PAPER 6

HOW TO GET A REALISTIC OPERATIONS AND MAINTENANCE BUDGET IN PLACE TO PRIORITISE ESSENTIAL MAINTENANCE OF WATER AND SANITATION INFRASTRUCTURE

Johan Bester
iX Engineers
George Municipality – case study

ABSTRACT

Why the obvious lack of prioritised expenditure on essential maintenance and operations? Most Municipalities show expenditure on capital projects and development of new opportunities, but an obvious lack of expenditure on O&M. How should the usual excuse "Insufficient O&M budget" be addressed? A first step should be to get a feasible maintenance prioritisation plan in place.

This paper will entail a value-add Maintenance Prioritisation Plan to provide the municipality with the necessary information for strategic planning regarding the capacity and O&M requirements for these infrastructure systems. Audit reports for each asset/system, which include the findings of a condition assessment, a scope of refurbishment works required and a scope of works required to upgrade the asset to meet future demands, need to be compiled. The replacement values of assets, as well as refurbishment and upgrade costs for each asset need to be estimated. Based on the findings of each audit report, an asset register update and a Grading and Prioritisation Matrix can be populated. The outputs of the matrixes will inform a Maintenance Prioritisation Plan to be utilised by the municipality as a tool to track progress on maintenance.

Taking the first steps to data-driven decisions:

Assess the value and performance of existing assets. This entailed a detailed condition assessment and performance testing of assets pertaining existing bulk conveyance water and sewer infrastructure, categorised in the table 1.

Review the existing asset register and update replacement values and refurbishment costs to inform the Maintenance and Operation budget.

Compile a Grading Matrix and a Prioritisation Matrix from the information gather during assessments to yield a Maintenance Prioritisation Plan.

1. INTRODUCTION – WHY THE NEED FOR A MAINTENANCE PLAN

This paper entails a value-add Maintenance Prioritisation Plan to provide the municipality with the necessary information for strategic planning regarding the capacity of infrastructure systems and the O&M requirements for these infrastructure systems.

Neglect of routine maintenance by local municipalities result in dire need for new infrastructure. Costly projects, focused on new infrastructure, bears funding challenges for the municipality. Hence the municipality prioritise co-founding for new infrastructure, leaving a fraction of the budget allocated towards maintenance. A well-defined maintenance plan is only a first step towards more sustainable operational and maintenance activities.

The main objective of the maintenance plan is to enhance the longevity, safety, and functions of the assets. Thus, the municipality can (i) maximize the value of the assets; (ii) minimize costly repairs; and (iii) ensure a satisfied community regarding service delivery.

By implementing a Grading Matrix to inform a Priority Matrix the maintenance team can depart from a "Patch-and-Pray" situation, grow towards a "Find-and-Fix" scenario, and strive for a "Predict-and-Prevent" state.

2. STEPS BY THE LOCAL MUNICIPALITY TO PRIORITISE MAINTENANCE

The municipality need to identify the various maintenance tasks. Categorising of these tasks is based on their urgency, the impact of the completed task and the available resources and skillsets in the maintenance teams.

Some basic steps and milestones should be to (i) update the asset register/ inventory; (ii) perform regular condition assessments of assets; and (iii) do performance testing of equipment thus, identify assets requiring immediate intervention. Furthermore, the municipality should rate the strategic importance of the asset (e.g., how critical is the asset to a functional system; what is the impact on essential service delivery). The municipality should consider (i) health and safety; (ii) legal requirements; (iii) environmental impacts, as well as (iv) end-user and community demand. The operations and maintenances teams should (i) compile incident reports; (ii) log customer complaints to address areas that require immediate attention; (iii) compile preventive maintenance schedules (activities and dates); and (iv) compile repairs close out reports.

All this valuable documented information advises data-driven decisions. Following these steps can assist the municipality with prioritising maintenance tasks effectively and allocating resources (maintenance teams and funds) efficiently. Thus, enhancing service delivery and community satisfaction.

