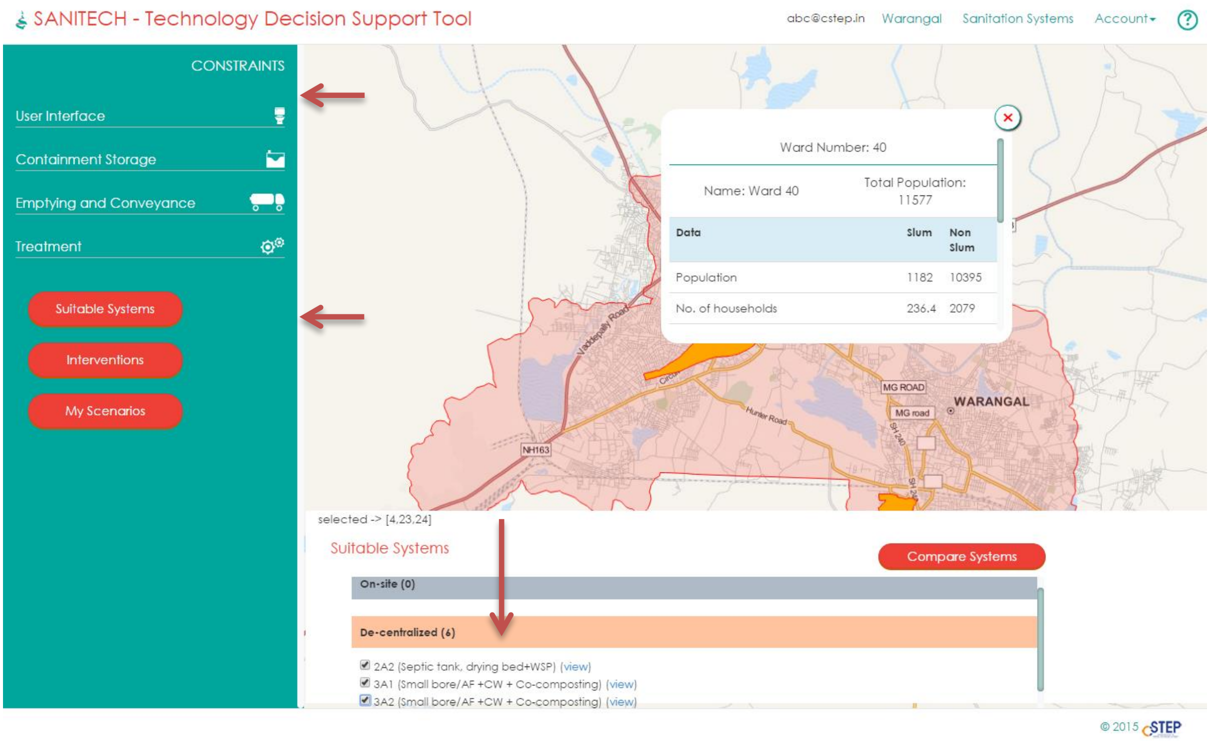
Step 3: Select City/Ward

- City/Ward data is displayed.

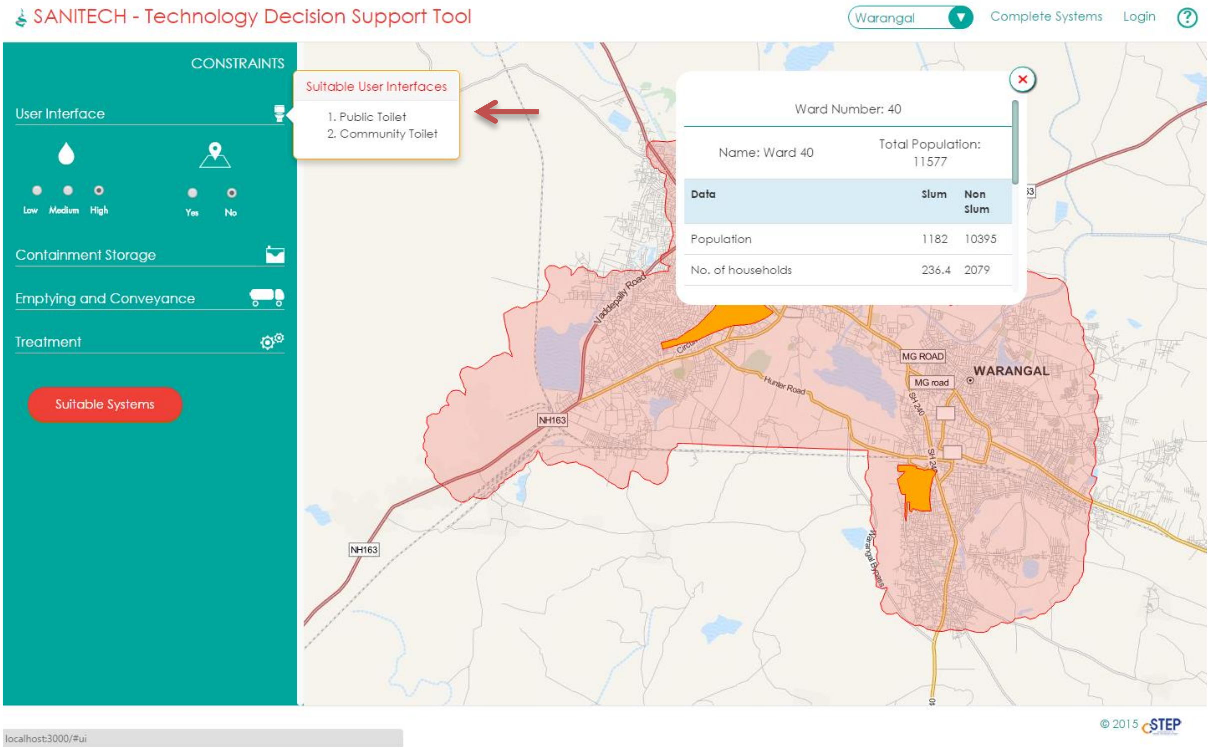


Step 4: Suitable Systems for the city/ward

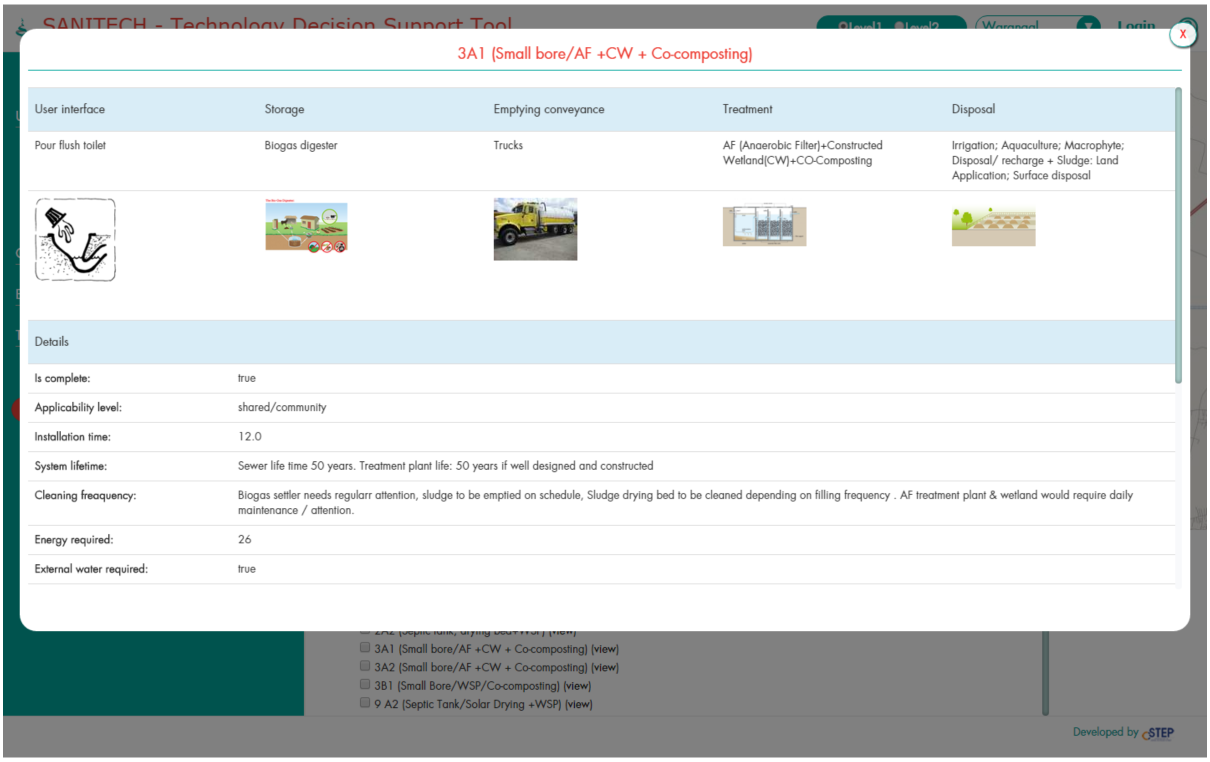
- The tool will suggest a range of suitable systems, based on the city/ward constraints entered – Left Panel
- User to modify the constraints and subsequently a new list of systems will be suggested
- Click the " Select Systems" button



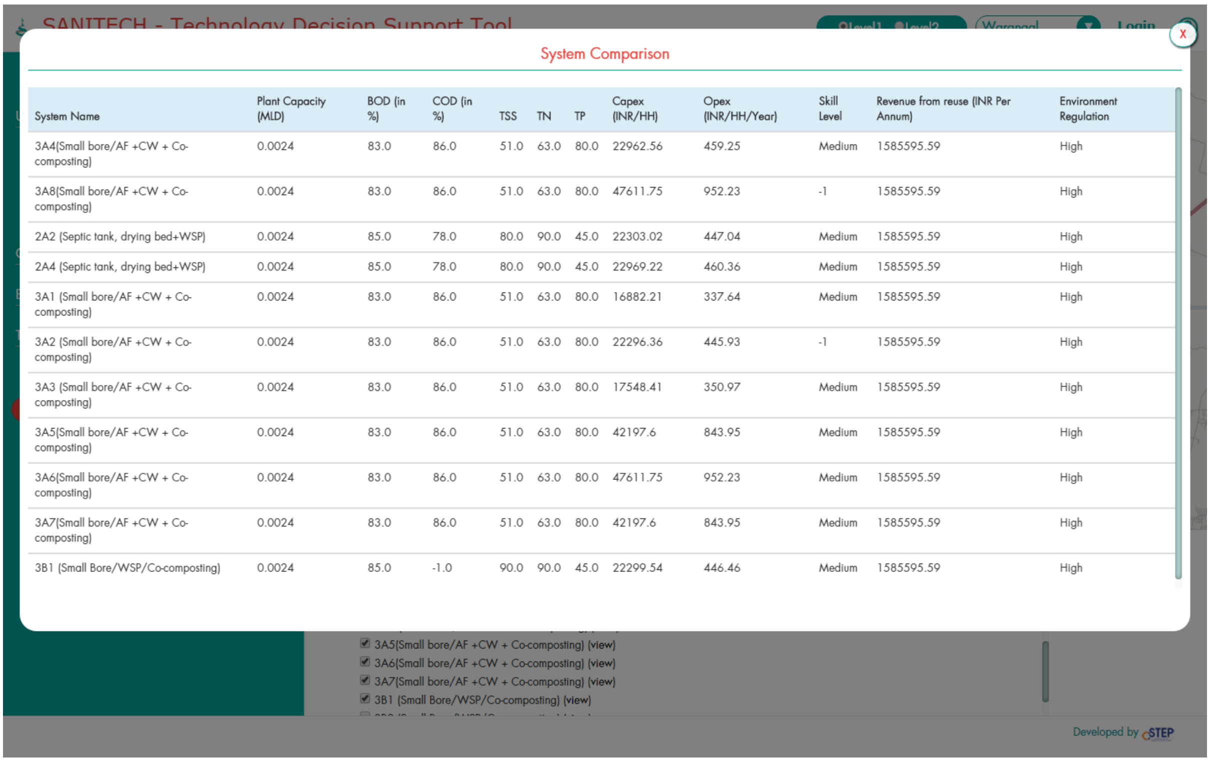
- Select constraints
- Suitable components of each part of value chain can be viewed



- Select suitable system/s
- View details of the selected system



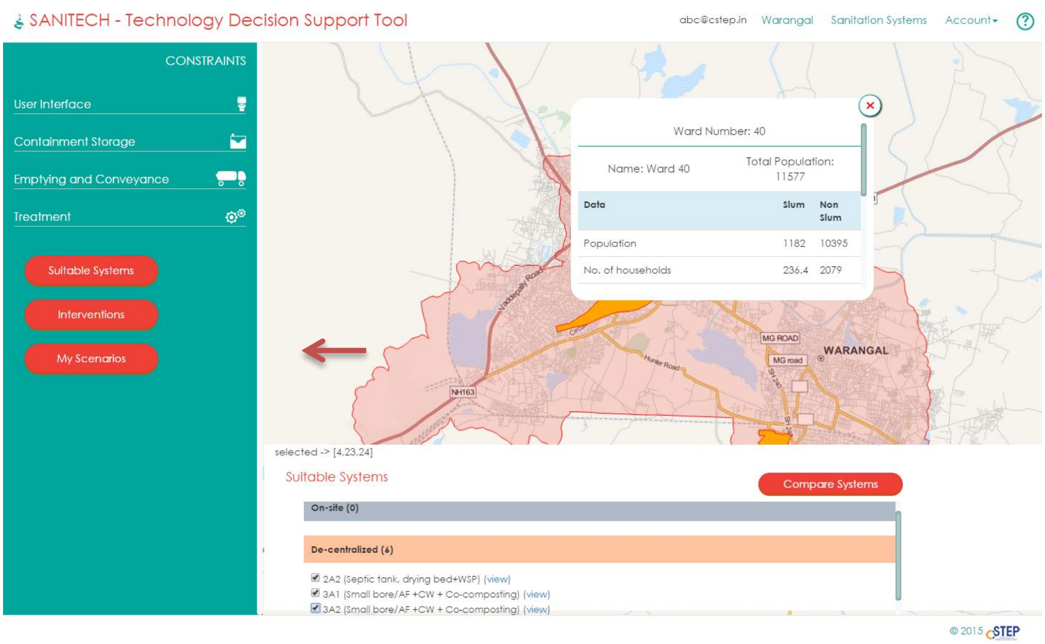
Step 5: Generating output for the selected system



