CAPACITY AND CONDITION – THE CRITICAL ELEMENTS FOR INFRASTRUCTURE PLANNING

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ABSTRACT

Parliament is debating the Local Government Act 2002 Amendment Bill (No. 3), that includes a requirement for local authorities to prepare an infrastructure strategy for a 30 year period. Although this may seem onerous, infrastructure planning for water and wastewater utilities can be effectively streamlined by focusing on two main elements: capacity and condition.

Cardno BTO carried out capacity and condition assessments for the Wanganui District Council's Beach Road Pumping Station (that also contains wastewater pre-treatment), as a basis for preparing a 30 Year Infrastructure Plan. Two specific asset management tools were used in the assessments that were vital in streamlining the process: the visual assessment methodology (NZWWA, 2008), and pump performance testing.

The visual assessment methodology ensures that the condition assessments of the civil, structural, mechanical, and electrical components were systematic and concise in identifying components of concern.

Pump performance testing helps determine the deterioration in capacity as well as in efficiency (and therefore operational cost), by comparison to benchmark performance tests. The rate of deterioration compared with the expected gain from refurbishment identifies when a replacement or refurbishment should take place, which is a critical factor in infrastructure planning.

The outcomes of the above assessments were used as the basis for scheduling improvements in the 30 Year Infrastructure Plan.

KEYWORDS

Infrastructure Planning, Capacity Assessment, Condition Assessment, Pump Performance Testing

1 INTRODUCTION

Parliament is debating the Local Government Act 2002 Amendment Bill (No. 3), that includes a requirement for local authorities to prepare an infrastructure strategy for a 30 year period. Although this may seem onerous, infrastructure planning can be effectively streamlined by focusing on two main elements: capacity and condition. The development of comprehensive asset capacity and condition information results in an Asset Manager's ability to prepare effective infrastructure planning, which in turn has the capability to provide long term benefits for the community.

This paper presents how Wanganui District Council (WDC) commissioned a 30 Year Master Plan for the Beach Road Pumping Station (BRPS) and the tools Cardno BTO used to prepare this Plan. This Plan forms an integral basis of WDC's long term infrastructure planning strategy.

1.1 THE TREATMENT PROCESS

The BRPS was originally constructed around 1980, and contains preliminary treatment (screening and grit removal) before pumping wastewater across the Whanganui River to the Wanganui Wastewater Treatment Plant (WWTP). The BRPS has three distinct process stages:

- The overflow (emergency) chamber for high flows and emergency conditions
- The pre-treatment room containing screening and grit removal
- The wet well and pump rooms

The overall system is summarised in Figure 1.

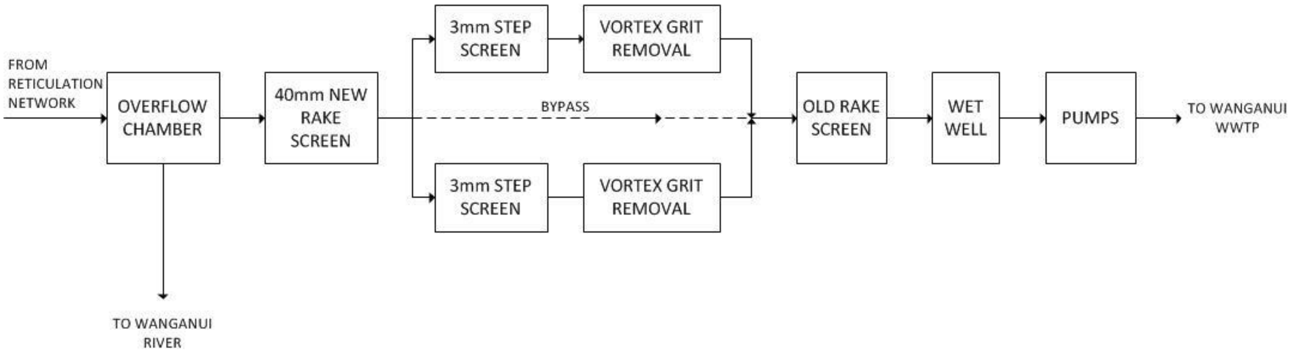


Figure 1– Process flow diagram of the Beach Road Pumping Station

1.1.1 OVERFLOW STRUCTURES

The overflow chamber receives flow from two large sewer mains and a third high level sewer. These are combined into a common chamber which flows through a port into the pre-treatment room. To operate the overflows, the two penstocks to the pre-treatment room must be manually closed. The overflow chamber contains three rectangular weirs at high level, approximately 4.8m above the chamber floor. The weirs combine to a common chamber before flowing out through two separate pipelines to the river. These pipes can be isolated with manual penstocks and there are flap valves to stop seawater ingress during high tides.

1.1.2 PRE-TREATMENT ROOM

The following equipment is installed in the pre-treatment room:

- 1 x 40mm new rake screen (Defender Series)
- 2 x 3mm step screen (Sam McCoy Fine step screen FSS30)
- 2 x screenings compaction systems with collection bins
- 2 x vortex grit removal chambers (5m diameter)
- 2 x Blowers for airlift pumps and sand trap for separation of accumulated grit
- 1 x old rake screen with mechanical rake and screenings collection tray

The rake screen was out of service during the site visit. It sits in the common chamber before flow is split to the grit chambers.

