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GORE FLORENCE HALL DEVELOPMENT

FCS # 0827/76/C

ENGINEERING REPORT
Sewage Collection System

Prepared for: GORE DEVELOPMENTS LIMITED
2C BRAEMAR
KINGSTON 10

NOVEMBER 2008

Overview

Gore Developments Limited acquired 72.4 ha (178.90ac) at Florence Hall, Trewlany, and proposes to construct 828 two-bedroom detached houses on the property. The proposed development aims to satisfy the demand for housing along the North Coast stretch between Montego Bay and Duncans and will support the housing needs for staff for the current and future hotels, resorts and villas. In addition to the homes the development will include a basic school.

This engineering report describes the sewerage designs including the street main collection system, lift station to the sewage treatment plant.

Sewerage Collection Design

Design References

The sewer collection design was prepared with reference to the Jamaica Institution of Engineers (JIE) Guidelines for Design and Construction of Housing Infrastructure Vol. 2 1984 sewerage systems and the British Standard European Union Code, BS EN 752-4 1998.

Design Criteria

The JIE guideline requires that sewers be designed and constructed to attain velocities when flowing full of not less than 2.0 ft. per second (approximately 0.6 m/s). Based on the JIE guideline the minimum pipe size is 8" with minimum slope of 0.4%. The British Standard requires either "velocity of 0.7m/s daily, or a gradient of at least 1: DN is specified.
Where self cleaning velocities cannot be achieved, provision should be made for adequate maintenance activities."

Flow Calculations

The sewer flow rates were checked using the British Standard European Union Code, Drain and Sewer systems outside buildings BS EN 752-4: 1998, Part 4: Hydraulic design and environmental considerations, section 10 Wastewater design flows. The empirical approach in Annex C was adopted.

Calculation of wastewater flows for sewer systems is shown below:

Where Q = Lps

k_{DU} = frequency factor

DU = discharge unit

The peak flow rates are given by $Q = k_{DU} \sqrt{\sum DU}$

The frequency factor (k_{DU}) for dwellings and offices is 0.5.

The following table details the discharge unit for the sanitary appliances considered.

Table 1.0

Sanitary fixture	Discharge unit	DU used
Bath and kitchen sink	0.8 to 1.3	1.0
Shower and washbasin	0.3 to 0.6	0.4
Water closet (4.0L to 9.0L)	1.2 to 2.5	1.8
Washing machine	0.5 to 0.8	0

The discharge units for each dwelling was calculated assuming that the average dwelling will consist of a shower, sink, water closet, kitchen sink, wash basin, giving a total of 3.8 discharge units per house.

The average daily demand of water by this development is estimated to be 956 m^3/day. The designs are based on the assumption that 90% of water used within the development enters the sewerage system however an infiltration rate of 10% of the sewage flow is added to that flow.

The sewage collection design for Florence Hall includes 200 mm diameter PVC pipes in the collection system.

Hydraulic Design

The Manning's equation was used to determine the velocities in the pipes.

Manning's equation in SI units $v = 1/n\ R^{2/3}\ S^{1/2}$

v = velocity of flow

n = manning's friction coefficient

R = hydraulic radius

S = slope

The manning coefficient for the pipe specified is shown below.

Table 1.1

Material	**Manning n**
Polyvinyl Chloride (PVC) with smooth inner walls [d,e]	0.009-0.011

[d] Neale, L.C. and R.E. Price. Flow characteristics of PVC sewer pipe. Journal of the Sanitary Engineering Division, Div. Proc 90SA3, ASCE. pp. 109-129. 1964.

[e] Bishop, R.R. and R.W. Jeppson. Hydraulic characteristics of PVC sewer pipe in sanitary sewers. Utah State University. Logan, Utah. September 1975.

The "n" value for minimum slope design of PVC sewer pipe is 0.009 as stated in the Uni-Bell PVC industry publication Handbook of PVC Pipe: Design and Construction.