TABLE 1: *Asset Categories*

Main Asset Category	Sub-Category
Civil & Structural	Sump / Wet Well
	Building / Structure
	Solids / Foreign Ingress
	Rising Main Capacity
	Grounds
Mechanical	Pumps
	Valves and Pipework
	Screening
	Ancillaries
Electrical	Main Supply Capacity
	Backup Generator
	MCC
	PLC & HMI
	Instrumentation
	Telemetry
	Lighting and General

3. TYPICAL ASPECTS OF A WELL-DEFINED MAINTENANCE PLAN

The Maintenance Plan for a municipality entails various maintenance aspects of infrastructure which is deemed assets of the municipality, including regular inspections, preventive measures, repairs and replacements.

Preventive maintenance entails the development of a schedule of routine diagnostic checks and inspections to inform possible servicing of equipment to address equipment deterioration proactively. These schedules are included in the Operational and Maintenance Manuals and data sheets from equipment suppliers. Following a routine/schedule prolongs the lifespan of equipment.

A break-down incident responsive system document valuable information regarding reactive maintenance. Reactive maintenance addresses unexpected equipment failure, or damages and emergencies. Reaction time regarding reactive maintenance serve as valuable mitigation measures in future risk assessment regarding operations.

Planned refurbishments (repairs and rehabilitation) yields from detailed condition assessments of infrastructure and should consider expected lifespan of equipment, as well as expected depreciation and deterioration of equipment.

Communication between operational and maintenance teams to inform clear reporting to inform and give feedback on progress to the end users are of essence. Documented maintenance activities, instrumentation data logs could contribute immensely to future machine learning and data-driven decisions.

Industry standards inform best practice. Regular training and development of maintenance staff is essential to the maintenance plan. Embracing further development and incorporation of emerging technologies, automation and machine learning will yield a "predict-and-prevent" scenario.

Community or end user engagement on social platforms raises awareness regarding these essential public assets and infrastructure. Collaboration and inputs from relevant stakeholders (department heads, maintenance staff) will align priorities with the holistic goals of the municipality and the community needs.

Realistic and feasible budget allocations form an integral part of any maintenance plan.

Continuous monitoring and evaluation will steer and improve future maintenance tasks and reassess priorities for a flexible and adaptable approach.

4. TYPICAL MUNICIPAL ASSETS RELATED TO THE WATER AND SANITATION DEPARTMENT

The typical municipal assets which influence the M&O budget, specific to the Water and Sanitation department include items mentioned in table 2.

The specific assets and their associated costs may vary depending on the size of the municipality, local regulations, infrastructure conditions, and the level of service provided by the water and sanitation department.

5. MAINTENANCE AND OPERATIONAL BUDGET INFLUENCERS

The maintenance and operational budgets for different local municipalities vary and are influenced by various factors. The budget influencers include the size of the local municipality; the population within the municipality; as well as the priorities and backlogs within the municipality.

Common sources and references of the typical budget may include the previous annual budget reports; the annual expenditure reports; the revenue of the municipality; the relevant policies of the finance department; the Medium-Term Revenue and Expenditure Framework; %-based on capital budget; %-based on value of assets; as well as the strategic planning sessions to develop long-term maintenance plans.

Aspects out of control of the managers and teams, which might also influence the budget are unpredicted failures; temporary overload on equipment; loadshedding schedules; vandalism and/or sabotage; availability/reliability of maintenance resource team; as well as availability/discontinue of replacement equipment/parts.

6. LOCAL MUNICIPALITY CASE STUDY

George Municipality undertook a comprehensive assessment of the sewer pump stations within the George Municipality boundaries. The purpose of these assessments is to provide George Municipality with the necessary information for strategic planning with regards to the capacity and operational and maintenance requirements for these pump stations.

Sewer pump stations forms a key part of wastewater infrastructure in that they enable effective conveyance of sewage in the reticulation network. The effective functioning and operation of sewer pump stations are critical to the reliability of the reticulation network.

There are approximately 106 sewer pump stations within the George Municipal boundaries, of which approximately 80 of these pump stations are owned and operated by George Municipality. The other pump stations are privately owned and operated, but most of them feed into the municipal sewer network.

