Bill & Melinda Gates foundation

City Wide Inclusive Sanitation Service Assessment and Planning

ESAWAS Regulators Association

ATHENA INFONOMICS

AGUA CONSULT

December 3, 2019

CWIS Planning – A Holistic Perspective

"The tool provides a platform for stakeholders to periodically review CW sanitation market, deliberate on investment options, make well informed structural/policy decisions"

ATHENA INFONOMICS

	Financial	Policy
National Government	• Limited budgetary headroom • Exhausted borrowing limits	• Sanitation service a right – improve access • Helps regulate environment mgt • Provides empirical justification for planning
County Government	• Assets transferred to utilities • Equity holding in utilities	• Pro-Sewerage political disposition
Regulator		• Level playing field for private sector • Balance between access, affordability and financial sustainability • Protect LIC customers • Helps appreciate cost to serve
Utility	• Capital budgeting challenge • Legacy assets • Compute to cost to serve better • Unrecovered revenues from public sector • Optimize future asset allocation • Improve accounting systems	• Cross-subsidization of LIC services • Improve operations efficiency • Partner with private sector
Private Sector	• Seeks high return (less regulated, higher risks, higher returns) • Willing to invest • Fears being crowded out	• Expects policy predictability • Interested to organize / formalize

ATHENA INFONOMICS

Tool Fundamentals

What Constitutes an Intervention – According to the Tool

SANITATION SYSTEM (HARDWARE)	REVENUE MODEL	SERVICE DELIVERY MODEL
Would the intervention comprise of an investment in a particular sanitation system/technology?	Would the intervention entail modifying the sources/method of revenue generation?	Who provides the service? How would it be provided – would it be regulated?

ATHENA INFONOMICS

Dimensions of a Sanitation Intervention

EQUITY / INCLUSIVITY	SAFETY	FINANCIAL VIABILITY
'Fairness' in **distribution** and **prioritization** of service quality, service prices, and public finance/subsidies	Amount of human waste that is safely managed	Management of resources and revenues to sustain performance

Indicator Choices for the Dimensions

EQUITY / INCLUSIVITY	SAFETY	FINANCIAL VIABILITY
1. Household Expenditure 2. Coverage and Quality of Sanitation Services for Low Income Households (LIH) 3. Subsidies/Investment Priorities and their Impact of LIH	1. Proportion of sludge that is safely managed across the sanitation supply chain – An SFD like approach	1. Net Income Projections for the Service Providers 2. Cost Coverage Ratio for the different sanitation systems

ATHENA INFONOMICS

Systems and Customer Typologies

System Number	Category	Toilet	Contain / Convey	R&T	Treatment
1	Sewer	Sewer Connection with Cistern Flush	Sewer Conventional	Sewer Conventional	WWTP
2	Sewer	Sewer Connection with Cistern Flush	Sewer Condominial - Septic Tank ABR	Vacuum Truck	WWTP
3	Sewer	Sewer Connection with Cistern Flush	Sewer Condominial - Ring Pit ABR	Vacuum Truck	WWTP
4	Sewer	Sewer Connection with Cistern Flush	Sewer Simplified - Connected to Conventional Sewers	Vacuum Truck	WWTP
5	Safe On-Site	Septic Tank (Individual) with Pour Flush	Individual Septic Tank	Vacuum Truck	WWTP
6	Safe On-Site	Septic Tank (Shared) with Pour Flush	Shared Septic Tank	Vacuum Truck	WWTP
7A	Safe On-Site	Lined Pit Latrine (Individual) with Slab	Individual Lined Pit Latrine	Manual and Transported in Barrels by Trucks	WWTP
7B	Safe On-Site	Lined Pit Latrine (Individual) with Slab	Individual Lined Pit Latrine	Vacuum Truck	WWTP
8	Unsafe On-Site	Unlined Pit Latrine (Individual) with Slab	Individual Unlined Pit Latrine	Manual and Transported in Barrels by Trucks	WWTP
9A	Safe On-Site	Lined Pit Latrine (Shared) with Slab	Shared Lined Pit Latrine	Manual and Transported in Barrels by Trucks	WWTP
9B	Safe On-Site	Lined Pit Latrine (Shared) with Slab	Shared Lined Pit Latrine	Vacuum Truck	WWTP
10	Unsafe On-Site	Unlined Pit Latrine (Shared) with Slab	Shared Unlined Pit Latrine	Manual and Transported in Barrels by Trucks	WWTP

NLIC **LIC**

Tool Workflow

Scenarios

Identify Service Delivery Models (Baseline, Planned)

Project Investments (Committed and Planned)

Determine Revenue Model (Baseline, Planned)

Coverage

Assumptions

Understanding the Demand Side – *Number of connections by system type, understanding the number of pits emptied*

Understanding Engineering Details – *ex: How large is a pit? How many HHs does it serve? No of HHs connected per KM of sewer line*

Cost and Revenue Data

What is the average tariff per meter cube for sewered households (LIC and NLIC)?

What is the price charged to the households per vacuum truck trip?

Outputs

Sustainability - Financial Analysis for Service Providers

Equity - Expenditure Analysis for Households, subsidy distribution

Safety – Overall City Level

A Look at the Tool – Using the Tool for the City of Oz

About Oz

- Oz is a small city with a population of around 500,000 and a population growth rate of 3%.
- The city currently has sewer network (serving 27% of the city's population) and two waste water treatment plants (capable of co-treatment). Both the network and the treatment plants are not well maintained and need to be rehabilitated.
- 48% of the population reside in Low Income Areas (slums, temporary settlements).
- The city's households are either connected to the sewer or have some form of on-site containment technology (septic tanks, lined pit latrines or unlined pit latrines).
- The city's utility currently has a regressive tariff system, where 30% of the water bill from **ALL** customers with access to water connection goes to sewerage sub-business.
- The utility does not regulate the removal and transportation service providers for on-site containment systems.