Based on the preceding specifications the following table was developed

Table 1.2 200mm diameter PVC pipe minimum slopes

No of lots on pipe leg	Flow Lps	Slope %	Velocity m/s
2	1.4	1.4	0.656
4	1.94	1.2	0.682
6	2.37	1.0	0.685
10	3.06	0.80	0.683
12	3.35	0.75	0.686
32	5.48	0.50	0.682
56	7.25	0.40	0.678

The pipe slopes shown on the sewer profile drawings conform to the above table.

A 200mm diameter PVC sewer pipe with 0.4% slope is capable of conveying 21Lps at a velocity of 1.05m/s and is 65% full.

Pipe bedding and installation details are shown and described in the design drawings.

The attached table outlines the sewerage calculations for Florence Hall.

FLORENCE HALL SUBDIVISION SEWAGE COLLECTION										
SEWERAGE DESIGN										
Roadway	From MH #	To MH #	Pipe #	Pipe Length m	Drop across MH m	Houses Connected	Cumulative Connections	Slope	Flow Lps	Manning's n
Road # 1	4	5	4	26.71	0.03	3	27	1.10%	6.52	0.01
	5	6	5	89.99	0.03	14	41	0.50%	8.04	0.01
	6	7	6	56.74	0.03	8	49	0.50%	8.78	0.01
	7	8	7	89.94	0.03	8	57	0.55%	9.47	0.01
Road K	1	1a	128	35.04	0.03	6	6	1.20%	3.07	0.01
	1a	4	1	39.43	0.03	4	10	0.56%	3.97	0.01
	2	3	2	67.68	0.03	11	11	1.00%	4.16	0.01
	3	4	3	35.72	0.03	3	14	0.73%	4.70	0.01
	2	15	8	90.01	0.03	12	12	1.61%	4.35	0.01
	15	16	9	65.63	0.03	10	22	0.50%	5.89	0.01
	16	17	10	90	0.03	13	35	0.50%	7.42	0.01
	17	18	11	90.15	0.03	13	48	0.50%	8.69	0.01
	18	19	12	64.01	0.03	9	57	4.31%	9.47	0.01
	19	20	13	90.11	0.03	11	68	7.00%	10.35	0.01
	20	113	14	21.27	0.03	0	72	1.98%		0.01
	113	21	130	48.94	0.03	6	86	1.08%	11.64	0.01
	21	22	15	81.74	0.03	12	98	2.50%	12.42	0.01
	22	23	16	70.44	0.03	10	108	8.30%	13.04	0.01
	23	24	17	92..09	0.03	15	123	5.26%	13.92	0.01
	24	25	18	90.02	0.03	11	134	1.76%	14.53	0.01
	25	26	19	70.22	0.03	9	283	3.38%	21.11	0.01
	26	27	20	80.11	0.03	12	390	0.50%	25.04	0.01
	27	28	21	44.15	0.03	5	403	4.00%	25.19	0.01
	28	29	22	50.34	0.03	6	409	8.25%	25.38	0.01
	29	30	23	62.01	0.03	5	414	10.44%	25.54	0.01
Road # J	8	9	28	60.44	0.03	5	62	1.00%	9.88	0.01
	9	10			0.03	20	139	0.75%	14.80	0.01
	10	11	30	71.7	0.03	7	194	4.23%	17.48	0.01
	11	12	31	33	0.03	2	223	0.50%	18.74	0.01
Road # 2	34	35	46	35.63	0.03	6	6	1.20%	3.07	0.01
	33	35	45	49.6	0.03	10	10	1.20%	3.97	0.01
Road # 4	45	11	49	85.3	0.03	9	27	0.50%	6.52	0.01
	44	45	48	20.64	0.03	2	18	0.50%	5.32	0.01
	35	39	47	72.36	0.03	2	18	3.40%	5.32	0.01
Road # 3	37	38	32	55.35	0.03	8	14	1,2%	4.70	0.01
	38	39	33	55.68	0.03	7	21	1.88%	5.75	0.01
	39	10	34	97.94	0.03	9	48	0.65%	8.69	0.01
	37	40	35	70.25	0.03	8	8	1.55%	3.55	0.01
	40	46	36	92.46	0.03	13	21	1.20%	5.75	0.01
	46	47	37	90.06	0.03	12	33	3.50%	7.21	0.01

