Richmond Harbour

PUMP AUDIT SUMMARY REPORT

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P1	10/12/19	N Taylor	J Bernard	N John	Issue for Comment

Content

1 Introduction

This report summarises the key findings of the pump station audit for Richmond Harbour. This review is based upon the data provided by Waterways Ireland (WI) and a site visit undertaken on 19th September 2019.

Pump testing was undertaken at the site visit and the following parameters measured:

- Power (using Fluke power meter)
- Levels and dimensions (laser/tape measure)

Due to the constraints of site, the flow rate and pressure were unable to be measured at the time of audit

2 System Description

2.1 Richmond Harbour

Richmond Harbour is located near Cloondara, County Clondra. The pump house is the first in a chain of pumping stations along the Royal Canal designed to maintain an upstream level within the canal from the River Camlin.

Figure 1 – Richmond Harbour PS (Left); Richmond Harbour Outfall (right)

Richmond Harbour comprises of 1no KSB PLZ300, fixed-speed axial flow pump. The pump station intake is direct from the River Camlin via a concrete intake culvert. The intake is fully submerged and is protected with a 100 mm spaced bar screen. No means of isolation was visible on the intake, but an access manway was observed on the high bank above the intake.

The pump discharge pipework is PN16 DN300 cast iron and contains 1no 300 mm gate isolation valve complete with pedestal. The pipework is located below ground level and can be accessed by a 500 mm x 1000 mm inspection hatch located on the pump house floor.

The rising main discharges directly into Richmond Harbour; the exact nature of the discharge could not be ascertained as it was submerged, but it is reported to have a flap valve on the exit.

There is 1no isolation valve contained within the pump station. In addition, 2no electrode level probes are located within the wet well and operate for low level protection.

2.1.1 Additional Observations

Due to the constraints of the site, it was not possible to ascertain either flow or pressure at the time of audit. The pipework within the station was not suitable for the equipment present on site and exposing the the rising main would have posed an unnecessary risk to the public as the excavation required to expose the pipework would have been substantial.

Figure 2 Richmond Harbour Existing Pump Name plates

Table 1 – Pump Details

Parameter	Description
Pump	KSB PLZ300
No. of Pumps	1
Duty Configuration	Duty (Submersible)
Rated Motor Output	15 kW
Impeller Diameter	290 mm Propeller Blade
Drives	Star Delta
Pipework	300 mm
Non-Return Valves	N/A
Wet Well Level Sensor	2no electrode probes for Low level protection
Wet Well Level	31.85 mAOD
Pump Centre Line	30.53 mAOD

2.1.2 Rising Main

The rising main consists of 300 mm cast iron and is approximately 8 m in length. The rising main runs from the pump house to Richmond Harbour and discharges fully submersed via a flap valve. It is reported that there are no other isolation or check valves present on the rising main. The pipeline condition is unknown but there are no reports of bursts arising since construction.

Table 2 – Pump Discharge Main Details

Parameter	Description
Approx. Length	8 m
Elevation Rise	0 m
Pipe Diameter	300 mm
Discharge Level	33.58 mAOD
Pipe Material	Cast Iron
Pipe Roughness	ks = 0.3 mm assumed

2.1.3 System Description

System curves have been derived for the following operating scenarios:

- Estimated Operation based on ideal curve

The suction and delivery elevations have been based on the site recorded measurements as there is no data for Richmond Harbour.

No site data could be taken during the pump audit, so the curves represented are for the PLZ300 operating at ideal performance.