The Potential Interventions for Oz –Business as Usual

SANITATION SYSTEM (HARDWARE)	REVENUE MODEL	SERVICE DELIVERY MODEL
Oz utility is planning to expand the sewer network to increase sewer coverage by 7% Oz utility will invest in a new WWTP	Oz utility will continue to apportion 30% of the water bill of **ALL** their water customers	Oz utility will not intervene to regulate the removal and transportation business

The Potential Interventions for Oz – Reform with a Sewer Focus

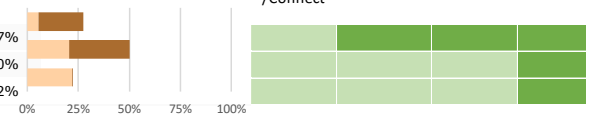
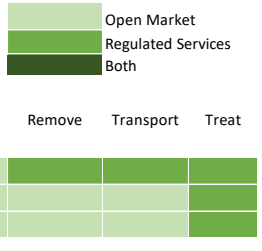
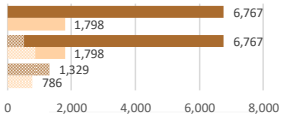
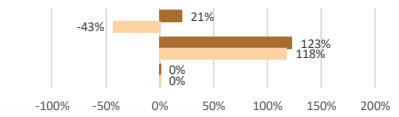
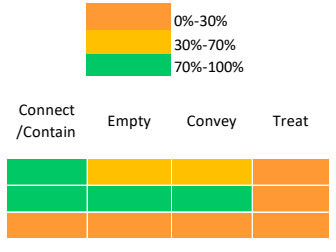
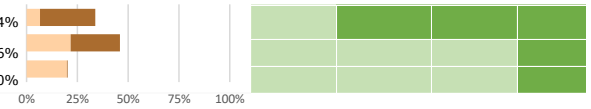
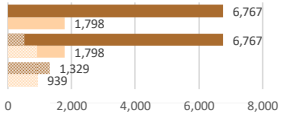
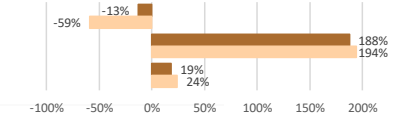
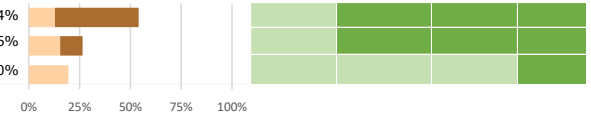
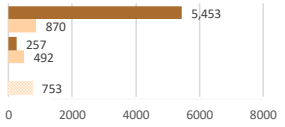
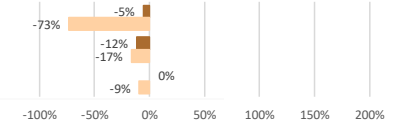
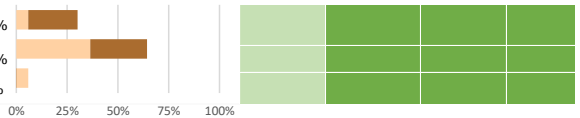
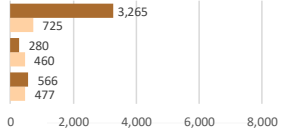
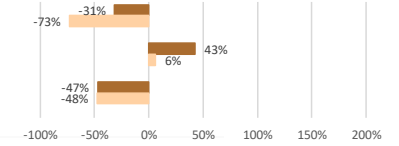
SANITATION SYSTEM (HARDWARE)	REVENUE MODEL	SERVICE DELIVERY MODEL
Oz utility is planning to expand the sewer network to increase sewer coverage by 27% Oz utility will invest in a new WWTP	Oz utility will introduce a separate volumetric tariff for all their customers connected to the sewer network The utility will increase the tariff to compensate for the expansion	The utility will sign service contracts with the open market vacuum truck operators, price control will be introduced

The Potential Interventions for Oz – Reform with a On-Site Focus

SANITATION SYSTEM (HARDWARE)	REVENUE MODEL	SERVICE DELIVERY MODEL
The utility will subsidize the construction of lined pit latrines in low income areas by 80% The utility will also invest in Mechanical Desludging Units and Transfer Trucks	Oz utility will introduce a separate volumetric tariff for all their customers connected to the sewer network The utility will actively regulate the prices of vacuum tank and MDU operators	The utility will sign service contracts with the open market vacuum truck operators, price control will be introduced The utility will provide MDUs for lease to the manual emptying groups (for free) and regulate the their prices

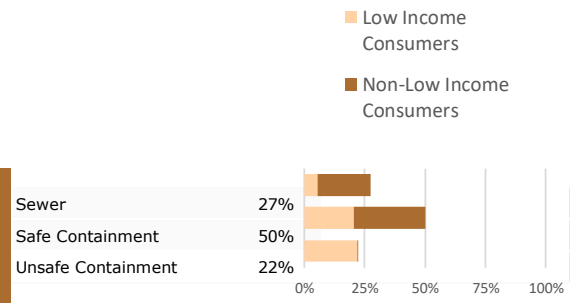
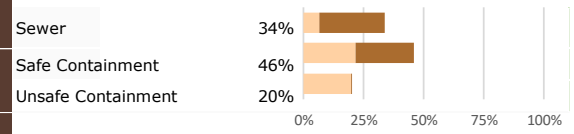
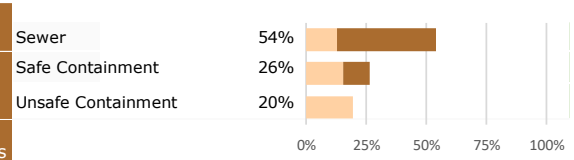
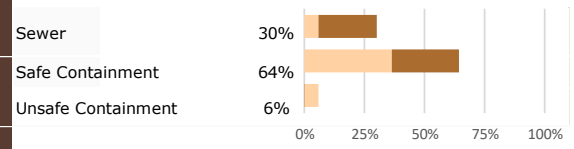
The Dashboard

CITY WIDE INCLUSIVE SANITATION SERVICE ASSESSMENT AND PLANNING TOOL - DASHBOARD - SCENARIO VIEW

SCENARIO		SERVICE SEGMENTS	POPULATION SERVED	MARKET STRUCTURE	EQUITY: ANNUAL HOUSEHOLD EXPENDITURE (Oz Dollars/HH/Year) - 2029	SUSTAINABILITY: COST TO BE RECOVERED VERSUS PRICE CHARGED - 2029	SAFETY: % OF SLUDGE SAFELY MANAGED
Baseline		Sewer 27% Safe Containment 50% Unsafe Containment 22%					
Scenario 1	Hardware: 25 KM of additional Sewer Network and Additional Waste Water Treatment Plant	Sewer 34% Safe Containment 46% Unsafe Containment 20%					
Business as Usual	Revenue Model: Remains Same						
	Service Delivery Model: Remains Same.						
Scenario 2	Hardware: 57KM of additional sewer network and a WWTP	Sewer 54% Safe Containment 26% Unsafe Containment 20%					
Reform - Sewer Investments	Revenue Model: Separate Volumetric Tariff for Sewer Customers and Price Control for Vacuum Tankers						
	Service Delivery Model: Utility introduces price control for vacuum tankers.						
Scenario 3	Hardware: 4 additional transportation trucks, 6 Mechanical Desludging Units and a Rehabilitating the WWTPs	Sewer 30% Safe Containment 64% Unsafe Containment 6%					
Reform - Onsite Investments	Revenue Model: Separate Volumetric Tariff for Sewer Customers.						
	Service Delivery Model: Utility enters Removal Business via providing MDUs and Transportation Trucks. Utility also introduces price control for vacuum tankers.						