The flow is directed to the grit chambers from the common channel by the grit bypass penstock. Each grit chamber used to have an inlet penstock but the support frames were disrupted by the screen installation. The outlet from each grit chamber has two manual stopboards, so each chamber can be fully isolated. Each grit chamber has a separate step screen in the inlet channel before flowing into the vortex grit chamber. All the screens have dedicated washpactor conveyors, which washes and compacts the screenings before dropping them into a bin.

The grit chambers are vortex-type chambers with a central collection chamber for the accumulated grit. The grit is removed by airlift pumps with the air supplied by a dedicated blower for each chamber. The blowers create a negative pressure in the outlet pipe, lifting the water and grit to the sand-trap. A pipe returns water from the top of the tank back to the inlet channel.

De-gritted wastewater from the grit chambers returns to the common channel, downstream of the grit bypass penstock. An old bar screen with a mechanical rake removes any further screenings to a tray. This also acts as a backup for high flows, if the grit chambers and fine screens are bypassed.

1.1.3 WET WELLS

The channel flows to two separate wet wells through two square ports, one for each wet well. Each wet well is serviced by two Variable Speed Drive (VSD) controlled dry mounted submersible centrifugal pumps operated to maintain a set level control.

2 CAPACITY & CONDITION ASSESSMENT TOOLS FOR UTILITY ASSET MANAGEMENT

With a shift to longer term infrastructure planning, a structured understanding of assets is required in order to provide accurate and reasonable budgets for infrastructure over the planning period. Without a broad understanding of the capacity, condition, and performance of an asset, as well as the community's requirements, an asset manager is simply guessing when preparing long term infrastructure plans.

In preparing long term infrastructure strategies, an Asset Manager can use information provided from the operations team of a treatment facility, but this is mostly suited for short term infrastructure planning systems; in addition this type of information does not always provide a structured approach to the longer term asset planning.

There are a variety of tools which can be used to provide this information at a greater level of accuracy for long term infrastructure planning. The tools used to prepare a long term infrastructure strategy will depend entirely on the asset under consideration. The case study presented for this paper is WDC's BRPS, and therefore the tools used are indicative of the nature of assets present at the BRPS.

The condition assessment was based on the guidelines contained in the Visual Assessment of Utility Assets (NZWWA, 2008).

The capacity assessments used were asset specific. The pre-treatment system was assessed based on the hydraulic capacity of the channel and each process unit. The pumping system was assessed based on pump performance testing to help determine the deterioration in capacity as well as in efficiency (and therefore operational cost).

3 CONDITION ASSESSMENT

A condition assessment was carried out on the BRPS. The site's civil/structural, mechanical, and electrical assets were examined closely by specialist engineers during a site visit. The condition of each of the assets was graded based on a classification system which also assigned a subsequent 'Action' grading. The asset condition grading criteria was based on the Visual Assessment of Utility Assets (NZWWA, 2008) and mutually agreed with the client. This grading is summarised in Table 1 – Asset condition grading criteria.

Table 1 – Asset condition grading criteria

Grade	Classification	Action	Description
1	Very Good	No Action required	New or near new condition Some wear or discolouration but no evidence of damage. Can include repaired assets where the repair is as good as the original.
2	Good	Monitor to see if there are changes	Deterioration or minor damage that may affect performance. Includes most repaired assets.
3	Moderate	Consider specialist assessment.	Clearly needs some attention but is still working. Structure in need of repair. Includes repaired where the repair is deteriorated.
4	Poor	Get specialist assessment.	Either not working or is working poorly because of damage or deterioration. Condition or structure is poor or structural integrity in question.
5	Very Poor	Replace or repair	Needs urgent attention.

3.1 EXAMPLE DOCUMENTATION FROM THE VISUAL CONDITION ASSESSMENT

Table 2 shows an example of how the results of the asset condition assessment were presented to the client. The condition assessment identified that several areas of the BRPS required urgent attention. Although WDC understood they had an aging asset, the severity of the issues had not previously been made apparent in a formal process. Since then, these items have been scheduled for repair or replacement in upcoming financial years.

Table 2 – Example: Electrical condition assessment of inlet screens

Asset Description: Inlet Screens General Condition: Grade 1 – Very Good Exceptions: Old rake screen and ancillaries and cable containment. Refer to photos and notes below	
	 
Inlet Screens Inlet screens control panel is in very good condition, however labels need to be secured.	*Inlet Screens* Inlet step screen and new rake screen motors in good condition.

3.2 CONDITION ASSESMENT FINDINGS

A summary of the significant outcomes from the condition assessments were the following:

Grade 5 issues (that require urgent attention) were:

Overflow Structure – Ceiling and Walls – The ceiling has evidence of concrete decomposition. It was recommended that an investigation be conducted to detail how it is best to address this issue.

Grade 4 issues (that require specialist assessment due to the item not working or working poorly) were the following:

Pump #3 – This pump should be the first pump to be refurbished to address its poor performance issues.

Inlet Screen – 40mm Rake Screen - This screen is only intermittently in service, due to a common breakdown with rocks/stones jamming the rake, causing damage to the rake, drive, and motor. It is recommended that a solution be developed to prevent this from happening in the future.

Generator – This aging asset is in poor condition.

Main Switchboard – The age of the switchboard is determined to be over 35 years old and is therefore considered to be beyond its life expectancy (normally 25 years). The switchboard should be replaced with a new modern and fully compliant and documented switchboard, complete with external VSD drives and flexible capacity for additional equipment, i.e. additional pumps and harmonic filter(s) where necessary.