Water pump stations, reservoirs and water towers form a key part of a water infrastructure system. Reservoirs and water towers allow for back-up emergency supply storage, whilst pump stations can be used to effectively convey and transfer water within a water network. The effective functioning, operation and condition of these water related infrastructure items are therefore of critical importance to the reliability of a water supply system.

TABLE 2: *Typical Municipal Assets*

Typical municipal assets related to water services	Typical municipal assets related to sanitation services
Water Treatment Works (Maintenance of equipment, Operational items like consumables, chemicals, energy, salaries)	Wastewater Treatment Works (Maintenance of equipment, Operational items like consumables, chemicals, energy, salaries)
Water distribution networks	Sewer collection systems
Water pump stations	Sewer pump stations
Reservoirs (storage facilities and balancing tanks)	Sewer sumps and balancing tanks
Flow meters: although advance metering systems have higher capital costs, it provides accurate data for improved revenue collection	Flow measurement structures
Water sources or abstraction points	Control and instrumentation systems: essential for efficient operation and data management systems
Control and instrumentation systems: essential for efficient operation and data management systems	Specialised equipment for maintenance (e.g., crane trucks; vacuum tankers)
Specialised equipment for maintenance	

FIGURE 1: *Thembalethu Pump Station*

FIGURE 2: *Thembalethu Pumps*

FIGURE 3: *Thembalethu Generator*

There are approximately 28 water pump stations, 41 Reservoirs and 3 water towers within the George Municipal boundaries.

The detailed assessments of the conveyance systems and storage infrastructure entailed photo summary report with observations and findings. Figures 1-3 show a typical sewer pump station with the associated assets

Furthermore, schematic layouts of assets; detailed and updated asset register; estimated status quo values of assets; potential refurbishment values; cost estimate of potential future upgrades; total replacement value of assets (relevant infrastructure, summarised within each respective engineering discipline) are included with the assessment to inform a comparative grading matrix. Additional to the grading of the assets a Prioritisation Matrix rank the priority of the asset and thus inform a maintenance prioritisation plan.

