VNF Briare Pumping Station

PUMP ASSESSMENT REPORT

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Content

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1 Introduction

This report summarises the key findings of Arcadis' technical assessment for VNF Briare 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.

The project considerations for this pumping station for implementation 2020 are as follows:

- Automation, supervision and telecontrol of pumping operations
- Optimising of operations time periods
- Implementing at least one new pump
- Motor IE3 or IE4 energy performance, Variable Speed Drive (VSD)
- Smart water and energy monitoring

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2 System Description

2.1 Pumping Station

Briare pumping station is equipped with 6 pumps although it operates with only 2 pumps for most of the time and up to 3 if necessary.

Table 1 – Pump Details

Parameter	Description
Pump	Xylem (Flygt) CP3231 / 705 with 53-455 performance curve
No. of Pumps	6
Duty Configuration	Duty / Duty / Assist + 3 Standby units assumed
Rated Motor Output	170 kW
Energy Conformance	IE2
Impeller Diameter	435 mm
Drives	Fixed Speed (assumed star-delta)
Pipework	300 mm diameter branch into 750 mm diameter manifold (3 pumps)
Wet Well Level	124.2 to 125.8 mNGF(based upon schematic)

2.2 Rising Mains

From the provided schematic drawing, there are twin 900 mm diameter rising mains of approximately 2650 m in length.

Table 2 – Rising Main Details

Parameter	Description
No. of parallel mains	2
Approx. Length	2650 m
Elevation Rise	Approximately 43 m
Pipe Diameter	900 mm
Discharge Level	168.1 mNGF
Pipe Material	Not known
Roughness (and Loss Coeff, K)	0.3 mm (Curves produced for 0.03 mm and 1.5 mm)

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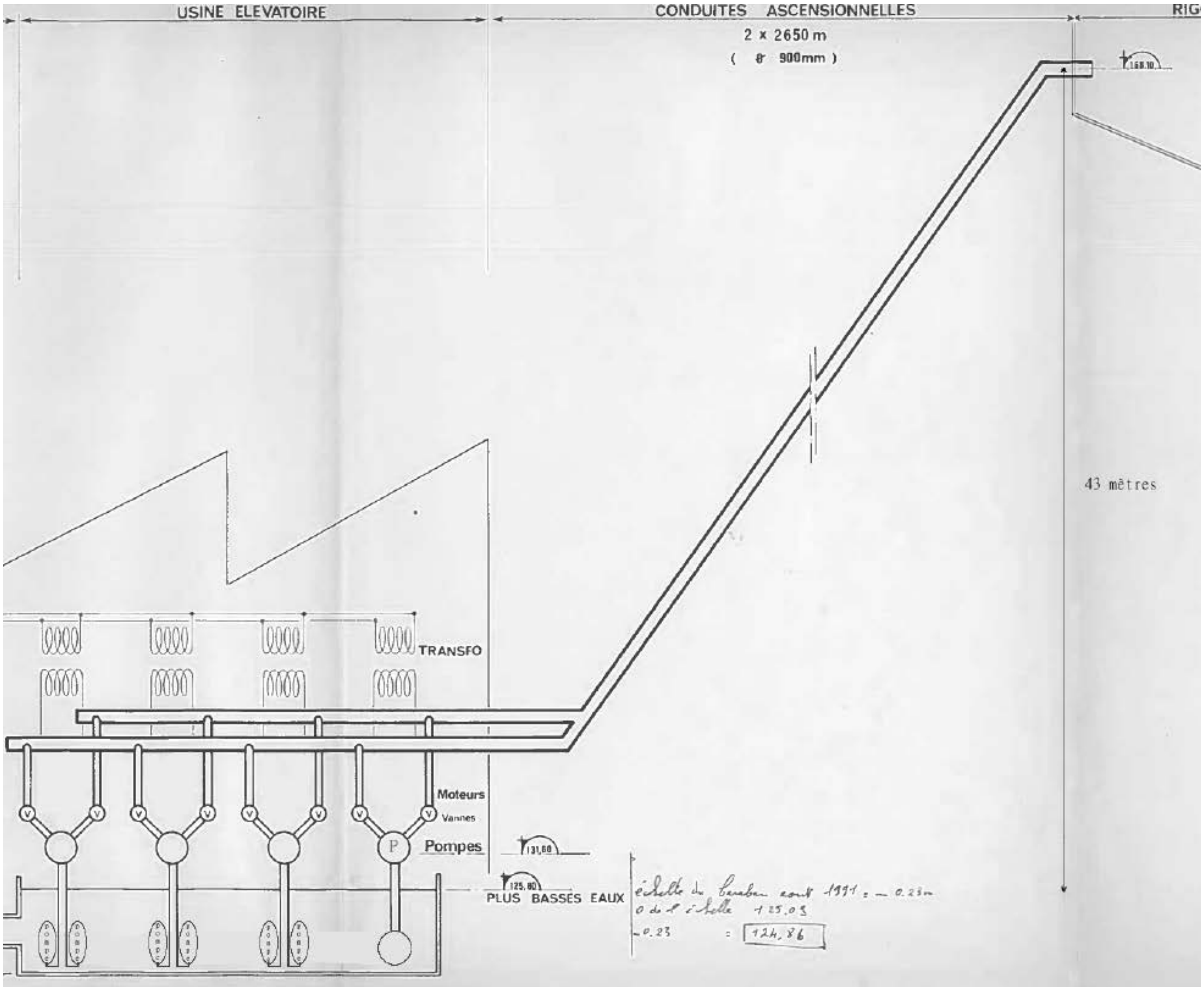


