Ilembe District Municipality

Review of the Technical Asset Register and Data Quality Standards

Part B: Sewer

May 2023

Table of Contents

1 Introduction & Background 4

2 Asset Register Statistics 5

3 Element Definition Problems 6

3.1 Data Connectivity Issues 6

3.1.1 Duplicate Elements 7

3.1.2 Connectivity Problems 7

3.1.3 Standalone Elements 8

3.1.4 Sewer Nodes without Elements on Top 8

3.1.5 Elements without D/S chain defined or Referencing Invalid D/S Chain 8

4 Element Attribute Issues 9

4.1 Missing Sewer Node Elevations (9,634) 9

4.2 Missing Manhole Elevations (3,791) 9

4.3 Sewers without Elevations (6,415) 10

4.4 Sewers with Inlet Level lower than their Outlet Level (137) 11

4.5 Pump Stations and Pump Configuration (104) 11

4.6 Sewers without Library Information or with 0 diameter (6,649) 11

4.7 Sewers Library Usage (10) 12

5 Network and Zoning Problems 13

5.1 Possible Missing Network 13

5.2 Missing Pump Lines/ Disconnected main components 14

5.2.1 Disconnected Manholes 14

5.2.2 Misplaced Manholes 14

5.2.3 Disconnected Pump Stations / Wrong pump line connection 15

5.2.4 Disconnected networks in Zoning 16

5.3 Rules for Zone definition (naming of zones) 18

5.4 Sewer Zones 18

5.4.1 Treatment Plants, Pump Stations, Catchment Nodes 19

6 Attachment 1: Asset Register Final Evaluation Tables for Sewer 20

List of Acronyms

AOI	Area of Interest
IDM	iLembe District Municipality
NDM	EDAMS Network Data Management
PS	Sewer Pump Station

List of Definitions

Compound Elements	Elements (Assets) that have a configuration such as pump stations, reservoir sites, meter chambers, control valve chambers, etc., where their main components are captured.
Element	Element refers to Asset (e.g., a specific pump)
Element Configuration	Element configuration holds the main components of compound element types. For example, a pump station configuration will hold all PS pumps in their respective configuration (e.g., installed in series or parallel).
Element Type	Element Type refers to Asset Type (e.g., pumps)
Library	A set of attributes per asset type grouped together into a library item. The Sewer network data model includes libraries for: sewers, pump lines and pumps.
Topological Elements	Topological elements are abstract in the sense that they do not refer to an actual entity in the field. Topology is used to define the relationships and connectivity of the elements in the EDAMS data model
Sewer Chain	A topological element type that establishes network connectivity for chain elements (sewers, pump lines, conduits, etc.)
Sewer Node	A topological element type that establishes network connectivity for node elements (pump stations, manholes, STPs, etc.)
Zoning	Zoning refers to Sewer/Catchment Zones

1 Introduction & Background

This report evaluates the information in the current Asset register, identifies changes that must be made and identifies areas that need further investigation with the objective of achieving an accurate representation of the Sewer network in *EDAMS Network Data Management (EDAMS-NDM)*.

A brief overview and timeline of the work carried out for the Sewer Network data conversion exercise is described in the section below:

1. The work started with the pre-processing of the external data provided by the IDM. This involved, fixing connectivity issues, attribute issues, and setting up external shapefiles as per the required EDAMS format. Some of the key findings are shown below:
    a. The IDM provided various datasets for the same network (as builts, master plans, esri generated from VILP/I/041, etc.).
    b. The datasets had multiple duplicates (exact location duplicates with exact attributes).
    c. The datasets had multiple duplicates with minor length changes (e.g., a pipe on top of another pipe with coverage 95%).
    d. Attributes existing in one dataset but not in others.
    e. Pump lines joined with sewers without clear indication, etc.

    Data pre-processing was performed to consolidate information, attributes, features, etc.
2. The above process was repeated multiple times in order to achieve the best possible result for every asset type. Every pre-processing was followed by EDAMS data conversion, then data evaluation, etc., to receive feedback from the system.
3. Consequently, the consultant proceeded with the final import of the pre-processed layers into the system.

This evaluation report will help the municipality with any problems regarding both, above and below ground assets, attributes, missing network, and zoning information so that the municipality can begin to address them as soon as possible with the objective of completing the Technical Asset Register with meaningful and correct information.

Please note that this report must be read in conjunction with Attachment 1 (Excel file). The attachment provides a detailed list of all relevant issues individually, along with their respective attributes and information. This information will help the Municipality in prioritizing the assets that require fixing and determining the order in which they should be addressed.

2 Asset Register Statistics

No	Element Type	Total no of Network Elements
Sewer Network		
1	Sewer Nodes	9,634
2	Sewer Chains	7,369
3	Sewer Pipes	7,345
4	Sewer Conduits	0
5	Sewer Manholes	3,791
6	Sewer Pump Stations	104
7	Sewer Pumps	0
8	Sewer Treatment Works	12
9	Sewer Storage Ponds	0
10	Sewer Connections	0
11	Sewer Pump Lines	22
12	Sewer Isolation Structures	0

There are 299 km of sewer pipes A breakdown per material type and per diameter is shown in the tables below:

Material	No of Pipes	Water Pipes length (km)
Unknown	7,117	292.06
Asb.-Cement	4	0.11
HAC	224	7.32
Totals	**7,345**	**299**

Nominal Diameter	No of Pipes	Pipe Length (km)
0	6,790	278.74
100	32	0.88
150	485	18.15
200	4	0.26
250	24	1.00
300	8	0.40
375	2	0.06
Totals	**7,345**	**299**

Note: 0 diameter is used to denote unknown

Furthermore, the pipe's age is calculated based on their commissioning date (according to the received data) and grouped as follows:

No	Age	No of Pipes	GIS length (km)
1	0-10 years	-	-
2	11-25 years	-	-
3	26-50 years	-	-
4	51-80 years	-	-
5	Unknown	7,345	299

Note: Year 1899 is used to denote unknown dates

3 Element Definition Problems

In this section we describe all different data issues regarding the connectivity of the network, the data attribute problems as well as discuss about vital missing elements.