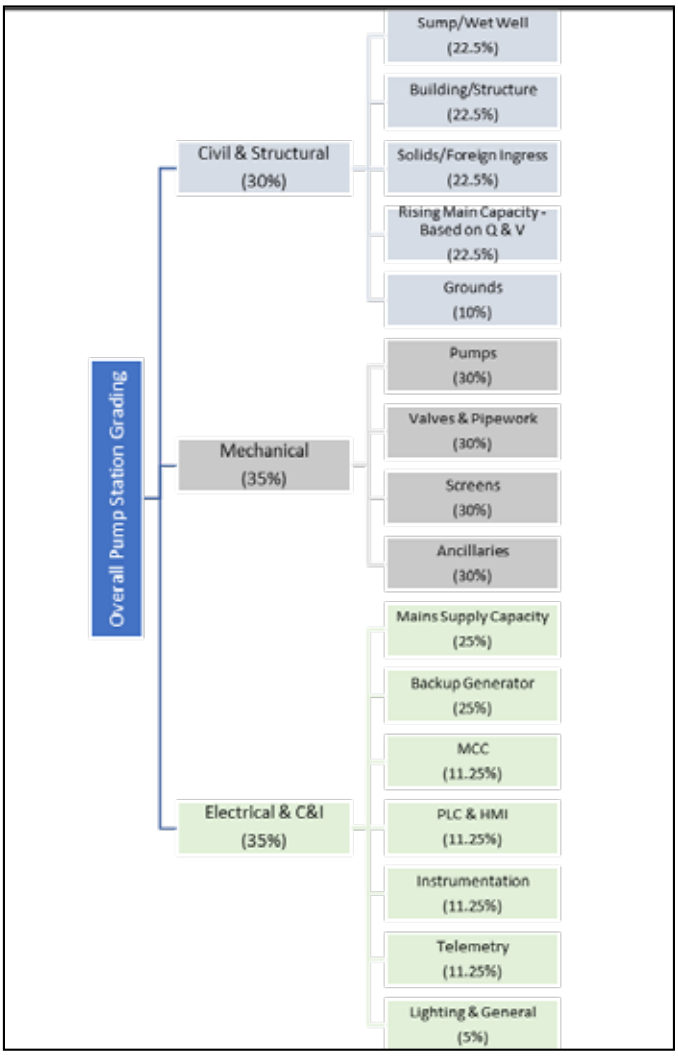


FIGURE 4: *Asset categories and sub-categories for sewer pump stations*

Audit reports were compiled for each asset/system which included the findings of a condition assessment, a scope of refurbishment works required and a scope of works required to upgrade the asset to meet future demands. Engineering specialists, each representing one of the following engineering disciplines, namely Civil, Structural, Mechanical and Electrical/ Electronic carried out these detail condition assessments.

Three main asset classes are split up into sub-categories and given gradings (refer to Figure 4). Sub-categories are given weightings to provide an overall asset grading to determine which areas to prioritise and what it will cost. Four categories (e.g., Environmental Impact, Security, Strategic Importance, and Asset grading) calculates a priority score and can be used to schedule a refurbishment and/or maintenance plan.

The replacement values of assets, as well as refurbishment and upgrade costs for each asset were estimated. Based on the findings of each audit report, an asset register was updated and a Grading Matrix and Prioritisation Matrix were populated. The outputs of the matrixes will inform a Maintenance Prioritisation Plan to be utilised by the municipality as tool to track progress on maintenance.

7. GRADING MATRIX AND PRIORITISATION MATRIX

The Grading Matrix and Prioritisation Matrix are compiled by assessing the condition of the key infrastructure at the various water and sanitation infrastructure systems. The main asset categories (Civil & Structural, Mechanical and Electrical & CI) of the pump stations were assessed to grade the current condition/situation at each pump station. The main asset categories are divided into sub-categories, with weightings of importance to the overall condition of the main asset category given to each sub-category. The grading of each sub-category combined with its relevant weighting then provides a grading for the main asset category. Figure 4 illustrates the main asset categories, its sub-categories, as well as their weightings for sewer pump stations.

The overall grading of the asset is then determined by combining the grading of the three main asset classes.

Each asset is then given an overall priority score by using the overall grading, the possible environmental impact of the pump station, the security risks, and the strategic importance of the pump station. Each of these four categories are given relevant weightings to give a priority score for each pump station. Sewer pump stations are prioritised based on their

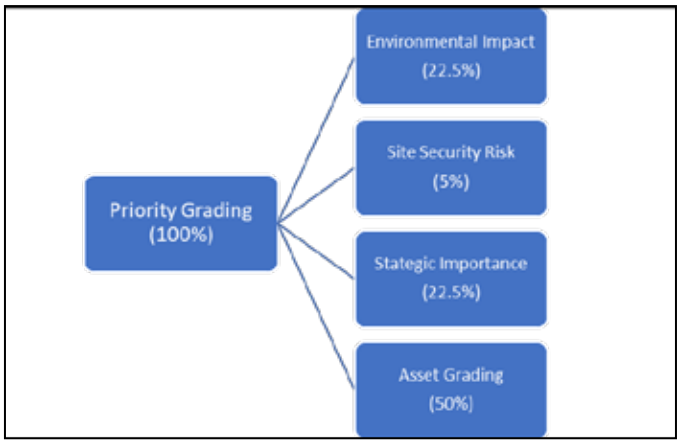


FIGURE 5: *Priority grading*

respective priority score. Figure 5 illustrates the weightings given to the four different categories.

The main asset categories, its sub-categories, with the associated weightings differ for the various types of assets (e.g., water pump stations do not have screens; reservoirs and water towers do not have pumps).

The maintenance prioritisation grading and accompanied cost estimates provided in the following section can be used by the George Municipality for planning purposes. The Grading Matrix and Priority Matrix are tools which can be used by George Municipality for maintenance and intervention planning at the various pump stations. The Maintenance Prioritisation Plan is seen as a live/work in progress document and is something that can be further workshopped with George Municipality to ensure that all aspects of importance and deemed influential to the grading are included in the matrix.