System Name	Plant Capacity (MLD)	BOD (in %)	COD (in %)	TSS	TN	TP	Capex (INR/HH)	Opex (INR/HH/Year)	Skill Level	Revenue from reuse (INR Per Annum)	Environment Regulation
3A4(Small bore/AF +CW + Co-composting)	0.0024	83.0	86.0	51.0	63.0	80.0	22962.56	459.25	Medium	1585595.59	High
3A8(Small bore/AF +CW + Co-composting)	0.0024	83.0	86.0	51.0	63.0	80.0	47611.75	952.23	-1	1585595.59	High
2A2 (Septic tank, drying bed+WSP)	0.0024	85.0	78.0	80.0	90.0	45.0	22303.02	447.04	Medium	1585595.59	High
2A4 (Septic tank, drying bed+WSP)	0.0024	85.0	78.0	80.0	90.0	45.0	22969.22	460.36	Medium	1585595.59	High
3A1 (Small bore/AF +CW + Co-composting)	0.0024	83.0	86.0	51.0	63.0	80.0	16882.21	337.64	Medium	1585595.59	High
3A2 (Small bore/AF +CW + Co-composting)	0.0024	83.0	86.0	51.0	63.0	80.0	22296.36	445.93	-1	1585595.59	High
3A3 (Small bore/AF +CW + Co-composting)	0.0024	83.0	86.0	51.0	63.0	80.0	17548.41	350.97	Medium	1585595.59	High
3A5(Small bore/AF +CW + Co-composting)	0.0024	83.0	86.0	51.0	63.0	80.0	42197.6	843.95	Medium	1585595.59	High
3A6(Small bore/AF +CW + Co-composting)	0.0024	83.0	86.0	51.0	63.0	80.0	47611.75	952.23	Medium	1585595.59	High
3A7(Small bore/AF +CW + Co-composting)	0.0024	83.0	86.0	51.0	63.0	80.0	42197.6	843.95	Medium	1585595.59	High
3B1 (Small Bore/WSP/Co-composting)	0.0024	85.0	-1.0	90.0	90.0	45.0	22299.54	446.46	Medium	1585595.59	High

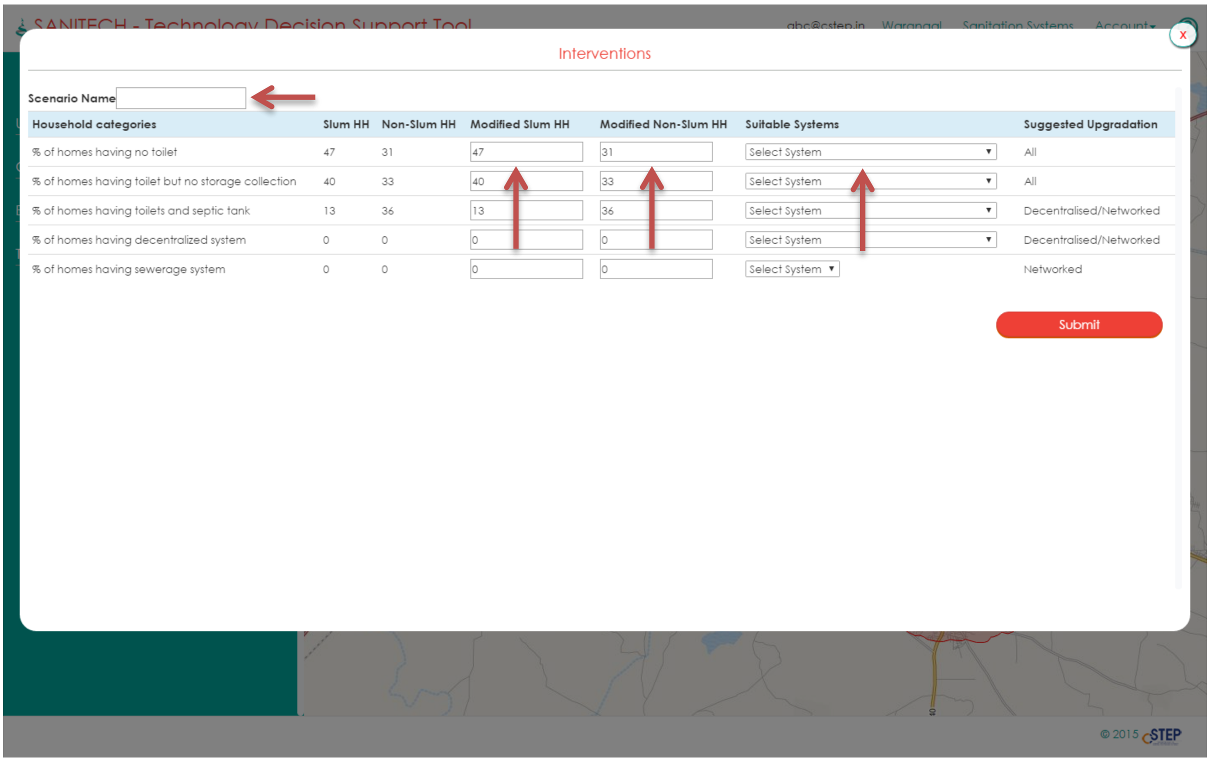
- The systems' outputs for the city (onsite, decentralised and centralised), assumes **total coverage** of all **non- served** population to toilets and/or storage, and/or treatment and disposal.
- After choosing different sanitation systems, user can compare the systems through a set of outputs.
- To create scenarios – click on INTERVENTIONS

Step 6: Interventions by user

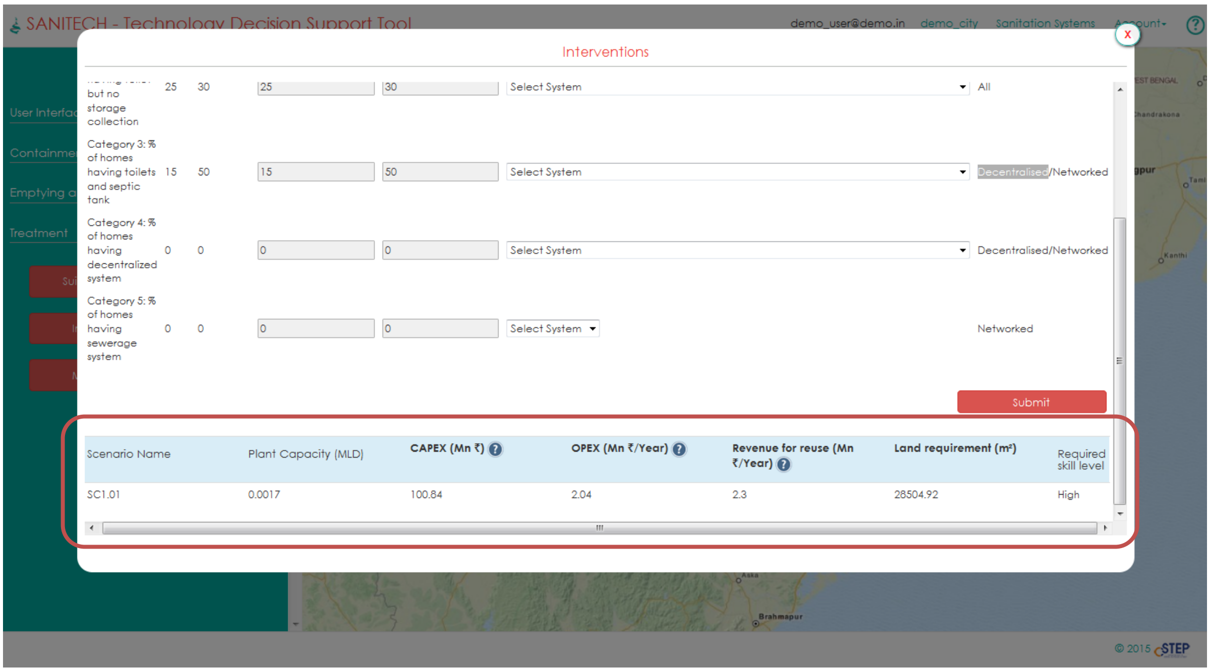


- View intervention screen by clicking the intervention button
  - Create Scenario

- You can choose to change the population to be served and/or
- Select a particular system for each type of population
  - Each of these set of interventions will be saved as a **scenario**

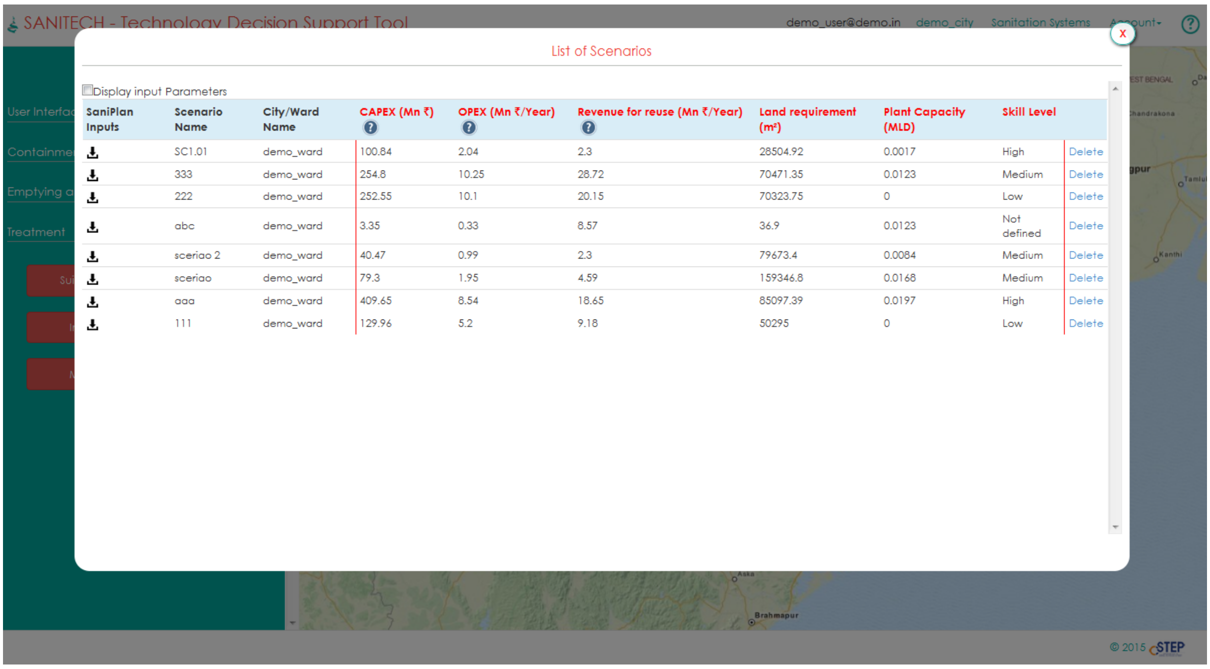


- Output can be generated by clicking the submit button



Step 7: Scenario Comparison

- Interventions done in Step 6, saved as scenarios can be compared
  - User can make "n" number of scenarios for the city/ward
  - Select multiple scenarios to compare outputs



SaniPlan Inputs	Scenario Name	City/Ward Name	CAPEX (Mn ₹)	OPEX (Mn ₹/Year)	Revenue for reuse (Mn ₹/Year)	Land requirement (m²)	Plant Capacity (MLD)	Skill Level	
	SC1.01	demo_ward	100.84	2.04	2.3	28504.92	0.0017	High	Delete
	333	demo_ward	254.8	10.25	28.72	70471.35	0.0123	Medium	Delete
	222	demo_ward	252.55	10.1	20.15	70323.75	0	Low	Delete
	abc	demo_ward	3.35	0.33	8.57	36.9	0.0123	Not defined	Delete
	sceriao 2	demo_ward	40.47	0.99	2.3	79673.4	0.0084	Medium	Delete
	sceriao	demo_ward	79.3	1.95	4.59	159346.8	0.0168	Medium	Delete
	aaa	demo_ward	409.65	8.54	18.65	85097.39	0.0197	High	Delete
	111	demo_ward	129.96	5.2	9.18	50295	0	Low	Delete

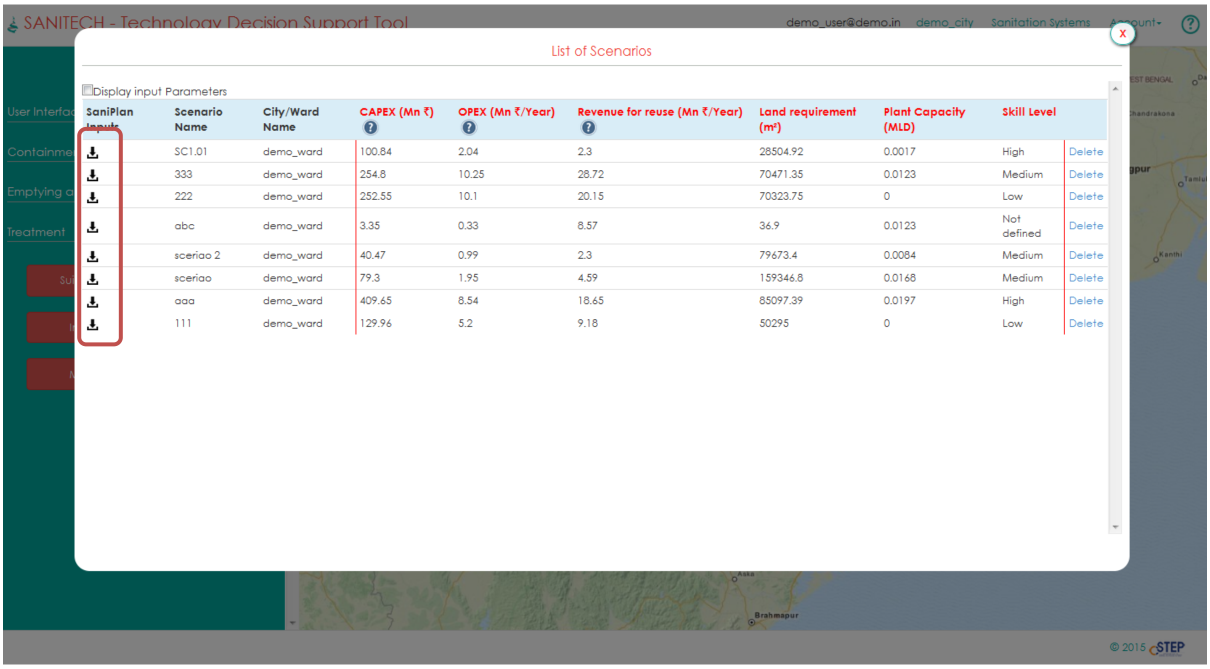
Step 8: Sanitech outputs for Saniplan

Sanitech can be used to generate inputs for another sanitation tool, Saniplan, which is a multi-year planning tool which focuses on improving service performance across themes of access, equity, service levels and quality, efficiency and financial sustainability.

