OMAINTEC CONFERENCE 2023 EXHIBITION

THE 20TH INTERNATIONAL OPERATIONS & MAINTENANCE CONFERENCE IN THE ARAB COUNTRIES

RAM Analysis for a Wastewater Treatment Plant

An Initiative by

OMAINTEC
المجلس العربي للتشغيل والصيانة
Arab Operations & Maintenance Council

Organized by

EXICON International Group
مجموعة أكزيكون الدولية
International Business Unit

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OMAINTEC 20 YEARS

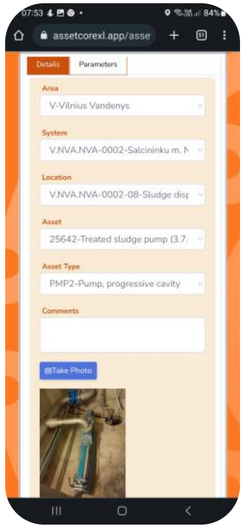
Introduction

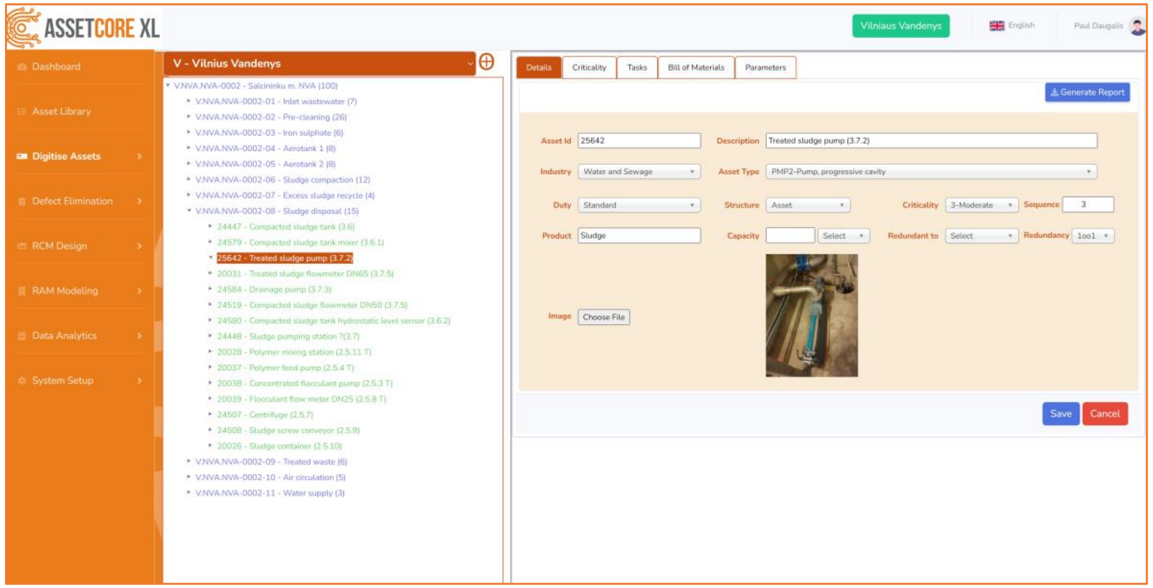
Šalčininkai wastewater treatment plant in a district of Vilnius, Lithuania was the subject of a pilot Reliability, Availability and Maintainability (RAM) study.

The purpose was to create a baseline model (digital twin) of the site to demonstrate the capability of benchmarking asset performance and comparing the resultant impact in improvements to maintenance strategy, spare holding, production bottlenecks and maintenance costs.

Data Collection

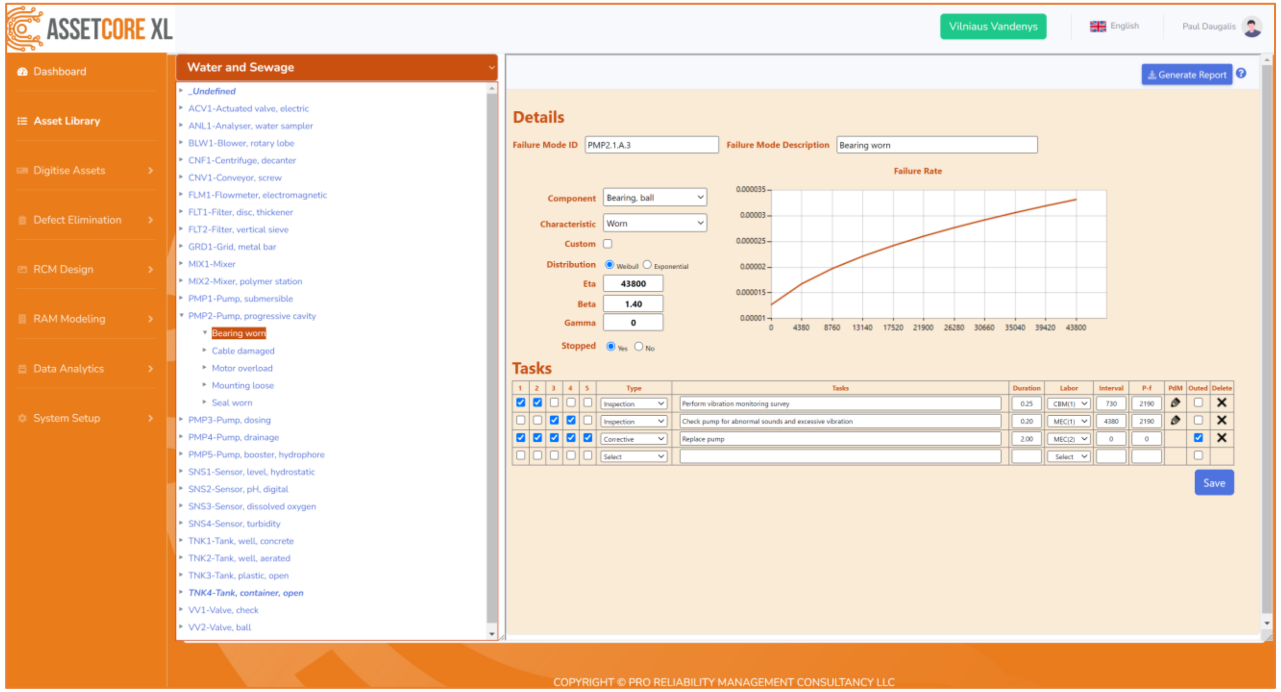
- First step is to collect all data on the assets included in the pilot study a through a site visit.
- A mobile app linked to AssetCoreXL was utilised to take photos and enter in the data parameters such as tag number, manufacturer, and model number.
- The existing asset structure needed review as it did not follow a production process required in a RAM model