4 CAPACITY ASSESSMENT – PRE-TREAMENT SYSTEM

Operators had advised that the screening and grit removal systems at the BRPS were not working very well. In particular, the grit removal processes at the BRPS performed poorly, the issues highlighted were mainly related to grit deposition in the channels prior to the grit chamber, as well as poor grit separation from the vortex chamber. Although the screens were new, the removal of solids in the screens was not considered optimal. This has ongoing implications for the planned downstream WWTP upgrade.

Wastewater passes through a rake screen and then splits into two channels; each channel contains a step screen and a vortex grit chamber. The current control philosophy is to use both channels under all operational circumstances.

A performance assessment of the treatment units at the BRPS was carried out. The rating of the individual units and channels was compared to various influent flow scenarios – refer to Table 3. A hydraulic profile of the plant was also prepared to help identify hydraulic bottlenecks or other issues at the site.

Table 3 – Results of hydraulic/performance assessment

Channel Section	**Channel Width (mm)**	**Velocity (m/s)**		
		280l/s (ADWF)	**350L/s (AADF)**	**1600L/s (Max Capacity of BRPS)**
New Rake screen	1500	0.36	0.42	0.92
Step screen (grit chamber inlet)	1000	0.46	0.51	0.86
Grit chamber outlet	2000	0.23	0.26	0.44
Common channel	1500	0.65	0.73	1.23
Common channel	1300	0.70	0.95	1.57
Common channel	2600	0.43	0.49	0.81

Minimum channel velocity to avoid grit deposition is typically in the order of 0.4l/s. As can be seen from Table 3, some channel velocities prior to the grit removal process are less than 0.4l/s under average dry weather flow conditions. Therefore this is the reason for grit sedimentation prior to the actual grit removal process.

According to design specifications, the flow rate towards the inlet screens (the 'approach velocity') is 1.6m/s. When comparing to the current average dry weather flow which is in the order of 0.4m/s, it is obvious why the screen performance was less than optimal. Without an adequate approach velocity, it is difficult for the screenings to be pressed onto the screen and retained and removed from the system. Operators were reporting some operational difficulties with the screens that were confirmed by the hydraulic analysis.

The use of two channels in all scenarios was resulting in significant deposition of grit and solids before the actual removal stages. The study identified that the best way of resolving this issue was to simply implement an alternative operating strategy, namely: operate the screening channels in a duty/standby operation under normal, average dry weather flow rates, with use of the second channel when wet weather events occur.

This solution required the installation of isolation penstocks and some control system changes. These are being installed in the current financial year. In addition, the actual vortex grit chamber internals and grit classification process were identified as being in need of replacement (by the mechanical condition assessment). The upgrade project will also incorporate a Design Build Contract to replace the grit equipment inside the grit chamber and install a grit classifier (rather than the existing 'sand-trap').

5 CAPACITY ASSESSMENT – PUMPING SYSTEM

As part of the infrastructure plan, Council desired to know not only the pumping capacity of the BRPS, but also the performance of the pumps, in terms of energy used to meet the pumping demand.

Energy for pumping water and wastewater is a major portion of the power costs for many Councils. In the current New Zealand and world climate of increasing energy costs and climate change issues, any reduction in energy use and carbon footprint through efficiency improvements will benefit not only the Council's 'bottom line', but also its obligations as a responsible and environmentally conscious organisation.

Typically, there is a benefit in pump performance testing all large energy users.

This section presents the following from the capacity assessment of the pumping system:

- An overview of the pumps at BRPS
- The testing method used to ascertain the pumping capacity and performance
- Presentation of the pumps performance
- Prediction of gains from future refurbishments

- Pump 1 refurbishment cost/benefit analysis

5.1 PUMPS OVERVIEW

The BRPS consists of five (including one spare) Flygt dry mounted submersible centrifugal pumps, operated in parallel and on variable speed drives (refer to Picture 1). The pumps were installed in 2006, and have the following specifications: Flygt model C3312.765, a 560mm impeller diameter, and an 180kW motor.

The original purchase agreement allowed for the pumps to have a major service by the supplier after around five years of operation. WDC are currently in the process of conducting a major service on each pump, with Pump 1 recently being reinstated after its major service.

The Council now have a policy to test the BRPS pumps on a regular on-going basis to monitor the pump performances to better determine capacity and efficiency of each of the pumps. Accurate pump performance testing allows benefits gained from various pump efficiency enhancements to be quantified accurately; repeatable performance measurements provide the knowledge required to make informed energy/cost based decisions regarding the upgrade of the pumps.

Picture 1 – Beach Road Pumping Station dry well and pumps

5.2 AVAILABLE METHODS OF PUMP PERFORMANCE TESTING

Currently there are two main methods for testing the performance of a pump. The most common approach is the traditional method that is well recognised in the industry but can lack in accuracy. The second less known method is the ‘thermodynamic’ method, which is a relatively new method and has the potential to provide much greater accuracy.

