VNF Stock Pumping Station

PUMP ASSESSMENT REPORT

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P1	15/11/19				

Content

1 Introduction

This report summarises the key findings of Arcadis' technical assessment for VNF Stock Pumping Station (PS) under Phase 1 on the Green WIN project. This is a desktop study review and is based upon the data provided by VNF via the Green WIN intranet site.

During 2020, VNF intend to carry out the following tasks at Stock PS:

- Renewal/Upgrade of pump station equipment
- Targeted water flow: 0.6 m^3/s (per pump)
- Motor IE3 or IE4 energy performance
- Smart water and energy monitoring
- Automation, supervision and telecontrol of pumping station operations
- Optimisation of operations time periods

2 System Description

2.1 Pumping Station

Stock PS is located on the east bank of the Stock Pond and is vital for the water supply of the Marne to the Rhine Canal and the Saar Canal. It is equipped with 4 no. pumps and allows the transfer of water to raise the level of the pond towards the canal in order to feed the Vosges sharing bay, and thus the Marne to the Rhine Canal, as well to Strasbourg as to Nancy, and the Saar Canal.

The pumping station is reported to be able to deliver approximately 171,000 m^3 over 24-hours with three pumps operating simultaneously and 230,000 m^3 with four pumps, although only three can be operated at the same time due to electrical restrictions.

The existing pumps appear to be horizontal, axially split, double suction, centrifugal pumps that are long-coupled to 110 kW slip ring motors. It is understood that the motors were refurbished in 2003.

Table 1 – Pump Details

Parameter	Description
Pump	Rateau EPB41
No. of Pumps	4
Configuration	Duty / Duty / Duty / Standby
Rated Motor Output	110 kW
Energy Conformance	IE1
Drives	Fixed Speed
Pipework	DN500 suction; DN450 discharge (assumed)

Wet Well Level	255.8 mNN (estimated bottom water level)

Each pump discharge pipe is provided with an actuated guillotine valve for isolation (figures 1 & 2). In addition to acting as an isolation / check valve, it is assumed that a secondary function of the actuated guillotine valve may be to prevent sudden load on the power system during start up.