The Dashboard – Summarizing the Scenarios

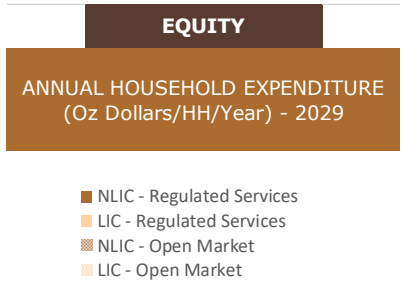
ATHENA INFONOMICS

SCENARIO		SERVICE SEGMENTS	POPULATION SERVED
Baseline			
Scenario 1	Hardware: 25 KM of additional Sewer Network and Additional Waste Water Treatment Plant		
Business as Usual	Revenue Model: Remains Same		
	Service Delivery Model: Remains Same.		
Scenario 2	Hardware: 57KM of additional sewer network and a WWTP		
Reform - Sewer Investments	Revenue Model: Separate Volumetric Tariff for Sewer Customers and Price Control for Vacuum Tankers		
	Service Delivery Model: Utility introduces price control for vacuum tankers.		
Scenario 3	Hardware: 4 additional transportation trucks, 6 Mechanical Desludging Units and a Rehabilitating the WWTPs		
Reform - Onsite Investments	Revenue Model: Separate Volumetric Tariff for Sewer Customers.		
	Service Delivery Model: Utility enters Removal Business via providing MDUs and Transportation Trucks. Utility also introduces price control for vacuum tankers.		

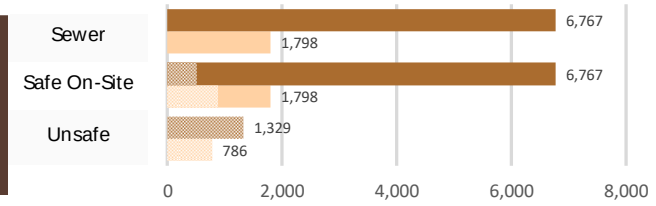
Dashboard Equity Indicator

ATHENA INFONOMICS

Scenarios Considered

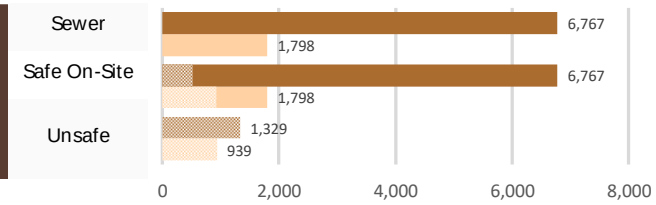


Baseline



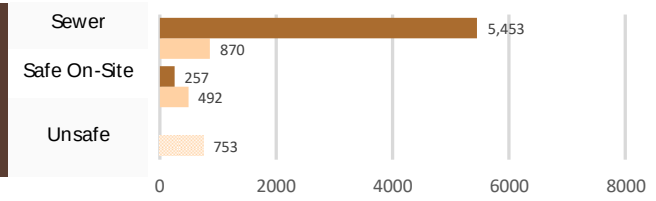
Those with safe on-site containment pay for services they never receive, artificially inflating their budget. A substantial portion of these are LIC HHs.

Scenario 1 - Business as Usual



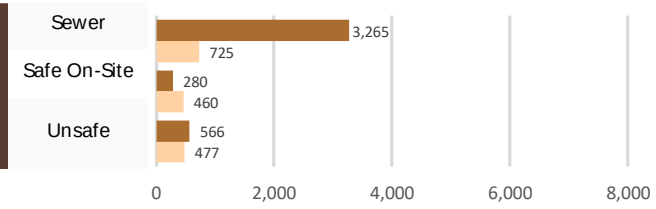
The regressive tariff system continues in the 'Business as Usual' scenario, the picture is the same as the baseline as there are no tariff reforms taken (including any increase in the tariff).

Scenario 2 - Reform with Sewer Focus



The introduction of the separate sewerage volumetric tariff system and price control regulations significantly reduces the expenditure of the households with safe on-site sanitation.

Scenario 3 - Reform with On-site Focus



The introduction of the separate sewerage volumetric tariff system and price control regulations significantly reduces the expenditure of the households with safe on-site sanitation. The utility is also helping the manual emptying groups in this scenario

Understanding the Sustainability Measure

- The sustainability measure used in the tool is the difference between the **Price Paid** for the sanitation service and the respective **Cost to Serve**.

- By 'Sanitation Service' we look at the recurring costs for the entire system from emptying/conveyance to treatment.