5.2.1 TRADITIONAL METHOD

The traditional method of pump performance testing uses the pumps measured head, flow and input power to calculate the efficiency. The major drawback with this method is that it depends largely on the accuracy of the devices used to measure the head, flow and power input. For example, if each of the 3 measuring devices (flow/head/power) is 95% accurate, this would equate to almost a 9% uncertainty (i.e. the quadrate of the individual uncertainties) in the overall efficiency calculation. In turn, if a calculation determined that a pump was 87% efficient, the uncertainty would be ± 9%, meaning that the pump could actually be as low as 79% efficient. Such magnitudes of inaccuracies undermine the benefits of long term pump efficiency testing as one is not be able to reliably detect/assess pump deterioration or improvements in efficiency when work is carried out on a pump.

5.2.2 THERMODYNAMIC METHOD

The P22 thermodynamic pump testing method can reliably measure temperature to 1/1000th of a Kelvin (0.001^{o}C). This enables measuring the minute temperature increase of the fluid as it passes through the pump. The thermodynamic method uses the principal that virtually all of the efficiency loss in a pump is transferred to heat and absorbed by the water/liquid it is pumping. This means that a measured difference between the input water temperature and the outlet water temperature can effectively indicate the efficiency of the pump. For example, a small difference between the inlet and outlet temperature of a pump indicates the pump is operating at a high efficiency and vice-versa. When the temperature difference is combined with the pump head and input power, a pump’s efficiency is calculated far more accurately and with better repeatability than any other method presently available for in-situ testing (+/-1% accuracy for clean water pumps compared to typically +/- 5-10%).

Cardno BTO hold the New Zealand licence from Robertson Technology Pty Ltd for using their thermodynamic technology to provide pump performance testing services using portable test equipment (P22P) for in-situ testing and for selling fixed pump performance systems (P22F) for permanent installation.

5.3 PUMP PERFORMANCE TESTING EQUIPMENT USED (THERMODYNAMIC METHOD)

Each P22P pump monitor system has two temperature probes, two pressure probes, one power meter and a software program. These are connected together using digital network technology that can utilise radio transmitters to allow the computer terminal to be situated away from the noises of a pump room. Figure 2 shows a schematic of a standard testing equipment configuration, and Picture 2 presents the portable testing equipment (discharge side only) installed during an in-situ pump performance test.

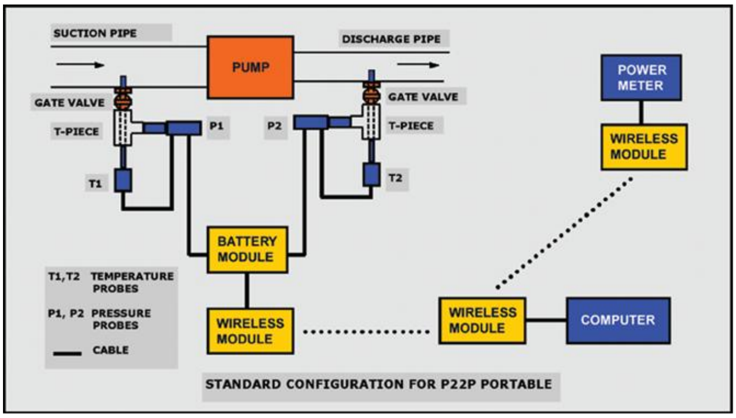
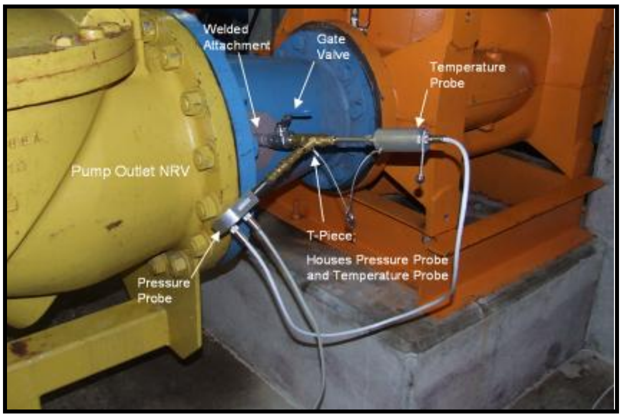


Figure 2 – Schematic of P22 portable pump performance monitor



Picture 2 – Instrumentation on delivery side of pump

5.4 GRAPHICAL COMPARISON OF PUMP PERFORMANCE CURVES

For each pump tested, the data obtained is represented in the standard graphical methods of:

- Flow vs. Efficiency
- Flow vs. Head
- Flow vs. Shaft power

The latest performance tests for each of the five BRPS pumps are compared against each other. All curves have been standardised to 75% of full speed. Flow variation was achieved by modulating the newly installed discharge valves.

Figures 3, 4 and 5 show the efficiency, head, and power respectively of the four BRPS pumps. The data points presented in these figures contain error bars that represent the uncertainty, by means of a 95% confidence interval.

The accuracy of the data obtained is typical for wastewater pumps, which is less accurate than for clean water pumps. Typically the reasons for this are due to more fluctuations in fluid inlet temperature and composition, as well as the potential for fibres to build up on the insertion probes affecting the measurements.