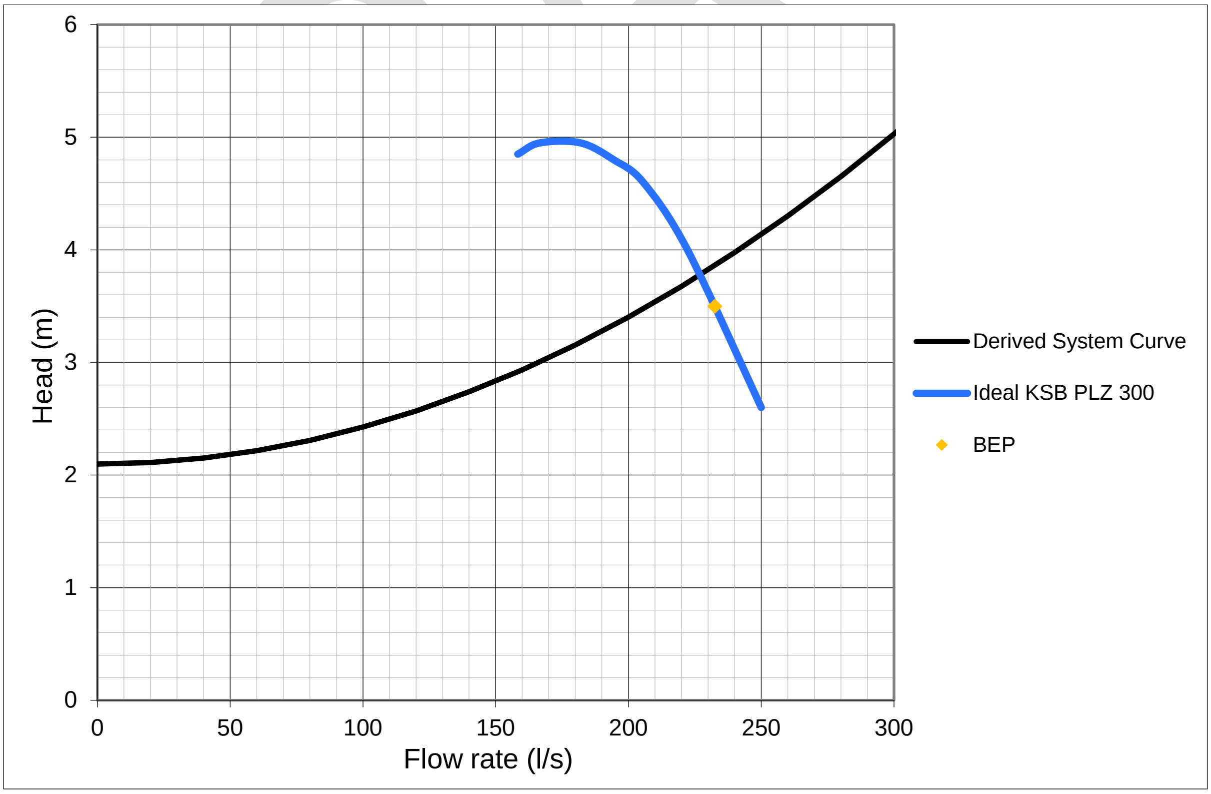
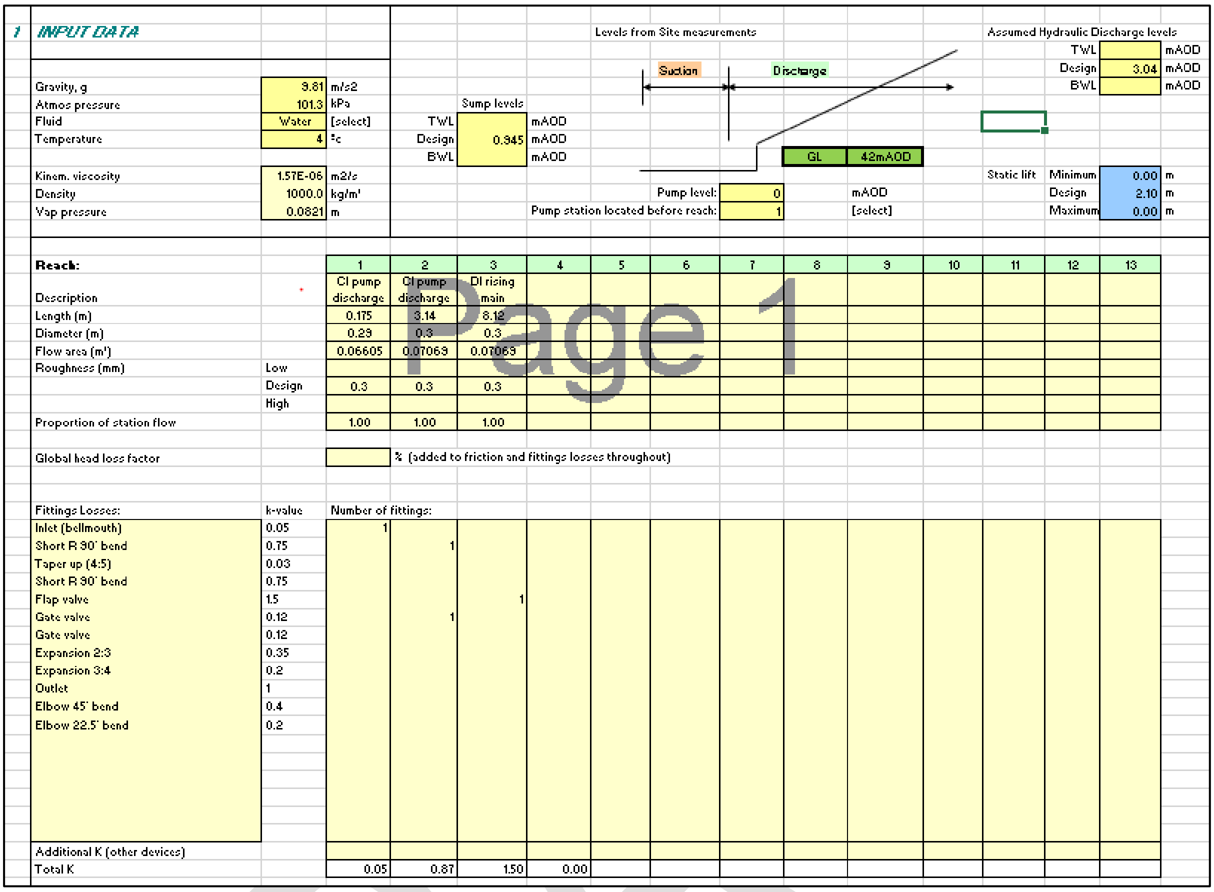