8. EXAMPLE USING THE MATRIX

As an example, the Herold's Bay PS 1 is ranked as No.1 on the Prioritisation Matrix. It is seen that the main contributing factors are "Environmental Impact" and "Strategic Importance". "Strategic Importance" cannot be reduced by any upgrade or refurbishment works and will only reduce once the "role" the Pump Station plays in the overall catchment area reduces. This can only occur with alterations to the sewer system.

If action is taken to reduce the grading score of "Environmental Impact" by including more redundancy, such as upgrading backup supply or the inclusion of an emergency storage sump, this will reduce the "Environmental Impact" grading. Furthermore, although an "Asset Grading" of 2.6 is fair, when reviewing the Grading Matrix, it is seen that the Electrical Grading of the pump station is 3.6.

For this example, it is assumed that the "Environmental Impact" is reduced to 3 by the inclusion of redundancy previously mentioned, and that an Electrical refurbishment was carried out which the changes an Electrical Grading to only 1. This has now changed the "Asset Grading of Herold's Bay PS 1 to 1.7. When these assumed upgrades/refurbishment works is reflected in the Grading Matrix, it will be carried over to the Prioritisation Matrix, and Herold's Bay PS 1's Priority Grading is then recalculated as follows:

$3\times22.5\% + 2\times5\% + 5\times22.5\% + 1.7\times50\% = 2.73$

The Prioritisation Matrix allows the user to sort Pump Stations by rank of either "Priority Grading", "Asset Grading", or "Estimated Refurbishment Cost". By making the changes as described in the previous paragraph, the Priority Rank of Herold's Bay PS 1 has now changed from No.1 to No.27.

The user of the Prioritisation Matrix tool can also decide which categories are of higher importance than others, by changing the weightings given to the different categories. To show an example of the impact of these weightings, the weightings of the categories used to calculate the Priority Grading were changed to Environmental Impact =10%, Site Security Risk =10%, Strategic Importance =10 %, and Asset Grading =70%. With these adjusted weightings, the Priority Grading for Herold's Bay PS 1 is then calculated as follows:

$5\times10\% + 2\times10\% + 5\times10\% + 2.6\times70\% = 3.00$

Herold's Bay PS 1 would then have a Priority Rank of No.22. This is an indication of how crucial it is to ensure the correct weightings are assigned to the relevant categories, based on user preference.

The ideal way of using the Matrix is by following the steps as set out below:

1. Ensure that the weightings assigned to the relevant categories are representative of their importance to the user.
2. Evaluate the Prioritisation Matrix and rank pump stations by their respective Priority Grading.
3. Review the Grading Matrix to determine what aspects of the pump station requires attention.
4. Review the relevant Audit Report for the specific pump station for recommended refurbishment/upgrade works proposed.
5. Update the Grading Matrix based on the works carried out at a particular pump station.