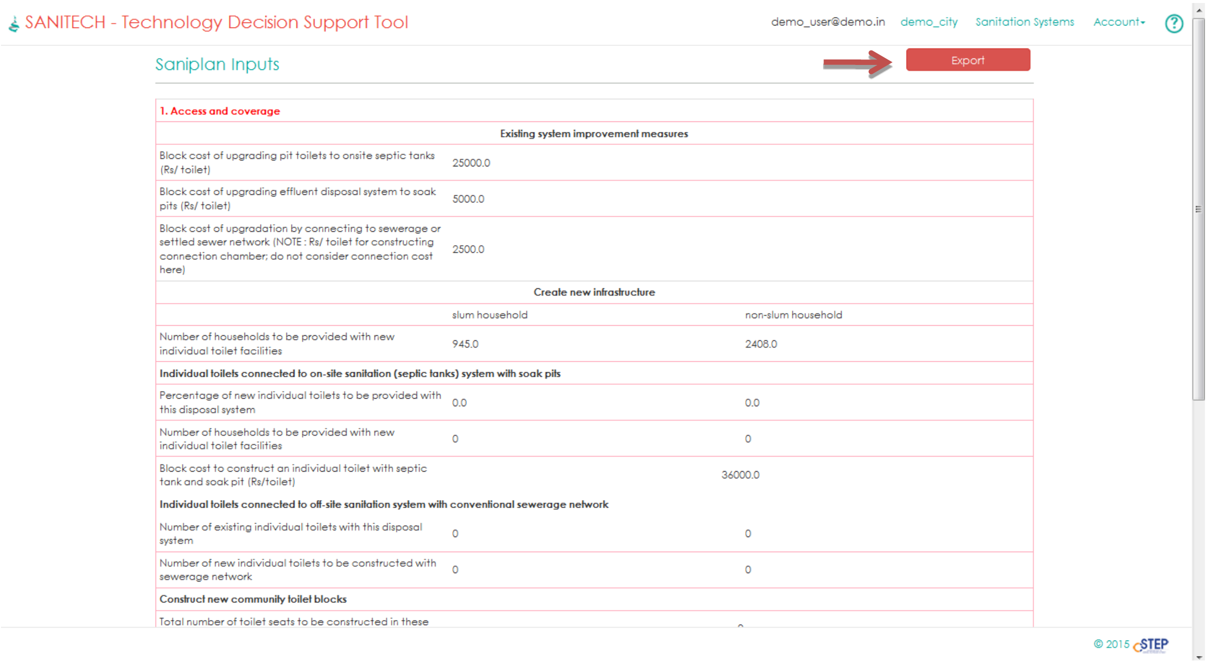
Saniplan operates in three steps – firstly, it measures the current performance levels. Sector performance indicators give the basis to assess the current service performance. Next, a set of actions are identified and undertaken with the aim to improve the performance. Finally, the financial impacts of these actions along with phasing are developed as the financial plan.

Among these three steps, Sanitech aligns itself with the second one. In action planning, Sanitech would allow users to not just take actions but also to observe the impacts of these actions on a set of indicators that cover different aspects such as health environmental safety social impact, etc. Through the application of sanitech, a preliminary understanding of the impact of actions is possible. Moreover, Sanitech allows users to commit a variety of interventions on the target city and choose the option that best fits their need(s).

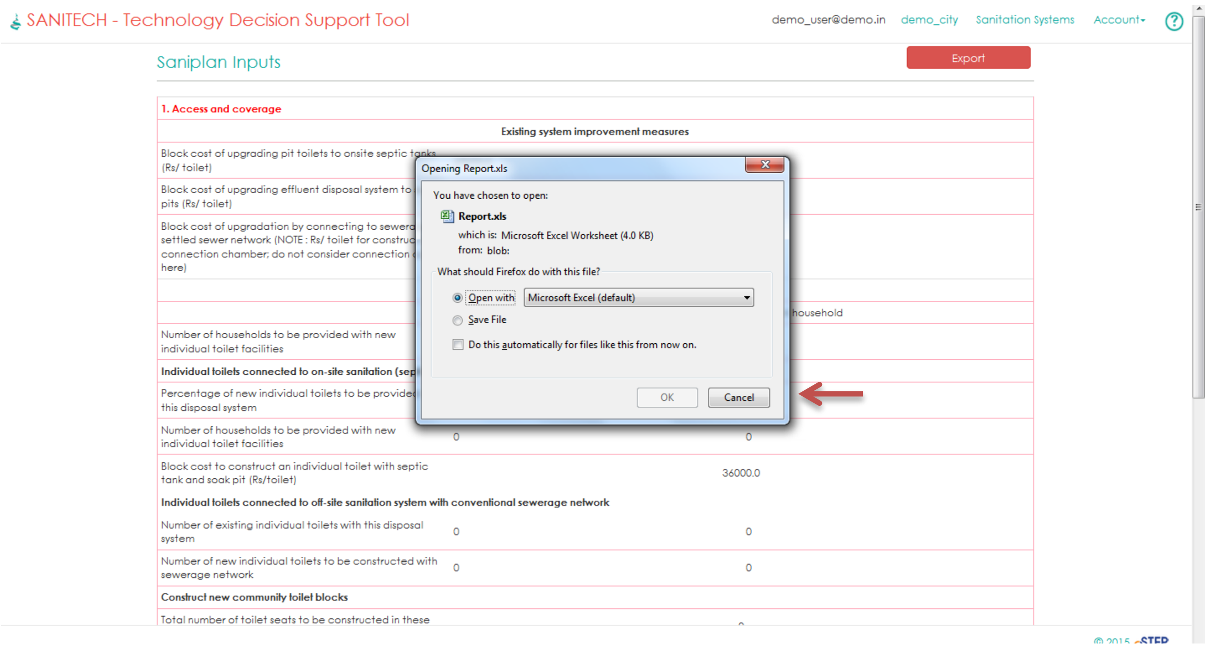
To use Sanitech for obtaining Saniplan input, users need to login (as described above) and create scenarios. These scenarios can then be downloaded as excel sheets with calculated values for various data requirements in saniplan.

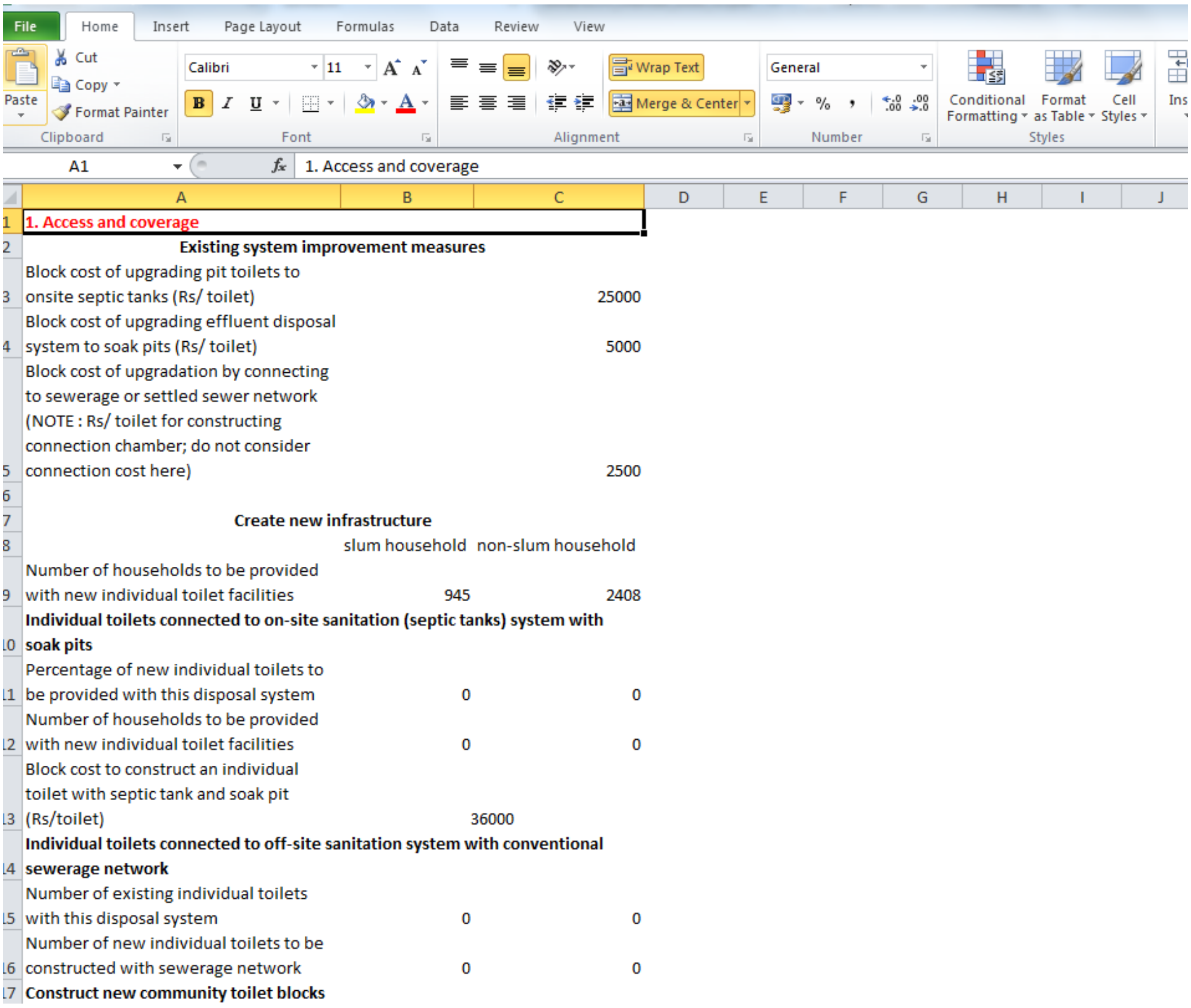


- The icons on the far left open a web page with Saniplan inputs, from where the excel sheet can be downloaded.



- Saniplan information. The export button can be used for generating the excel sheet