Figure 1 – Briare PS System Schematic and Elevations

3 System Curves

From the provided data, system curves have been derived by Arcadis.

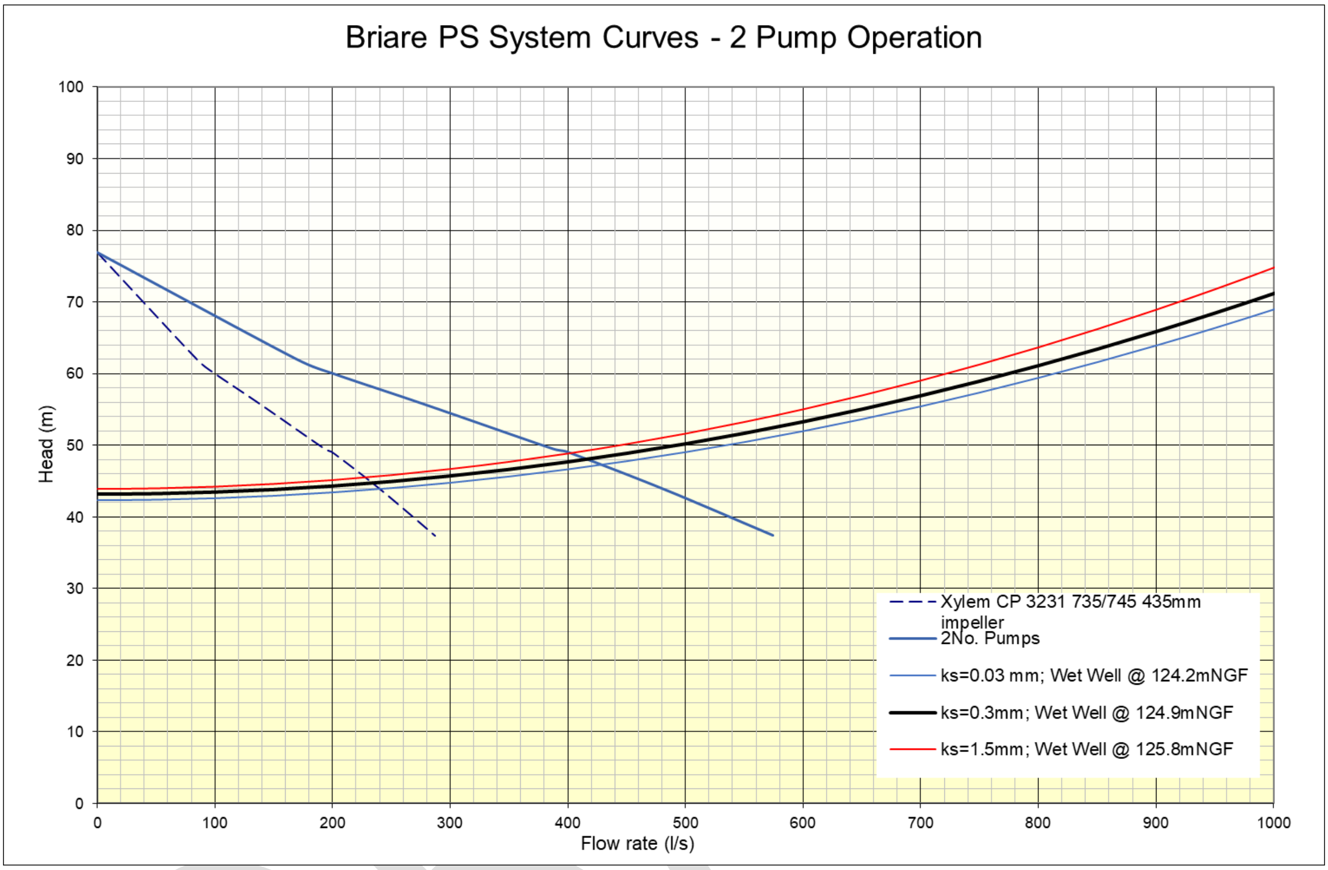
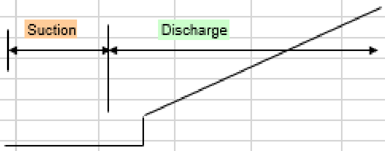