A summary of the errors and warnings is shown below:

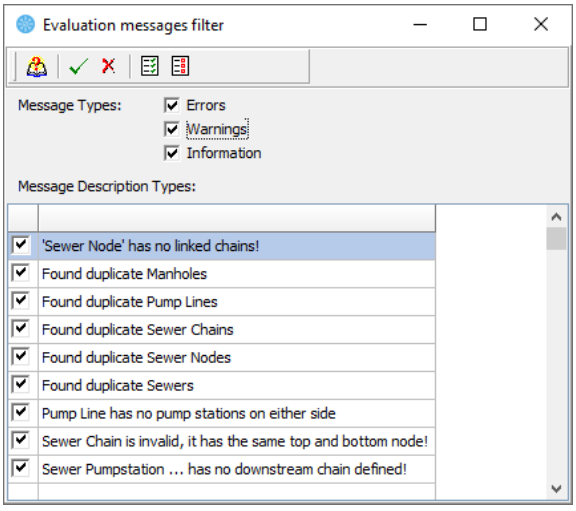
Report Code	Description	No of Records	Comments
Connectivity Errors/Warnings			
ARE.1.1	Standalone Sewer Nodes	2,146	Delete standalone nodes if no elements on top/ Connect to the network if other assets on top
ARE.1.2	Duplicate Sewer Nodes	89	Delete duplicate node if no elements on top / Investigate if duplicate location is correct
ARE.1.3	Duplicate Manholes	42	Delete duplicate element / Move to correct location if not duplicate
ARE.1.4	Duplicate Sewer Chains	14	Delete duplicate element / Move to correct location if not duplicate
ARE.1.5	Duplicate Sewers	8	Delete duplicate element / Move to correct location if not duplicate
ARE.1.6	Duplicate Pump Lines	6	Delete duplicate element / Move to correct location if not duplicate
ARE.1.7	Sewer Chain is invalid	6	Investigate and fix in Network Data Management
ARE.1.8	Pump Line without PS on either side	11	Investigate and fix in Network Data Management
ARE.1.9	Pump Station without D/S chain defined	104	Investigate and fix in Network Data Management
ARE.1.10	Manhole has more than 1 outgoing Sewer	76	Investigate and fix in Network Data Management
ARE.1.11	Sewer Nodes Without Manholes on top	5,727	Investigate and fix in Network Data Management
Element Attribute Errors			
ARE.2.1	Sewers Without Library	141	Investigate and fix in Network Data Management
ARE.2.2	Manholes with missing Elevations (Invert, Top level or Depth)	3,791	Field Investigation needed unless data found in digital format
ARE.2.3	Sewers without Elevations	6,415	Field Investigation needed unless data found in digital format
ARE.2.4	Sewers with Inlet Level lower than their Outlet Level	137	Investigate and fix in Network Data Management
Main Elements & their Attributes			
ARE.3.1	List of Manholes	3,791	Check records with empty values
ARE.3.1	List of Sewer Chains	7,369	Check records with empty values
ARE.3.1	List of Sewer Pump Stations and their Pumps	104	Check records with empty values
Sewer Libraries			
ARE.4.1	Sewers Library Usage	10	Fix if required
Zoning			
ARE.5.1	Catchment Zones	182	Setting up of Sewer Zones is an on going exercise

The image is taken out of Attachment 1, where you can find all detailed lists for each error category plus a list of summaries per element.

3.1 Data Connectivity Issues

By analysing the data and more specifically the data connectivity issues we found that there are multiple errors and warnings regarding the actual connectivity of the network, however, there are a lot more errors regarding the required and highly essential attributes that need to be captured.

The image below shows the different types of the network connectivity issues found in the existing database:



As seen above the issues can be grouped into three main categories:

1. Duplicate elements (Nodes, chains, pipes, manholes, pump lines)
2. Standalone elements (Nodes)
3. Elements without D/S chain defined (Pump Stations, Isolation Structures, etc)
4. Pump Lines without Pump Stations on either side
5. Invalid Chains

3.1.1 Duplicate Elements

3.1.1.1 Duplicate Sewer Nodes (89)

There are 89 duplicate sewer nodes. If these duplicates sewer nodes are also standalone then they can be deleted without any problems. Otherwise, the users need to investigate the connectivity in order to ensure that no other necessary data are deleted. Remember that by deleting a sewer node, you are deleting everything that 'sits' on top of it (e.g., manholes, pump stations, etc.).

3.1.1.2 Duplicate Manholes (42)

There are 42 duplicate manholes. Duplicate manholes also have a duplicate sewer node beneath them. These manholes must be investigated and either deleted or moved to the correct location.

3.1.1.3 Duplicate Sewer Chains (14)

There are 14 duplicate sewer chains. Sewer chains are a virtual asset type, and it exists purely to retain the network connectivity within the system. Sewer chains have other assets on top such as, sewers and pump lines, therefore their deletion must be investigated so as to not delete any other important assets.

3.1.1.4 Duplicate Sewers (8)

There are 8 duplicate sewers. Duplicates should be investigated and deleted within the system.

3.1.1.5 Duplicate pump lines (6)

There are 6 duplicate pump lines. Duplicates should be investigated and deleted within the system. Pump lines were inferred from the initial dataset as lines with more than 3 segments located close to pump stations as there wasn't any flag within the attributes separating sewers from pump lines.

3.1.2 Connectivity Problems

Data Connectivity problems consist of errors regarding the system rules for connectivity.