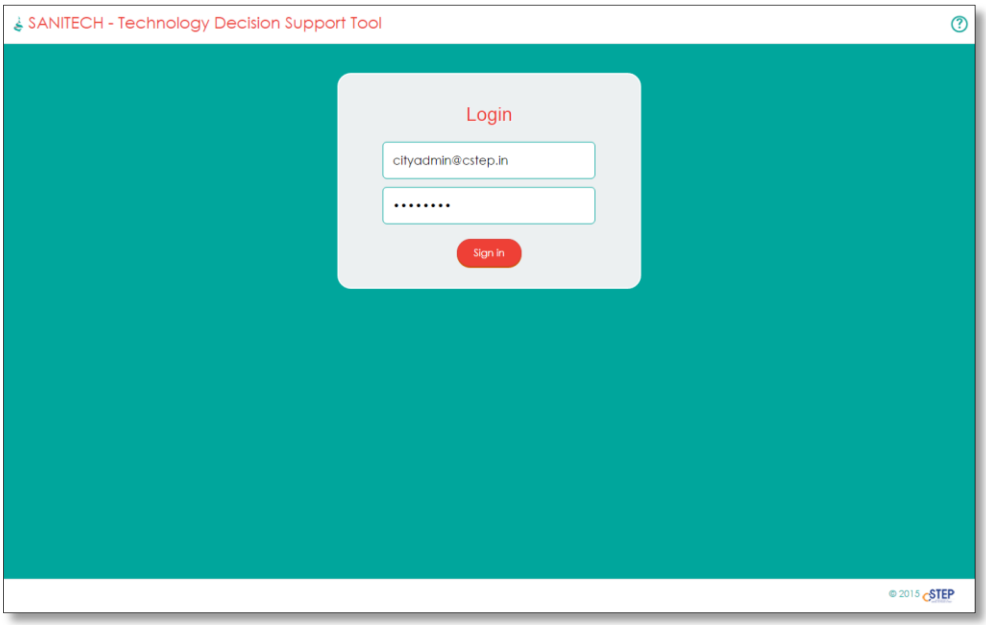




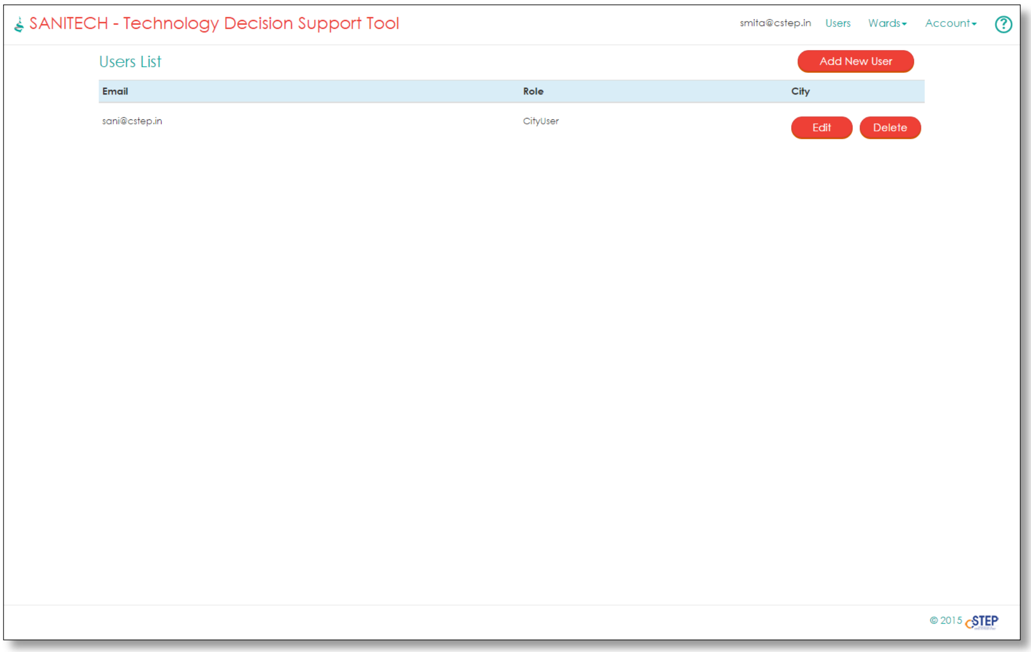
Excel sheet with Saniplan inputs

Application overview - Creation of City Admin and City User

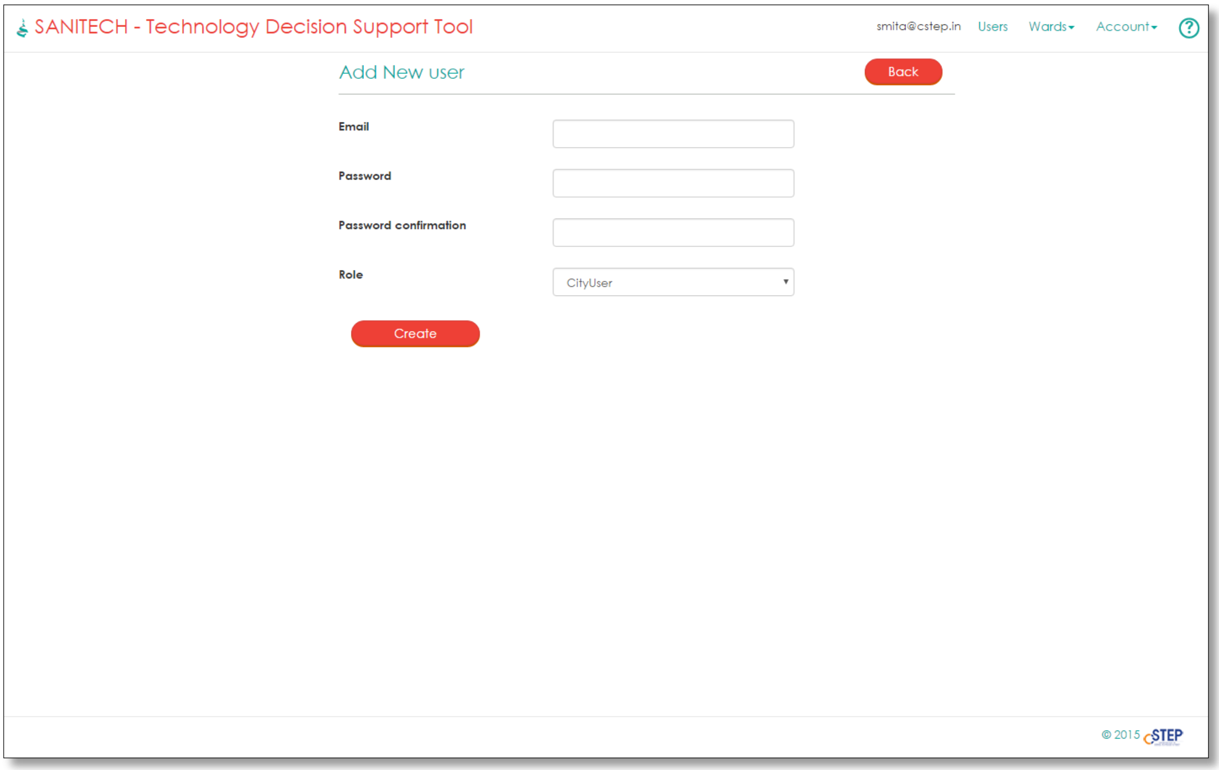
1. CSTEP creates the login credentials for city admin
   - Login to the tool to enter city/ward data and constraints or create new city/ward (with login details from CSTEP)
     - Login as city admin
     - User list can be viewed
     - New users can be created
     - User profile can be edited
   - City users are created
   - City /ward data can be entered
   - Sanitation specific data can be entered

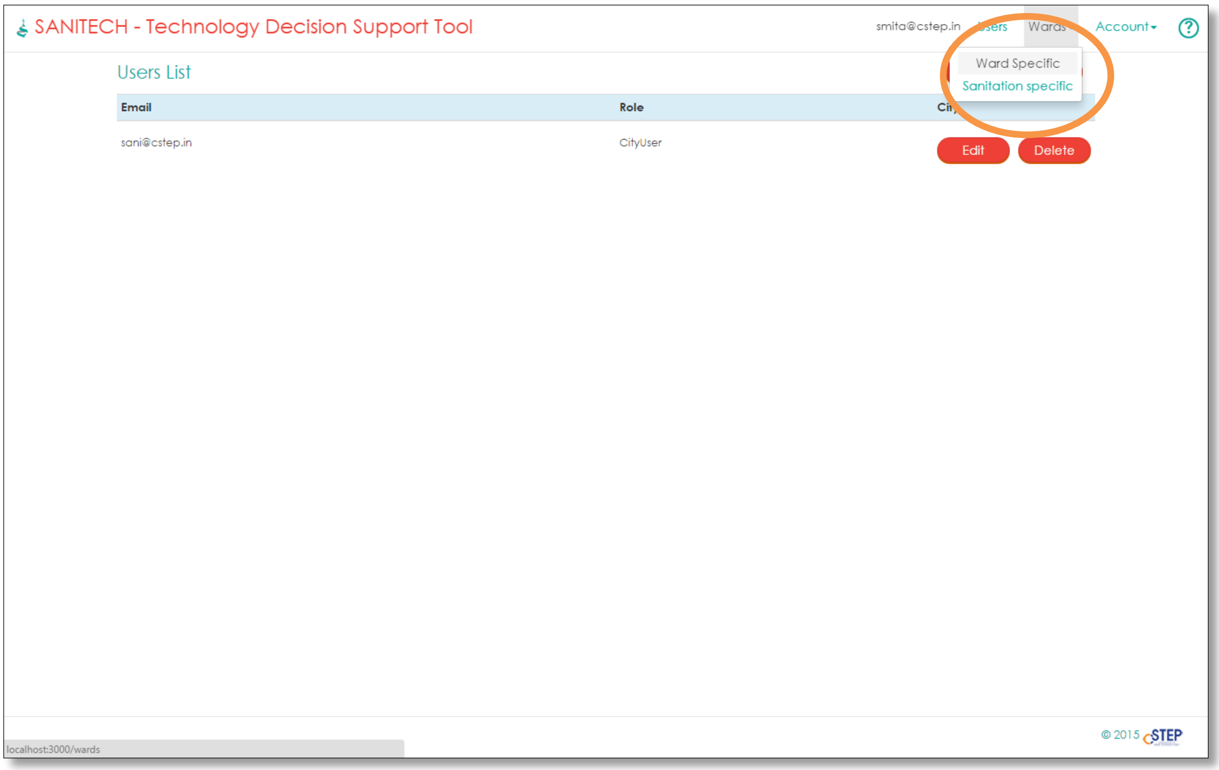


   - Login with city admin details



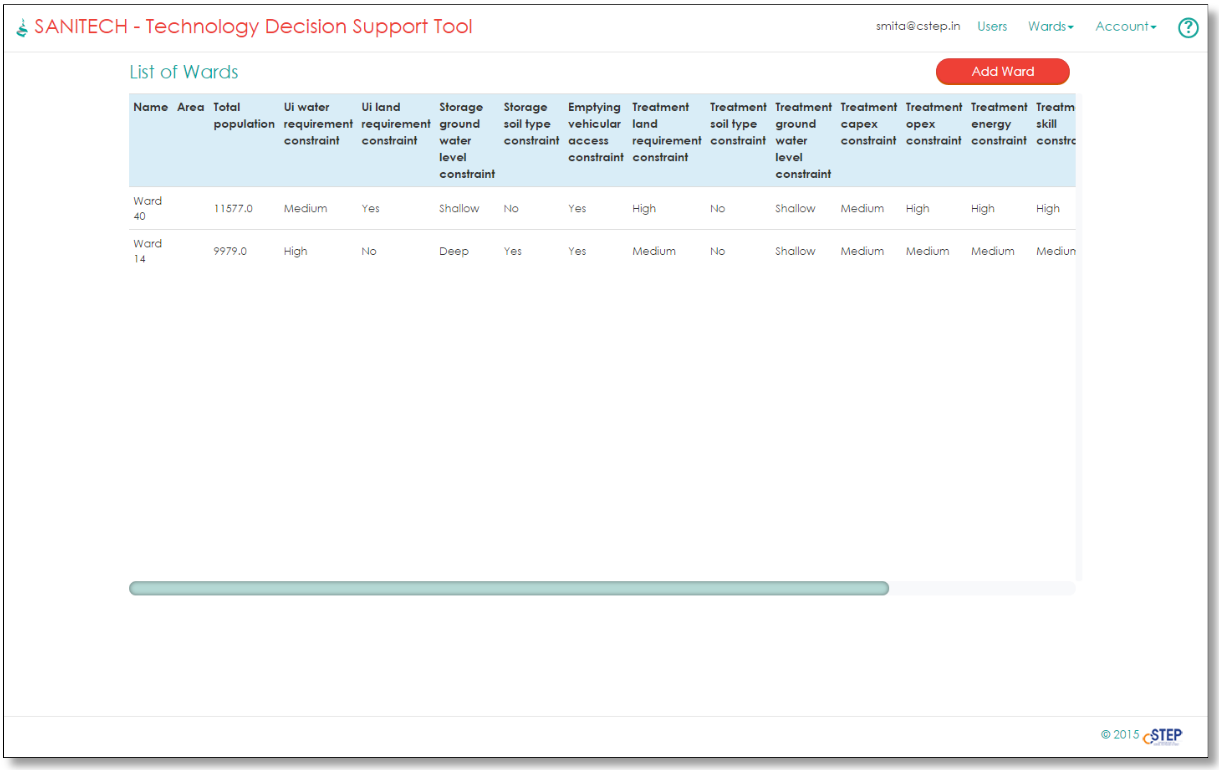
- Existing users can be viewed/edited. New users can be added, as below.



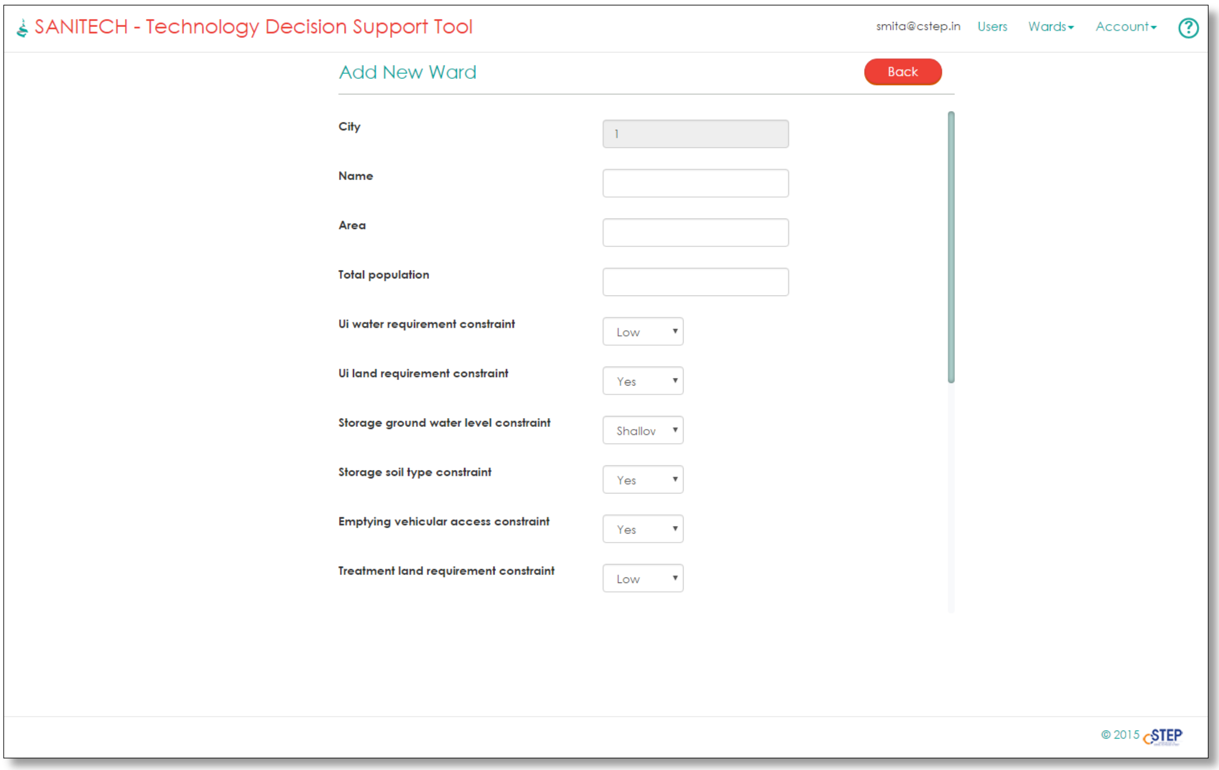


- To add Ward/Spatial unit data, select either ward specific (population based information and local conditions) or sanitation specific (existing sanitation situation).