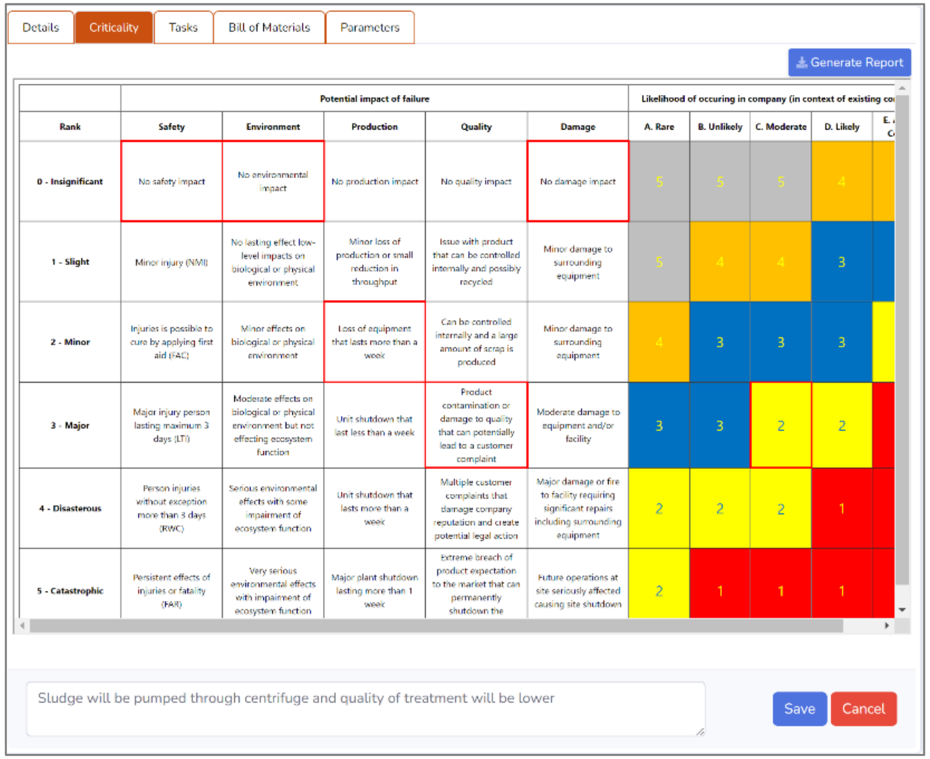


Asset Library

- The asset types needed to be revised as they currently were at a high level ie. “Pumps”
- Each asset type was broken down to failure modes as defined by SAE JA1011/12
- Tasks were extracted from OEM manuals and site spreadsheets and reversed back into failure modes
- Weibull failure parameters were assigned based on data sources and reliability knowledge