FLORENCE HALL SUBDIVISION SEWAGE COLLECTION										
SEWERAGE DESIGN										
Roadway	From MH #	To MH #	Pipe #	Pipe Length m	Drop across MH m	Houses Connected	Cumulative Connections	Slope	Flow Lps	Manning's n
	47	48	38	54.43	0.03	4	37	3.50%	7.63	0.01
	48	49	39	70.26	0.03	6	43	4.00%	8.23	0.01
	49	50	40	106.13	0.03	17	60	4.75%	9.72	0.01
	50	51	41	106.17	0.03	15	75	6.15%	10.87	0.01
	51	52	42	70.22	0.03	9	121	0.75%	13.80	0.01
	52	53	43	44.92	0.03	6	134	0.40%	14.53	0.01
	53	25	44	69.09	0.03	6	140	3.00%	14.85	0.01
Road # 6	15	36	23	84.97	0.03	4	4	1.19%	2.51	0.01
	36	37	24	46.58	0.03	2	6	1.00%	3.07	0.01
Road # 7	16	40	25	89.54	0.03	3	3	4.06%	2.17	0.01
	40	41	26	75	0.03	5	8	0.40%	3.55	0.01
	41	42	27	23.49	0.03	2	10	0.40%	3.97	0.01
Road # F	48	54	55	83.42	0.03	10	10	1.75%	3.97	0.01
	54	55	56	43.99	0.03	6	16	1.40%	5.02	0.01
	55	56	57	44.07	0.03	5	21	1.75%	5.75	0.01
	56	57			0.03	12	33	1.75%	7.21	0.01
	57	58	59	91.78	0.03	14	47	2.30%	8.60	0.01
	58	59	126	69.17	0.03	10	75	5.04%	10.87	0.01
	59	60	60	70.01	0.03	8	83	0.72%	11.43	0.01
	60	61	61	82.21	0.03	7	90	0.79%	11.91	0.01
	61	62	62	46.62	0.03	6	96	5.30%	12.30	0.01
	62	26	63	90.39	0.03	7	103	6.70%	12.74	0.01
Road # F	48	20	54	71.73	0.03	4	4	2.00%	2.51	0.01
Road # H	49	63	64	70.45	0.03	5	5	4.08%	2.81	0.01
	63	64	65	99.52	0.03	14	19	5.50%	5.47	0.01
	64	65	66	99.15	0.03	14	33	1.00%	7.21	0.01
	65	51	67	70.7	0.03	4	37	3.25%	7.63	0.01
Road # 12	66	67	68	87.91	0.03	16	16	1.40%	5.02	0.01
	67	58	69	69.1	0.03	2	18	0.50%	5.32	0.01
Road G	60	68	70	33.35	0.03	2	2	1.20%	1.77	0.01
	68	52	71	69.44	0.03	5	7	7.10%	3.32	0.01
Road # 15	28	109	72	61.38	0.03	4	4	2.07%	2.51	0.01
	109	110	73	78.84	0.03	9	13	3.40%	4.52	0.01
	110	111	74	44.81	0.03	7	20	4.00%	5.61	0.01
Road D	79	80	96	35.77	0.03	3	3	1.20%	2.17	0.01
	80	81	97	90.03	0.03	7	10	1.25%	3.97	0.01