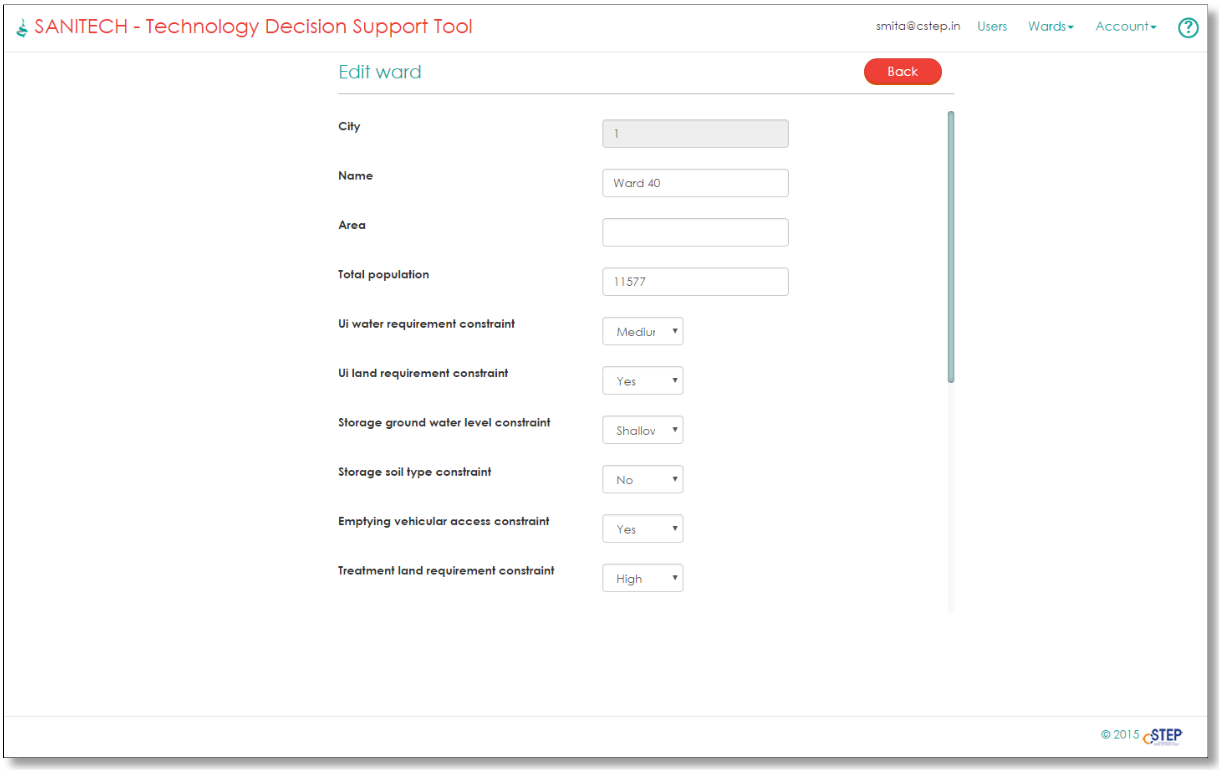
NOTE: both categories of information are required by the tool. Here the ward specific category is chosen first -



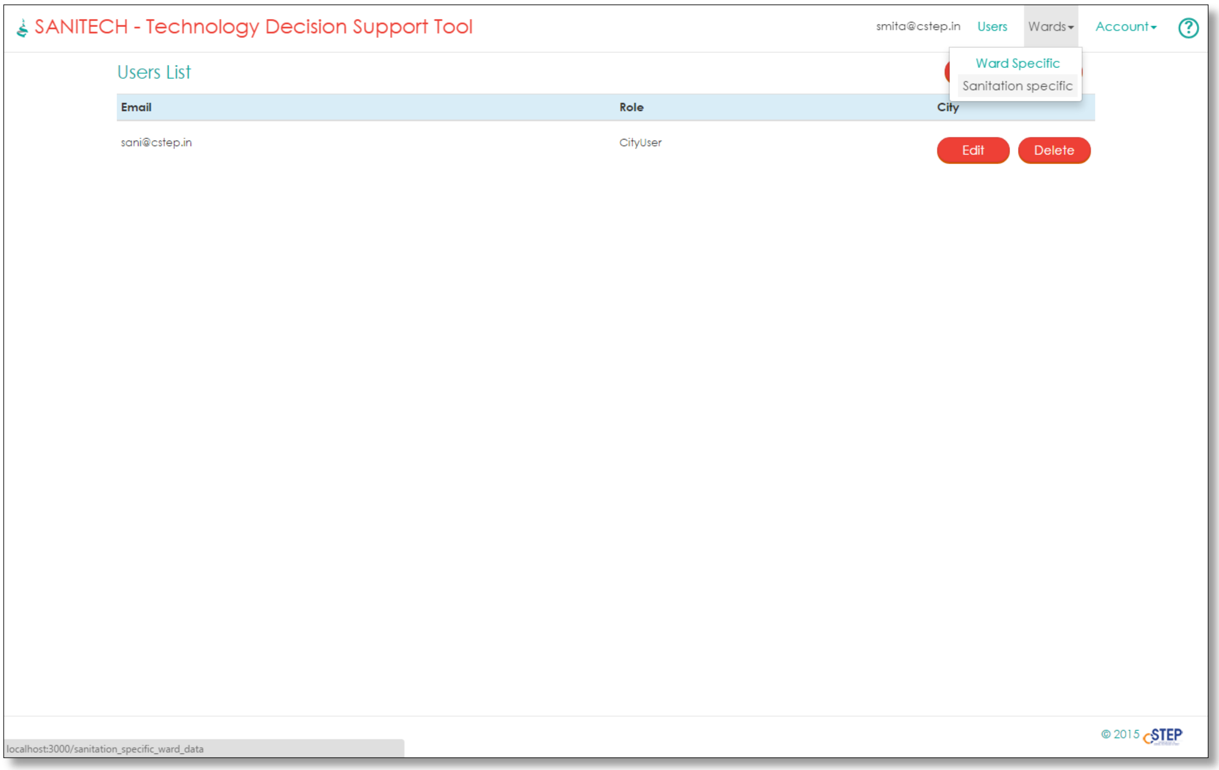
- New wards can be added to the list



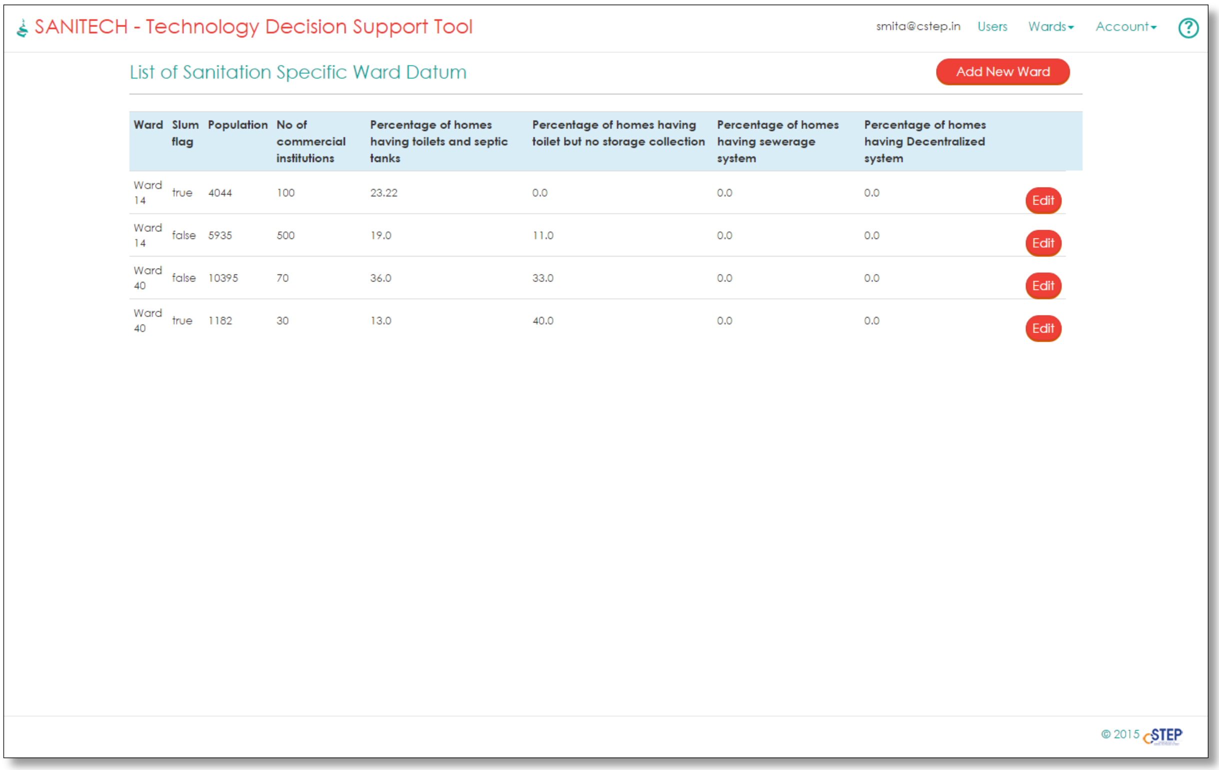
- Click on edit button to edit the entered ward/city details



- Select the sanitation specific option to view the details

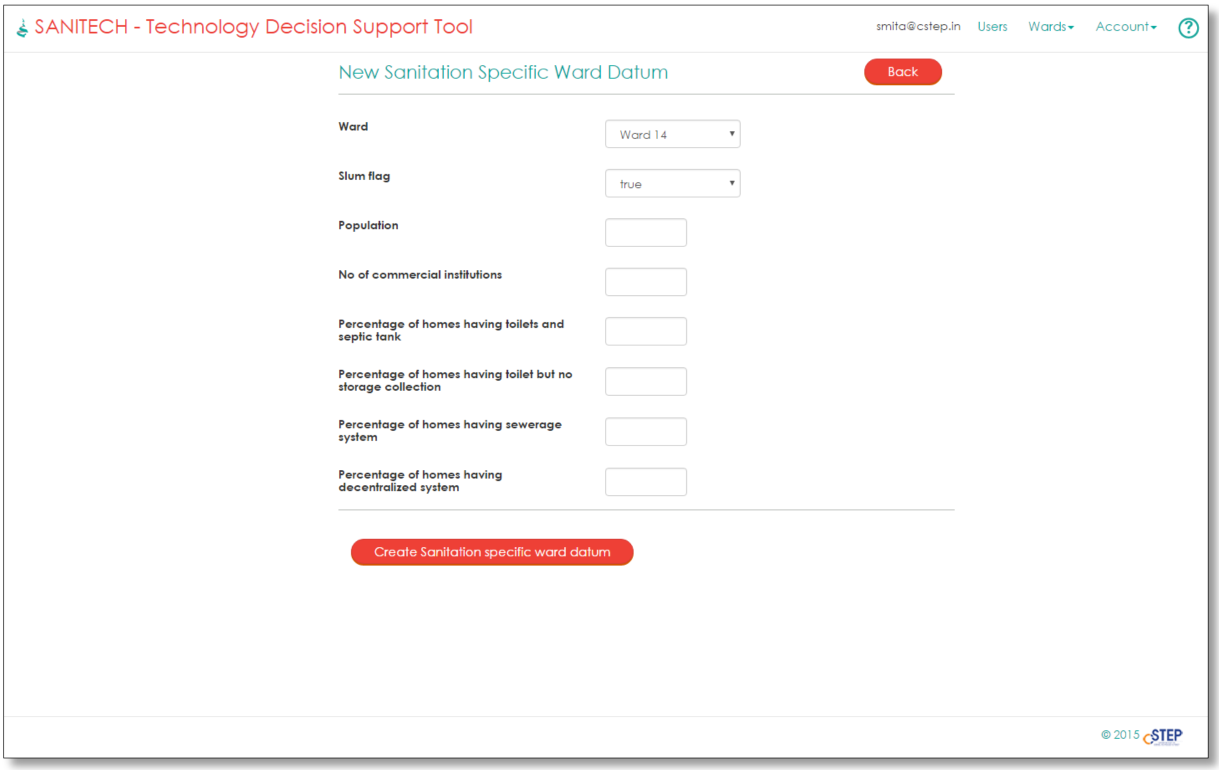


- List of sanitation specific data

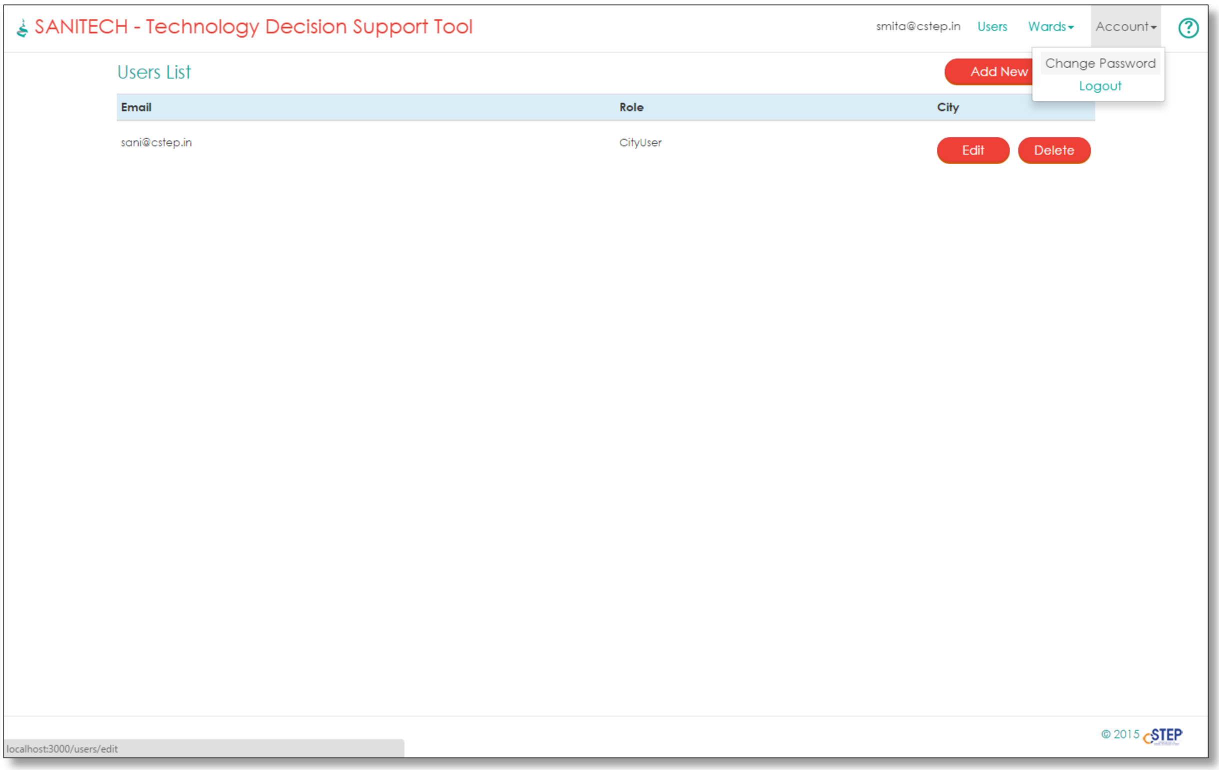


Ward	Slum flag	Population	No of commercial institutions	Percentage of homes having toilets and septic tanks	Percentage of homes having toilet but no storage collection	Percentage of homes having sewerage system	Percentage of homes having Decentralized system	
Ward 14	true	4044	100	23.22	0.0	0.0	0.0	Edit
Ward 14	false	5935	500	19.0	11.0	0.0	0.0	Edit
Ward 40	false	10395	70	36.0	33.0	0.0	0.0	Edit
Ward 40	true	1182	30	13.0	40.0	0.0	0.0	Edit