- We arrive at the cost to serve by dividing the total of all relevant costs associated to a service by the relevant operational metric (could be metric cube or trips based on the type of technology)

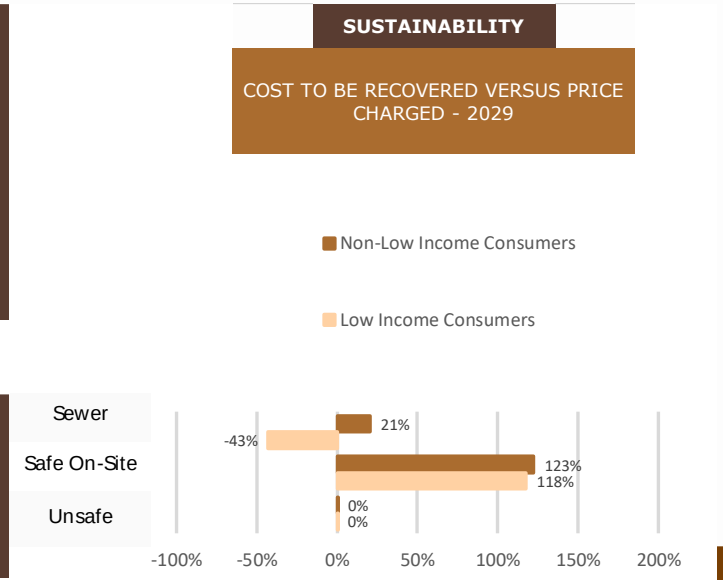
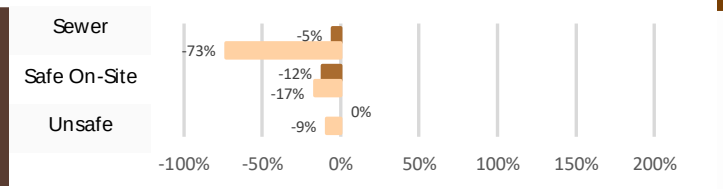
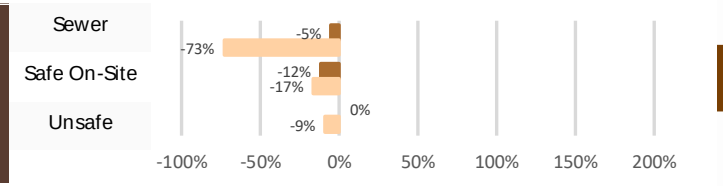
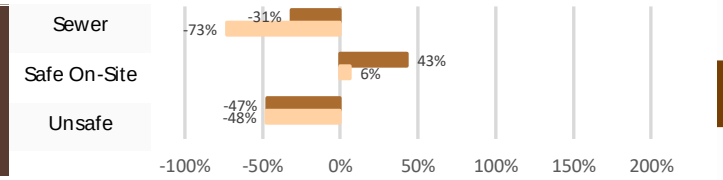
$$\frac{\text{All Relevant Direct and Indirect Costs}}{\text{Relevant Operational Metric}}$$

- We then compare this with the total price paid and standardize it by the cost. A negative number implies that the customers pay lesser than the cost of the service.

$$\frac{\text{Price Paid} - \text{Cost to Serve}}{\text{Cost to Serve}}$$

Dashboard Sustainability Indicator

ATHENA INFONOMICS

Scenarios Considered	
Baseline	
Scenario 1 - Business as Usual	
Scenario 2 - Reform with Sewer Focus	
Scenario 3 - Reform with On-site Focus	

Due to the current tariff model, the households with on-site sanitation are infact subsidizing the sewer population.

The introduction of the separate tariff system and regulations substantially brings down the profits.

The utility is almost completely subsidizing the emptying of unlined pits, and to a large extent is reducing the profit margins of the vacuum tankers. The LIC are most benefitted as they often have shared lined pits/septic tanks.

Dashboard Safety Indicator

ATHENA INFONOMICS

Scenarios Considered		SAFETY: % OF SLUDGE SAFELY MANAGED			
		0%-30%	30%-70%	70%-100%	
		Connect /Contain	Empty	Convey	Treat
Baseline	Sewer				
	Safe On-Site				
	Unsafe				
Scenario 1 - Business as Usual	Sewer				
	Safe On-Site				
	Unsafe				
Scenario 2 - Reform with Sewer Focus	Sewer				
	Safe On-Site				
	Unsafe				
Scenario 3 - Reform with On-site Focus	Sewer				
	Safe On-Site				
	Unsafe				

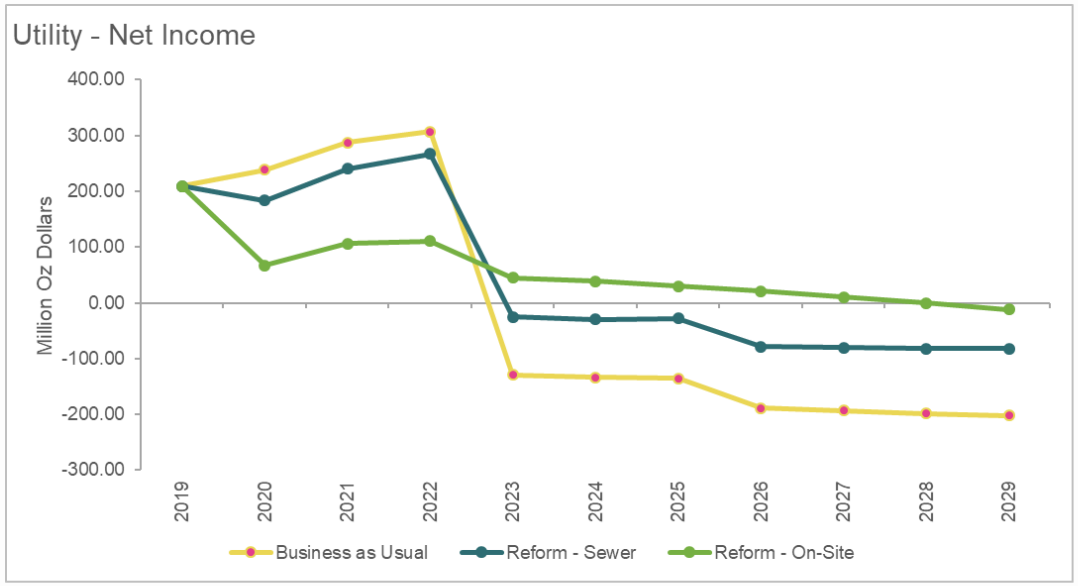
The improperly maintained sewer pipes and waste water treatment plants are causing much of the trouble.