FLORENCE HALL SUBDIVISION SEWAGE COLLECTION										
SEWERAGE DESIGN										
Roadway	From MH #	To MH #	Pipe #	Pipe Length m	Drop across MH m	Houses Connected	Cumulative Connections	Slope	Flow Lps	Manning's n
	81	82	98	90	0.03	7	17	4.75%	5.17	0.01
	82	84	99	90.16	0.03	9	26	1.00%	6.40	0.01
	84	85	100	25.61	0.03	2	30	0.75%	6.87	0.01
	85	86	101	39	0.03	4	34	0.50%	7.32	0.01
	86	89	102	68	0.03	8	42	0.40%	8.13	0.01
	89	96	103	72.79	0.03	10	54	0.40%	9.22	0.01
	95	96	100	25.62	0.03	11	11	3.19%	4.16	0.01
Road A	96	97	90	48.58	0.03	2	67	0.40%	10.27	0.01
	97	98	91	97.79	0.03	13	80	0.40%	11.22	0.01
	98	99	92	95.11	0.03	13	93	0.40%	12.10	0.01
	99	104	93	65.18	0.03	9	102	0.40%	12.67	0.01
Road A	100	104	94	90.08	0.03	9	9	5.40%	3.76	0.01
	100	74	95	73.32	0.03	4	4	3.00%	2.51	0.01
Road B	90	89	106	43.49	0.03	2	2	3.89%	1.77	0.01
	90	91	106	43.49	0.03	6	6	1.35%	3.07	0.01
	91	92	108	45.24	0.03	7	13	1.87%	4.52	0.01
	92	93	109	24.41	0.03	3	24	0.40%	6.15	0.01
Road C	86	87	110	59.8	0.03	1	1	2.50%	1.25	0.01
	87	88	111	29.03	0.03	4	5	1.00%	2.81	0.01
	88	92	112	57.32	0.03	3	8	0.40%	3.55	0.01
Road # 5	83	84	105	42.21	0.03	2	2	3.89%	1.77	0.01
Road # 11	101	106	12	90.05	0.03	10	10	3.25%	3.97	0.01
	105	106	119	35	0.03	7	7	4.40%	3.32	0.01
Road # 13	100	101	121	70.82	0.03	9	9	6.50%	3.76	0.01
	101	102	122	105.51	0.03	15	24	5.00%	6.15	0.01
	102	103	123	35.79	0.03	5	29	0.40%	6.76	0.01
Road # 14	69a	70	77	69.53	0.03	9	240	0.89%	19.44	0.01
	70	71	78	69.98	0.03	10	250	2.00%	19.84	0.01
	71	72	79	52.34	0.03	7	257	2.15%	20.12	0.01
	72	73	80	47.67	0.03	6	263	4.82%	20.35	0.01
	73	74	81	85.57	0.03	12	295	0.40%	21.56	0.01
	74	75	82	90.04	0.03	13	312	2.34%	22.17	0.01
	75	76	83	84.07	0.03	12	324	6.35%	22.59	0.01