Figure 2 – Derived System Curves for 2-Pump Operation

1	*INPUT DATA*					
	Gravity, g	9.81	m/s2			
	Atmos pressure	101.3	kPa	Sump levels		
	Fluid	Water	[select]	TWL	125.8	mNGF
	Temperature	3	°c	Design	124.86	mNGF
				BWL	124.2	mNGF
	Kinem. viscosity	1.62E-06	m2/s			
	Density	1000.0	kg/m³			
	Vap pressure	0.0766	m			



Pump level:			mNGF
Pump station located before reach:	1		[select]

Assumed Hydraulic Discharge levels

	TWL	168.10	mNGF
	Design	168.10	mNGF
	BWL	168.10	mNGF
Static lift	Minimum	42.3	m
	Design	43.24	m
	Maximum	43.9	m

Reach:		1	2	3	4	5	6	7	8	9	10	11	12	13
Description		Pump Discharge pipework	Delivery DI vertical pipework	DI pump horizontal discharge within PS	CI rising main discharge									
Length (m)		1	9	10	2650									
Diameter (m)		0.2	0.3	0.75	0.9									
Flow area (m²)		0.03142	0.070686	0.44179	0.63617	0	0	0	0	0	0	0	0	0
Roughness (mm)	Low	0.03	0.03	0.03	0.03									
	Design	0.3	0.3	0.3	0.3									
	High	1.5	1.5	1.5	4.5									
Proportion of station flow		0.5	0.5	1	0.5									

Global head loss factor 0 % (added to friction and fittings losses throughout)

	Fittings Losses:	k-value	Number of fittings:												
1	Inlet (slightly rounded)	0.25	1												
2	Short R 90° bend	0.75	1	1	2	2									
3	Swing check valve	1		1											
4	Gate valve	0.12		1											
5	T straight through	0.35			3										
6	T line to branch 90°	1.2		1											
7	Taper up (1:2)	0.12													
8	Butterfly valve	0.3													
9	Expansion 4:5	0.15	1												
10	Contraction 5:4	0.15													
11	Short R 45° bend	0.3				2									
12	Long R 45° bend	0.2													
13	Outlet	1				1									
14															
15															
16	Outlet	1													
	Additional K (other devices)														
	Total K		1.15	3.07	2.55	3.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 3 – Hydraulic Calculation Input Data (3 pump operation)

The key observations from the derived system curves is that the existing pump selection provides a very good correlation with VNF's own technical assessment.

4 Pump Selection Review

4.1 Xylem Selection Review

Arcadis has reviewed the pump selection using Xylem's pump selection tool to assess the specific energy performance of the existing pumps and to investigate if there are more energy efficient alternatives to the existing pumps.

Table 3 – Pump Selection Data (Per Pump)

Configuration	Selection (Xylem)	Flow Rate (l/s)	Input Power (kW)	Overall Efficiency (%)	Specific Energy (kWh/1000 m^3)
3 pumps	CP3231 / 735 455 435mm	634	398	75.5	174
2 pumps	CP3231 / 735 455 435mm	422	265	75.4	174
1 pump	CP3231 / 735 455 435mm	214	133	75.7	172
3 pumps	CP3231 / 736 455 435mm (IE3)	638	390	77.4	170
2 pumps	CP3231 / 736 455 435mm (IE3)	424	260	77.4	170
1 pump	CP3231 / 736 455 435mm (IE3)	216	130	77.8	167

As it can be seen from Table 3, the best fit Xylem selection was the existing pump for a closed "C" impeller option. There was an "N" type semi open impeller version of the same pump was also available that gave marginal specific energy improvement (<1 kWh/1000 m^3) which has not been presented.