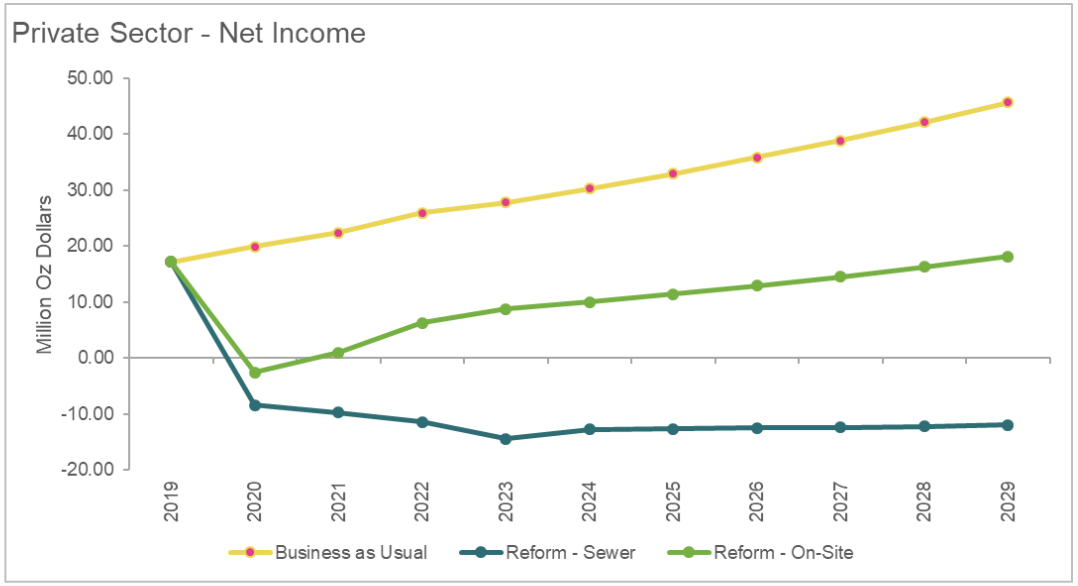
The rehabilitation of sewers and WWTP improves the safety numbers, but the lack of proper regulation of vacuum truck operators and manual emptying groups implies that not much of the sludge collected reaches the WWTP

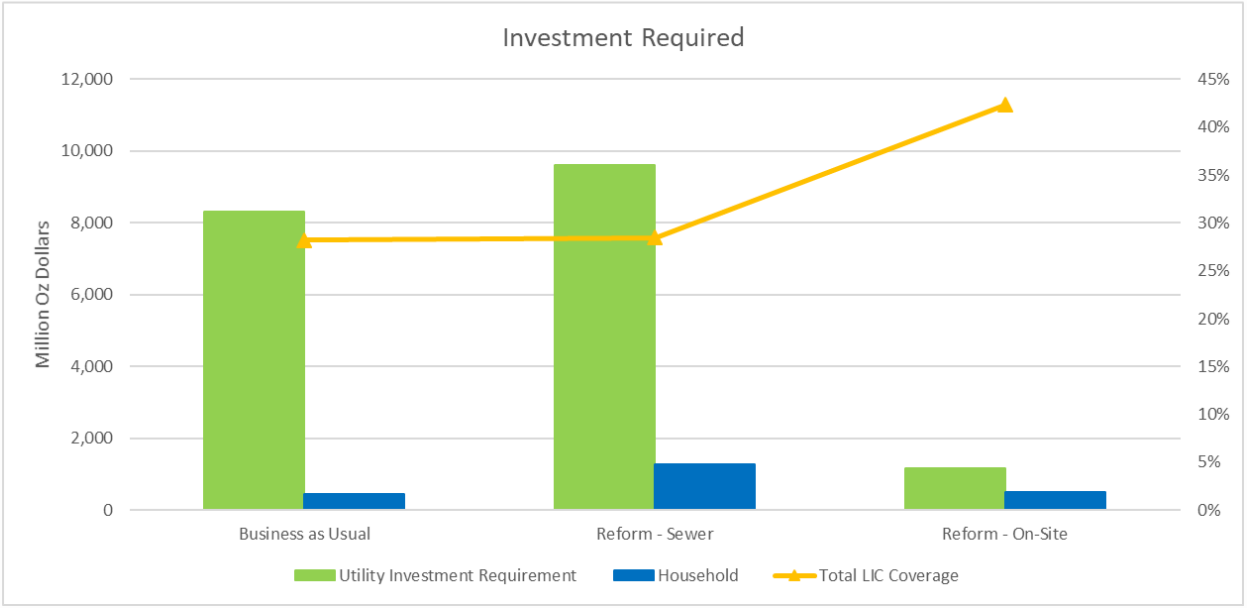
The regulation of the private sector and rehabilitation of WWTP and sewer network seems to have an impact on the safety parameters for sewer and safe on-site connections

The regulation of manual emptying groups, vacuum tanker and the rehabilitation of existing sewer and WWTP infrastructure has the highest impact on safety