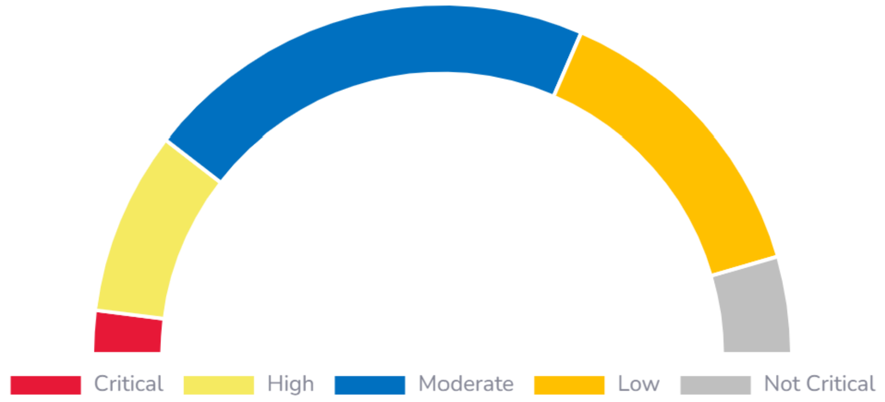


Criticality Assessment



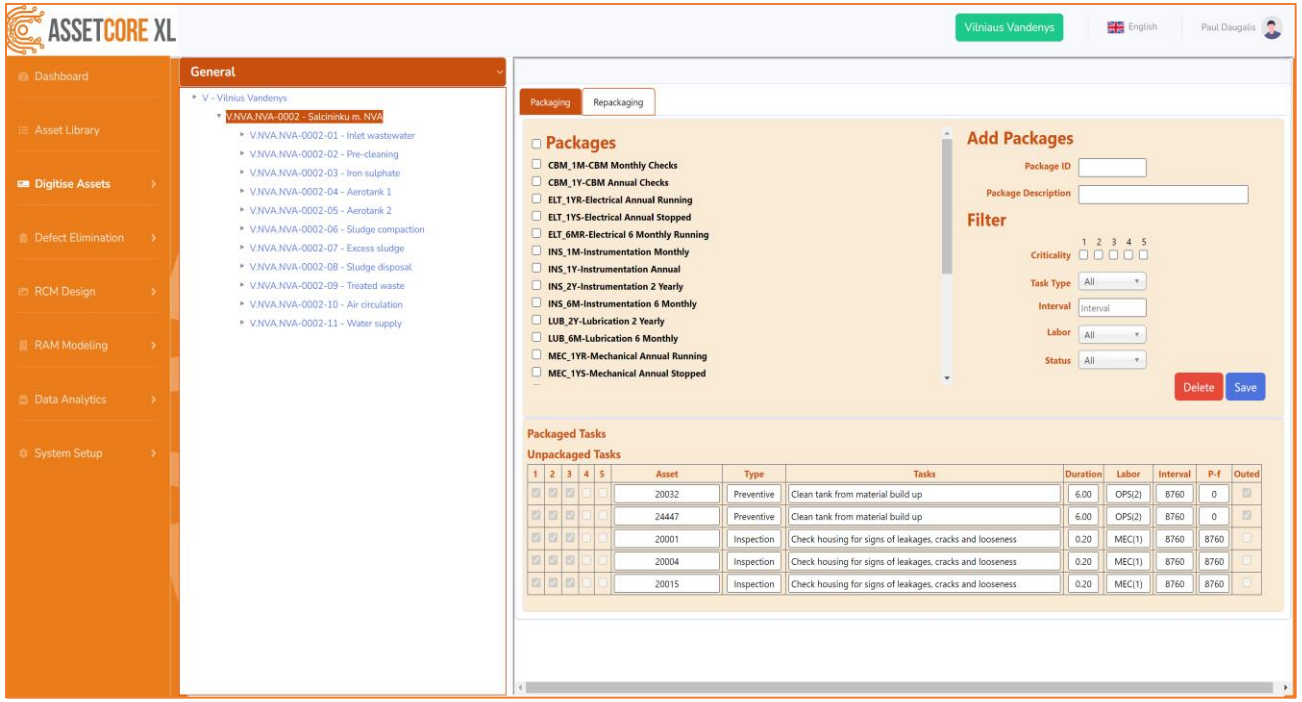
	Potential impact of failure					Likelihood of occuring in company (in context of existing co			
Rank	Safety	Environment	Production	Quality	Damage	A. Rare	B. Unlikely	C. Moderate	D. Likely
0 - Insignificant	No safety impact	No environmental impact	No production impact	No quality impact	No damage impact	5	5	5	4
1 - Slight	Minor injury (NMI)	No lasting effect low-level impacts on biological or physical environment	Minor loss of production or small reduction in throughput	Issue with product that can be controlled internally and possibly recycled	Minor damage to surrounding equipment	5	4	4	3
2 - Minor	Injuries is possible to cure by applying first aid (FAC)	Minor effects on biological or physical environment	Loss of equipment that lasts more than a week	Can be controlled internally and a large amount of scrap is produced	Minor damage to surrounding equipment	4	3	3	3
3 - Major	Major injury person lasting maximum 3 days (LTI)	Moderate effects on biological or physical environment but not effecting ecosystem function	Unit shutdown that last less than a week	Product contamination or damage to quality that can potentially lead to a customer complaint	Moderate damage to equipment and/or facility	3	3	2	2
4 - Disasterous	Person injuries without exception more than 3 days (RWC)	Serious environmental effects with some impairment of ecosystem function	Unit shutdown that lasts more than a week	Multiple customer complaints that damage company reputation and create potential legal action	Major damage or fire to facility requiring significant repairs including surrounding equipment	2	2	2	1
5 - Catastrophic	Persistent effects of injuries or fatality (FAR)	Very serious environmental effects with impairment of ecosystem function	Major plant shutdown lasting more than 1 week	Extreme breach of product expectation to the market that can permanently shutdown the	Future operations at site seriously affected causing site shutdown	2	1	1	1

Criticality Profile



Work Packaging

- All relevant tasks were grouped into practical packages to be executed within the CMMS preventive maintenance program.
- Typical packages or grouping should consider the following:
    - Asset type
    - System or sub-system
    - Specific route
    - Criticality
    - Task type
    - Discipline
    - Interval
    - Status