Figure 3 – Richmond Harbour Derived System Curve and KSB PLZ300 pump in ideal condition



1 INPUT DATA

Gravity, g	9.81	m/s2
Atmos pressure	101.3	kPa
Fluid	Water	[select]
Temperature	4	°c
Kinem. viscosity	1.57E-06	m2/s
Density	1000.0	kg/m³
Vap pressure	0.0821	m

Sump levels

TWL		mAOD
Design	0.945	mAOD
BWL		mAOD

Levels from Site measurements

Pump level:	0	mAOD
Pump station located before reach:	1	[select]

Assumed Hydraulic Discharge levels

TWL		mAOD
Design	3.04	mAOD
BWL		mAOD

Static lift			
	Minimum	0.00	m
	Design	2.10	m
	Maximum	0.00	m

Reach:		1	2	3	4	5	6	7	8	9	10	11	12	13
Description		CI pump discharge	CI pump discharge	DI rising main										
Length (m)		0.175	3.14	8.12										
Diameter (m)		0.29	0.3	0.3										
Flow area (m²)		0.06605	0.07069	0.07069										
Roughness (mm)	Low													
	Design	0.3	0.3	0.3										
	High													
Proportion of station flow		1.00	1.00	1.00										

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

Fittings Losses:	k-value	Number of fittings: 1	2	3	4	5	6	7	8	9	10	11	12	13
Inlet (bellmouth)	0.05	1												
Short R 90˚ bend	0.75		1											
Taper up (4:5)	0.03													
Short R 90˚ bend	0.75													
Flap valve	1.5			1										
Gate valve	0.12		1											
Gate valve	0.12													
Expansion 2:3	0.35													
Expansion 3:4	0.2													
Outlet	1													
Elbow 45˚ bend	0.4													
Elbow 22.5˚ bend	0.2													
Additional K (other devices)														
Total K		0.05	0.87	1.50	0.00									

Figure 4 - Hydraulic Calculation Input Data

2.2 Key Observations

2.2.1 General

The key observations from the derived system curves are as follows:

a) The flow and pressures could not be ascertained on site, but if the pump is operating correctly, a flow of 227 l/s @ 3.8 m head should be possible.