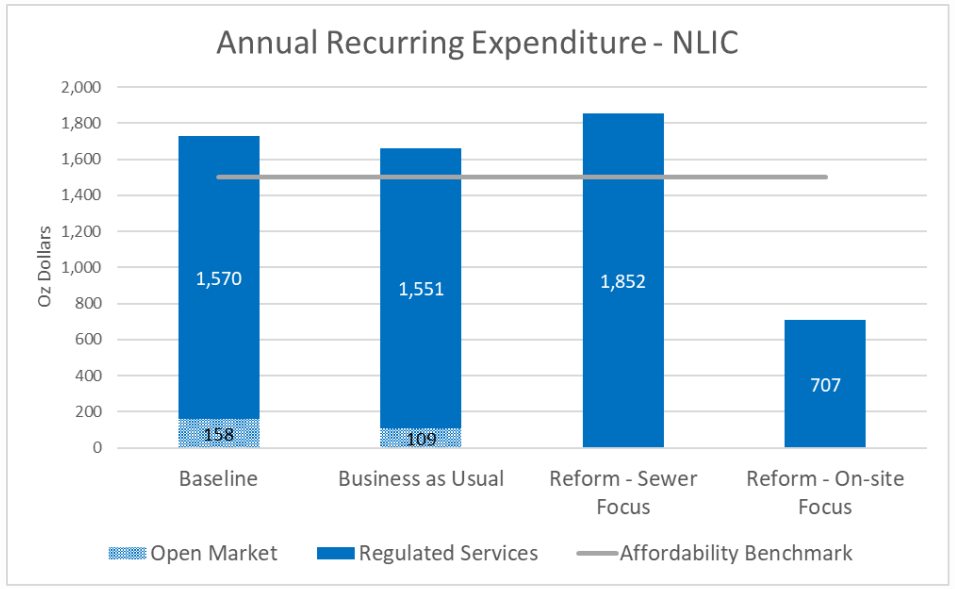
Provider View

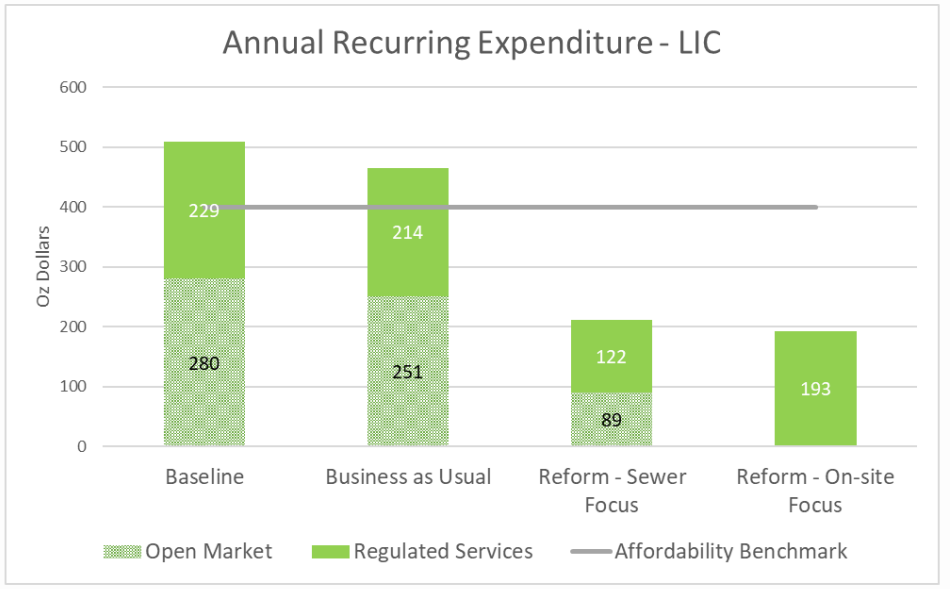


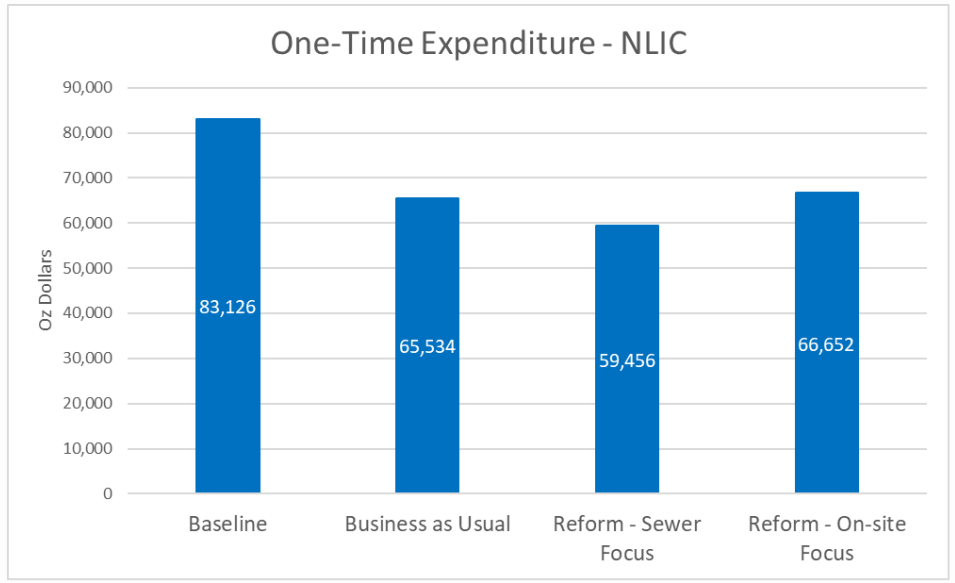


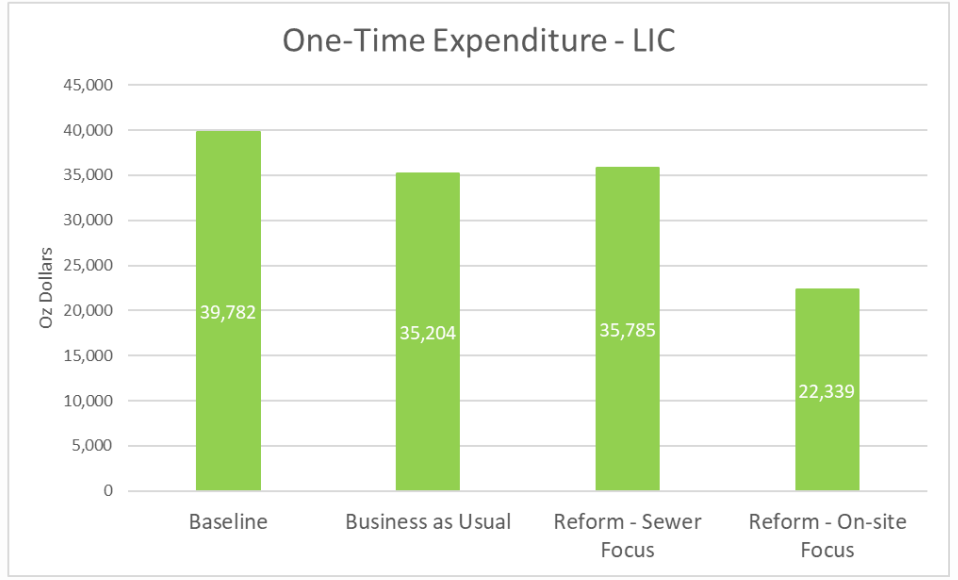


Household View

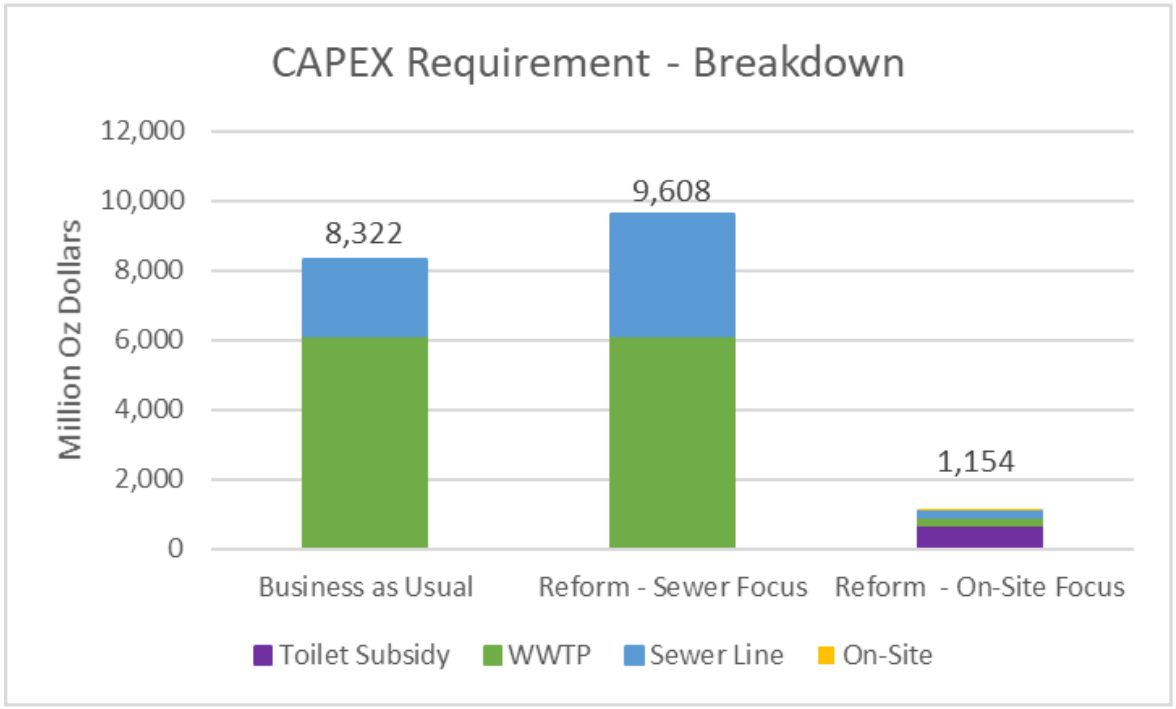


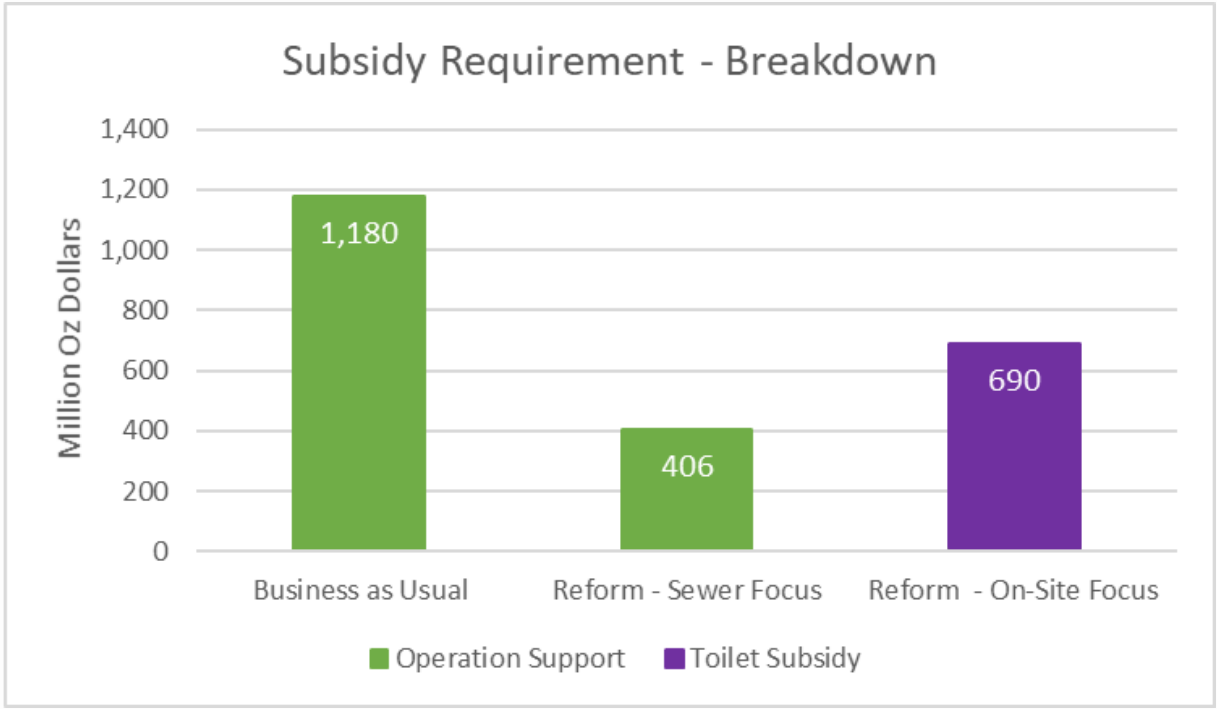






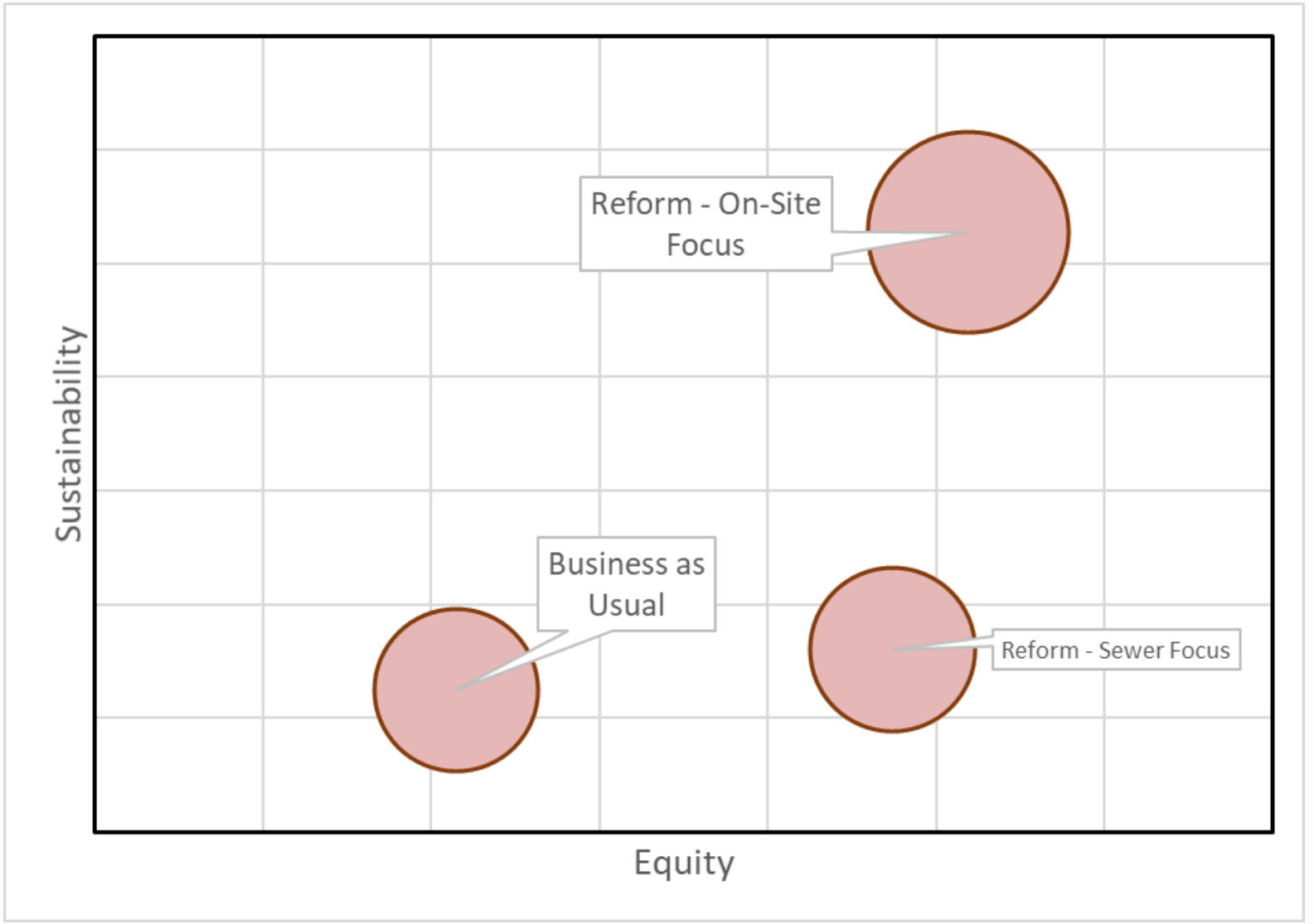
Subsidy View





ATHENA INFONOMICS

"The tool helps understand trade-offs more holistically"



Data Challenges

Data Challenges

ATHENA INFONOMICS

- **Toilet Database and Understanding of the Baseline data** – Toilet Database & Potentially Leveraging Maji Data
- **Understanding the costs and demand base for private sector** - The CACTUS initiative might greatly help in addressing this gap and understanding costs for private players
- **Repository of planning data and historical data about costs for operations** – Tools such as the tariff model in Lusaka are helping us organize such data better. City level master planning documents would also be a very useful source of data
- **Sub-business (cost center) level cost capturing** – There is a lot of interest in wanting to capture cost data at the level of the sub-business unit (sewer network, WWTP, on-site business)