Work Instructions

ASSETCORE XL	WORK INSTRUCTION MEC_6MR	Last Reviewed 27/11/2022 Revision : Rev_0

Mechanical 6 Monthly Running

Purpose: To check for any abnormalities that could present a safety hazard, or damage to equipment, or cause a breakdown or stop production.	Expected Duration: 3 Hours and 18 Minutes

Minimum PPE	Other PPE required during this task
EYE PROTECTION MUST BE WORN; FOOT PROTECTION MUST BE WORN; HEAD PROTECTION MUST BE WORN; DUST MASK MUST BE WORN; SAFETY VEST MUST BE WORN	

☑ Equipment Running Inspection

Read this entire document right through prior to starting the task

No Safety Guards are to be removed or Safety device overridden while doing this inspection

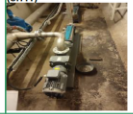
Activity	Description/ Definition/Meaning
☑ Look	Abnormalities, leaks, colour deterioration caused by heat
☑ Listen	Leaks, abnormal or unusual noise, vibration
○ Touch (Limited)	Motor/Gear Box/Frame away from any moving parts, vibration
○ Smell	Leak, burning
☑ Measure Temperature	Using hand held Infrared or Laser equipment, or permanently installed gauges
○ Measure Pressure	Using permanently installed gauges
○ Record Notes	Record or make a note of your findings
☑ Adjust (Limited)	Small adjustments that can only be conducted while the equipment is running

☑ Pre-Check (Things to check before starting)	Permits Requires	
☑ Conducted as JSA	○ Hot Work	○ HV Isolation
☐ Isolation Procedure	○ Confined Space Entry	○ Working at Heights
☐ Lockout and Tagging Procedure	○ Permit to Penetrate	

Specialized Tools Material required		People (Who is required or needs to be notified)	
☑ Torch	☑ Infrared Temp. device	☑ Operator/Maintainer	100%

ASSETCORE XL	WORK INSTRUCTION MEC_6MR	Last Reviewed 27/11/2022 Revision : Rev_0

MEC_6MR-Mechanical 6 Monthly Running

ID	Asset	Task	Duration	Acceptable Limit	Reading
	V.NVA.NVA-0002-02-Pre-cleaning				
1	20016-Oily fat pump (2.1.22)	**Housing cracked** Check pump housing for signs of leakage	0.10	The pump is clean and no leaks visible	
	V.NVA.NVA-0002-03-Iron sulphate				
2	24524-Cracker dosing pump to aerotank 1 (2.3.2) 	**Housing cracked** Check pump housing for signs of leakage	0.10	The pump is clean and no leaks visible	
3	24525-Cracker dosing pump to aerotank 2 (2.3.3) 	**Housing cracked** Check pump housing for signs of leakage	0.10	The pump is clean and no leaks visible	
	V.NVA.NVA-0002-06-Sludge compaction				
4	25645-Treated sludge pump (3.7.1) 	**Bearing worn** Check pump for abnormal sounds and excessive vibration	0.20	No grinding or cavitation noises	
5	20027-Polymer mixing station (2.5.11 D) 	**Tank leakage** Check tank seals and surroundings for leakage	0.20	The area is free for spillages and leaks	

ASSETCORE XL	WORK INSTRUCTION MEC_6MR	Last Reviewed 27/11/2022 Revision : Rev_0

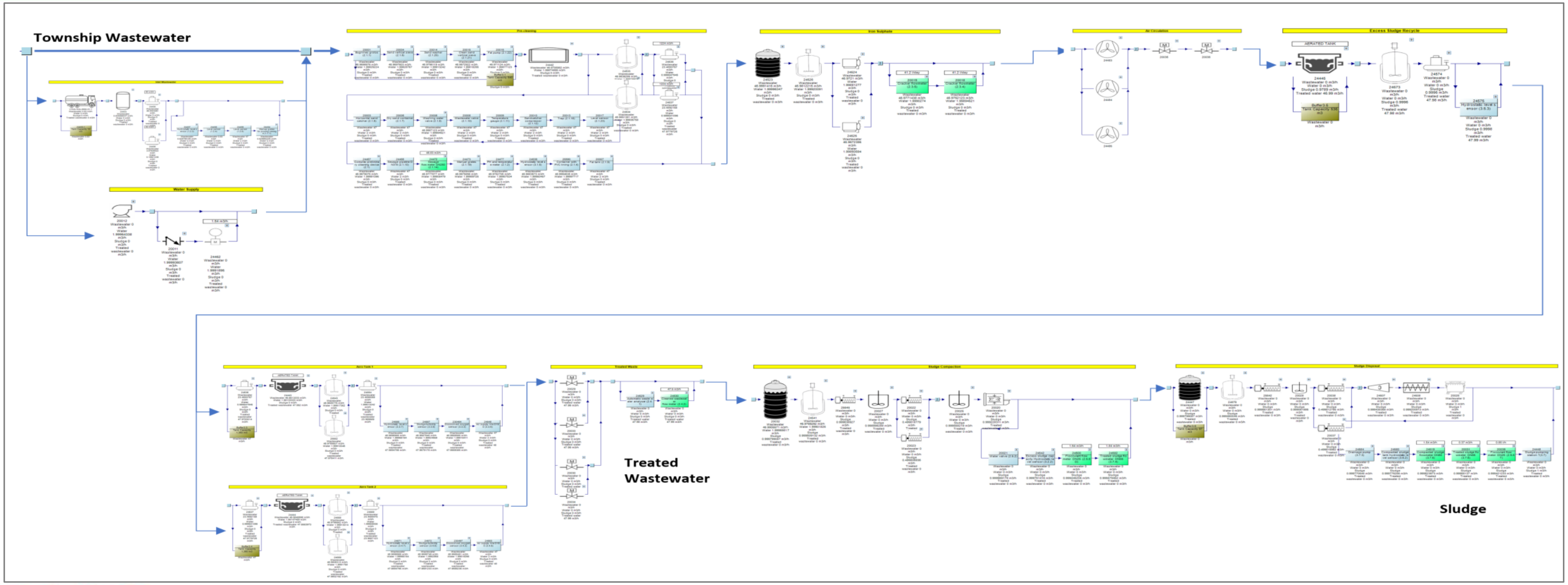
⚠	**Please give as much detail as possible to allow the planner to schedule corrective actions** (See 3 examples below)	
1.1	Need Urgent Repair	
1.2	Unable to see the bottom 50% of thr dump hopper due to product building	
1.3	There is exclusive vibration in Safety Guard.	