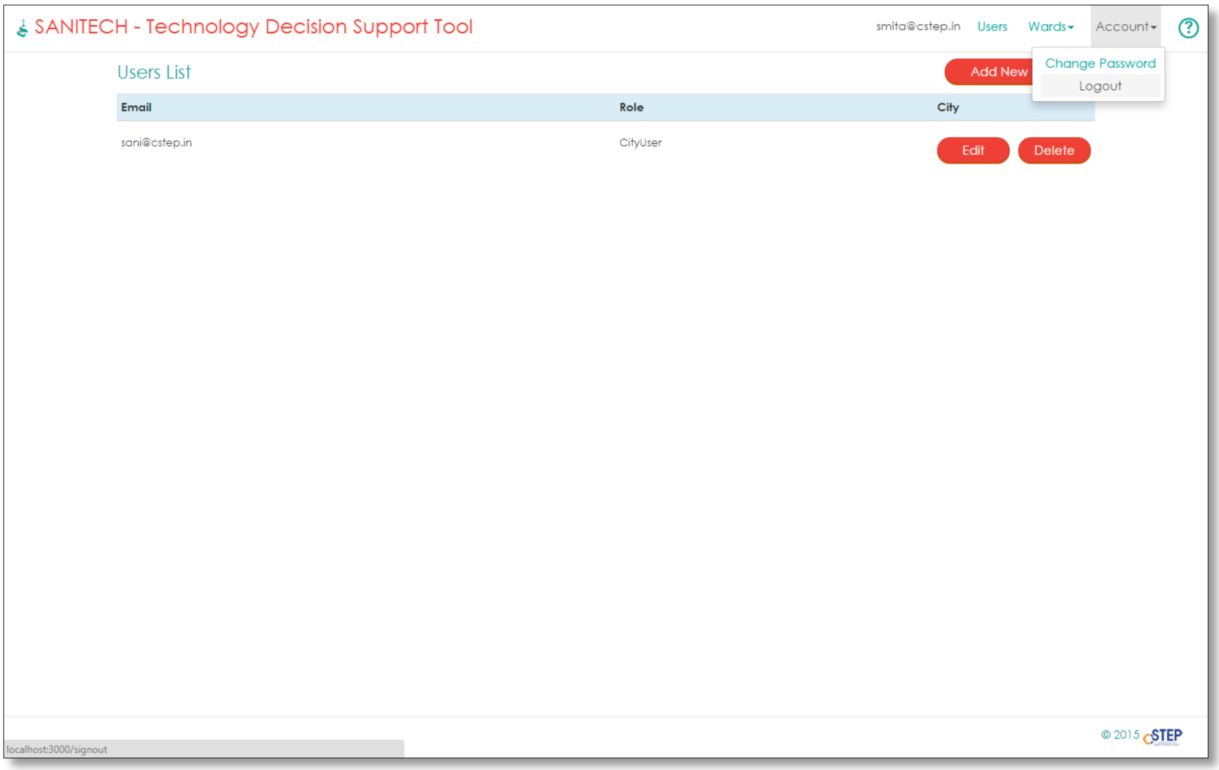
- Click to add new sanitation specific details to the list

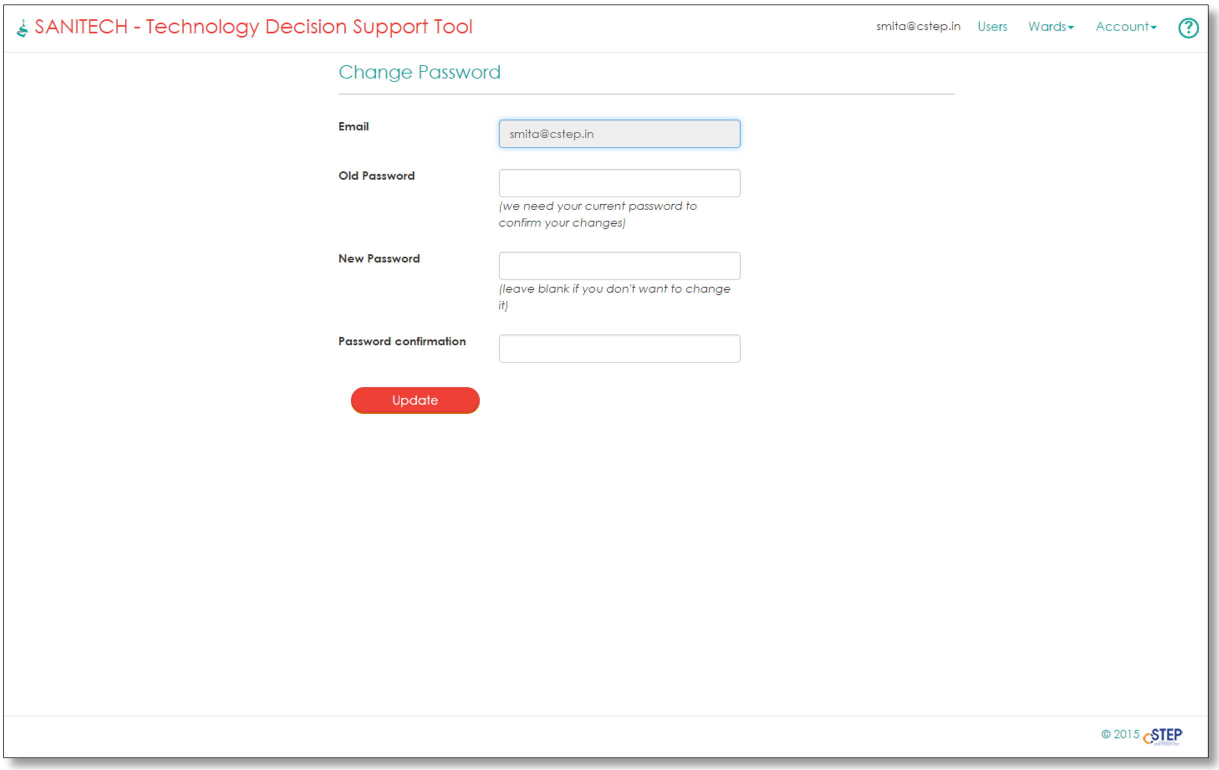


- Click on edit to edit the present sanitation specific data in the list

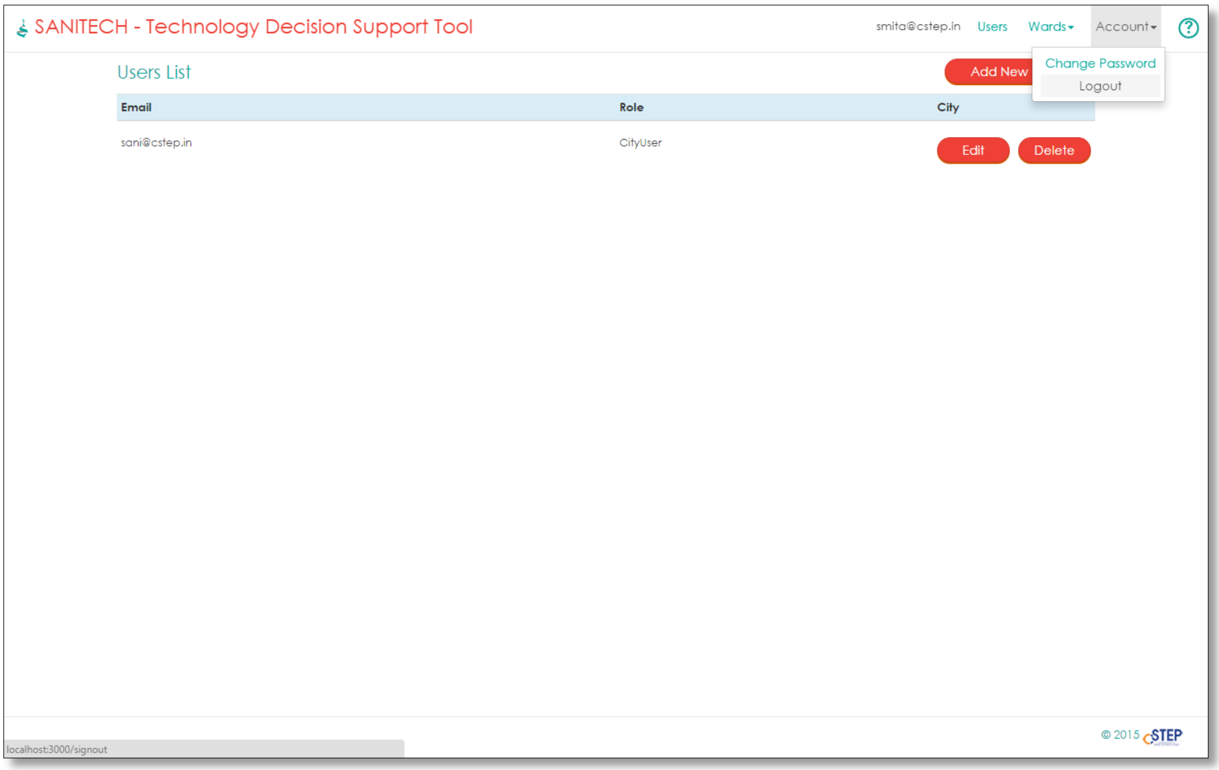


- Go to accounts option to change your password or logout





- Once you select the change password, add the new password and update it

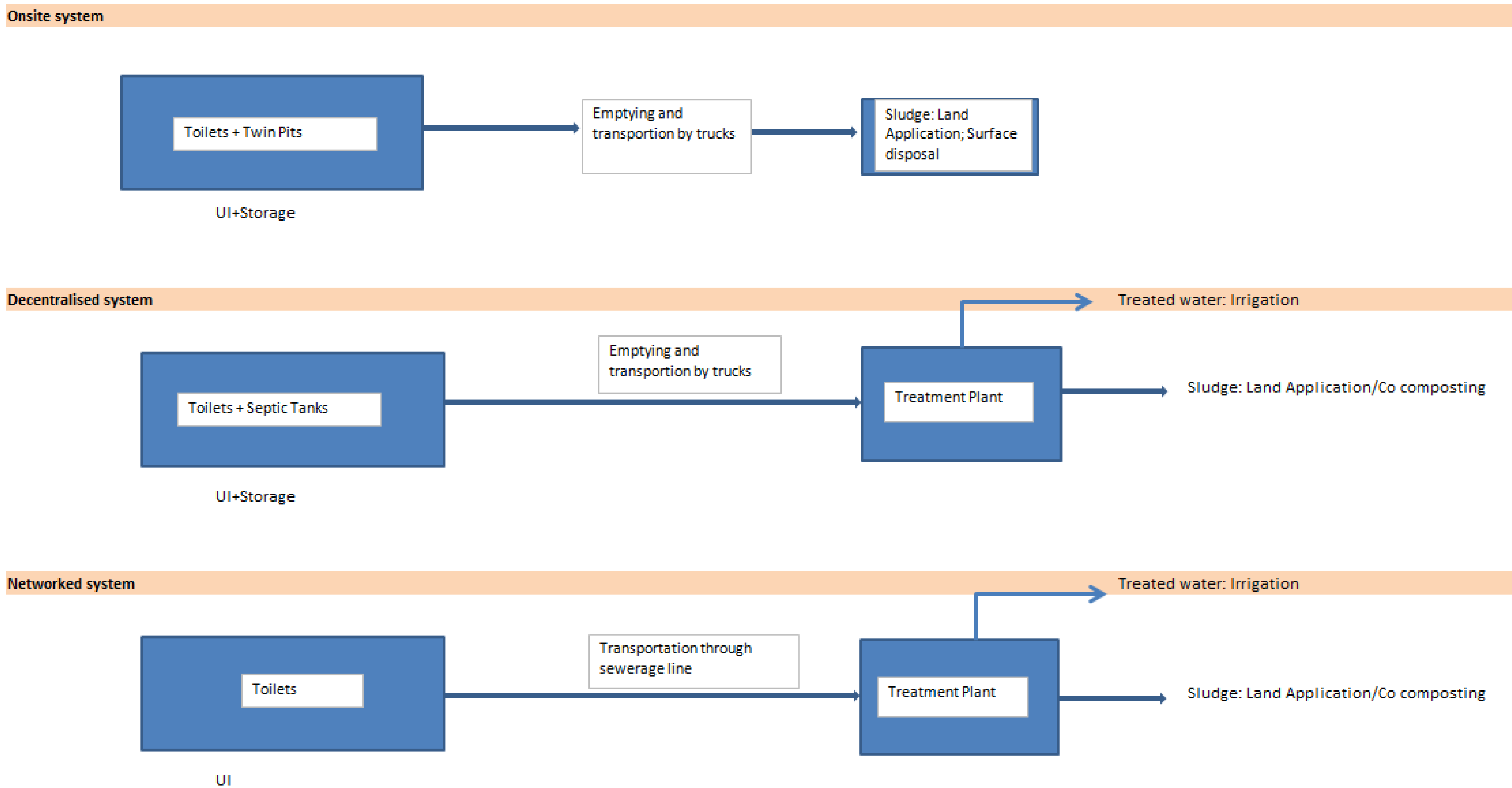


- Do logout

Annexure 1

FORMULAS USED IN ONSITE, DECENTRALISED AND NETWORKED SYSTEM IN THE TOOL

Types of System



Scenarios

If the **onsite system** is selected, % of homes having no toilets and % of homes having toilets (but no storage/collection) will be converted to onsite system.

If the **decentralised system** is selected, % of homes having no toilets, % of homes having toilets (but no storage/collection) and % of homes having toilets and septic tank will be converted to decentralised system. Community and public toilets are applicable for decentralised system.

If the **networked system** is selected, % of homes having no toilets, % of homes having toilets (but no storage/collection), % of homes having toilets and septic tank and % of homes having decentralised system (ie, all systems other than sewerage system) will be converted to networked system.