- **Demand Factors** - Willingness to Pay of the consumers for sanitation systems and barriers to their uptake of technologies need to be better captured. This would help improve the accuracy of the demand estimates.

Annexure

Equity

ATHENA INFONOMICS

The price paid by a household of type i and with system t is,

$$H_{it} = \frac{\text{Price Per Event/Year}}{\#HHs * Frequency} \qquad i \in \{\text{LIC, NLIC}\}$$

The average expenditure is computed by weighting across the systems in that group,

$$E_{ic} = \sum_{t \in \{5,6,7,9\}} w_{it} * H_{it} \qquad i \in \{\text{LIC, NLIC}\}$$

The weights are arrived at by the relative proportion of population in the type (LIC/NLIC) with system t,

$$W_{it} = \frac{\%\, HH_{it}}{\sum_{j \in \{5,6,7,9\}} \%HH_{ij}} \qquad i \in \{\text{LIC, NLIC}\}$$

System Number (t)	Description	Category (c)
System 1	Conventional	Sewer
System 2	Condominial 1	Sewer
System 3	Condominial 2	Sewer
System 4	Simplified	Sewer
System 5	Ind. ST	Safe On-Site
System 6	Shared ST	Safe On-Site
System 7A	Ind. PL (Manual)	Safe On-Site
System 7B	Ind PL (Vacuum)	Safe On-Site
System 8	Ind Pl (Unhygenic)	Unsafe On-Site
System 9A	Shared. PL (Manual)	Safe On-Site
System 9B	Shared PL (Vacuum)	Safe On-Site
System 10	Shared Pl (Unhygenic)	Unsafe On-Site

Sustainability