b) If the pump- was operating on its factory curve, then the maximum efficiency that could be obtained would be circa 74%.

c) It is recommended that an inline flowmeter and pressure monitor be installed to obtain data on the current pump.

d) During the time of the audit, there was a noticeable leak through the stuffing box packing.

e) During the time of audit, it was observed that the auto degreasing system had been removed due to repeated failure and the grease was being applied manually.

f) The pump house in its current guise could not accommodate a second pump. It would require substantial civil and structural works to both open the inlet bay to accommodate the additional pump and the pump house would likely need to be extended to maintain sufficient access.

3 Net Positive Suction Head (NPSH) & Submergence

NPSH available (NPSHa) calculations have shown that there is 11.2 m of positive suction head available within the system. No published NPSH required (NPSHr) data could be found on the PLZ300 pump to provide a comparison, so this aspect cannot be investigated any further. It is recommended that if this data becomes available in the future that the NSPHr be verified as suitable.

Initial ANSI-98 submergence calculations based on the levels indicated from the site audit have shown that there is insufficient water coverage above the pump. A minimum bell submergence of 1134 mm is required to reduce the risk of air entrainment which Richmond Harbour did not satisfy at the time of the audit. It should be noted the water level was taken from measurements on site and based upon the historic pump drawings, the PLZ300 pump installed may differ from the historic drawing.

It should be noted that there is no historic level data or historic drawings for Richmond Harbour, so this submergence acceptability would be conditional on a further survey if it is decided that the PLZ300 is to be retained.

4 Energy Analysis

During the pump audit visit by Samatrix Ltd, a temporary “Fluke” power meter was connected at the pump starter compartment to record power into the drive.

Although the power readings were taken at the time, with no flow or pressure measurements it is impossible to ascertain the current performance of the pump. The following comparison has been made based on the pump matching the factory curve, which may not be the case. If a pump can be found that can outperform the ideal factory curve, then a recommendation for change can be made.

Table 3 – Richmond Harbour Input power, Efficiency and Specific Energy based on factory curve

Pump Configuration	Ideal Flow rate (l/s)	Calculated Head (m)	Measured Power Factor	Required power (kW)	Pump Efficiency	Specific energy (kWh/1000 m³)
Ideal PLZ 300 Unit	229	3.8	0.85	13.7	74%	16.4

5 Potential Areas for Improvement

5.1 Pump Control and Instrumentation

At present the pump is effectively run manually in “hand” with the only control being an automatic stop from the low level probes contained within the wet well. This means that the pump is likely to be pumping for periods of time where flow may not be required, and therefore wasting energy.

Operation upon level would necessitate a level sensor (e.g. ultrasonic or radar type installed within a stilling well) on Richmond Harbour to measure the level and provide a signal back to the pump control panel and possibly SCADA. Predetermined level thresholds would be as set start and stop levels for the pump.

With regard to the type of sensors, ultrasonic or radar type sensors are recommended. Using either ultrasonic or radar type level sensors would allow the following benefits:

- Non-contact, low maintenance measurement
- Unaffected by medium properties and fouling
- Freely adjustable measuring range
- Measured level outputs can be used for both information and control

Utilising the level sensor could limit the operational hours as the pump could be used to "top up" as required during quieter periods.

In addition, there is currently no instrumentation measuring pump performance such as a flow meter or pressure indicating device. Without any instrumentation there is little way of knowing how the pump is operating day to day and it gives no opportunity for any proactive maintenance or trends to be ascertained for the system.

It is recommended that a flow meter be installed on the rising main as a minimum to ascertain flows over time. This would likely require a flow meter chamber inserted between the pump house and the outlet for ease of maintenance with appropriate ductwork to take the signals back to the MCC.

It is recommended that a pressure transducer be installed on the line to ascertain pressure over time. This could be included on any accessible section of pipework within the wet well for ease of access and cabling. The pump pressure could then be calculated from known levels and losses between the transducer and the pump.