3.1.2.1 Manholes with more than 1 Outgoing Sewer (76)

This kind of error is fundamental, and it's not allowed in the system due to connectivity rules. Having more than 1 outgoing sewer connected to the same manhole is not accepted since such a connection is not permitted in the field as well. Currently,

there are 76 such errors in the system. The users need to carefully investigate and do one of the following:

- Delete the unwanted sewer(s) OR
- Reverse the chain in order to change the flow direction of one of the sewers to ingoing at the manhole. OR
- Capture an isolation structure instead of a manhole if this is checked by field validation.

In any case, at the end there must be only one outgoing sewer connected to any single manhole.

3.1.2.2 Pump Line without PS on either side (11)

There are 11 pump lines without any pump stations on either side of the pump line. This kind of error is fundamental, and it's not allowed in the system due to connectivity rules. The municipality must investigate and either move the line to the correct pump station or vice versa. If the pump line is actually a sewer, then the users must transfer the line to sewer and delete the pump line.

3.1.2.3 Invalid Sewer Chains (6)

The error "invalid sewer chains" refers to chains that have the same bottom and top node (i.e., creating a close circuit by itself) which is something that cannot exist in real life. All errors of this type must be rectified within the system either by deleting the chain or by breaking the close circuit (e.g., by splitting the chain in two).

3.1.3 Standalone Elements

All standalone elements need to be investigated and fixed.

3.1.3.1 Standalone Sewer Nodes (2,146)

Check if standalone nodes have any other asset on top (e.g., manhole, pump station, etc.) and fix accordingly. If no other asset on top, then it's safe to delete the node.

3.1.4 Sewer Nodes without Elements on Top

3.1.4.1 Sewer Nodes without Manholes on top (5,727)

There are 5,727 sewer nodes that do not have a manhole or any other asset on top of them. As per EDAMS NDM connectivity rules, a manhole must always be on top of any sewer node except when the node has some other element on top (i.e., pump station, isolation structure, treatment plant, etc). So, under any circumstances, all sewer nodes should and must have an element on top.

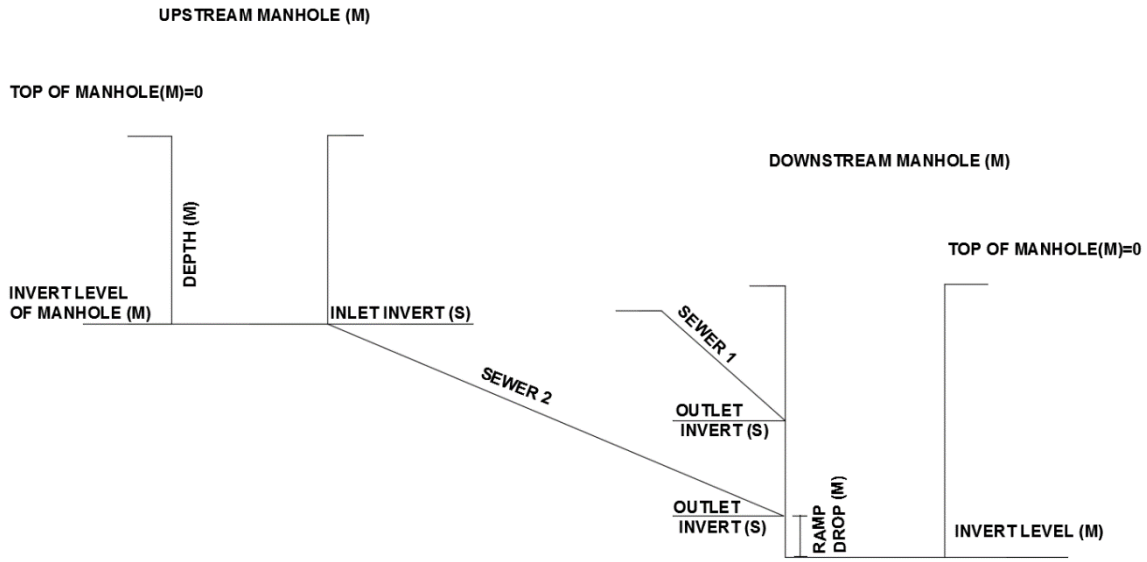
3.1.5 Elements without D/S chain defined or Referencing Invalid D/S Chain

3.1.5.1 Pump Stations without D/S chain defined (104)

There are 104 pump stations that are missing their downstream chain definition. In order to fix this error type, the municipality needs to capture the pump lines in the network (if missing) and then indicate the D/S (i.e., pump line) of every pump station in the network.

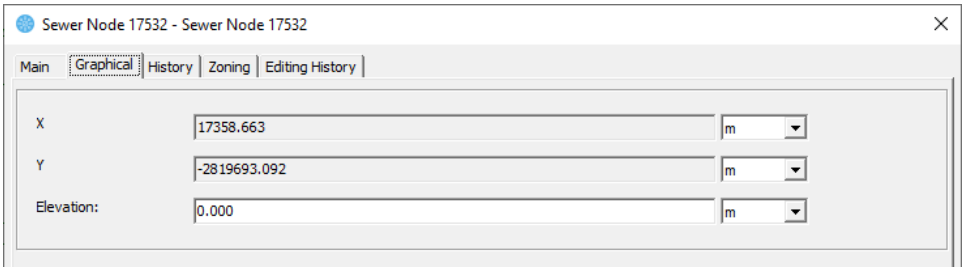
4 Element Attribute Issues

The data attribute and configuration issues refer to errors and warnings concerning the necessary attributes of the network elements. Such attributes can be the sewer pipes libraries, the manhole/sewer elevations and slopes, the compound element configurations (such as pump details, etc) as well as secondary attribute problems that help to complete the asset registry. In this report we will only refer to the important attributes, the ones that are vital for a correct asset registry. To better understand important attributes on manholes and sewers use the following diagram in conjunction with the error messages within the below sections:



4.1 Missing Sewer Node Elevations (9,634)

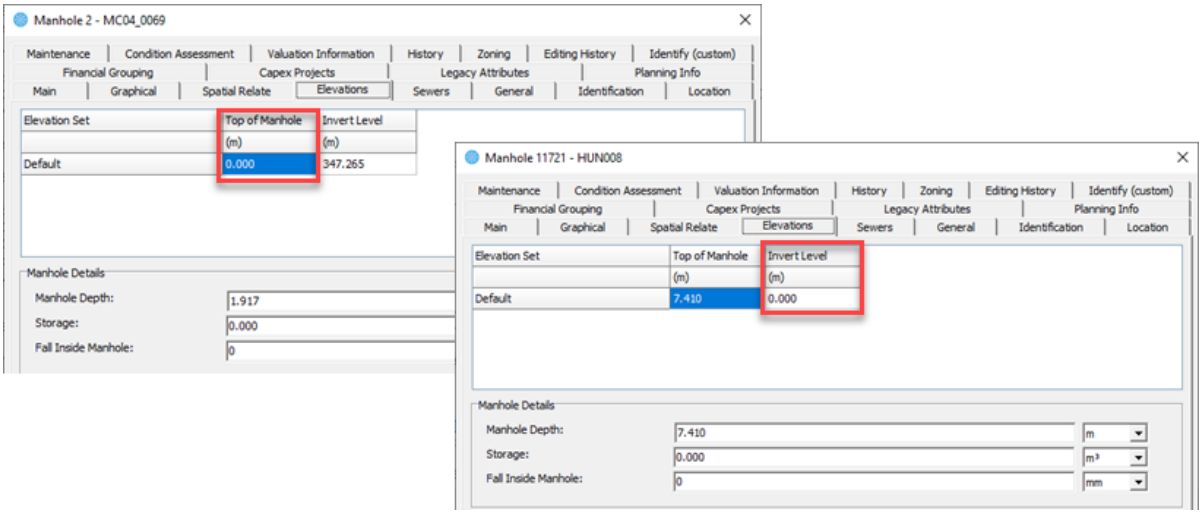
All sewer nodes are without an elevation. Contour lines can be used to update the node elevations in bulk. However, for important elements such as manholes, sewer levels, treatment works, storage ponds, etc it's advisable to use surveyed elevations instead.



4.2 Missing Manhole Elevations (3,791)

There are 3,791 (all) manholes without either Top Manhole Level, Invert Level or Depth. This information is essential to the system, since the sewer slopes are calculated directly from the manhole elevation sets.

A few different examples are shown below:

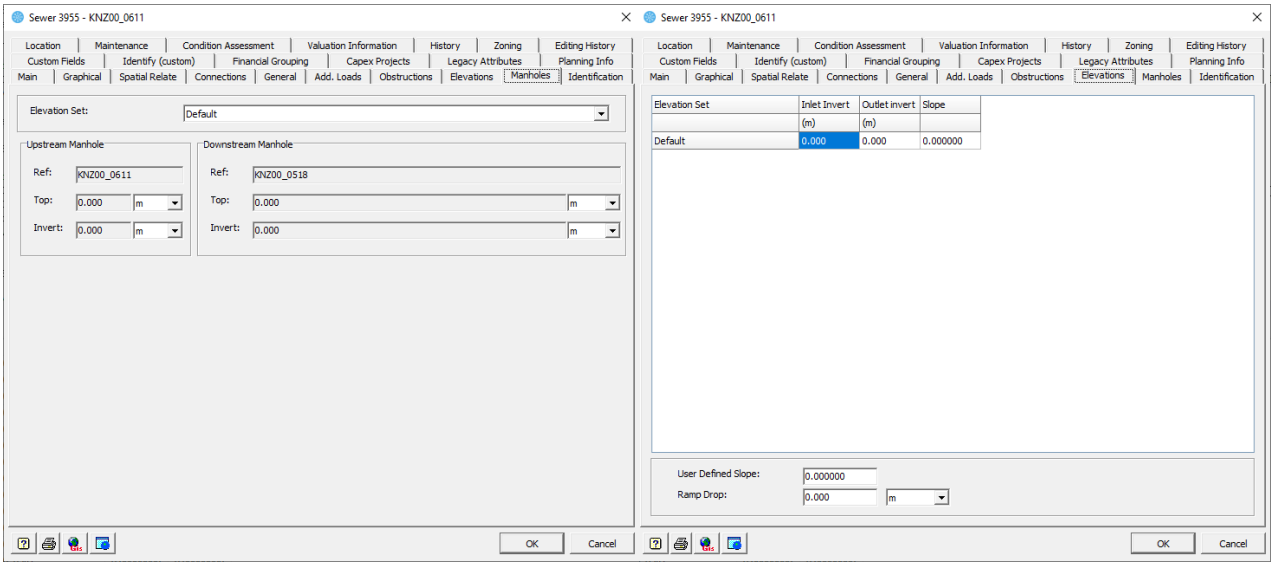


The data should exist in some form of document from the contractors that carried out the implementation. Please investigate and capture all necessary information. If information is not readily available, then field validations are recommended.

The information can be captured in the EDAMS Sewer excel templates and then imported into the system in bulk rather than capturing manually one-by-one.

4.3 Sewers without Elevations (6,415)

There are 6,415 out of 7,345 sewers without elevations. The two images below show the essential information that needs to be captured for the sewer levels.

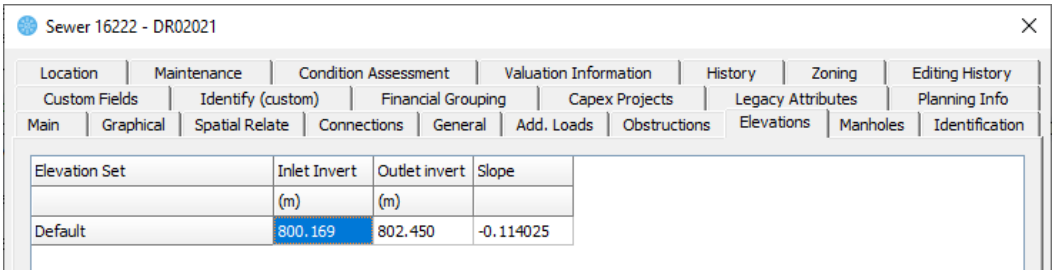


If the manhole levels are captured correctly, then the inlet/outlet invert levels (in the elevation set) will be calculated automatically. The user has the option to manually define the slope, if the calculated one is not correctly defined and differs from what actually is in the field. Moreover, they can introduce ramp drops whenever they exist in the field. Usually, the user defined slope is used when ramp drops exist.