Outputs

OUTPUT PARAMETERS`		ONSITE	DECENTRALIZED			NETWORKED
		Individual	Individual	Community	Public	Individual
User interface-Number of Toilets to be constructed	Individual Toilets	Formula 1	Formula 18	NA	NA	Formula 38
	Community Toilets	NA	NA	Formula 56	NA	NA
	Public Toilets	NA	NA	NA	Formula 71	NA
Collection	Twin pits	Formula 2	NA	NA	NA	NA
	Septic tank	NA	Formula 19	Formula 57	Formula 72	NA
Treatment	Plant capacity	NA	Formula 20	Formula 58	Formula 73	Formula 39
	Efficiency of the plant					
	BOD	Formula 3	Formula 21	Formula 21	Formula 21	Formula 40
	COD	Formula 4	Formula 22	Formula 22	Formula 22	Formula 41
	TSS	Formula 5	Formula 23	Formula 23	Formula 23	Formula 42
	TN	Formula 6	Formula 24	Formula 24	Formula 24	Formula 43
	TP	Formula 7	Formula 25	Formula 25	Formula 25	Formula 44

Conveyance	number of trucks needed	NA	Formula 26	Formula 59	Formula 74	NA
Costs	CAPEX	Formula 8	Formula 27	Formula 60	Formula 75	Formula 45
	OPEX	Formula 9	Formula 28	Formula 61	Formula 76	Formula 46
	Revenue from reuse	Formula 10	Formula 29	Total O&M cost = UI cost + Manpower cost + Transportation cost + Treatment cost UI cost = Number of community toilets to be constructed * UI OPEX Manpower cost = Number of community toilets to be constructed * Manpower cost (Storage /Collection) OPEX Transportation cost = No of trucks *	Total O&M cost = UI cost + Manpower cost + Transportation cost + Treatment cost UI cost = Number of public toilets to be constructed * UI OPEX Manpower cost = Number of public toilets to be constructed * Manpower cost (Storage /Collection) OPEX Transportation cost = No	Formula 47

				Transportation OPEX Treatment cost = Plant capacity* [Primary Treatment OPEX + 60% * (Effluent Treatment OPEX + Disinfection OPEX + 30% * SludgeTreatment OPEX] Formula 62	of trucks * Transportation OPEX Treatment cost = Plant capacity* [Primary Treatment OPEX + 60% * (Effluent Treatment OPEX + Disinfection OPEX + 30% * SludgeTreatment OPEX] Formula 77	
Resource requirement	Energy required (if any)	Formula 11	Formula 30	Formula 63	Formula 78	Formula 48
	External water required (if any)	Formula 12	Formula 31	Formula 64	Formula	Formula 49
	Land requirement (Household)	Formula 13	Formula 32	Formula 65	Formula 79	Formula 50
	Land requirement (Treatment)	NA	Land requirement **(household) = Land requirement (UI) + Land requirement (storage)**	Formula 66	Land requirement (Unit wise) = Land requirement (UI) + Land requirement (storage)	Land requirement (Household) = Land requirement (UI) + Land requirement (storage)

			Formula 33		Formula 80	Formula 51
	Skill Level	Land requirement **(household) = Land requirement (UI) + Land requirement (storage)** Formula 14	Formula 34	Formula 67	Plant capacity * Land requirement primary treatment + 60% * Land requirement [effluent treatment + disinfection] + 30% *Land requirement sludge treatment **Formula 81**	Formula 52
Policy Compliance	OD free	Formula 15	Formula 35	Formula 68	Formula 82	Formula 53
	Environmental Regulation	Formula 16	Formula 36	Formula 69	Formula 83	Formula 54
	Health Regulation	Formula 17	Formula 37	Formula 70	Formula 84	Formula 55

Ward details:

Each category of population with varying types of systems are provided with the following notations.

Category of population	Notations
% of homes having toilets and septic tank	A
% of homes having toilets (but no storage/collection)	B
% of homes has sewerage system	C
% of homes having decentralised system	D
% of homes having no toilets	E= 1-A-B-C-D

Assumptions

Parameter	Units	Value
Septage Calculation		
Average volume of residential septic tank	m3/HH	3
Average volume of commercial septic tank	m3/commercial institute	10
Average volume of sludge generated/capita	L/day	0.1
No of days in a year	#	365
Weeks in a year	#	52
No of years for filling up twin pits/septic tanks	#	2
No of days for maintenance of plant	days/year	15
No of trucks calculation		
Capacity of the truck	cubic meters	10
Hours of operation per day	Hours	8
Efficiency of trucking operation	%	90%
No of persons per household	#	5
Financial calculation		
Cost of sewerage pipeline	INR/capita	2500
CAPEX Contingency	% of project cost	2%
Density of sludge	kg/L	1.5
Water sent for irrigation (applicable only in decentralised and networked system)	% of fecal sludge	20%
Sludge converted to manure for land application	%	5%

Additional assumptions used in community and public toilets:

Particulars	Value	Unit
No of community toilets per 50 households	5	#
No of public toilets per 50 households	3	#
Average volume of septic tank/biogas digester	10	m^3

Time taken for storage of sludge in septic tank/biogas digester	5	Years

Note: All commercial institutions are assumed to have septic tank systems.

Note: Text highlighted in YELLOW is taken from the system parameters in the tool.

Formulas Used in Onsite System

Formula 1

User interface- Number of Toilets to be constructed

Individual = [No of households $_{non\ slum}$ *E$_{non\ slum}$] + [No of households $_{slum}$*E $_{slum}$]

Formula 2

Collection

No of twin pits to be constructed = [No of households $_{non\ slum}$* (B+E)$_{non\ slum}$] +[No of households $_{slum}$* (B+E) $_{slum}$]

Treatment

Efficiency of the plant:

Formula 3

BOD =BOD

Formula 4

COD=COD

Formula 5

TSS=TSS

Formula 6

TN=TN

Formula 7

TP=TP

Costs

Formula 8

CAPEX

Total CAPEX = UI + Storage+ Transportation+ Contingency

UI = [No of households $_{non\ slum}$ * E $_{non\ slum}$+ No of households $_{slum}$ * E $_{slum}$*]* UI CAPEX

Storage = [No of households $_{non\ slum}$* (B+E)$_{non\ slum}$ + No of households$_{slum}$* (B+E)$_{slum}$)* Storage/collection CAPEX]

Transportation = Number of trucks * Transportation CAPEX (INR/truck)

Contingency = CAPEX Contingency * (UI + Storage)

No of homes considered for the financial calculation= (No of households$_{non\ slum}$ *(B+E) $_{non\ slum}$)+ (No of households $_{slum}$ *(B+E) $_{slum}$)

No of trucks = Volume of sludge generated/ Average septic tank volume/ Number of septic tank volumes accommodated in the truck/ Adjusted loads per day per truck

Volume of sludge generated = (No of households$_{non\ slum}$ *(B+E) $_{non\ slum}$)+ (No of households $_{slum}$ *(B+E) $_{slum}$)* No of persons per household* Avg volume of sludge generated/capita* No of years for filling up storage tanks

Number of septic tank volumes accommodated in the truck =Capacity of the truck /Average septic tank volume

Adjusted loads per day per truck= number of loads per day per truck* efficiency of trucking operation

Number of loads per day per truck = Hours of operation per day/(Estimated drive time to the home or business+ Estimated time to pump the tank+ Estimated drive time from collection site to treatment plant+ Estimated unloading time at the treatment facility+ Estimated drive time to the next home or business)

Formula 9

OPEX

Total O&M cost = UI cost +Manpower cost

UI cost = No of homes considered for the financial calculation* UI OPEX

Manpower cost = Total CAPEX * Manpower cost (Storage /Collection) OPEX

Formula 10

Revenue from Reuse

Revenue from reuse = sale of manure

Sale of manure = Quantity of manure generated for land application* Revenue from land application

Quantity of manure generated for land application = Total Sludge generated*1000* No of days in a year * Sludge converted to manure for land application * Density of sludge

Total Sludge generated = [(B+E)$_{non\ slum}$* No of households $_{non\ slum}$ + (B+E)$_{slum}$* No of households $_{slum}$]* Avg volume of sludge generated/capita* No of persons per household* No of years for filling up twin pits)/1000

Resource Requirement

Formula 11

Energy required = Energy required

Formula 12

External water required = External water required

Formula 13

Land requirement (household) = Land requirement (UI) + Land requirement (storage)

Formula 14

Skill required = Skill required

Policy Compliance

Formula 15

OD free = OD free

Formula 16

Environmental regulation = Env regulation

Formula 17

Health regulation= Health regulation

Formulas Used in Decentralized System

Formula 18

User interface- Number of Toilets to be constructed

Individual = [No of households $_{non\ slum}$ *$E_{non\ slum}$] + [No of households $_{slum}$*E_{slum}]

Formula 19

Collection

No of septic tanks to be constructed = [No of households $_{non\ slum}$* $(B+E)_{non\ slum}$] +[No of households $_{slum}$* $(B+E)_{slum}$]

Treatment

Formula 20

Plant Capacity

Plant capacity = Design flow of septage treatment facility/1000

Design flow of septage treatment facility = Flow of treatment plant for non-slum areas + Flow of treatment plant for Slum areas

> Flow of treatment plant for non-slum areas =(A* No of households * % of the septic tanks that are desludgable* Avg volume of residential septic tank/ target desluding frequency (years)/ Working days per year)+ (No of commercial institutions* Avg volume of commercial septic tank/ target desluding frequency (years)/ Working days per year) + ((B+E)* No of households* Avg volume of sludge generated/capita* No of persons per household)/1000
>
> Flow of treatment plant for Slum areas = (A* No of households * % of the pits that are desludgable* Avg volume of residential septic tank/ target desluding frequency (years)/ Working days per year)+ (No of commercial institutions* Avg volume of commercial septic tank/ target desluding frequency (years)/ Working days per year)+ ((B+E)* No of households* Avg volume of sludge generated/capita* No of persons per household)/1000
>
> Working days per year = (How many days a week will your program operate?* Weeks in a year) - No of days for maintenance of plant

Efficiency of the plant

Formula 21

BOD =BOD

Formula 22

COD=COD

Formula 23

TSS=TSS

Formula 24

TN=TN

Formula 25

TP=TP

Conveyance

Formula 26

No of trucks = Design flow of septage treatment facility/ Average septic tank volume/ Number of septic tank volumes accommodated in the truck/ Adjusted loads per day per truck

Number of septic tank volumes accommodated in the truck =Capacity of the truck /Average septic tank volume
Adjusted loads per day per truck= number of loads per day per truck* efficiency of trucking operation

Number of loads per day per truck = Hours of operation per day/(Estimated drive time to the home or business+ Estimated time to pump the tank+ Estimated drive time from collection site to treatment plant+ Estimated unloading time at the treatment facility+ Estimated drive time to the next home or business)

Costs

CAPEX

Formula 27

Total CAPEX = UI + Storage+ Transportation + Treatment+ Contingency

UI = [No of households $_{non\ slum}$ * E $_{non\ slum}$+ No of households $_{slum}$ * E $_{slum}$*]* UI CAPEX

Storage = [No of households $_{non\ slum}$* (B+E)$_{non\ slum}$ + No of households$_{slum}$* (B+E)$_{slum}$)* Storage/collection CAPEX]

Transportation = Number of trucks * Transportation CAPEX (INR/truck)

Treatment = Design flow of septage treatment facility/1000*[Primary Treatment CAPEX +60% * (Effluent Treatment CAPEX +Disinfection CAPEX) + 30% * SludgeTreatment CAPEX]

Contingency = CAPEX Contingency * (UI + Storage + Transportation + Treatment)

No of homes considered for the financial calculation= (No of households $_{non\ slum}$ * (A+B+E)$_{non\ slum}$) + (No of households $_{slum}$ * (A+B+E)$_{slum}$)

OPEX

Formula 28

Total O&M cost = UI cost + Manpower cost + Transportation cost + Treatment cost

UI cost = [No of households $_{non\ slum}$ * E $_{non\ slum}$+ No of households $_{slum}$ * E $_{slum}$*]* UI OPEX

Manpower cost = No of homes considered for the financial calculation* Manpower cost (Storage /Collection) OPEX

Transportation cost = No of trucks * Transportation OPEX

Treatment cost = Design flow of septage treatment facility/1000* [Primary Treatment OPEX + 60% * (Effluent Treatment OPEX + Disinfection OPEX + 30% * SludgeTreatment OPEX]

Revenue from Reuse

Formula 29

Revenue from reuse = Sale of treated water + sale of manure

Sale of manure = Quantity of manure generated for land application* Revenue from land application

Quantity of manure generated for land application = Total Sludge generated* Sludge converted to manure for land application * Density of sludge

Sale of treated water = Quantity of water generated for irrigation * Revenue from irrigation/1000

Quantity of water generated for irrigation = Total Sludge generated * water sent for irrigation

Total Sludge generated= [(No of households $_{non\ slum}$ * $(A+B+E)_{non\ slum}$ + No of households $_{slum}$ * $(A+B+E)_{slum}$] * No of persons per household* Avg volume of sludge generated/capita* No of days in a year

Resource Requirement

Formula 30

Energy required = Energy required

Formula 31

External water required = External water required

Formula 32

Land requirement (household) = Land requirement (UI) + Land requirement (storage)

Formula 33

Land requirement (Treatment) = Design flow of septage treatment facility/1000 * Land requirement primary treatment + 60% * Land requirement [effluent treatment + disinfection] + 30% *Land requirement sludge treatment

Formula 34

Skill required = Skill required

Policy Compliance

Formula 35

OD free = OD free

Formula 36

Environmental regulation = Env regulation

Formula 37

Health regulation= Health regulation

Formulas Used in Networked System

Formula 38

User interface- Number of Toilets to be constructed

Individual = [No of households $_{non\ slum}$ *$E_{non\ slum}$] + [No of households $_{slum}$*E $_{slum}$]

Treatment

Formula 39

Plant Capacity

Plant capacity = Design flow of septage treatment facility/1000

Design flow of septage treatment facility = [No of households $_{non\ slum}$*$(A+B+D+E)_{non\ slum}$ +* No of households $_{slum}$*$(A+B+D+E)_{slum}$]* No of persons per household* Avg volume of sludge generated/capita/1000

Efficiency of the plant

Formula 40

BOD =BOD

Formula 41

COD=COD

Formula 42

TSS=TSS

Formula 43

TN=TN

Formula 44

TP=TP

Costs

Formula 45

CAPEX

Total CAPEX = UI + Transportation + Treatment+ Contingency

UI = [No of households $_{non\ slum}$ * E $_{non\ slum}$+ No of households $_{slum}$ * E $_{slum}$*]* UI CAPEX

Transportation = [No of households $_{non\ slum}$* $(A+B+D+E)_{non\ slum}$+ No of households $_{slum}$* $(A+B+D+E)_{slum}$]* No of persons per household * Transportation CAPEX (INR/capita)