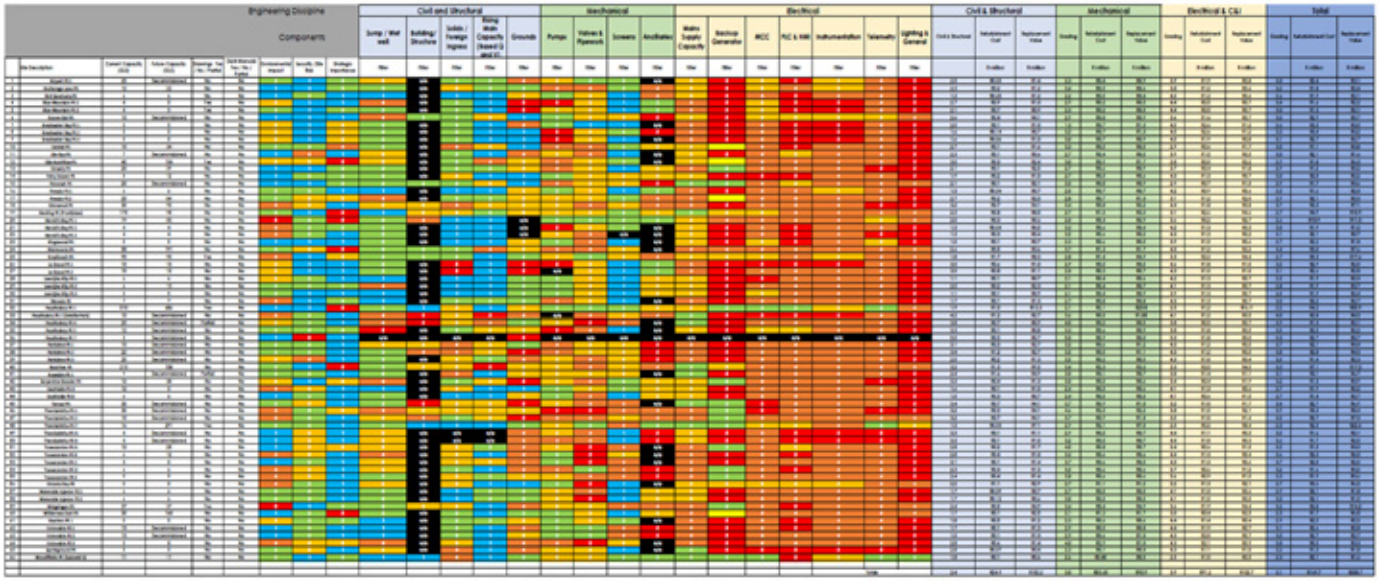
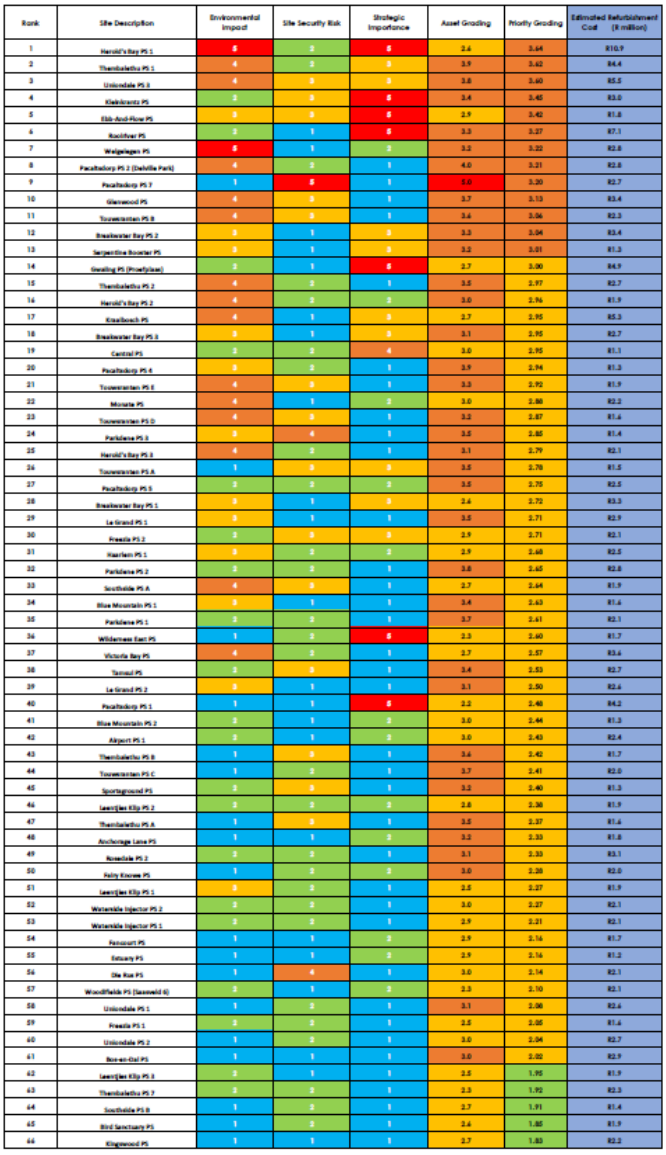