Please investigate, find any information you have on the element elevations and levels and use them to update the current asset registry.

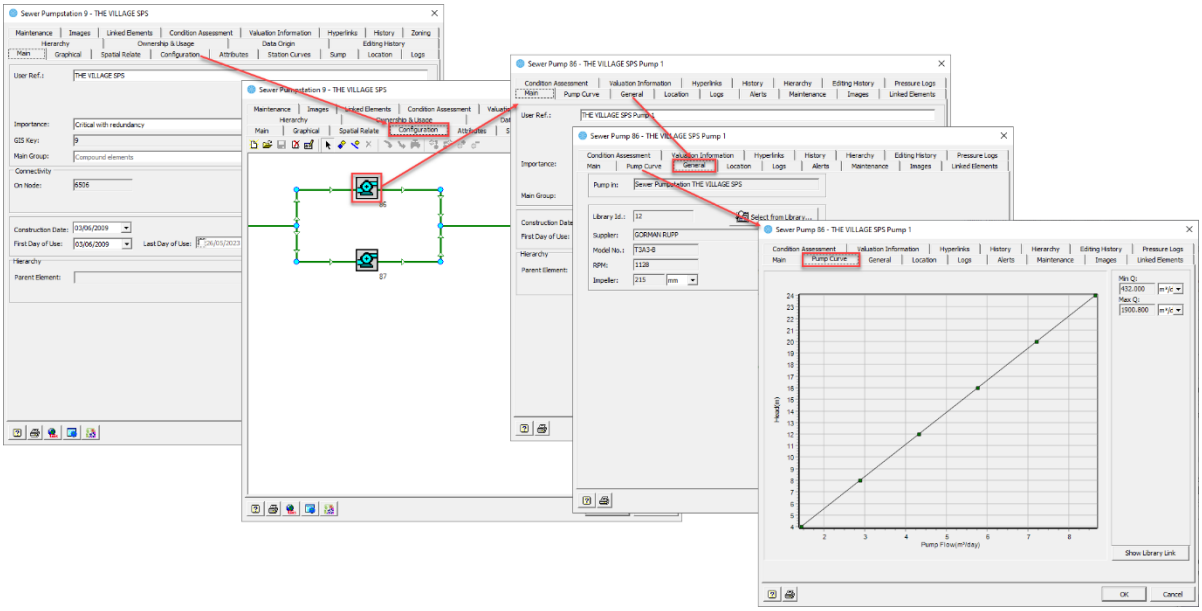
4.4 Sewers with Inlet Level lower than their Outlet Level (137)

There are 137 sewers where their inlet level is lower than their outlet level. If the elevation information is correct, then there must be a lift pump in the manhole, and this is not indicated under the upstream manhole information. Please investigate and fix in EDAMS NDM. An example of such issue is shown below:



4.5 Pump Stations and Pump Configuration (104)

There are 104 pump stations within the Sewer Asset Register. None of them has a configuration (as expected), therefore the municipality must go through and capture the missing pumps within the correct configuration (no of pumps, parallel/series). An example of a complete pump station configuration can be seen below:



The pump station has a reference, D/S chain, and it has a configuration with two pumps installed in parallel. The pumps have a reference, they have a library attached and the library has the pump curve defined. This is an example of a correctly defined pump station.

4.6 Sewers without Library Information or with 0 diameter (6,649)

There are 6,649 sewers without library information or with default library attached where diameter is equal to 0. As you can understand this is essential information for the asset

registry, for rehabilitation planning, maintenance, sewer load analysis, etc. Without sewer diameters, elevations and slopes the registry is considered incomplete. Complete list as mentioned in previous sections can be found in Attachment 1.

4.7 Sewers Library Usage (10)

Currently there are only 10 different library items used within the sewer pipes network. You can see below the complete list of libraries used in the system along with the number of sewer pipes connected to them and the sewers length in total for each category.