Step Number	Notes Comments and Required Actions	Planner Actioned

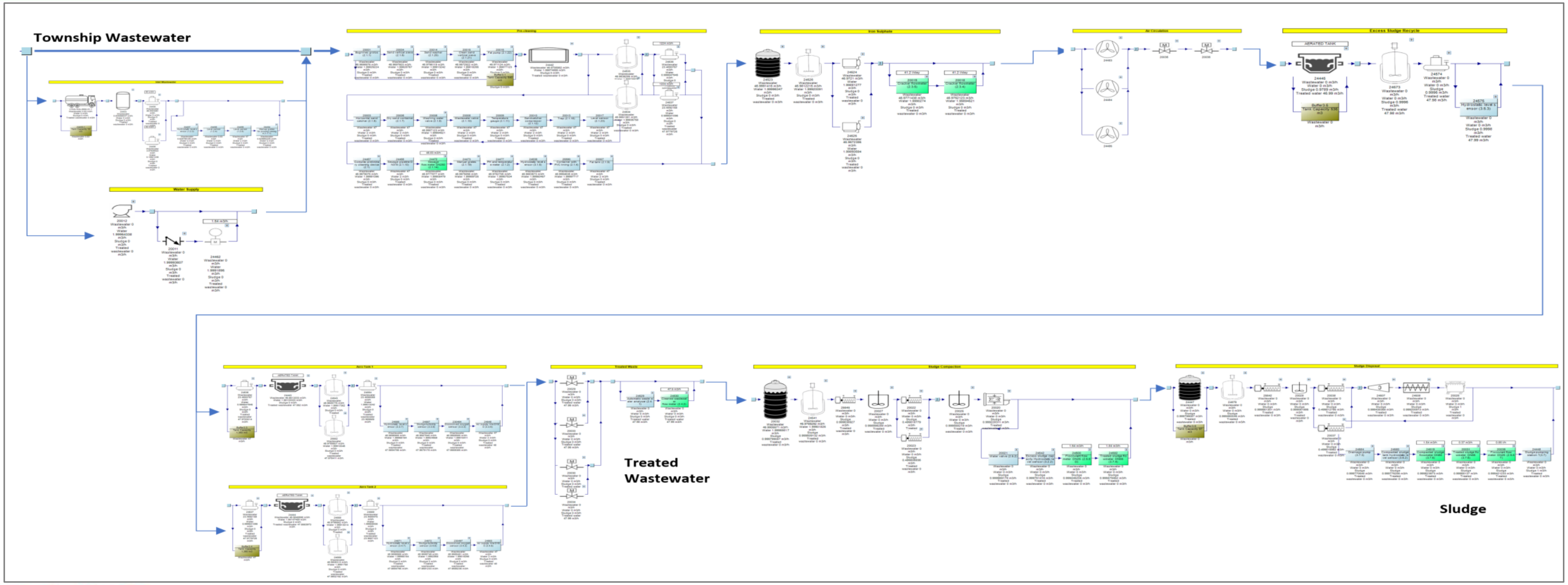
Note: Use the back of this page to draw pictures or diagrams or if you run out of space here

Task Notes: (Notes relating to the procedure steps above. Include the Step number in the note)
- ○
- ○
- ○
- ○

Reliability Block Diagram (RBD)



Reliability Block Diagram (RBD)