An 'intelligent' monitoring system could be adopted at this site to encompass parameters such as flow rate, pressure, power, efficiency, etc. This could be implemented based upon SCADA/telemetry data and programmed to allow automatic adaption and correction of operation, informative data analysis reporting, and preventative fault alarms to help save energy, reduce downtime and prevent pump blocking.

It should be noted that this option would require a capital investment to upgrade the EICA components within the pumping station to achieve this.

5.2 Pump Selection

There are alternatives that can be explored in this instance, either a pump can be found to fit within the current wet well and maintain the single pump system. This would likely require another vertical axial flow pump, such as the KSB PNW. Alternatively, KSB have confirmed that the PLZ300 does still have replacements available and could be swapped out like-for-like if required.

If a duty/standby system is the preferred to improve resilience, then substantial works would be required. There is insufficient space at present to accommodate this option within the current building, and the building would need extending to accommodate such a change. This option would require the system to be offline for a prolonged period, which may not be feasible from either an operational or logistics point of view.

Alternatively, constructing a completely new pump station to house either a single duty or duty/standby system may be a lower risk option. The new pump station could either be connected into the existing inlet culvert or have a new culvert constructed to minimise the impact on current operations. A new wet well has the benefit of being constructed offline whilst the existing wet well is in use. This option will come at additional cost but does provide a more resilient system and allows more flexibility from an operations point of view.

The exact flow rates and water levels required will need to be confirmed by the University of Liege study and confirmed by Waterways Ireland. Once presented, these options can be explored in more detail.

Table 4 – Comparison of alternative KSB Vertical pump selections

CONFIGURATION	SELECTION	FLOW RATE (L/S)	PRESSURE (M)	RATED POWER (KW)	PUMP AND MOTOR EFFICIENCY (%)	ESTIMATED SPECIFIC ENERGY* (KWH/1000 M^3)	SAVING ON SPECIFIC ENERGY (KWH/1000 M^3)	KWH USAGE BASED ON 2016 FIGURES (KWH)
Duty	KSB PNW A4 300-270	225	3.8	10.2	79.6	14.9	-1.7	70,509*
Duty	KSB PLZ 300 (Ideal Unit)	229	3.8	13.7	72	16.6	-	78,554

**Estimated kWh saving based upon existing PLZ300 pump operating at ideal performance*

The KSB PNW A4-300 pump performs better than the ideal PLZ300 pump. It is highly likely given the age of the existing pump (installed 1968) that there has been some degradation of performance in that time, although any degradation could not be verified from the on-site audit. As the PNW A4-300 pump performs better from any energy point of view than the ideal PLZ300 the recommendation would be to replace the pump.