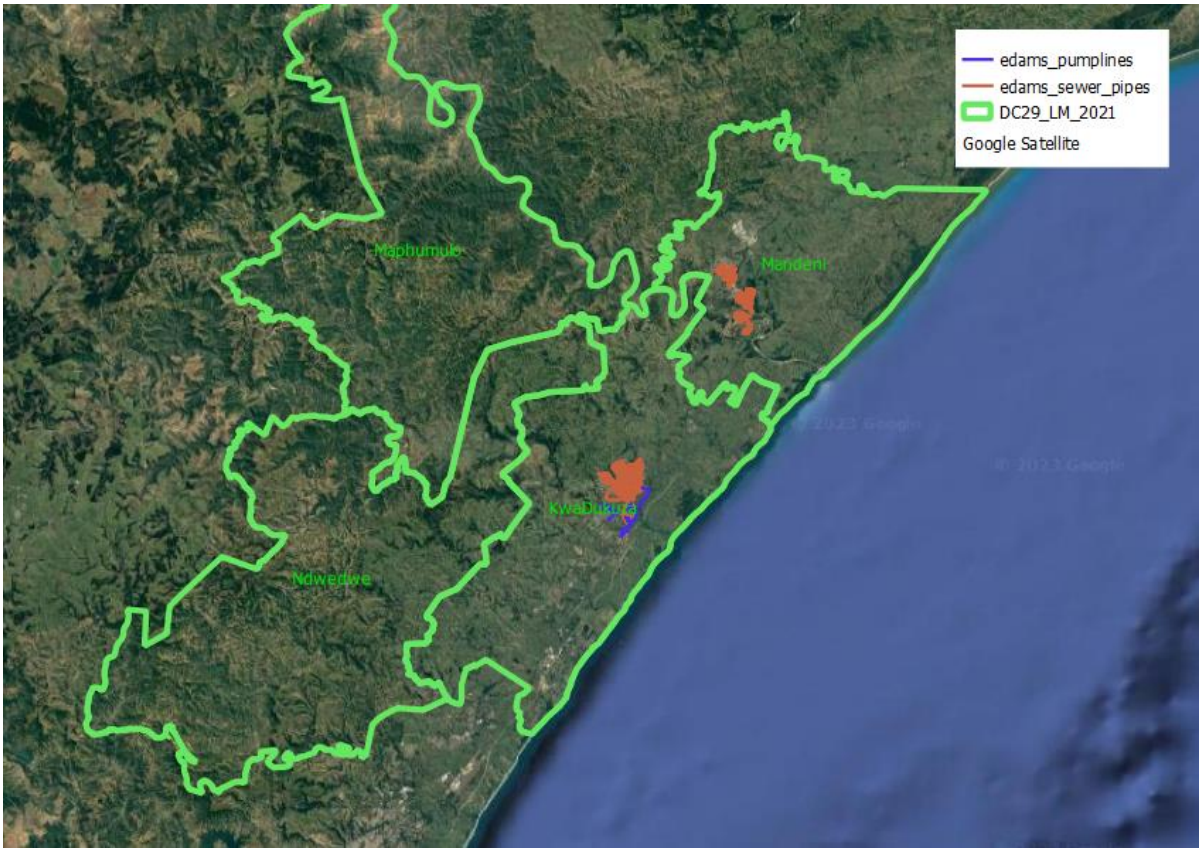
Pipe Library Id	Material Name	Class Name	Nominal Diameter (mm)	Pipes Count	Pipes Length (m)
88	Asb.-Cement	Default	150	4	110.81
84	Default	Default	0	6,647	273,146.84
86	Default	Default	150	259	10,781.48
92	Default	Default	200	4	256.11
94	Default	Default	250	24	1,003.83
96	Default	Default	300	8	400.63
100	Default	Default	100	32	878.14
102	Default	Default	375	2	55.93
90	HAC	Default	150	222	7,261.71
98	HAC	Default	0	2	60.80

It’s important to review the table above and more specifically the ‘Default’ Material type and the 0 nominal diameter items. Once the problematic libraries are fixed, the sewers’ data will be updated automatically.

5 Network and Zoning Problems

5.1 Possible Missing Network

During the asset register evaluation, we noticed that there are large areas within the IDM's jurisdiction without network coverage, especially when compared to the water network. In our investigation we used satellite images in conjunction with the local municipalities layer. See image below showing areas with missing network.



In general, the dataset consists of small networks within the KwaDukuza and Mandeni Local Municipalities covering just a fraction of the municipal AOI.

As can be seen, there are areas without any sewer network at all, whereas other areas seem to be missing large parts of their networks. The municipality has to investigate the following:

1. The possibility of having the missing network in an external GIS format (i.e. shapefile, CAD, etc)
2. Missing the network in its entirety
3. Networks not in the municipality's jurisdiction (e.g., trusts, etc)

If there is available network in an external format, then the consultant, Hydro-Comp, can assist in converting the data in EDAMS NDM. If, on the other hand, the municipality doesn't have any data regarding these areas, they need to put down procedures and schedules in order to capture them as soon as possible.

5.2 Missing Pump Lines/ Disconnected main components

5.2.1 Disconnected Manholes

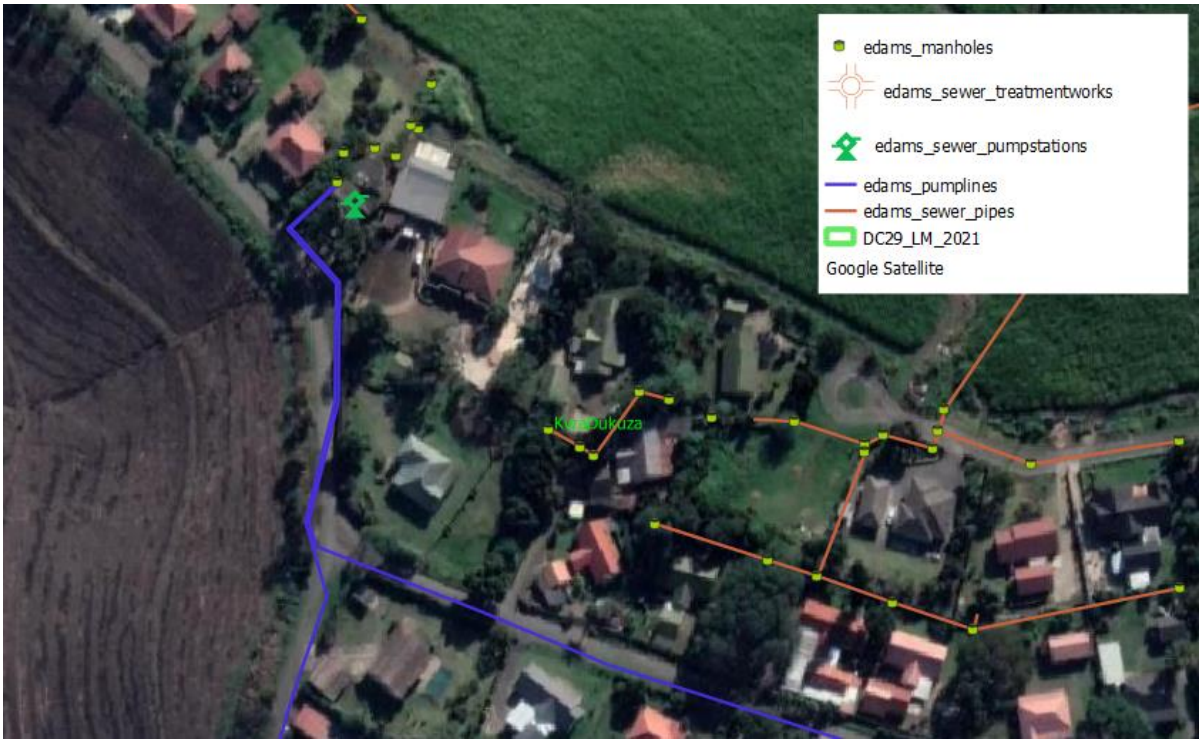
An example of a network with wrongly connected main components (manholes):

In the example above, manholes exist in various areas as standalone, without any sewers connected to them.