Treatment = Plant capacity* (Effluent Treatment CAPEX +Disinfection CAPEX)

Contingency = CAPEX Contingency * (UI + Transportation + Treatment)

No of homes considered for the financial calculation= (No of households $_{non\ slum}$ * $(A+B+D+E)_{non\ slum}$) + (No of households $_{slum}$ * $(A+B+D+E)_{slum}$)

Formula 46

OPEX

Total O&M cost = UI cost + Treatment cost

UI cost = [No of households $_{non\ slum}$ * E $_{non\ slum}$+ No of households $_{slum}$ * E $_{slum}$*]* UI OPEX

Treatment cost = Treatment OPEX* (Effluent Treatment OPEX +Disinfection OPEX)

Formula 47

Revenue from Reuse

Revenue from reuse = Sale of treated water + sale of manure

Sale of manure = Quantity of manure generated for land application* Revenue from land application

Quantity of manure generated for land application = Total Sludge generated* Sludge converted to manure for land application * Density of sludge

Sale of treated water = Quantity of water generated for irrigation * Revenue from irrigation/1000

Quantity of water generated for irrigation = Total Sludge generated * water sent for irrigation

Total Sludge generated= [(No of households $_{non\ slum}$ * $(A+B+D+E)_{non\ slum}$ + No of households $_{slum}$ * $(A+B+D+E)_{slum}$] * No of persons per household* Avg volume of sludge generated/capita* No of days in a year

Resource Requirement

Formula 48

Energy required = Energy required

Formula 49

External water required = External water required

Formula 50

Land requirement (Household) = Land requirement (UI) + Land requirement (storage)

Formula 51

Land requirement (Treatment) = Design flow of septage treatment facility/1000 * Land requirement [effluent treatment + disinfection]

Formula 52

Skill required = Skill required

Policy Compliance

Formula 53

OD free = OD free

Formula 54

Environmental regulation = Env regulation

Formula 55

Health regulation= Health regulation

Formulas Used in Community Toilets

Formula 56

User Interface- Number of toilets to be constructed

Community= IF (No of homes considered for community toilet>50, No of homes considered for community toilet/50*No of community toilets per 50 households), else (No of community toilets per 50 households)

No of homes considered for community toilet = [No of households $_{non\ slum}$* $E_{non\ slum}$] +[No of households $_{slum}$* E_{slum}]

Collection

Formula 57

No of septic tanks to be constructed = Number of community toilets to be constructed

Treatment

Formula 58

Plant capacity= Design flow of septage treatment facility/1000

Design flow of septage treatment facility = Number of community toilets to be constructed * 50 *Avg volume of sludge generated/capita* time taken for storage of sludge in septic tank/biogas digester/1000

Conveyance

Formula 59

No of trucks = Design flow of septage treatment facility/ Average volume of septic tank/biogas digester / Number of septic tank volumes accommodated in the truck/ Adjusted loads per day per truck

Number of septic tank volumes accommodated in the truck =Capacity of the truck /Average septic tank volume

Adjusted loads per day per truck= number of loads per day per truck* efficiency of trucking operation

Number of loads per day per truck = Hours of operation per day/(Estimated drive time to the home or business+ Estimated time to pump the tank+ Estimated drive time from collection site to treatment plant+ Estimated unloading time at the treatment facility+ Estimated drive time to the next home or business)

Costs

Formula 60

CAPEX

CAPEX = Total CAPEX/ No of homes considered for community toilet

Total CAPEX = UI + Storage+ Transportation + Treatment+ Contingency

UI = Number of community toilets to be constructed* UI CAPEX

Storage = Number of community toilets to be constructed* Storage/collection CAPEX]

Transportation = Number of trucks * Transportation CAPEX (INR/truck)

Treatment = Plant capacity*[Primary Treatment CAPEX +60% * (Effluent Treatment CAPEX +Disinfection CAPEX) + 30% * SludgeTreatment CAPEX]

Contingency = CAPEX Contingency * (UI + Storage+ Transportation + Treatment)

No of homes considered for community toilet = (No of households $_{non\ slum}$ * E $_{non\ slum}$) + (No of households $_{slum}$ * E $_{slum}$)

Formula 61

OPEX

Total O&M cost = UI cost + Manpower cost + Transportation cost + Treatment cost

UI cost = Number of community toilets to be constructed * UI OPEX

Manpower cost = Number of community toilets to be constructed * Manpower cost (Storage /Collection) OPEX

Transportation cost = No of trucks * Transportation OPEX

Treatment cost = Plant capacity* [Primary Treatment OPEX + 60% * (Effluent Treatment OPEX + Disinfection OPEX + 30% * SludgeTreatment OPEX]

Formula 62

Revenue from Reuse

Revenue from reuse = Sale of treated water + sale of manure

Sale of manure = Quantity of manure generated for land application* Revenue from land application

Quantity of manure generated for land application = Total Sludge generated* Sludge converted to manure for land application * Density of sludge

Sale of treated water = Quantity of water generated for irrigation * Revenue from irrigation/1000

Quantity of water generated for irrigation = Total Sludge generated * water sent for irrigation

Total Sludge generated= [(No of households $_{non\ slum}$ * (A+B+D+E)$_{non\ slum}$ + No of households $_{slum}$ * (A+B+D+E) $_{slum}$] * No of persons per household* Avg volume of sludge generated/capita* No of days in a year

Resource Requirement

Formula 63

Energy required = Energy required

Formula 64

External water required = External water required

Formula 65

Land requirement (Unit wise) = Land requirement (UI) + Land requirement (storage)

Formula 66

Land requirement (Treatment) = Plant capacity * Land requirement primary treatment + 60% * Land requirement [effluent treatment + disinfection] + 30% *Land requirement sludge treatment

Formula 67

Skill required = Skill required

Policy Compliance

Formula 68

OD free = OD free

Formula 69

Environmental regulation = Env regulation

Formula 70

Health regulation= Health regulation

Formulas Used in Public Toilets

Formula 71

User Interface- Number of toilets to be constructed

Public = IF (No of homes considered for public toilet>50, No of homes considered for public toilet/50*No of public toilets per 50 households), else (No of public toilets per 50 households)

> No of homes considered for public toilet = No of households $_{non\ slum}$* $E_{non\ slum}$] +[No of households $_{slum}$* E_{slum}]

Collection

Formula 72

No of septic tanks to be constructed = Number of public toilets to be constructed

Treatment

Formula 73

Plant capacity= Design flow of septage treatment facility/1000

> Design flow of septage treatment facility = Number of public toilets to be constructed * 50 *Avg volume of sludge generated/capita* time taken for storage of sludge in septic tank/biogas digester/1000

Conveyance

Formula 74

No of trucks = Design flow of septage treatment facility/ Average volume of septic tank/biogas digester / Number of septic tank volumes accommodated in the truck/ Adjusted loads per day per truck

> Number of septic tank volumes accommodated in the truck =Capacity of the truck /Average septic tank volume
>
> Adjusted loads per day per truck= number of loads per day per truck* efficiency of trucking operation
>
> Number of loads per day per truck = Hours of operation per day/(Estimated drive time to the home or business+ Estimated time to pump the tank+ Estimated drive time from collection site to treatment plant+ Estimated unloading time at the treatment facility+ Estimated drive time to the next home or business)

Costs

Formula 75

CAPEX

CAPEX = Total CAPEX/ No of homes considered for community toilet

> Total CAPEX = UI + Storage+ Transportation + Treatment+ Contingency
>
> UI = Number of public toilets to be constructed* UI CAPEX
>
> Storage = Number of public toilets to be constructed* Storage/collection CAPEX]

Transportation = Number of trucks * Transportation CAPEX (INR/truck)

Treatment = Plant capacity* [Primary Treatment CAPEX + 60% * (Effluent Treatment CAPEX + Disinfection CAPEX + 30% * SludgeTreatment CAPEX]

Contingency = CAPEX Contingency * (UI + Storage+ Transportation + Treatment)

No of homes considered for public toilet = (No of households $_{non\ slum}$ * $E_{non\ slum}$) + (No of households $_{slum}$ * E_{slum})

Formula 76

OPEX

Total O&M cost = UI cost + Manpower cost + Transportation cost + Treatment cost

UI cost = Number of public toilets to be constructed * UI OPEX

Manpower cost = Number of public toilets to be constructed * Manpower cost (Storage /Collection) OPEX

Transportation cost = No of trucks * Transportation OPEX

Treatment cost = Plant capacity* [Primary Treatment OPEX + 60% * (Effluent Treatment OPEX + Disinfection OPEX + 30% * SludgeTreatment OPEX]

Formula 77

Revenue from Reuse

Revenue from reuse = Sale of treated water + sale of manure

Sale of manure = Quantity of manure generated for land application* Revenue from land application

Quantity of manure generated for land application = Total Sludge generated* Sludge converted to manure for land application * Density of sludge

Sale of treated water = Quantity of water generated for irrigation * Revenue from irrigation/1000

Quantity of water generated for irrigation = Total Sludge generated * water sent for irrigation

Total Sludge generated= [(No of households $_{non\ slum}$ * $(1- C)_{non\ slum}$ + No of households $_{slum}$ * $(1- C)_{slum}$] * No of persons per household* Avg volume of sludge generated/capita* No of days in a year

Resource Requirement

Formula 788

Energy required = Energy required

Formula 79

External water required = External water required

Formula 790

Land requirement (Unit wise) = Land requirement (UI) + Land requirement (storage)

Formula 801

Land requirement (Treatment) = Plant capacity * Land requirement primary treatment + 60% * Land requirement [effluent treatment + disinfection] + 30% *Land requirement sludge treatment

Formula 812

Skill required = Skill required

Policy Compliance

Formula 823

OD free = OD free

Formula 834

Environmental regulation = Env regulation

Formula 845

Health regulation= Health regulation

Calculation of IRR and NPV

Steps:

1) Calculate total revenue
2) Calculate O&M cost
3) Calculate interest from term loan
4) Calculate depreciation cost
5) Calculate Earnings before interest, tax, depreciation and amortisation (EBITDA)
6) Calculate Profit before tax (PBT)
7) Calculate Tax
8) Calculate profit after tax (PAT)
9) Calculate Net Cash flow
10) Calculate NPV
11) Calculate IRR

Step 1: Calculate total revenue

User fee_i = No of homes considered for financial calculation * User fee per HH * (1+ UF_esc)^ (i-1)

Revenue from treated water $_i$ = Quantity of manure generated for land application* Revenue from land application* (1+ RM_esc)^(i-1)

Revenue from $manure_i$ = Quantity of water generated for irrigation * Revenue from irrigation/1000* (1+ RI_esc)^(i-1)

Quantity of manure generated for land application = Total Sludge generated* Sludge converted to manure for land application (%)* Density of sludge

Sale of treated water = Quantity of water generated for irrigation * Revenue from irrigation /1000

Quantity of water generated for irrigation (L) = Total Sludge generated(L) * water retrieved for irrigation (%)

Calculation of total sludge generated

Total sludge generated = Sludge generated _new (For onsite system)

Total sludge generated = Sludge generated_existing+ Sludge generated _new (For decentralised system)

Sludge generated_existing = [(No of households $_{non\ slum}$ * $A_{non\ slum}$ + No of households $_{slum}$ * A_{slum}] * % tanks desludgeable* No of persons per household* Avg volume of sludge generated* No of days in a year

Sludge generated _new = No of homes considered for financial calculation of onsite system * No of persons per household* Avg volume of sludge generated (L/day/capita)* No of years for filling twin pit*No of days in a year

if, i = 3,5,7,9

No of homes for financial calculation = Calculated value as in the previous calculations,

else (0)

Total revenue $_i$ = User fee $_i$ + Revenue from treated water $_i$ + Revenue from manure$_i$

Step 2: Calcualate O&M cost

UI OPEX i = UI OPEX * (1+ UI_esc))^(i-1)

Manpower cost i = Manpower cost * (1+ Man_esc))^(i-1)

Transportation cost i = Transportation cost (1+ transp_esc))^(i-1)

Treatment cost = Plant capacity* [Primary Treatment OPEX* (1+ ptreat_esc)^ (i-1)+ 60% * [Effluent Treatment OPEX* (1+etreat_esc)^ (i-1) + Disinfection OPEX* (1+dtreat_esc)^(i-1)] + 40% * SludgeTreatment OPEX*(1+streat_esc)^(i-1)]

Total O&M cost i = UI OPEX i + Manpower cost i + Transportation cost i + Treatment cost i

In case of onsite systems, O&M cost is calculated only for years 3,5,7,9.

Step 3: Calculate Interest from term loan

Effective interest rate = [(Interest on term loan @ market rate)* (Debt%) +(Interest subsidy from government)*Grants/100]

If (i<= Moratorium)

{

Repayment = 0

Interest i = $\frac{Debt*TotalCAPEX*Effectiveinterestrate}{100*100}$

}

else

{

$$Repayment = \frac{(Debt + Grants) * TotalCAPEX}{100 * Repaymentperiod}$$

$OB_0 = Debt\,\% * TotalCAPEX$

$CB_i = OB_i$ – Repayment

$OB_{i+1} = CB_i$

$$Interesti = \frac{(OBi + CBi) * Effectiveinterestrate}{2 * 100}$$

}

Step 4: Calculate depreciation cost

Book depreciation = Total CAPEX * Book depreciation rate/100

Step 5: Calculate EBITDA

$EBITDA_i$ = Total $revenue_i$ – Total O&M $cost_i$

Step 6: Calculate PBT

$PBT_i = EBITDA_i$ – Interest from term $loan_i$ – Book depreciation

Step 7: Calculate Tax

If (PBT>0, $Tax_i = PBT_i$ * Tax rate/100, else (0))

Step 8: Calculate PAT

$PAT_i = PBT_i - Tax_i$

Step 9: Calculate net cash flow

Net cash flow, $C_i = PAT_i$ + Interest from term loan $_i$ + Book depreciation

Step 10: Calculate NPV

Discount rate, r = [(((Debt %+ Grants) * Effective interest rate*(1-(tax rate/100))/(100*100)) + (ROE *(1-(Grants+Debt)/100)*100)]

$$NPV = \sum_{i=1}^{n} \frac{C_i}{(1+r)^i} - TotalCAPEX$$

n = lifetime of project (10 years)

Step 11: Calculate IRR

Calculate r when NPV becomes 0.