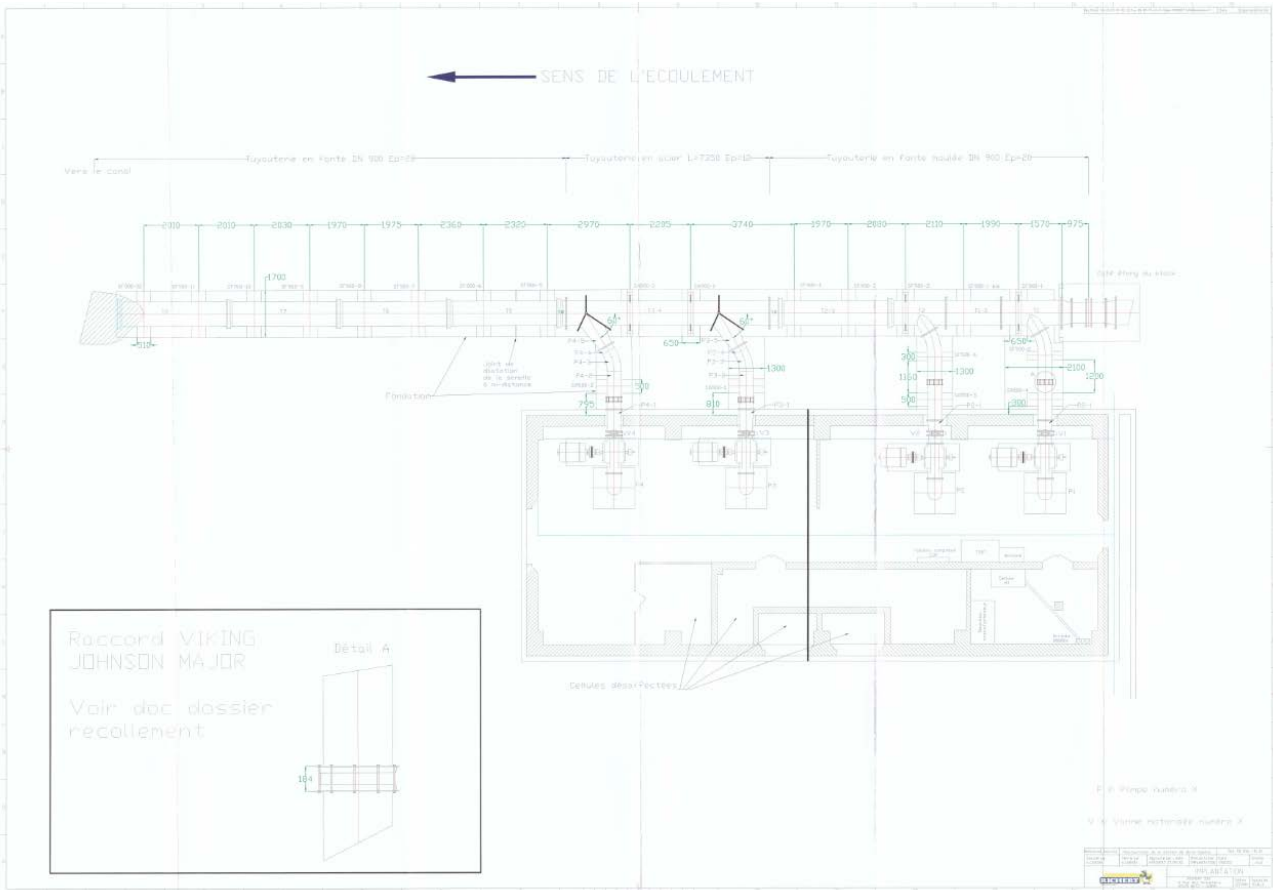

Figure 1 – Existing Pump Arrangement (Plan)