RBD Techniques

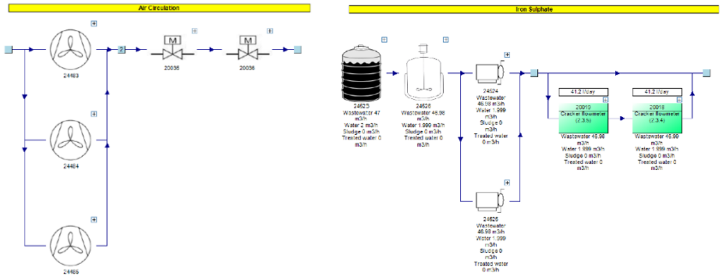


Figure 13. Application of redundancy arrangements

Redundancy Arrangements

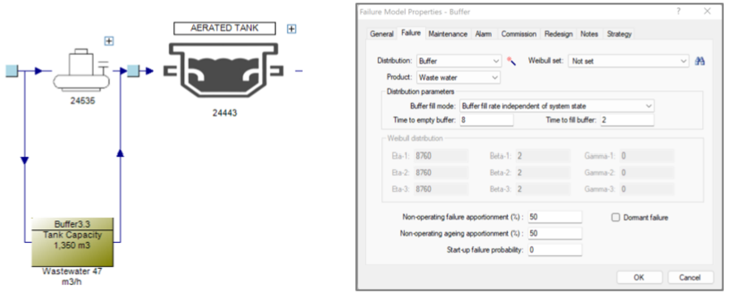


Figure 14. A tank used as a buffer to ensure system availability on pump failure

Storage and Buffer Capacity

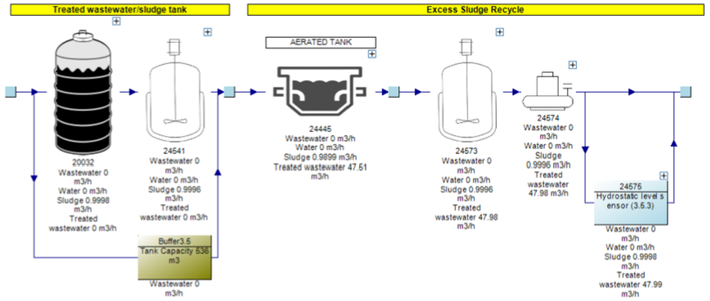
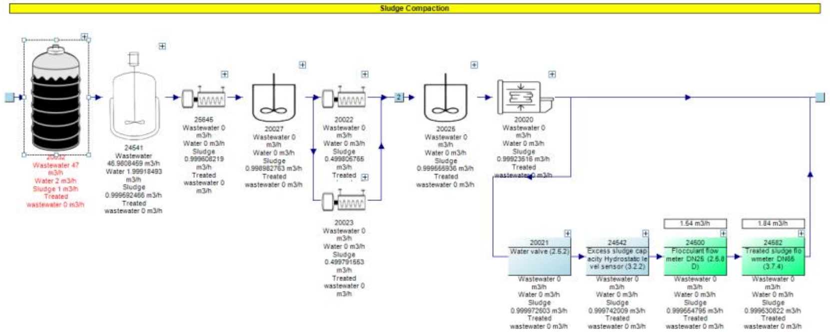