FLORENCE HALL SUBDIVISION SEWAGE COLLECTION										
SEWERAGE DESIGN										
Roadway	From MH #	To MH #	Pipe #	Pipe Length m	Drop across MH m	Houses Connected	Cumulative Connections	Slope	Flow Lps	Manning's n
	76	30	84	56.54	0.03	5	329	2.00%	22.76	0.01
	30	31	85	61.8	0.03	7	750	1.38%	34.37	0.01
	31	32	86	51.62	0.03	2	942	0.40%	38.52	0.01
Road # 9	71	77	87	68.87	0.03	4	4	1.20%	2.51	0.01
	77	78	88	90.51	0.03	12	16	1.20%	5.02	0.01
	78	73	89	70.34	0.03	4	20	2.20%	5.61	0.01
Road # 8	69	69a	76	29.01	0.03	3	3	1.20%	2.17	0.01
	14	69a	75	26.62	0.03	2	228	0.50%	18.95	0.01
Road M	112	113	129	48.04	0.03	8	8	1.12%		
Sew MH 93 to 31	93	94	113	68.33	0.03	5	29	0.50%	6.76	0.01
	94	104	114	43.96	0.03	0	29	3.39%	6.76	0.01
	104	106	115	70.77	0.03	0	140	4.31%	14.85	0.01
	106	107	116	85.12	0.03	1	158	3.45%	15.77	0.01
	107	108	117	84.62	0.03	1	159	0.40%	15.82	0.01
	108	31	118	88.85	0.03	0	190	0.40%	17.30	0.01
Sew MH 111 to 32	111	32	125	97.38	0.03	5	25	3.76%	6.27	0.01
Sew MH 12 to 14	12	13	52	84.23	0.03	1	224	14.50%	18.78	0.01
	13	14	53	43.76	0.03	2	226	9.20%	18.87	0.01
Sew MH 42 to 44	42	43	50	80.46	0.03	6	16	2.00%	5.02	0.01
	43	44	51	29.1	0.03	0	16	6.10%	5.02	0.01
Sew MH 103 to 108	103	108	124	43.11	0.03	2	31	2.85%	6.99	0.01
Sew MH 32 to PS	32	PS	127			1	968		39.05	0.01

Lift Station

Table 2

Florence Hall Pump Station Flows		Qty	Unit
1	Average Flow	956	m^3/d
2	Peak Flow Factor	2.1	
3	Peak Flow	2,008	m^3/d
4	Infiltration is 10% of average flow	96	m^3/d
5	Minimum flow is 12.5% of avg. flow	120	m^3/d
6	Maximum flow	2,103	m^3/d
7	Minimum pump rate	1,461	l/m

The volume of the wet well is based on the pumping regime and the influent flow characteristics.

Two pumps will be used at the facility with 100% stand by. The pumps should cycle to ensure that the sewage does not become septic. A minimum running time will be assumed to be 3 minutes and minimum cycle time of 15 minutes. The minimum cycle time can be shown to occur when Qin is equal to 0.5Qout.

Table 2.1

Sump and Pump levels		Qty	Unit
a	Pumping rate	1,461	Lpm
b	Minimum running time (tr min)	3	min
c	Minimum cycle time (tr min)	17.5	min
d	V = working volume of wet well		
e	Minimum working vol. based on running time		
	$V_{min} = (tr\ min) \times (Q_{out} - Q_{min\ in})$	2,794	L
f	Minimum working vol. based on cycle time		
	Shortest cycle time when $Q_{in} = 0.5Q_{out}$		
g	$V_{min} = (0.5Q_{out} \times tc\ min)/2$	6,390	L
h	Working Volume	6,390	L
	or	6.39	cu m
	Rectangular sewage well		
i	Plan dimensions (L)	2.75	m
	Width	2.75	m
	Area	7.56	sq m
j	Height of Working volume	0.84	m

Total cycle time (t_c) = Filling time (t_f) + running time (t_r)

$t_c = t_f + t_r$
$t_f = V/Q_{in}$
$t_r = V/(Q_{out} - Q_{in})$
$t_c = V/Q_{in} + V/(Q_{out} - Q_{in})$
The proposed wet well internal dimensions are 2.75m x 2.75m x 4.5m. The height of the working volume is 0.84 m.
Approximately 87 m of 200mm PVC pipe is used for the force main with a total change in elevation of 3.74m (from minimum level in wet well to inlet works elevation). The total dynamic head used is4.07 m. A constant speed pump is recommended to discharge 24.3 *l/s* or 1461*l/m*.

Submersible pumps will be used and an appropriate supplier will be selected. One possible pump supplied by ABS is included in the appendix.

Conclusion

The proposed sewage collection system will adequately meet the sustainable infrastructure needs of the proposed development at Florence Hall.

The construction details are shown in the drawings submitted.