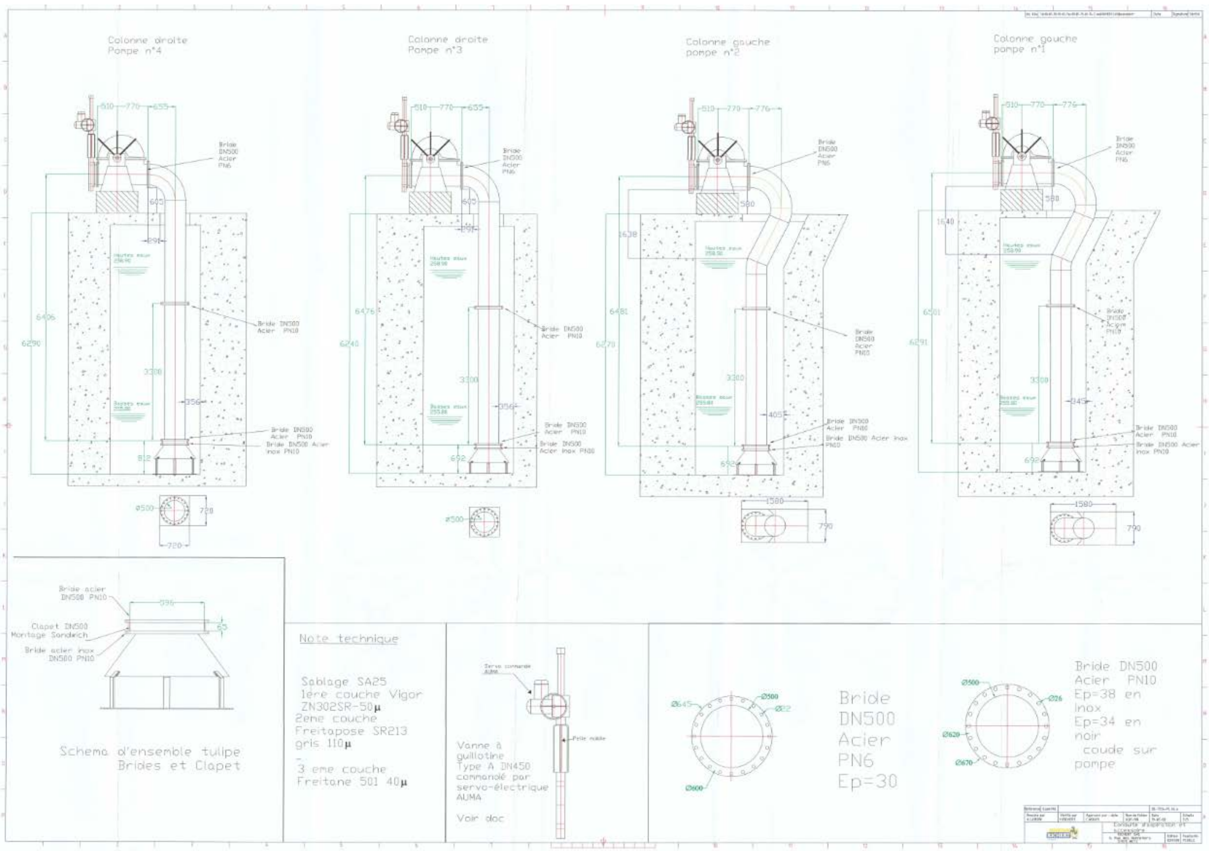

Figure 2 – Existing Pump Arrangement (Sections)

2.2 Rising Main

The pipework is a part-buried, 900 mm diameter cast iron main and allow allows water to both be returned to the canal and to feed the pond. It is provided with a 700 mm diameter guillotine 'percent' valve which regulates the flow of water to the pond, via the opening percentage and the calculated flow. The rising main pipework is 200 m long,120 m of which is buried.

Table 2 – Rising Main Details

Parameter	Description
Approx. Length	200 m
Pipe Diameter	900 mm
Discharge Level	266.16 mNN
Pipe Material	Cast iron and steel
Roughness (k_s)	0.3 mm (Curves produced for 0.03 mm, 0.3 mm and 0.6 mm)

3 System Curves

As no manufacturers or test pump curve data is available, the system and pump curves have been derived by Arcadis from the pumps list and provided reports.

Figure 3 indicates that a single pump is capable of delivering a flow rate of between approximately 345 l/s and 430 l/s based on the variation in water levels. With 3 pumps running in parallel, up to 1170 l/s is possible. At the design lift, a pump duty of approximately 410 l/s at 8.2 m head is suggested. This is less than the required nominal flow rate of 600 l/s.

Using the average throughput of 4000 m^3/h at the design lift, the existing pump efficiency has been estimated at 49.8% (average value with three pumps running) assuming an IE1 motor efficiency of 93.3%.