5.2.2 Misplaced Manholes

There are multiple standalone manholes that seem to be wrongly misplaced (i.e., very close to sewers but not directly connected).

5.2.3 Disconnected Pump Stations / Wrong pump line connection



The above serves three different examples:

1. There is a pump line (blue line) connected to the manhole instead of the pump station.
2. There is a standalone pump station (not connected to the network).
3. There is a very small sewer network disconnected from the rest of the area.

All cases must be rectified within the system so that GIS shows the exact location of assets as well as the correct connection with assets.

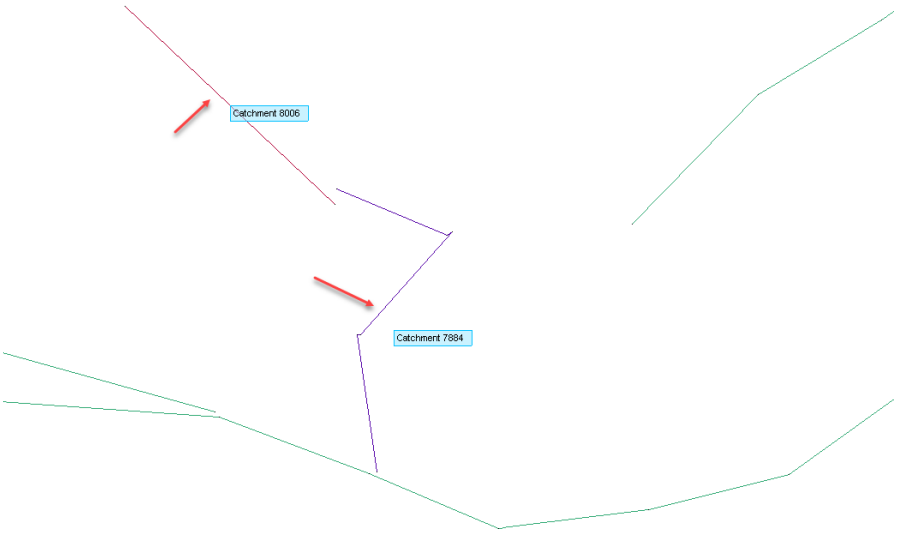
Another example of a standalone pump station where it's clear that it should be connected at the beginning of the pump line.

Example of disconnected small networks / missing network.

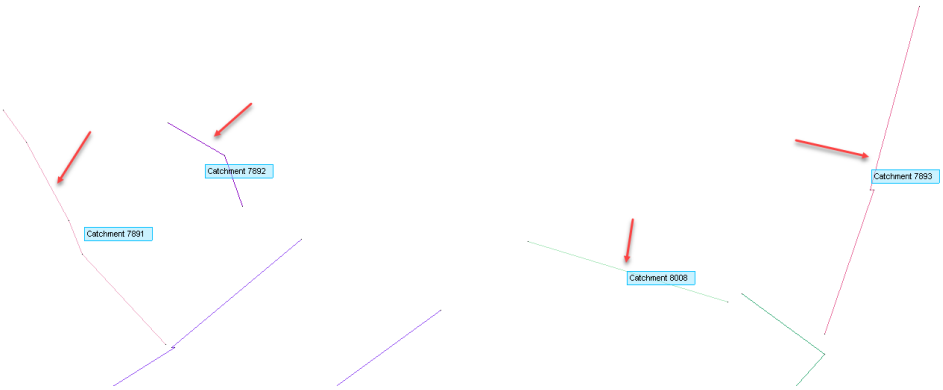
5.2.4 Disconnected networks in Zoning

Various examples of disconnected networks within EDAMS Zoning can be found in the images below.