Figure 12. Common system used within the excess sludge recycle system



Common Assets

RBD Techniques

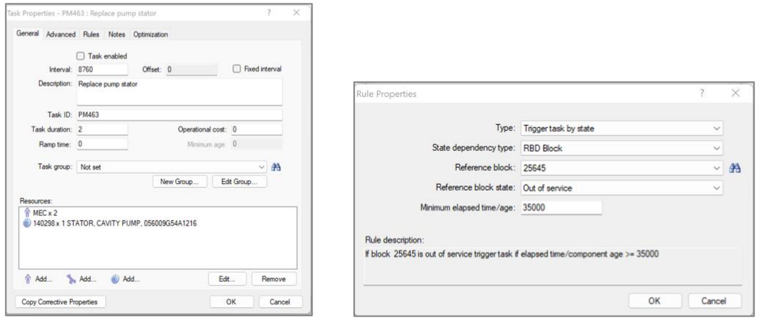


Figure 15. Setup for opportunistic maintenance for progressive cavity pumps

Opportunistic Maintenance

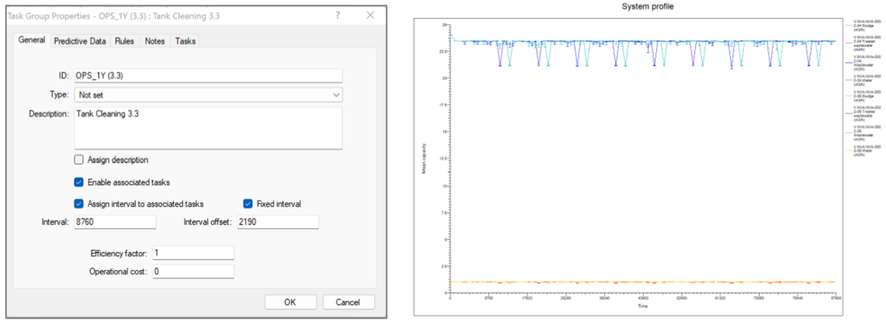


Figure 16. Interval offset for aerated tanks

Task Alignment

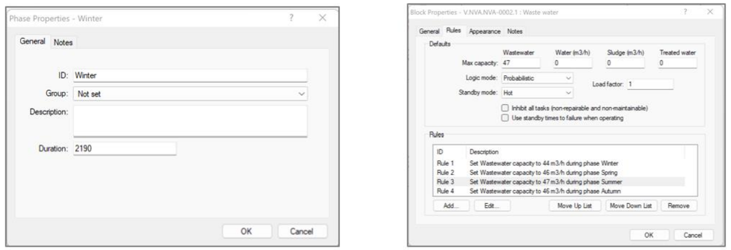


Figure 19. Phases representing the seasonal intake of wastewater

Phases

Figure 20. A 30-minute switching delay was added to air blowers

Switching delay

RBD Techniques

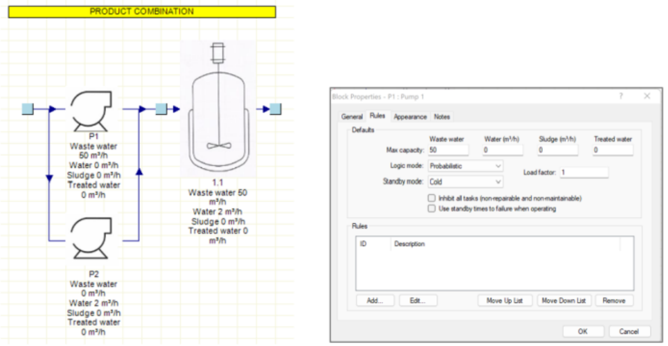


Figure 17. 2 pumps with different products pumped to a common mixing tank

Figure 18. 2 systems separated to predict product flow rates

Production Modelling

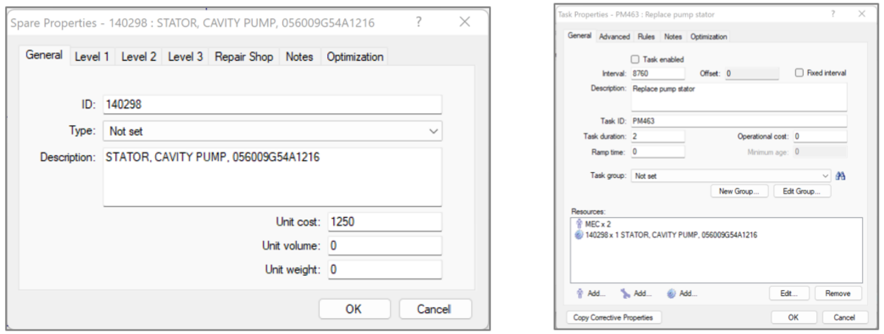


Figure 21. Spare part data for the stator for a progressive cavity pump

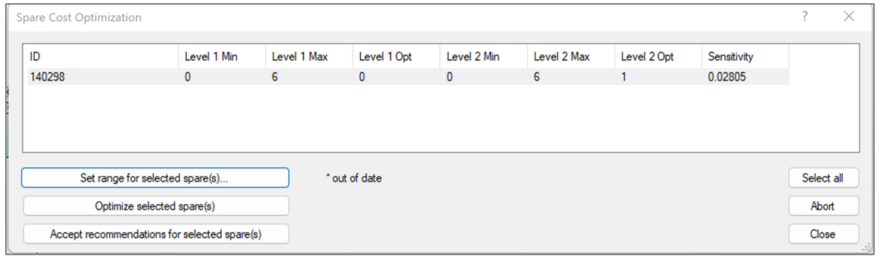


Figure 22. Optimised spare holding for the stator

Spares Optimsation

Results (Baseline)

- **Reliability (MTBO)** = 250.57 hours
- **Availability (Am)** = 97.26%
- **Maintainability (MTTR)** = 6.88 hours
- **Production** = Wastewater 45.70 m3/h
- **Maintenance Costs, Labour (€)** = 214,204 (21,420 pa)

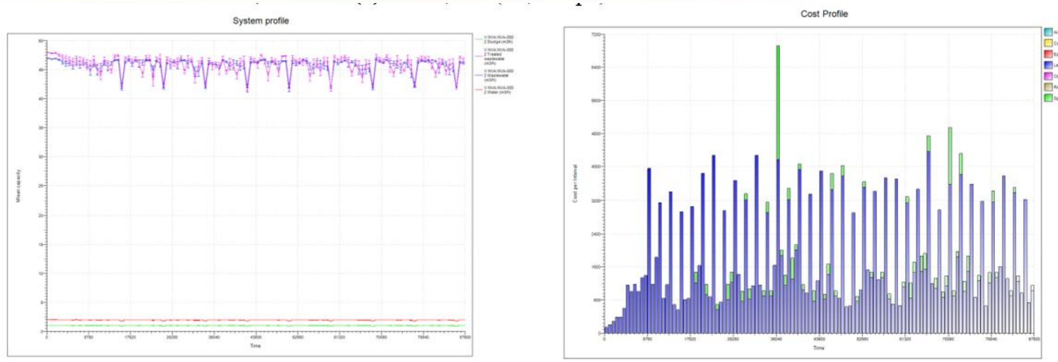


Figure 23. System capacity profile and maintenance costs over 10 years

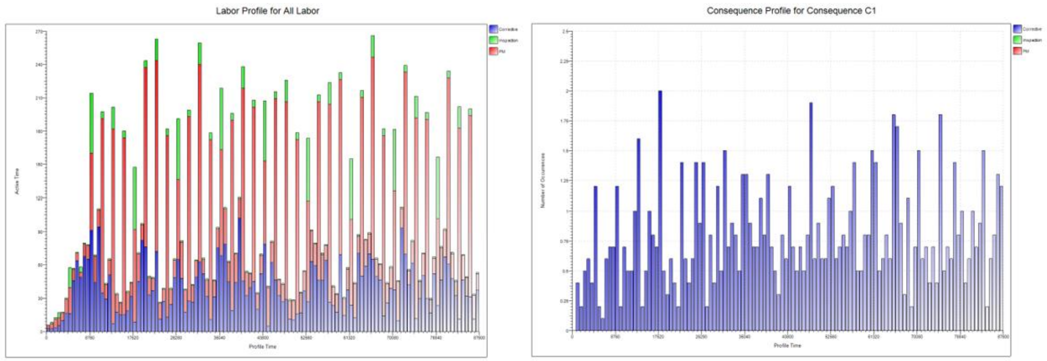


Figure 24. Labour task profile and resultant loss of water treatment capacity consequences over 10 years