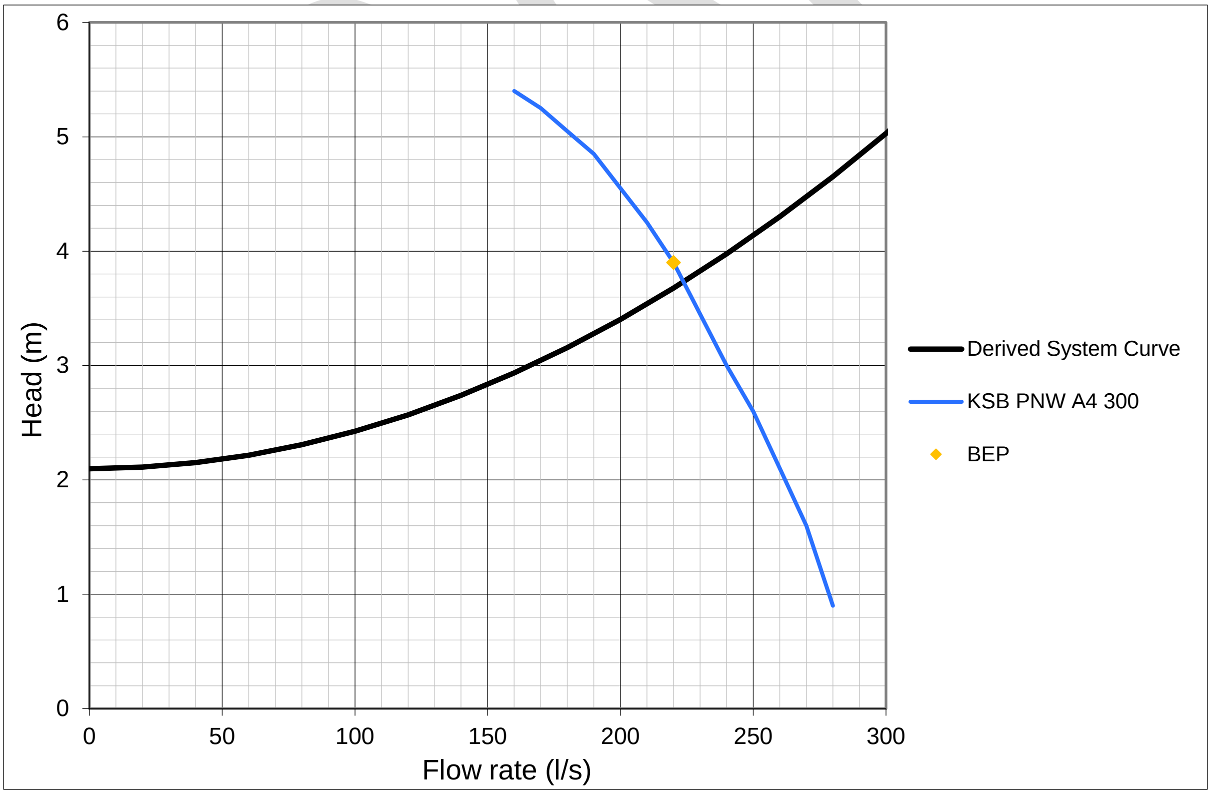


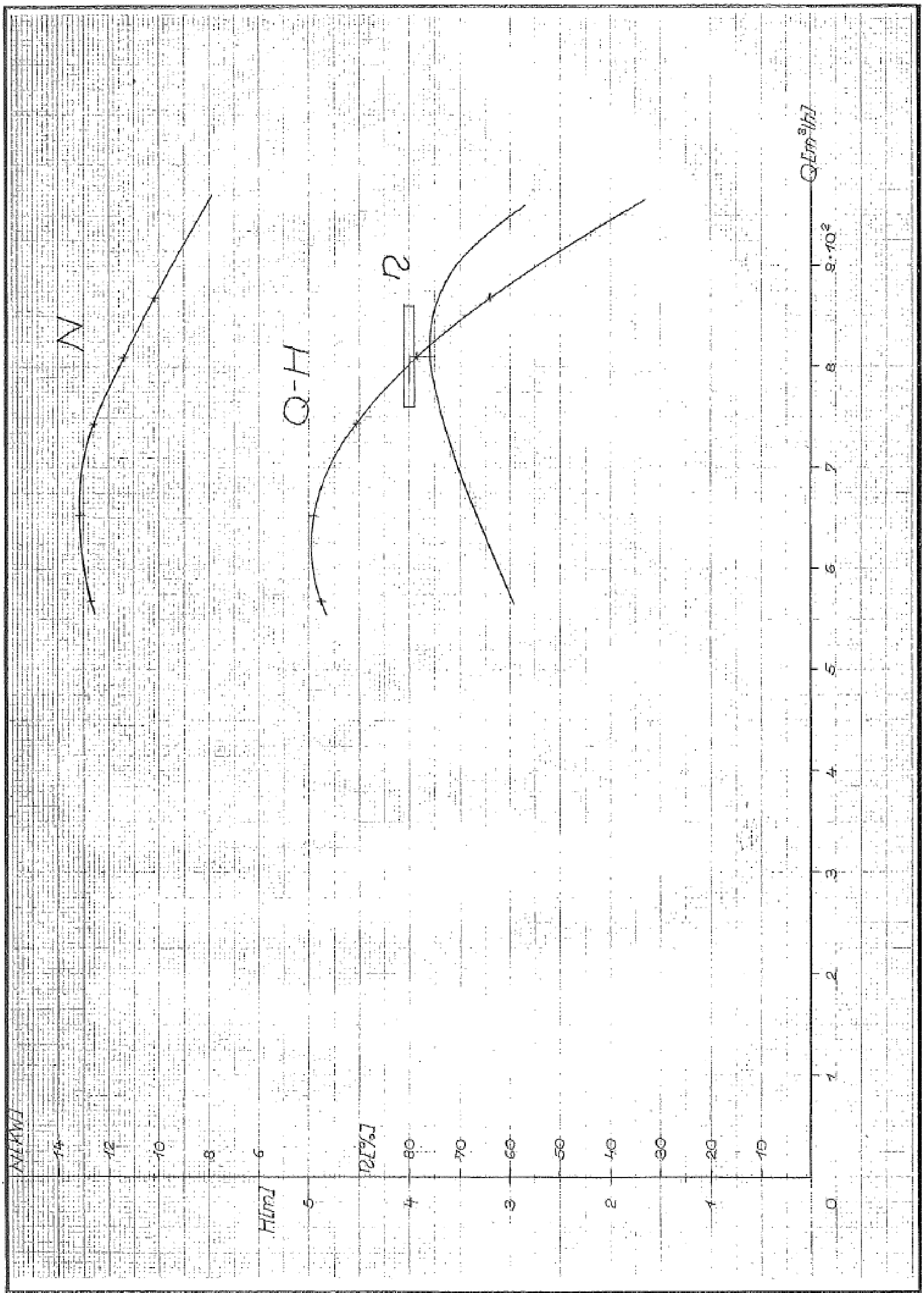
Figure 5 – Richmond Harbour Derived System Curve with KSB PNW A4-300-270 pump in operation