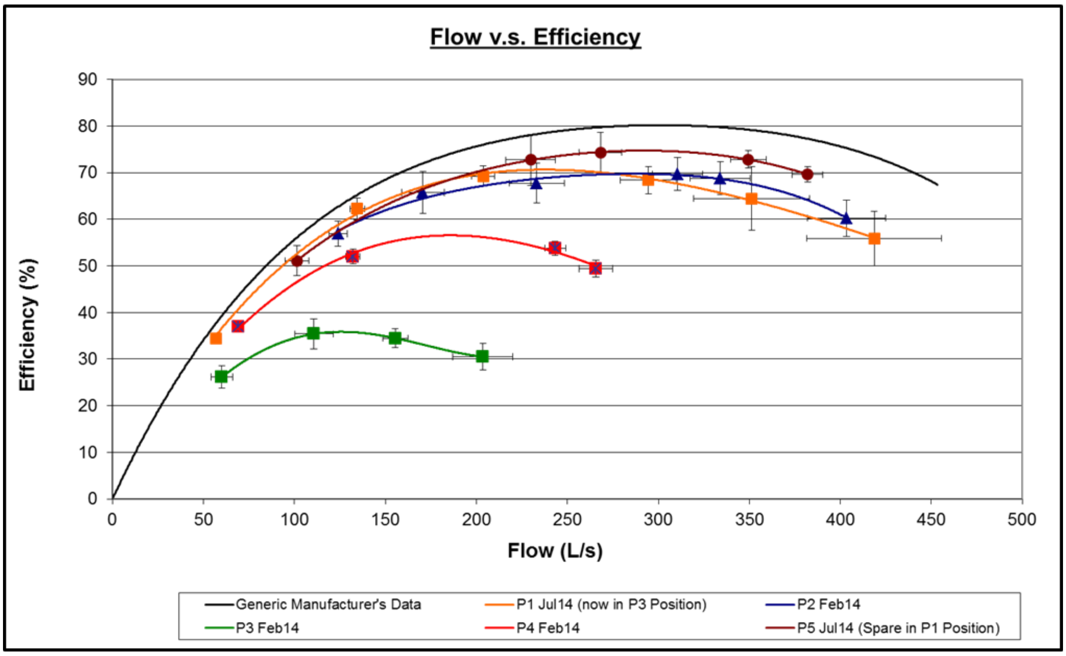


Figure 3 – All pumps' efficiency vs. flow (at 75% of full speed)

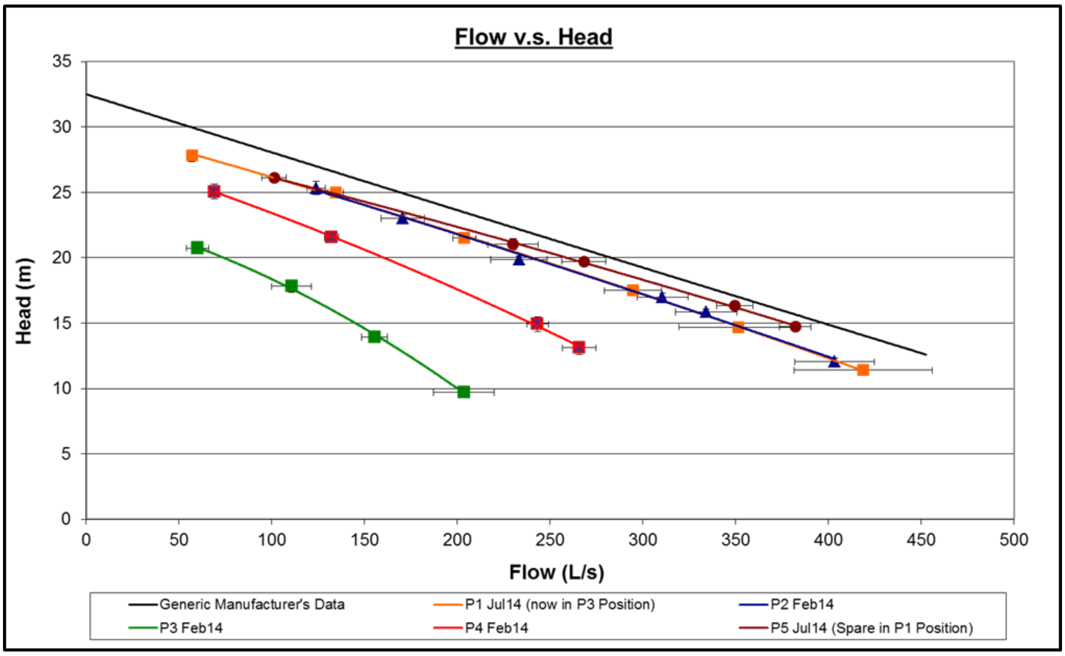


Figure 4 – All pumps' head vs. flow (at 75% of full speed)