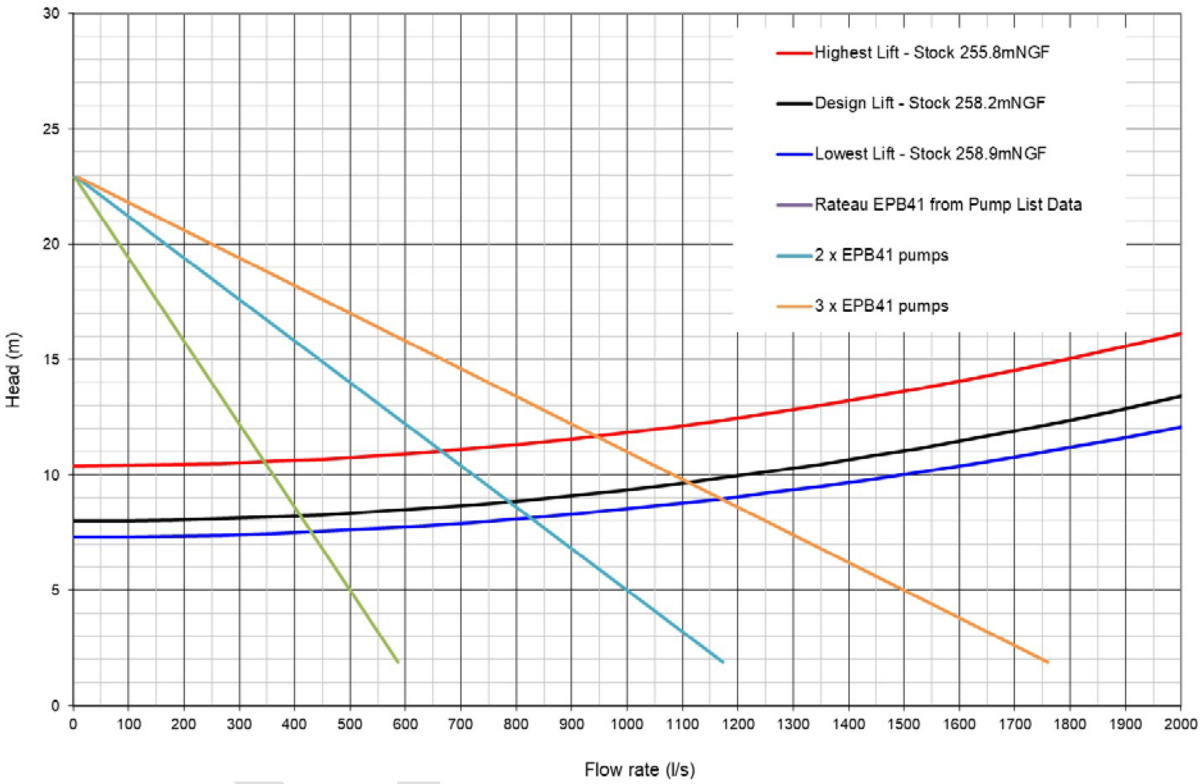

Figure 3 – Derived System Curves for existing Rateau pumps

4 Pump Selection Review

Arcadis have investigated if there are energy efficient alternatives to the existing pumps, based on achieving 600 l/s at 11 m head at the design lift, and have identified two potential candidates to provide a comparison between different pump types:

- Bedford SB45.12.06 390 mm impeller suspended submersible pump
- Xylem 20 x 18 WLS 518 mm impeller horizontal split case pump

As indicated in Table 3, both the Bedford and Xylem pump selections could provide the required flow rate of 600 l/s per pump. They would also provide greater resilience and operational flexibility as they are likely to be able to deliver an average throughput of 4000 m^3/h with only 2No. pumps operating in parallel.

Table 3 – Comparison of potential alternative pump selections

Pump	Duty Point	NPSHr (m)	Motor Rating (kW)	Pump Efficiency at duty point (%)	Motor Efficiency* (%)
Bedford	600 l/s at 11.4 m		90	87.5	95.2
Xylem	600 l/s at 11.0 m	5.5	90	88.9	95.2