The cost to serve per meter cube for system t is[1],

$$C_t = \frac{\text{Direct Costs and Apportioned Indirect Costs}}{\text{m}^3 \text{ of Sludge Handled}}$$

The cost to serve for a event (example – desludging an individual pit) is,

$$R_{it} = C_t * V_{it} \ , i \in \{\text{LIC, NLIC}\}$$

The weighted average difference between the cost to serve and the price paid per event is reported,

$$E_{ic} = \sum w_{it}(P_{it} - R_{it}) \qquad i \in \{\text{LIC, NLIC}\}$$

The weights are arrived at by the relative proportion of population in the type (LIC/NLIC) with system t,

$$W_{it} = \frac{\%\, HH_{it}}{\sum_{j\in\{1,2,3,4\}} \%HH_{ij}} \qquad i \in \{\text{LIC, NLIC}\}$$

System Number (t)	Description	Category (c)
System 1	Conventional	Sewer
System 2	Condominial 1	Sewer
System 3	Condominial 2	Sewer
System 4	Simplified	Sewer
System 5	Ind. ST	Safe On-Site
System 6	Shared ST	Safe On-Site
System 7A	Ind. PL (Manual)	Safe On-Site
System 7B	Ind PL (Vacuum)	Safe On-Site
System 8	Ind Pl (Unhygenic)	Unsafe On-Site
System 9A	Shared. PL (Manual)	Safe On-Site
System 9B	Shared PL (Vacuum)	Safe On-Site
System 10	Shared Pl (Unhygenic)	Unsafe On-Site

[1] For vacuum tankers, this is done at a event/trip level (denominator) and not by volume