Prepared By

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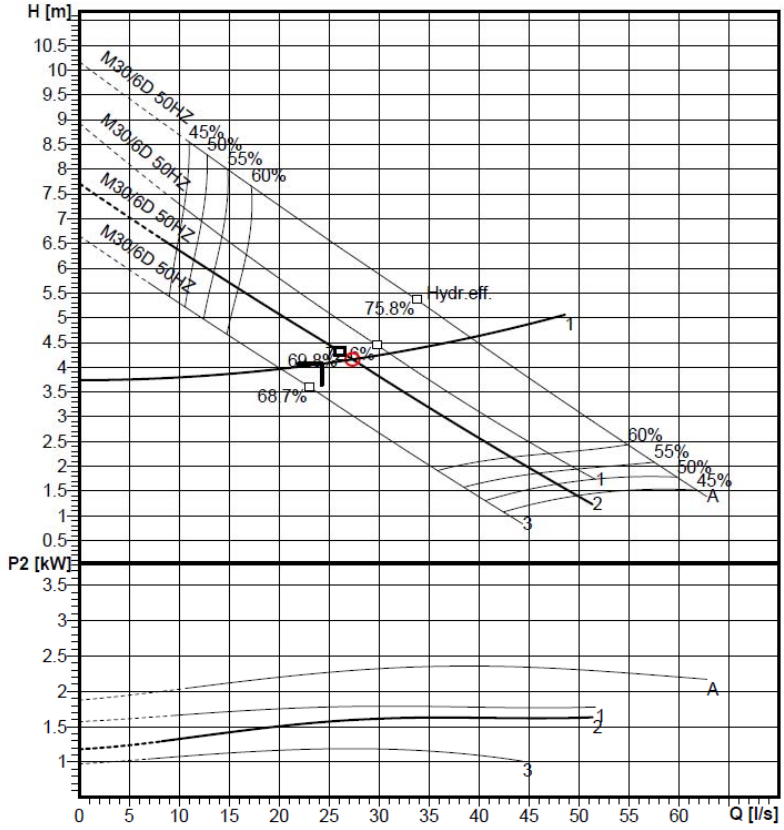
November 20, 2008

