RMA Engineers

Subdivision - Trunk Infrastructure | Drayton Wellcamp Road | Glenvale

Sewer Rising Main Water Hammer Analysis

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REPORT CONTROL SHEET

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Report author:	Dean Griffin

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			Name	**RPEQ no.**	**Signature**	**Date**
0	Dean Griffin	Tony Loveday	Jason Wardle	7789		3/4/2019
1	Dean Griffin	Nicholas Kohn	Jason Wardle	7789	RMA Engineers Jason Wardle RPEQ: 7789	13/5/2019

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This report is a professional opinion based on the information available at the time of writing. It is not intended as a quote, guarantee or warranty and does not cover any latent defects.
This report will comment on the Civil infrastructure to the project and may outline probable costs but the extent of the commission of RMA does not extend to detailed cost feasibility, as such the costs should not be relied on for financing arrangements.
The conclusions in this report should not be read in isolation. We recommend that its contents be reviewed in person with the author so that the assumptions and available information can be discussed in detail to enable the reader to make their own risk assessment in conjunction with information from other sources.

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1. Introduction

In response to **Issue 3.12 of Information Request OW/2018/6323 dated 1/2/2019**, we have undertaken a surge analysis of the proposed sewer rising main.

The 1.8km sewer rising main will pump from the proposed sewage pumping station in Drayton-Wellcamp Road to a proposed discharge manhole located within Lot 279 on AG3110 between Devine Road and Hursley Road. Refer to site plan in Figure 1.

Analysis was undertaken using Bentley Hammer software version 10.0200.43.