It is noted that the specific energy for the pump remains almost the same regardless of the number of pumps running.

The pump is available with an IE3 high efficiency motor and its hydraulic and energy data has also been presented for this option.

With an IE3 motor the pumping specific energy is reduced by approximately 4 kWh/1000 m^3 under the typical running situations of either 2 pumps or 3 pumps operating in parallel.

5 Energy Assessment

Energy consumption reports from EDF from 2017 and 2018 were reviewed for this study.

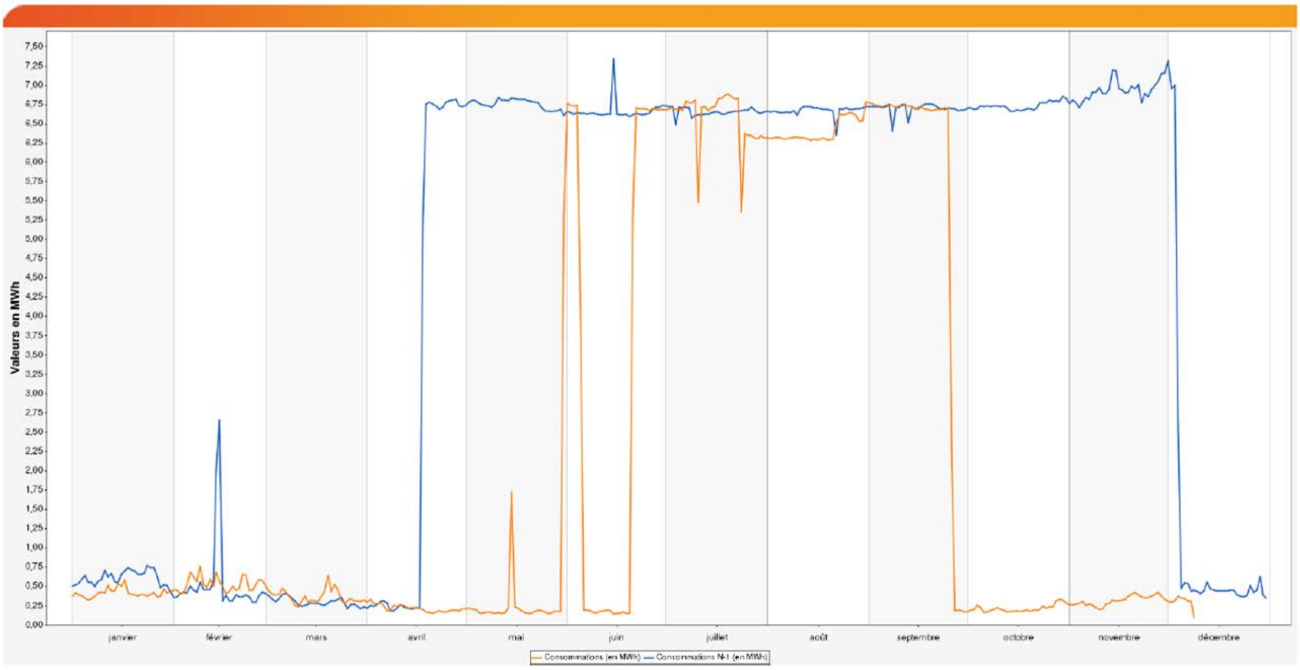


Figure 4 – Briare Energy Consumption 2017 (blue) and 2018 (orange)

Based on the EDF reports, Arcadis have deduced that there is base supplementary load of approximately 10 kW during the summer months and 20 kW during the winter months, which is likely to concern the building services for the pumping station (e.g. Heating, Lighting, Panels).

The typical loads during the summer months reflect a load of approximately 280 kW. Taking off 10 kW base load leaves a pumping load of approximately 270 kW. From the system curve and Xylem data review, this aligns with the predicted load for two running pumps of 265 kW and reflects the operational description provided by VNF.

It is noted that the load reduced by approximately 15 kW during July and August 2018. Based on the data provided, there is no obvious explanation for this at this time.

As no flow measurement have been undertaken, VNF have estimated the cost of pumping at 222 kWh/1000 m^3 which is based upon pump running time and assigning an arbitrary 200 l/s per pump. It also does not consider any supplementary loads.

From initial calculations, the estimated specific energy of pumping with 2 or 3 existing pumps is 174 kWh/1000 m^3. Using an IE3 motor on one pump is anticipated to reduce this to 172 kWh/1000 m^3.