APPENDIX

AFP 1541 50 Hz



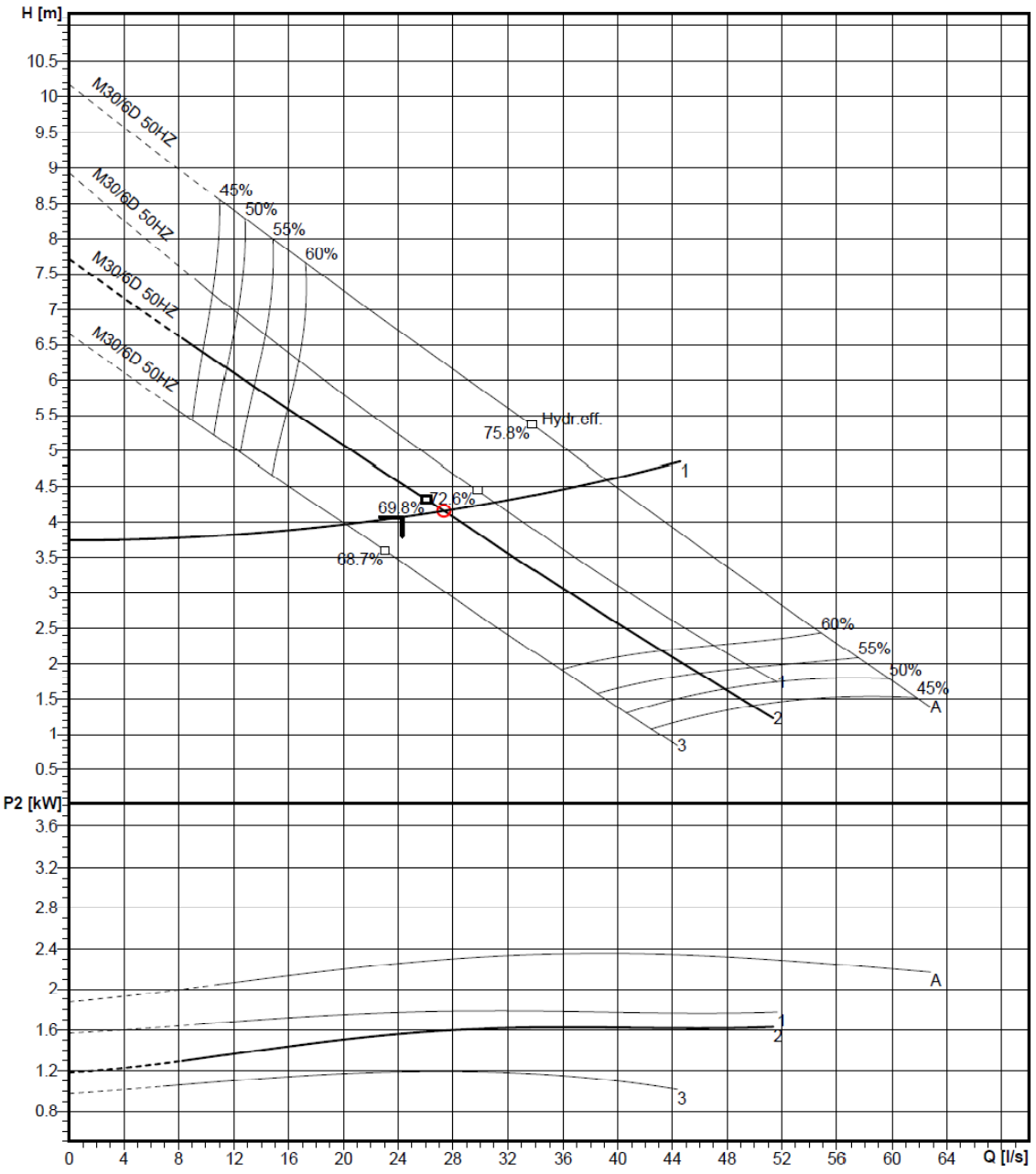
Testnorm
ISO 9906 - Annex A1/A2

2005-06-14

Operating data specification			
Flow	27.3 l/s	Head	4.16 m
Static head	3.74 m	Efficiency	69.9 %
Shaft power	1.6 kW	NPSH	1.0 m
Fluid	Water	Temperature	277 K
Nature of system	Single head pump	No. of pumps	1
Pump data			
Type	AFP 1541 50 Hz	Make	ABS
Series	AFP M1-ME3 (1kW-22kW)	Impeller	ContraBlock impeller, 1 vane
N° of vanes	1	Impeller size	253 mm
Free passage	100 mm	Suction port	DN150
Discharge port	DN150		
Motor data			
Rated voltage	400 V	Frequency	50 Hz
Rated power P2	3 kW	Nominal speed	920 1/min
Number of poles	6	Efficiency	73.6 %
Power factor	0.756	Rated current	7.79 A
Starting current	32.6 A	Rated torque	31.1 Nm
Starting torque	46.1 Nm	Degree of protection	IP68
Insulation class	F		

ABSEL PRO 1.7.2 / 2006-12-21

abs We know how water works	**Pump performance curves** AFP 1541 50 Hz			Curve number Reference curve AFP 1541REV
			Discharge DN150	Frequency 50 Hz
Density 1000 kg/m³	Viscosity 1.57 mm²/s	Testnorm ISO 9906 - Annex A1/A2	Rated speed 920 1/min	Date 2008-11-24
Flow 27.3 l/s	Head 4.16 m	Rated power 1.6 kW	Hydraulic efficiency 69.9 %	NPSH 1.0 m



Impeller size 253 mm	N° of vanes 1	Impeller ContraBlock impeller, 1 vane	Solid size 100 mm	Revision 2005-06-14

ABSEL PRO 1.7.2 / 2006-12-21