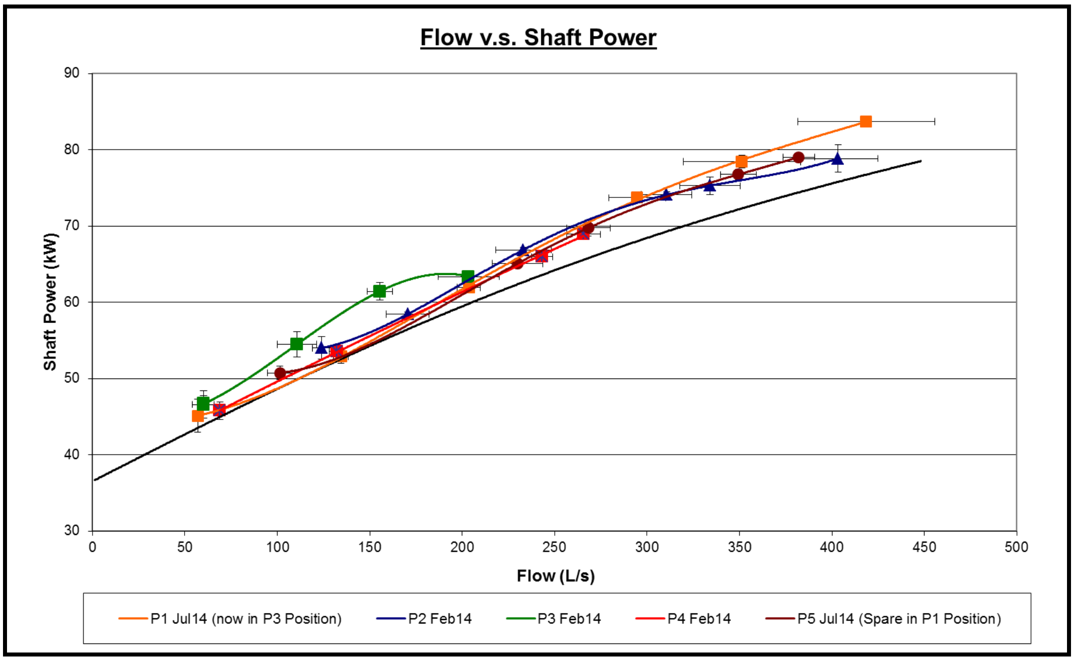


Figure 5 – All pumps' shaft power vs. flow (at 75% of full speed)

5.5 COMPARISON OF PERFORMANCE BY BEST EFFICIENCY POINT

Pump performance is assessed by estimating the difference of the Best Efficiency Point (BEP) of the benchmark pump test data compared to the BEP of current pump performance tests, as summarised in Table 4. A conclusion can then be made which indicates whether the pump that was tested was operating efficiently or if there has been deterioration of the pump performance.

Table 4 – Comparison of pump best efficiency points and change in performance

Test Date	**Pump 1**	**Pump 2**	**Pump 3**	**Pump 4**	**Pump 5 (spare)**
July 2011	68.3%	77.7%	66.6%	69.8%	-
Feb 2014	59.5%	70.0%	35.0%	55.1%	-
July 2014	71.2%	-	-	-	75.5%
Generic Manufacturer's Data	80.0%				
Change in Performance	**+11.7%**	**-10%**	**-45%**	**-24.9%**	**-4.5%**

Pump 5 has a measured BEP around 4.5% less than that of the generic manufacturer's data. This emphasises the difference between the stated generic manufacturer's data, and that of an actual installed pumps performance, and therefore the necessity of in-situ pump performance tests when pumps are new to provide a realistic benchmark.

Pump 1 was recently refurbished, which has yielded an increase in efficiency of around 11.7% compared to the performance measured in February 2014. Refurbished Pump 1 has a BEP that is 4.3% less than that of Pump 5 (the spare/new pump), and 8.8% less than that of the generic manufacturer's data. This is a realistic outcome from such a pump refurbishment, in our opinion and experience.

Pump 2 has the highest BEP of the BRPS pumps (excluding the spare Pump 5). This may have been caused by a combination of the following: different pump impeller diameter, lower total pump run hours than other pumps, a more favourable 'wet well outlet location' / 'suction pipe' to Pump 2 to minimise pumping of debris.

Pump 3 is the most deteriorated pump; it now has approximately half the efficiency of Pump 2. This is consistent with observations by operations staff; who have observed that the flow through Pump 3 has declined significantly. Possible reasons for Pump 3 deteriorating further than the other pumps could be due to the following: the suction pipework to Pump 3 favours pumping debris accumulated in the wet well, higher total pump run hours than the other pumps.

5.6 POTENTIAL SAVINGS FROM FUTURE REFURBISHMENTS

Estimation of potential savings is different for a fixed speed or variable speed pump. For a variable speed pump, the increase in energy use due to deterioration has been approximated by estimating the increase in pump speed to maintain the same duty flow, for the given system. Unless the variable speed pump output is limited by the pump reaching its maximum speed, then there is no loss in output capacity but there is an increase in energy use. In addition, for a variable speed pump the effect of wear on power required is much more dramatic than for the case of a fixed speed pump due to the increase in energy use being in proportion to the speed ratio cubed (as per the pump affinity laws).

As a general note, it is difficult to estimate savings from any efficiency improvements unless accurate data of pump running times, flows, and other system data are available. Assumptions made in the estimation of potential savings presented are the following:

- Power cost of $0.145/kWh.
- The average hours of operation were assumed to be 12 hours/day for all four pumps, and assumed an even duty/assist rotation between all pumps.
- An average instantaneous flow rate set point of 340l/s was assumed.
- A representative system curve was derived by measuring the suction pressure, discharge pressure, and flow rate for various pump speeds and number of pumps operating.
- The post refurbishment benchmark performance of the pump has been assumed to be each of the following: generic manufacturer's data, Pump 5 (spare/new pump) performance, and refurbished Pump 1 performance.

Table 5 shows the estimated annual cost and electricity savings from the refurbishment of the BRPS pumps, with various refurbished performance benchmarks. Comparing the various benchmarks highlights the potential difference in estimated savings due to the different assumed refurbished performances.