VNF's assessment of total pumped volume during 2016 is 2,907,360 m^3. Based on this annual volume, the use of an IE3 motor on a single pump (assuming 66% utilisation) would bring a reduction of 3,873 kWh per annum. If all pumps were changed then the saving would increase to 11,629 kWh per annum.

Arcadis has investigated the impact of a variable speed drive. Figure 5 shows the anticipated performance for a single pump operation.

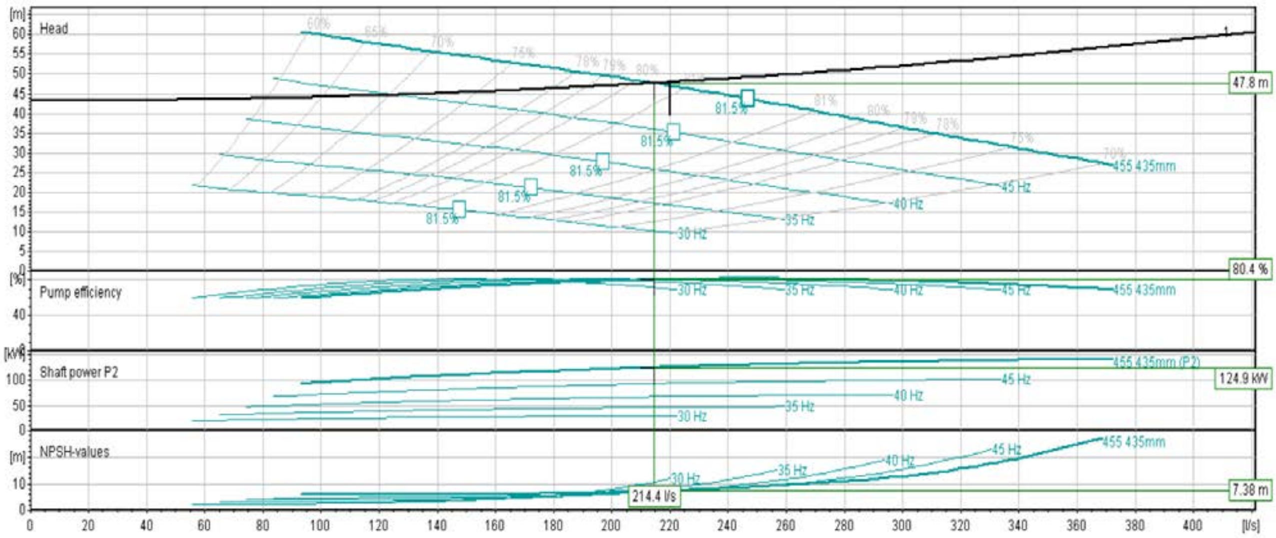


Figure 5 – 1-pump operation performance curves with VSD

As it can be seen from Figure 5, the pump efficiency would reduce with speed reduction as its BEP is to the right of the duty point. With VSD losses also to consider, the specific energy would increase with operation at a reduced speed.

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6 Preliminary Findings

6.1 Pump Selection

The existing pump selection is well matched, based applying reasonable design assumptions for pipe losses. An IE3 high efficiency motor is available for this pump model and would be expected to offer an approximate 2% energy efficiency saving per pump.

It should be noted that the system curve has been derived in the absence of actual flow and pressure monitoring data. Therefore, there is a risk of incorrect assumptions being applied.

6.2 Pump Drive

It is not anticipated that any energy savings would be achieved through the use of VSDs. The use of VSDs is actually likely to increase energy consumption.

6.3 Energy Improvement Potential

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

- Optimisation of pumping volumes and durations (i.e. only pump when needed)
- Use of high efficiency motors
- Possible review of building services (e.g. LED lighting, heating settings)

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7 Recommendations

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

- Undertake on site flow and pressure monitoring assessment to determine actual system characteristics
- Consider use of an IE3 motor for new pumps.
- Continue with fixed speed drives.
- Install an automated control system based on downstream (and upstream) level monitoring
- Install SCADA system and introduce performance metric reporting and possible smart control adjustment.

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Appendix A- Source Drawings and Documents

Document/Drawing Reference	Title or Description	Originator
TBC	TBC	TBC

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Interreg
North-West Europe
Green WIN
European Regional Development Fund

Canal & River Trust
Making life better by water

LIÈGE université

Ministerie van Infrastructuur en Waterstaat

Waterways Ireland
Uiscebhealaí Éireann
Watterweys Airlann

vnf
Voies navigables de France

VLAAMSE LAND MAATSCHAPPIJ