FIGURE 6: *Example of a Grading Matrix*



Rank	Site Description	Environmental Impact	Site Security Risk	Strategic Importance	Asset Grading	Priority Grading	Estimated Refurbishment Cost (R million)
1	Herold's Bay PS 1	5	2	5	2.6	3.64	R10.9
2	Thembalethu PS 1	4	2	3	3.9	3.62	R4.4
3	Uniondale PS 3	4	2	3	3.8	3.60	R5.5
4	Klein Brants PS	2	2	5	3.4	3.45	R3.0
5	Ebb-And-Flow PS	3	2	5	2.9	3.42	R1.8
6	Rooiflier PS	3	1	5	3.3	3.27	R7.1
7	Welgelegen PS	5	1	2	3.2	3.22	R2.8
8	Pacaltsdorp PS 2 (Delville Park)	4	2	1	4.0	3.21	R2.8
9	Pacaltsdorp PS 7	1	5	1	5.0	3.20	R2.7
10	Glenwood PS	4	2	1	3.7	3.13	R3.4
11	Touwsranten PS 8	4	2	1	3.4	3.06	R2.3
12	Breakwater Bay PS 2	3	1	3	3.3	3.04	R3.4
13	Serpentine Booster PS	1	1	1	3.2	3.01	R1.3
14	Gwaing PS (Proefplaas)	2	1	5	2.7	3.00	R4.9
15	Thembalethu PS 2	4	2	1	3.5	2.97	R2.7
16	Herold's Bay PS 2	4	2	2	3.0	2.96	R1.9
17	Kleinbosch PS	4	1	2	2.7	2.95	R5.3
18	Breakwater Bay PS 3	1	1	1	3.1	2.95	R2.7
19	Central PS	2	2	4	3.0	2.95	R1.1
20	Pacaltsdorp PS 4	3	2	1	3.9	2.94	R1.3
21	Touwsranten PS 5	4	2	1	3.3	2.92	R1.9
22	Mossie PS	4	1	2	3.0	2.88	R2.2
23	Touwsranten PS D	4	2	1	3.2	2.87	R1.4
24	Parkdene PS 3	3	4	1	3.5	2.85	R1.4
25	Herold's Bay PS 3	4	2	1	3.1	2.79	R2.1
26	Touwsranten PS A	1	2	3	3.5	2.78	R1.5
27	Pacaltsdorp PS 5	2	2	2	3.5	2.75	R2.5
28	Breakwater Bay PS 1	2	1	2	3.4	2.72	R3.3
29	Le Grand PS 1	2	1	1	3.5	2.71	R2.9
30	Fraaiz PS 2	2	2	2	2.9	2.71	R2.1
31	Haarlem PS 1	2	2	2	2.9	2.68	R2.5
32	Parkdene PS 2	2	2	1	3.8	2.65	R2.8
33	Southside PS A	4	2	1	2.7	2.64	R1.9
34	Blue Mountain PS 1	2	1	1	3.4	2.63	R1.4
35	Parkdene PS 1	2	2	1	3.7	2.61	R2.1
36	Wilderness East PS	1	2	5	2.3	2.60	R1.7
37	Victoria Bay PS	4	2	1	2.7	2.57	R3.6
38	Tarsus PS	2	2	1	3.4	2.53	R2.7
39	Le Grand PS 2	2	1	1	3.1	2.50	R2.4
40	Pacaltsdorp PS 1	1	1	5	2.2	2.48	R4.2
41	Blue Mountain PS 2	2	1	2	3.0	2.44	R1.3
42	Airport PS 1	2	1	2	3.0	2.43	R2.4
43	Thembalethu PS B	1	2	1	3.4	2.42	R1.7
44	Touwsranten PS C	1	2	1	3.7	2.41	R2.0
45	Sportsground PS	2	2	1	3.2	2.40	R1.3
46	Leentjies Klip PS 2	2	2	2	2.8	2.38	R1.9
47	Thembalethu PS A	1	2	1	3.5	2.37	R1.4
48	Anchorage Lane PS	1	1	2	3.2	2.33	R1.8
49	Kroeslee PS 2	2	2	1	3.1	2.33	R3.1
50	Fairy Knowe PS	1	2	2	3.0	2.28	R2.0
51	Leentjies Klip PS 1	2	2	1	2.5	2.27	R1.9
52	Waterside Injector PS 2	2	2	1	3.0	2.27	R2.1
53	Waterside Injector PS 1	2	2	1	2.9	2.21	R2.1
54	Fencourt PS	1	1	2	2.9	2.16	R1.7
55	Estuary PS	1	1	2	2.9	2.16	R1.2
56	De Rus PS	1	4	1	3.0	2.14	R2.1
57	Woodfields PS (Seaweld 6)	2	1	2	2.3	2.10	R2.1
58	Uniondale PS 1	1	2	1	3.1	2.08	R2.4
59	Fraaiz PS 1	2	2	1	2.8	2.05	R1.4
60	Uniondale PS 2	1	2	1	3.0	2.04	R2.7
61	Ros-en-Dal PS	1	1	1	3.0	2.02	R2.9
62	Leentjies Klip PS 3	2	1	1	2.5	1.95	R1.9
63	Thembalethu PS 7	2	2	1	2.3	1.92	R2.3
64	Southside PS B	1	2	1	2.7	1.91	R1.4
65	Bird Sanctuary PS	1	2	1	2.4	1.85	R1.9
66	Kingswood PS	1	1	1	2.7	1.83	R2.2