6 Preliminary Recommendations

- Once required flow rates, operating levels and levels of resilience have been ascertained it is recommended that the pump at Richmond Harbour be changed to a more efficient alternative.
- Install a level control system for the pump potentially via a radar/ultrasonic level sensor in a stilling tube.
- To establish more accurately the potential energy savings and carbon reduction it is recommended that the pressure and flow measurements be ascertained before the pump is replaced.
- Install instrumentation (e.g. flow/pressure) on the rising main to allow for trend data and proactive maintenance. This should be done in conjunction with the decision to upgrade to a duty standby system and to locate the external flowmeter chamber
- If no record drawings can be located, a survey of the inlet culvert should be undertaken to determine dimensions and facilitate future works
- Install power monitoring.
- Install a SCADA / HMI system which can be used to remotely monitor the pumping station and record data which in turn can be used to optimise operation and performance.
- Consider the feasibility of resilience options in further detail.

APPENDIX A

KSB PLZ 300



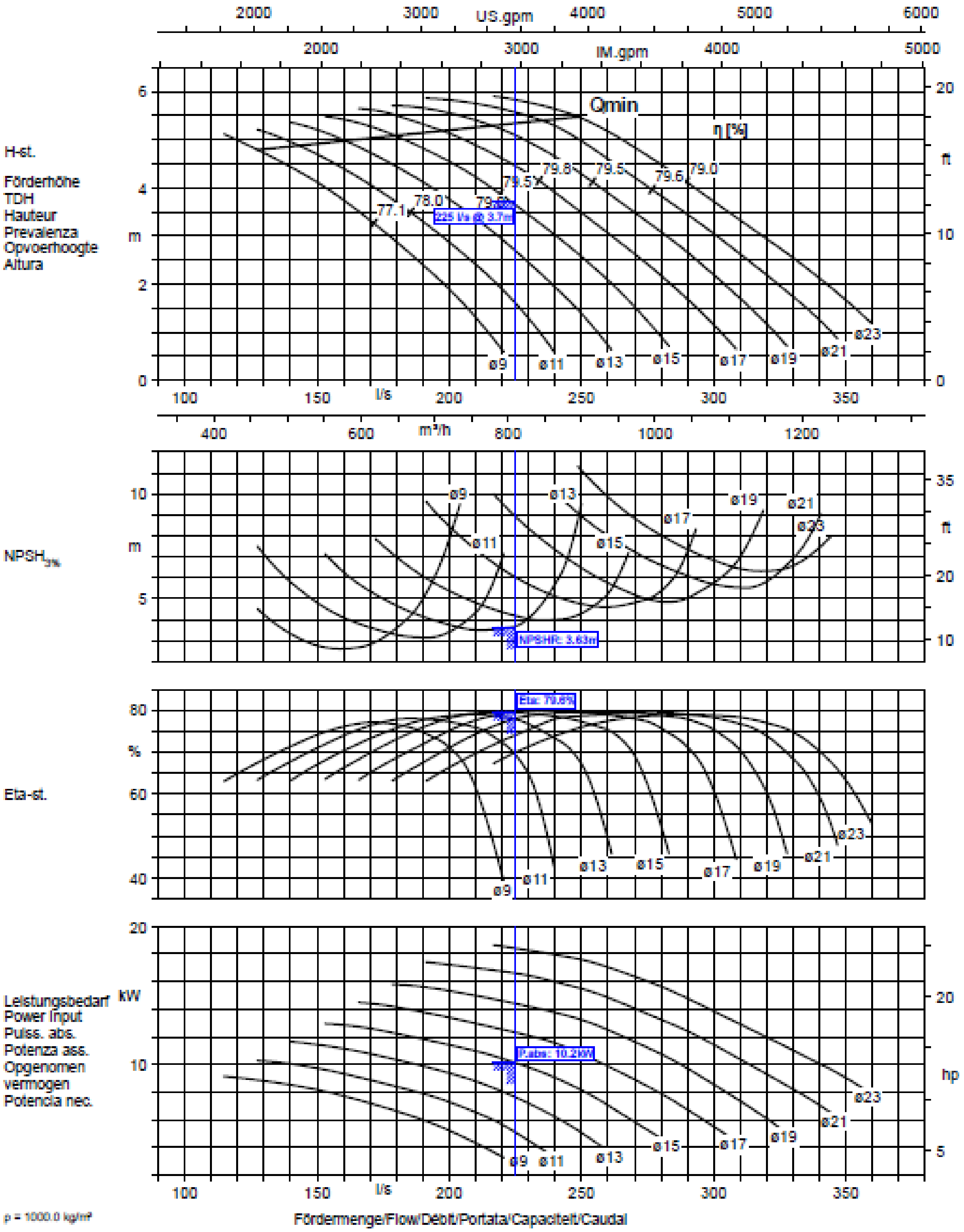
Laufrad / Schaufel-Z. Nr. 80-602420-3	Leitrad / Gehäuse-Z. Nr.	A1g0,0150	Test -Kurve
Mod. Nr. 12700 ; S-Typ	80-203281-1	n- 1447-1464	n. Kurve
Laufrad 290 Ø max: Breite mm	Mod. Nr. 17357 / 17427 /7	Typ PLZ 300	Datum: 13.3.68
abgedreht auf 290 Ø: Einstell ∢ 13,5 °	Stufenzahl 1	Werk-Nr. 701583	Name: [illegible]

KSB Klein, Schanzlin & Becker AG Werk Bremen — Nr. 83 -089425-8

APPENDIX B

KSB PNW A4 300-270

Baureihe-Größe / Type-Size / Modèle — Tipo / Serie / Tipo	Nenndrehzahl / Nom. speed / Vitesse nom. — Velocità di rotazione nom. / Nominaal toerental / Revoluciones nom.	Laufrad-Ø / Impeller Dia. / Diamètre de roue — Ø Girante / Ø Waaier / Ø Rodete	KSB
PNW A4 300-270	1450 1/min (50Hz)		
Projekt / Project / Projet — Progetto / Projekt / Proyecto	Angebots-Nr. / Project No. / No. de l'offre — Offerta-No. / Offertenr. / Oferta-No.	Pos.-Nr. / Item No. / No. de pos. — Pos.Nr. / Positienr. / Pos.-Nr.	KSB LIMITED 2 Cotton Way LOUGHBOROUGH Leicestershire LE11 5TF
PLZ Replacement	Preliminary		



ρ = 1000.0 kg/m³

12/2011

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