Table 5 – Potential savings from future pump refurbishment compared to various benchmarks

Refurbished Benchmark	Parameter	Pump 1 (Jul14)	Pump 2 (Feb14)	Pump 3 (Feb14)	Pump 4 (Feb14)	Pump 5 (Jul14)
Generic Manufacturer's	Potential power savings (kWh/Year)	37,700	42,600	260,300	88,400	36,000
	Potential cost savings ($/Year)	$5,500	$6,200	$37,800	$12,800	$5,200
Pump 5 (spare)	Potential power savings (kWh/Year)	1,800	7,500	117,000	63,000	-
	Potential cost savings ($/Year)	$250	$1,100	$17,000	$9,000	-
Pump 1 (refurbished)	**Potential power savings (kWh/Year)**	**-**	**5,600**	**115,000**	**60,800**	**-**
	Potential cost savings ($/Year)	**-**	**$800**	**$16,700**	**$8,800**	**-**

Based on the outcomes of the Pump 1 refurbishment, the accuracy of prediction of a pump's refurbished performance are in the following order:

- Results of actual pump refurbishments
- In-situ performance test of actual pump when new
- Generic manufacturer's performance

For example, if the Pump 1 refurbished performance was assumed to be that of the Spare Pump 5 or the generic manufacturer's performance, it would have overestimated the gains from refurbishment by around $250 and $5,500 per annum respectively.

If Pump 2, 3, and 4 were refurbished to the same performance as 'Refurbished Pump 1', annual energy savings of around 181,400kWh could potentially be achieved. An estimated annual saving of $26,300 can be made from this arrangement, assuming the same even duty/assist rotation occurs.

5.7 PUMP 1 REFURBISHMENT COST/BENEFIT ANALYSIS

Pump 1 was recently refurbished, as part of the original purchase agreement which allowed for the pumps to have a major service by the supplier after a period of operation. The refurbishment consisted of the following:

- Freight
- Dismantled and cleaned
- Replacement of the following parts is also required: bearings, wear ring, mechanical seal and all other rubber sealing parts..
- Setting the pump 'wear ring' tolerance back to the manufacturer's specifications (where the most pump performance benefit will be gained)
- Shaft repair and balancing

The cost of the refurbishment of was estimated to be $23,000.

Figure 6 presents the refurbished Pump 1 performance, compared to various benchmarks (generic manufacturer's data, Spare Pump 5, and previous performance tests).

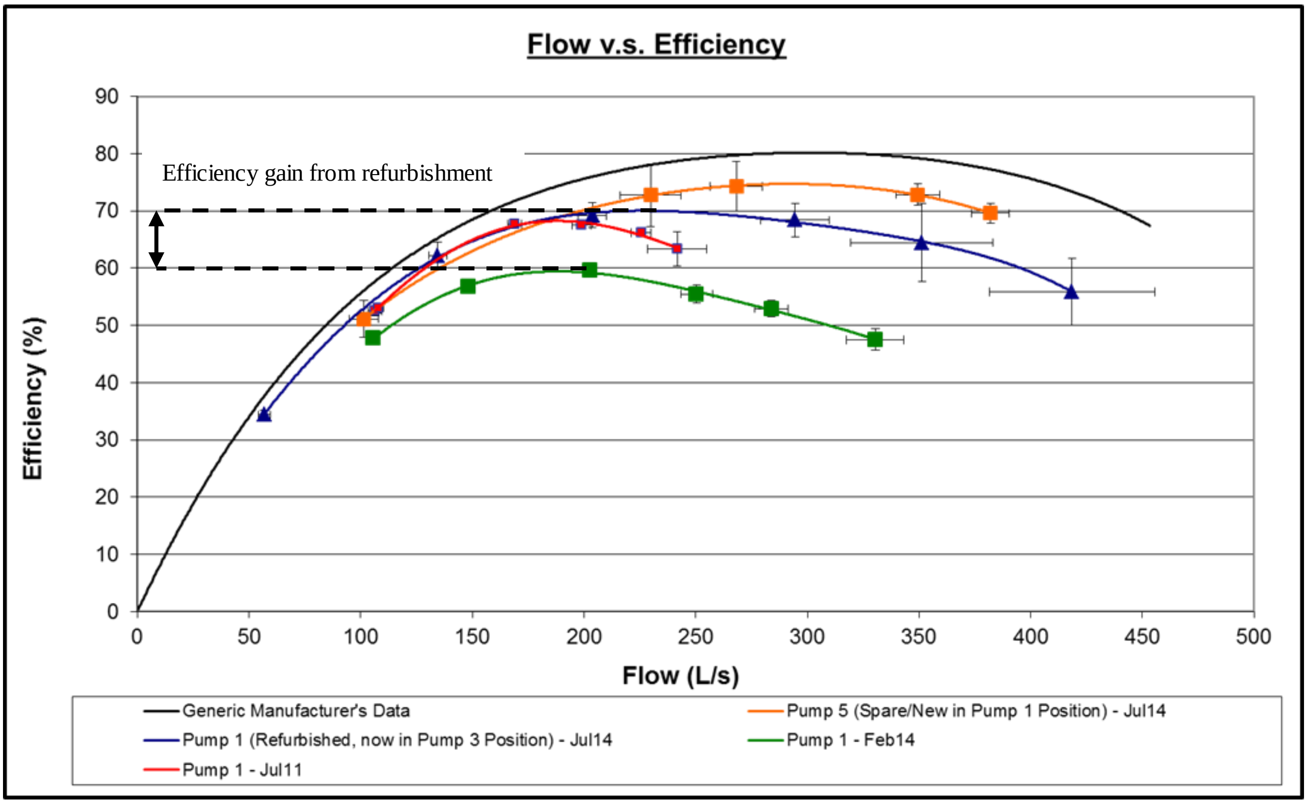


Figure 6 – Pump 1 pre and post refurbishment efficiency (at 75% of full speed) compared to various benchmarks

The refurbishment of Pump 1 yielded an increase in efficiency of around 11.7% compared to the performance measured in February 2014. Refurbished Pump 1 has a BEP that is 4.3% less than that of Pump 5 (the spare/new pump), and 8.8% less than that of the generic manufacturer's data. This is in our opinion, a realistic outcome from such a pump refurbishment.