* IE3 motor minimum efficiency

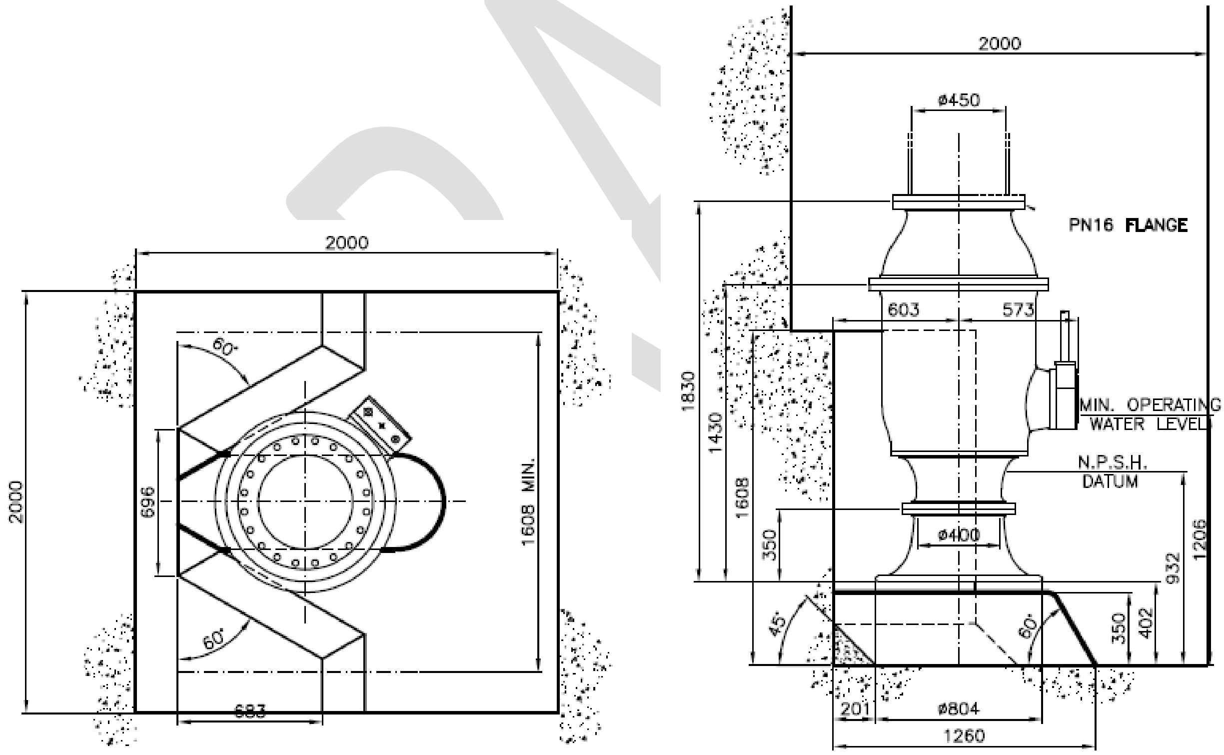

Figure 4 – Potential pump type: Bedford suspended submersible arrangement

The Bedford pump selection is capable of delivering a slightly higher head and flow rate at the design lift and would also remove the need for a priming system due to the suspended submersible pump configuration (Figure 3), thus minimising maintenance requirements.

The Xylem pump selection would provide a similar suction lift configuration to the existing Rateau pump arrangement; however, provision of an automatic priming system would need to be considered to eliminate operator burden at pump start-up which is likely to increase the overall CAPEX and OPEX.

Due to the existing pumps being horizontal split case type, the sump arrangement does not appear to be suitable for conventional submersible pumps (i.e. with guide rails) or typical end suction centrifugal pumps.

Installation of any submersible or immersible type pump would need to consider the requirement to protect it against potential damage from pebbles and other debris that may enter the sumps.