FIGURE 7: *Example of Prioritisation Matrix*

6. Evaluate the Prioritisation Matrix and rank pump stations by their updated respective Priority Grading.

9. CONCLUSIONS

Maintenance budgets are not adequate at many local municipalities. Regular maintenance tasks are not prioritised and mostly neglected due to lack of a well-defined maintenance plan. A maintenance prioritisation plan can enhance a data-driven decision-making process and allow for work team feedback to reassess and amend the plan for future maintenance activities.

Following basic steps can assist the municipality with prioritising maintenance tasks effectively and allocating resources (maintenance teams and funds) efficiently, thus enhancing service delivery and community satisfaction.

Grading of assessed infrastructure, together with prioritisation criteria, can be weighted to calculate a prioritisation score/grade. These grades inform a maintenance prioritisation plan.

The Grading Matrix provides the Municipality with the status of the condition of the sewer pump station assets. It entails additional data such as the estimated replacement value of each pump station, as well as the estimated refurbishment costs. By timeously updating the Grading Matrix, as and when refurbishments or replacements happen, the Municipality regrade the relevant infrastructure. This then influences the Prioritisation Matrix.

The Prioritisation Matrix combines the grading score calculated in the Grading Matrix, with other categories of relevance, to provide the Municipality with a list of ranked infrastructure in order of "priority". The pump station at the top of the list will then have the highest priority in terms of the need for intervention to ensure functional operation. By regularly updating this matrix the municipality will have relevant information to update their Maintenance Plan regarding the infrastructure.

The use of the Grading Matrix and Prioritisation Matrix, with the added information provided in the Asset Register, will enable the Municipality to move away from a reactive approach and toward a proactive approach regarding the operation and maintenance of the infrastructure. Furthermore, these tools inform planning and budgeting.

10. RECOMMENDATIONS

Maintenance task should be prioritised at municipalities. It is recommended that municipalities do condition assessments of their existing sewer and water pump stations. The replacement value of these assets (to include short-term refurbishment costs) should be updated. The municipality should do a grading of the existing infrastructure to inform a grading matrix and the compile a Priority Matrix to inform a Maintenance Prioritisation Plan.

11. REFERENCES

Two concurrent projects for George Municipality, namely:

- Project 16 (Work Package 3): Sanitation Pump Station Audit
- Project 16 (Work Package 6): Water Pump Station, Reservoir & Tower Audit