The estimated gain from the recent refurbishment of Pump 1 (with the same assumptions as listed in Section 5.6) has been estimated to be $6,300 per annum (or 43,500kWh per annum), compared to Pump 1's measured performance in February 2014.

The simple payback period from the refurbishment was estimated to be 3.7 years, based on the refurbishment cost of $23,000.

6 30 YEAR INFRASTRUCTURE PLAN RECOMMENTATIONS

The outcomes of the capacity and condition assessments are summarised in Table 6. These were incorporated into Council's 30 year infrastructure plan for the BRPS.

Table 6 – Summary of 30 year infrastructure plan recommendations

Priority	Asset	Issues	Solution	Timeframe
1.	Pumps #1 #2 #3 #4	Major overhaul required to maintain capacity and efficiency. Pump #3 poor performance	Requires refurbishment	Immediate
2.	Rake Screen (New)	Jams with rocks and breaks rake/shaft/motor	Torque Switch Shear Pin	
3.	Grit Removal and Handling	Poor performance	Modification Options: • Duty/assist operation • Radius inlet bends • Chamber floor, internals • New grit pumps, classifier	
4.	Hydraulic Actuation System	Poor condition	Replace with electric actuation systems	
5.	Control Systems Upgrade	PLC asset life expired - Rockwell SLC500 is a discontinued range Poor control	Upgrade control system	
6.	Rake Screen (Old)	Deterioration and damage	Decommission	
7.	Pumps #1 #2 #3 #4	Poor performance	Schedule pump performance testing	Annually
8.	Overflow Structure	Concrete decomposition of ceiling and wall	Investigate best solution; repair and re-surface	2014/15
9.	Generator	Aging asset in poor condition	Replace with new unit that is suitable for water bore	
10.	Transformer	Aging asset	Obtain an up to date assessment including HV cable condition	
11.	Main Switchboard	Design life exceeded	Replace, with consideration of other electrical components	
12.	Building	Lighting, signage, etc.	Building Warrant of Fitness	
13.	River Overflow System Upgrade	Lack of automation Silt blockages	Automate if overflow is required	
14.	Pre-Treatment and Dry Well Wall Structures	Concrete corrosion	Investigate best solution; repair and re-surface	2015/16
15.	Pumps #1 #2 #3 #4	Major overhaul required to maintain capacity and efficiency.	Refurbishment	2020/21
16.	Pumps #1 #2 #3 #4	Reached end of asset life	Replacement	2026/27
17.	Inlet Screens	Reached end of asset life	Replacement	2031/32
18.	Grit Removal and Handling	Reached end of asset life	Replacement	2035/36

7 CONCLUSIONS

The imminent need for infrastructure planning on a 30 year horizon will require a wider understanding of asset value, capacity, and condition than is currently required by the Local Government Act 2002, being 10 years. While this may seem onerous to councils, it is actually an opportunity to carry out a rigorous review process to better understand assets, and the future needs of the community.

Cardno BTO carried out capacity and condition assessments for the Wanganui District Council's Beach Road Pumping Station (that also contains wastewater pre-treatment), as a basis for preparing a 30 Year Infrastructure Plan.

Use of the 'Visual Assessment of Utility Assets' guidelines (NZWWA, 2008) ensures that the condition assessments of the civil, structural, mechanical, and electrical components are systematic and concise in identifying components of concern.

Capacity assessments are always asset specific. For this case study, two types of assessments were required.

The pre-treatment system was assessed based on hydraulic capacity of the channel and each process unit.

The pumping system was assessed based on pump performance testing to help determine the deterioration in capacity as well as in efficiency (and therefore operational cost). Regular on-going pump performance tests allow accurate determination of the performance benefits from the refurbishments, as well as comparison to the cost of refurbishment or replacement to allow a cost/benefit analysis.

The capacity and condition assessments have identified numerous items to be included in Wanganui District Council's 30 year infrastructure plan, some of which are currently in the process of being implemented.

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REFERENCES

NZWWA (2008) 'Visual Assessment of Utility Assets, 1st Edition' NZWWA, Wellington, New Zealand

Beebe, R. (2004) 'Predictive Maintenance of Pumps using Condition Monitoring' Elsevier Advanced Technology, Oxford, UK

NOMENCLATURE

AADF	Annual Average Daily Flow
ADWF	Average Dry Weather Flow
BEP	Best Efficiency Point
BRPS	Beach Road Pumping Station
NZWWA	New Zealand Water and Wastewater Association (now WaterNZ)
VSD	Variable Speed Drive
WDC	Wanganui District Council
WWTP	Wastewater Treatment Plant