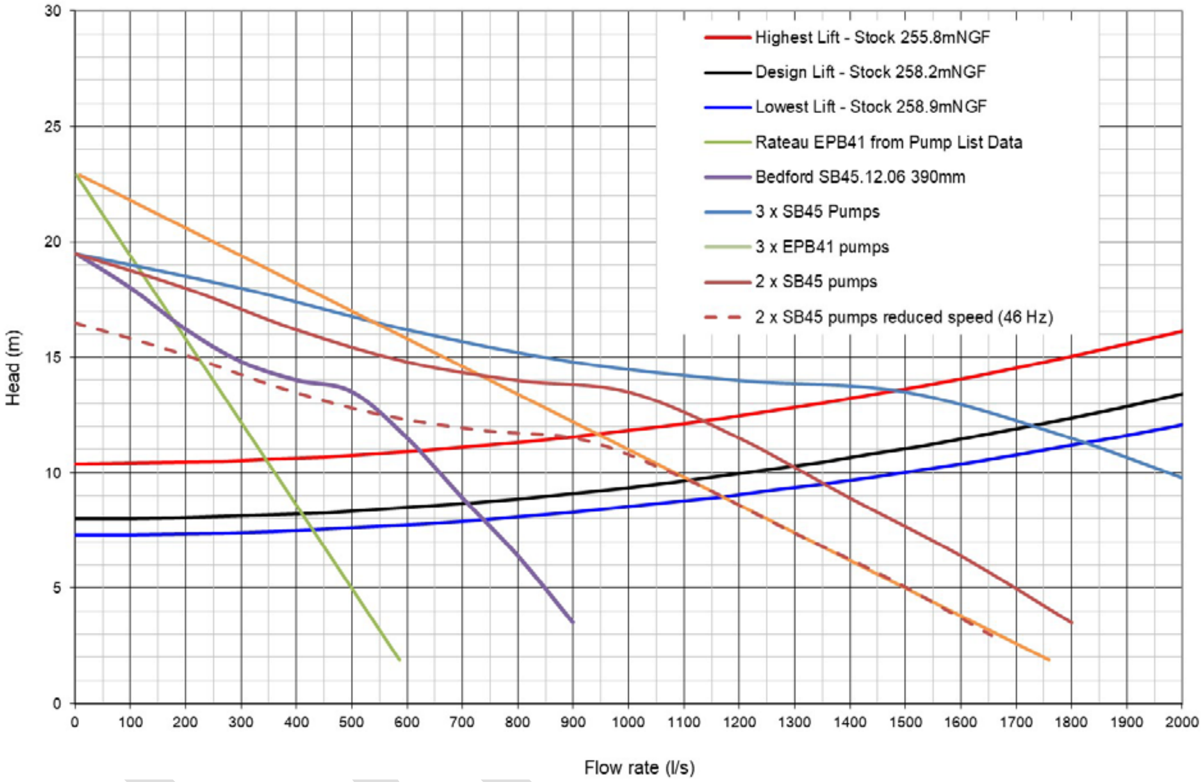

Figure 5 – Derived System Curves with Alternative Bedford Pump Selection

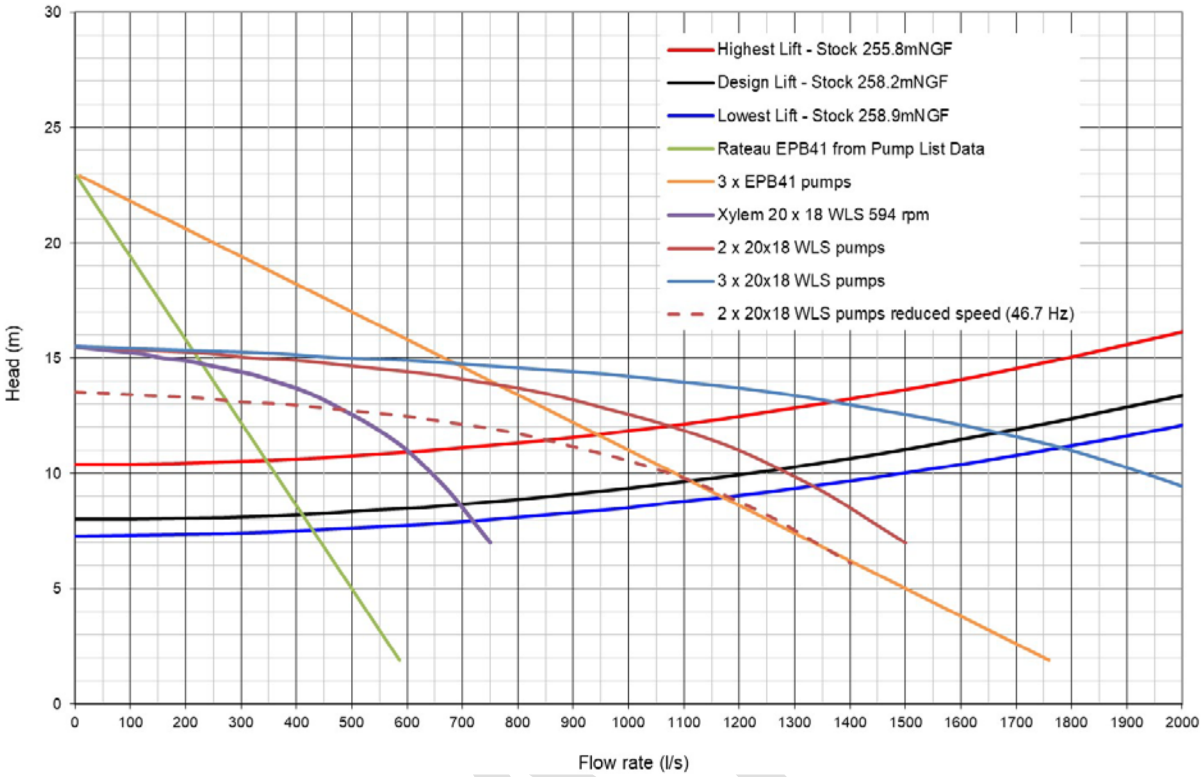

Figure 6 – Derived System Curves with Alternative Xylem Pump Selection

5 Energy Assessment

Using VNF energy audit data for 2017 and based on a theoretical annual volume of 6,755,509 m^3 at the design lift, a comparison has been undertaken to demonstrate the potential for energy improvement at the site. This is shown in table 4.

Table 4 – Energy Comparison Old Pumps vs Alternative Pump Selection

Pump Configuration		**Motor Rating (kW)**	**Static Lift**	**Average throughput (m^3/h)**	**Specific Energy (kWh/1000 m^3)**	**Annual Energy Consumption (kWh)**	**Annual Saving (kWh)**
Rateau	3 pumps (fixed speed)	110	Design	4,000	56.7	382,762	-
Bedford	2 pumps (fixed speed)	90		4,608	37.8	255,294	127,468

Pump Configuration		Motor Rating (kW)	Static Lift	Average throughput (m³/h)	Specific Energy (kWh/1000 m³)	Annual Energy Consumption (kWh)	Annual Saving (kWh)
Xylem	2 pumps (fixed speed)	90		4,536	36.5	248,181	134,581
Bedford	2 pumps (VSD)	90		4,000	32.6	220,036	162,726
Xylem	2 pumps (VSD)	90					

6 Preliminary Findings

6.1 Pump Selection and Arrangement

In principle, a wet well suspended pump installation, such as the Bedford offering, is preferred ahead of the Xylem selection as no priming system is necessary. There appears to be adequate space to fit the pumps based on the existing record drawings; however, this assumption would need to be verified on site by VNF and installation of submersible pumps would require civil modifications to the sump and slab to suit.