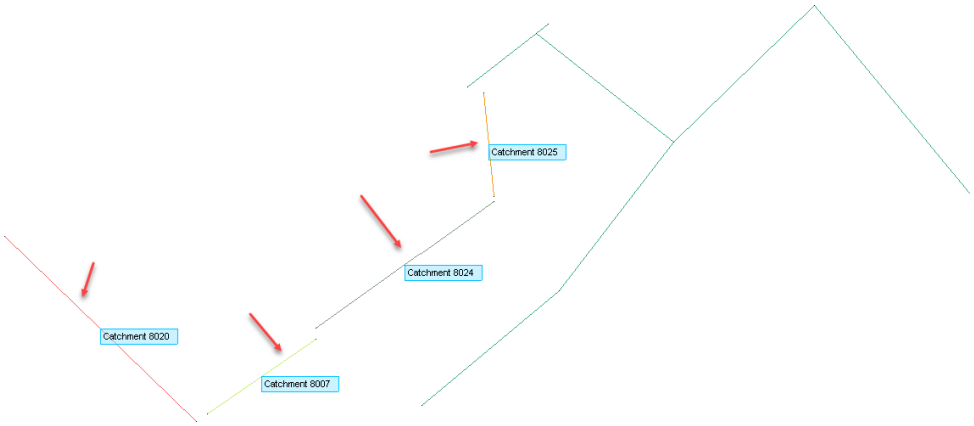
5.2.4.1 Example 1



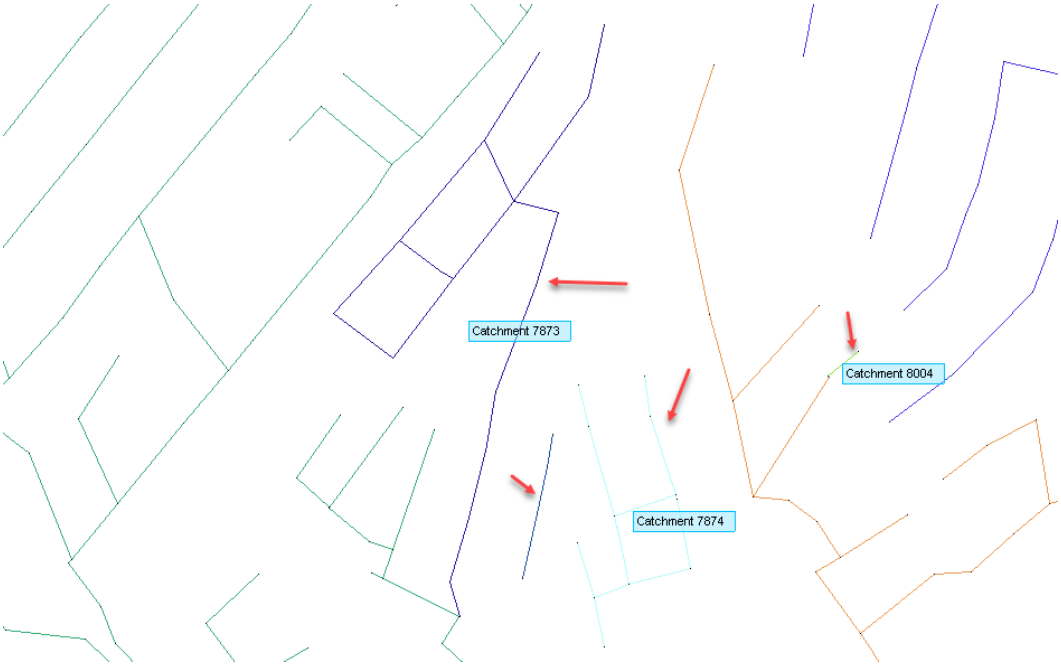
5.2.4.2 *Example 2*



5.2.4.3 *Example 3*



5.2.4.4 *Example 4*



5.3 Rules for Zone definition (naming of zones)

The current zone names are the ones generated by the system, i.e. they all begin with Catchment followed by a generated number. The municipality and the system users need to specify correct and meaningful names for the zones. A good rule is to start with the catchments with pumps and pump lines, then move to the main sewer lines and then specify the rest as being sewer network catchments.

Sewer Treatment Plant	Pumpline-1	Pumpline-2	Main Sewer-1	Catchment
Sewer TP 1	South Pumpline		South Main Sewer	Area 1
				Area 2
				Area 3
				etc
	North Pumpline	Central Pumpline	Central Main Sewer	Area 1
				Area 2
				Area 3
				etc
		West Pumpline	North/West Main Sewer	Area 1
				Area 2
				Area 3
				etc

A guideline for zone naming is shown above. This can be used in order to correctly define the catchment zones in the existing network.

5.4 Sewer Zones

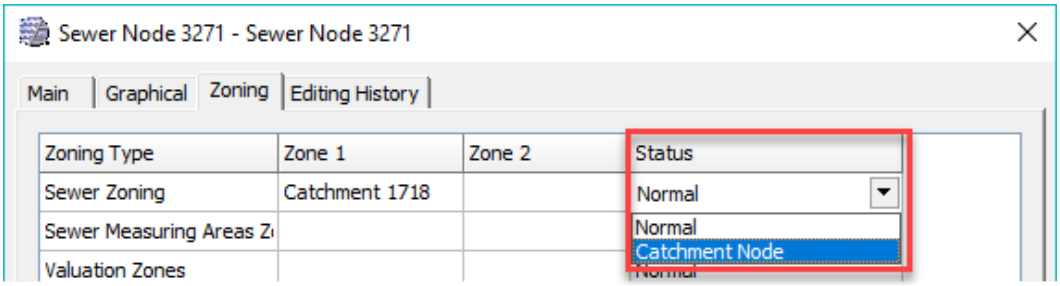
Currently there are 182 sewer zones in the system, and all of them are system generated. A table with all zones containing sewers with length more than 10km is shown below. A complete list of the sewer zones can be found in Attachment 1 along with the pipe length and elements per zone.

Zone Details		Zone Size	Zone Elements Count		
ID	Name	Sewers' length (m)	Manholes	Sewers	Pump Stations
7857	Catchment 7857	20,921	199	620	0
7903	Catchment 7903	19,965	0	520	0
7867	Catchment 7867	19,664	314	473	0
7905	Catchment 7905	16,990	0	350	0
7921	Catchment 7921	16,990	0	350	0
7896	Catchment 7896	15,437	7	329	0
7999	Catchment 7999 (pump lines)	14,836	0	0	0
7910	Catchment 7910	10,329	0	207	0
7925	Catchment 7925	10,329	0	207	0

5.4.1 Treatment Plants, Pump Stations, Catchment Nodes

All three can alter how the system re-zones the network. It's logical that whenever there is a pump station and therefore a pump line, the system is rezoning the catchments into two separate zones, the one at the beginning of the pump station and the other at the end of the pump line. Moreover, whenever the system reaches a treatment plant it rezones the catchments once again in order to separate the zones connected to it. Furthermore, another way to separate zones manually is to define catchment nodes. These are virtual node statuses that have the ability to separate the zones between the catchment nodes.

An example of how-to setup the catchment nodes is shown below:



Specific training will be provided on EDAMS Zoning Manager where all zoning related functions will be explained in detail.

6 Attachment 1: Asset Register Final Evaluation Tables for Sewer