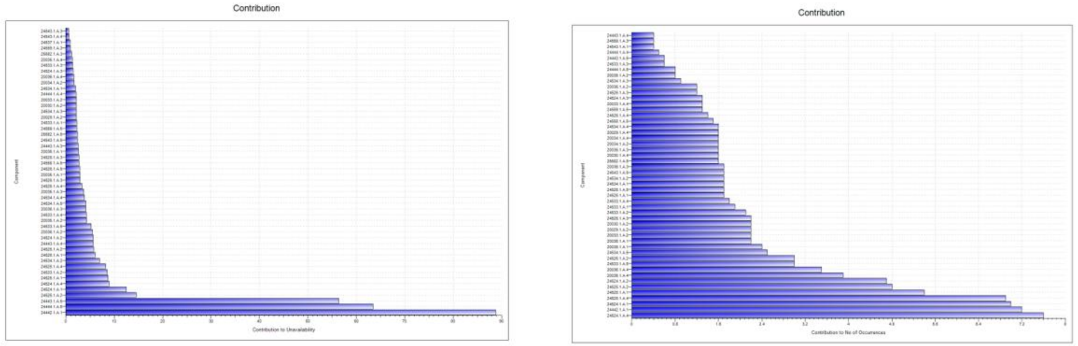
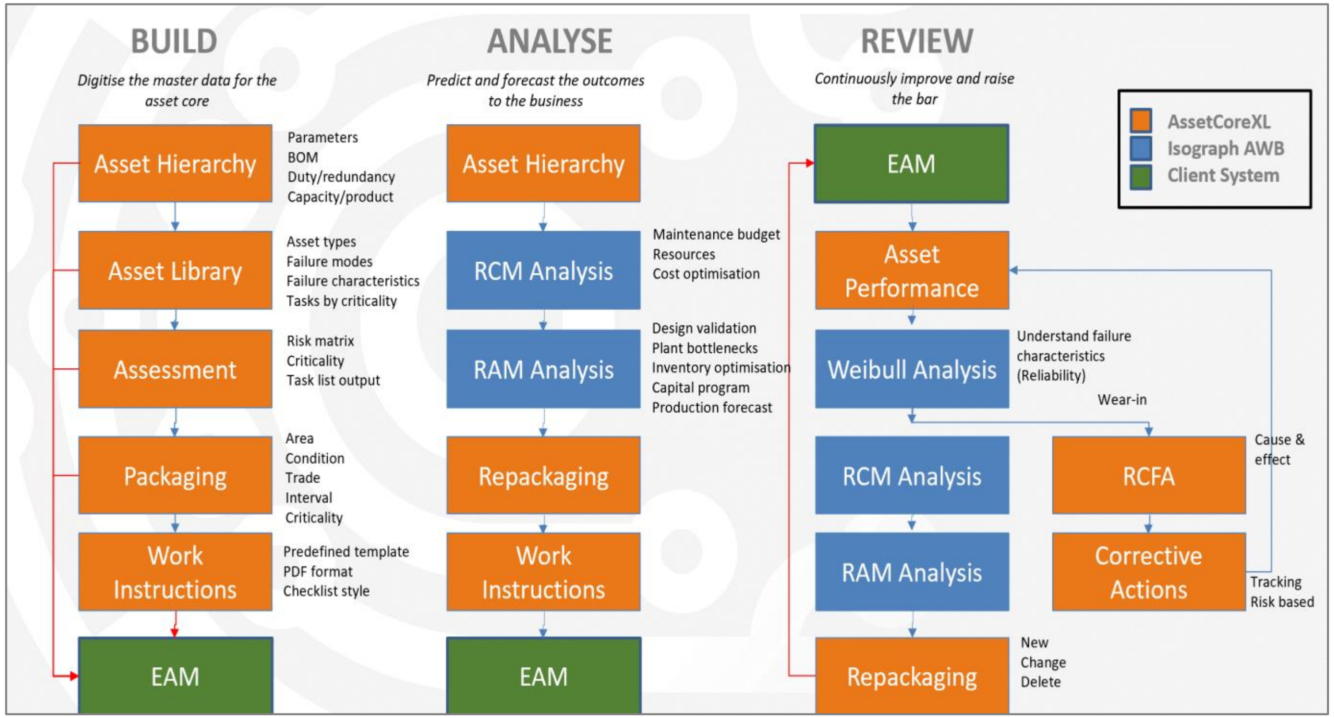


Figure 25. Assets with the largest contribution to unavailability and failure frequency

Conclusion

1. Clear labelling of assets
2. Centralised library for best practices
3. Standardisation of maintenance plans and task lists across the network
4. Develop Bills of Materials (BOM) for critical assets
5. Construct RBD for the entire water and wastewater network
6. Data alignment to Maximo (CMMS)
7. Spare part holding for critical assets
8. Implement a defect elimination program



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THANK YOU!

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