A submersible pump arrangement should also allow the actuated guillotine valves to be removed and replaced with manual isolation valves and non-return valves on each pump discharge. This would help further reduce operation and maintenance requirements. Note that wafer type valves or similar may be required due to the limited space within the pump station building.

6.2 Pump Drive

The use of IE3 (or IE4) high efficiency motors will provide efficiency benefits and the use of variable speed drives may enhance these efficiency savings, in particular if the flow rate needs to accommodate variations in water levels, etc. and to be automated with close control.

Other benefits of VSDs include:

- Reduction in starting current
- Protection against surge
- Operational flexibility, e.g. in terms of the ability to vary the flow rate and manage/control individual pump units

The use of VSDs would incur a higher capital cost than fixed speed drives and would require harmonic assessment and possible mitigation, such as harmonic filters, depending on the power supply characteristic.

6.3 Energy Improvement Potential

The potential for energy improvement at this site is considered as follows:

- Optimisation of pumping volumes and durations (e.g. only pump when needed or during off-peak tariff bands)
- Use of high efficiency motors
- Review heating system for building frost protection

7 Recommendations

In order to improve the energy efficiency of the pumping station the following measures are recommended:

- Automation of pumping e.g. via level control
- Installation of new submersible pump units complete with high efficiency motors
- Consider implementation of variable speed drives
- Installation of flow meter on common main to provide automation of pump flow control as well as the facility for remote monitoring

Appendix A - Source Drawings and Documents

Document/Drawing Reference	Title or Description	Originator
TBC	TBC	TBC