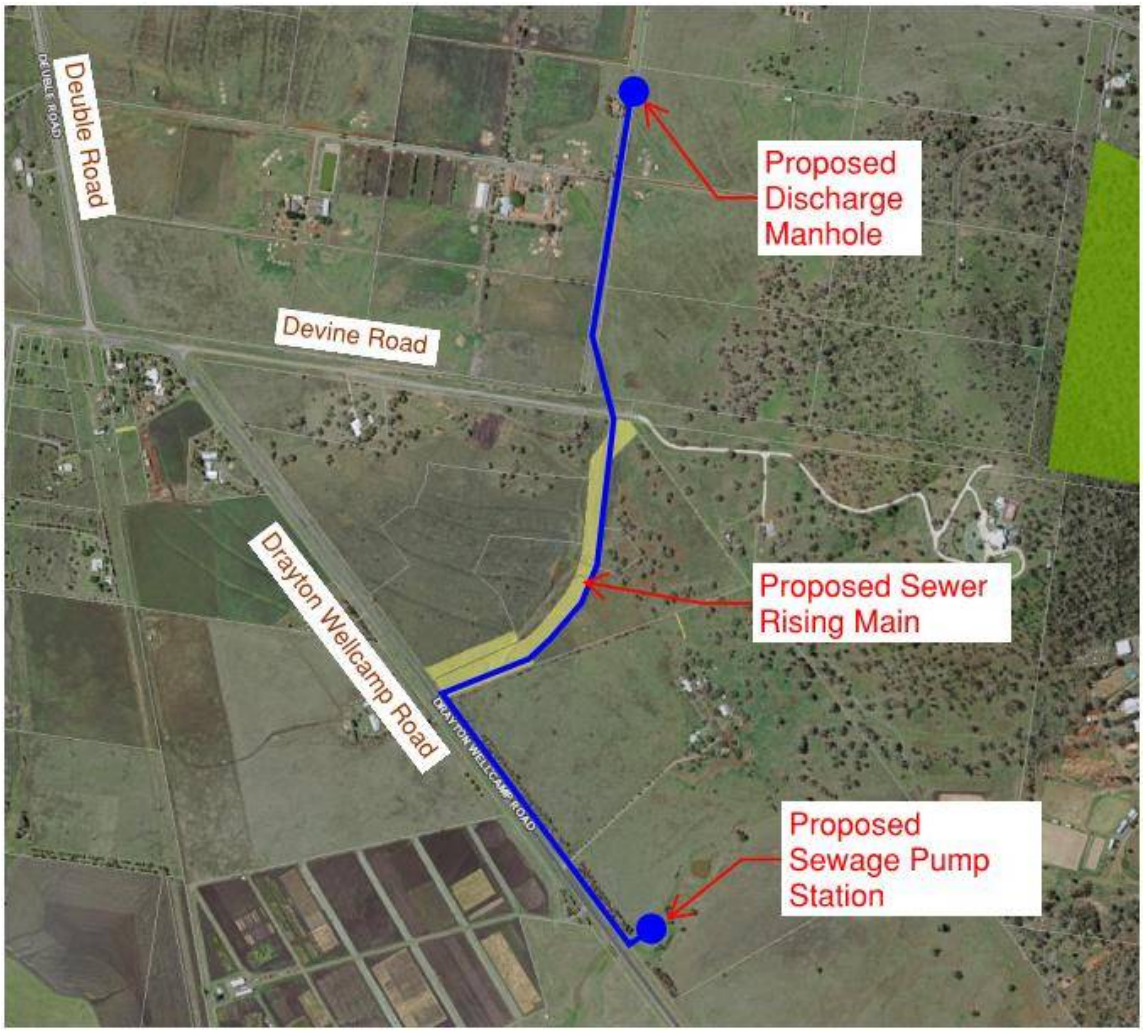

Figure 1 Site Plan

1.1 Assumptions

We have made the following assumptions in relation to the conditions to be modelled:

- Fluid and atmosphere temperatures of 20° C.
- Pumps will be fitted with variable speed drives.
- Pump failure affects all pumps simultaneously and is a result of power failure that also prevents any variable speed drives from functioning. Hence the pumps will slow down on inertia only.

- The outlet at the discharge manhole is an atmospheric free-flowing discharge.
- Any new gas release valves are assumed to be combination type.
- Any surge vessels are assumed to be sealed hydro-pneumatic type with bladders or an air valve vented type.

2. Model information

The chainages mentioned in this report and appendices represent the distance from the proposed sewage pump station.

The elevations used in the model and in this report are in terms of Australian Height Datum.

2.1 Scenario modelled

As the pumps will be fitted with soft-start variable frequency drives (which will mitigate surges related to normal start and stop operations) the modelling concentrated on the power failure case.

2.2 Pipe properties

Pipe materials and properties considered were as follows:

- DN200 Oriented Polyvinyl Chloride (PVC-O)
    - Modulus of elasticity = 4 GPa
    - Poisson's ratio = 0.45
    - Hazen-Williams C = 150
    - Pressure rating = PN 16 / PN20
    - Internal diameter = 220.1 mm / 217.1 mm
    - Wall thickness = 5.7 mm / 7.1 mm
    - Temperature derating = 0.94 (25 degrees)
    - Fatigue derating f = 0.41 (9x 10^6 cycles)
    - Minimum required strength = 50 Mpa

Short lengths of PN35 ductile iron (lined with calcium aluminate cement) have been designed at proposed road crossings and / or under stormwater pipe crossings and are not considered detrimental to the analysis.

2.3 Pump details

Under ultimate development conditions the pump station will run on two pumps in a duty/standby arrangement. Peak wet weather flow under ultimate conditions is 59.36 L/s.

Each pump will have the following properties:

- Rated flow = 59.4 L/s
- Rated head = 74.51 m
- Rated speed = 1475 rpm
- Rated power = 105 kW
- Rated efficiency = 73.3 %

2.4 Gas release valves

Air valves have been assumed to be similar to Bermad C50-J Combination Air Valves.

Ductile bodies with plastic inlet shrouds are recommended for corrosion resistance in the event of scratching/chipping of the epoxy coating.

Air valve properties considered were as follows:

- DN50 Triple acting
    - Inflow orifice diameter = 50 mm
    - Large outflow orifice diameter = 45 mm
    - Small outflow orifice diameter = 8 mm

2.5 Surge Vessels

The surge vessel located at the sewage pump station has been assumed to be sealed hydro-pneumatic tank with a bladder. It will require compressed air to be provided and controlled with respect to the pumps:

- Total volume = 200 L
- Initial volume = 50 L
- Inlet diameter = 225 mm

The surge vessel located at Devine Road has been assumed to be a tank vented to the atmosphere with a gas release valve as per Section 2.4:

- Total volume = 200 L
- Initial volume = 50 L
- Inlet diameter = 225 mm
- Inflow Orifice diameter = 50 mm
- Large Outflow Orifice diameter = 45 mm

2.6 Failure modes

The primary failure mode considered was total power loss (pump stop by inertia only)

2.7 References

- Toowoomba Regional Planning Scheme
- Water Services Association of Australia
- Plastic Industry Pipe Association of Australia
- RMA Engineers Drawings 14070-C-S0801 to S0804 inclusive.
- Aquatec STP Design Rev3 (1/4/19)

3. Analysis

The PVC-O pipeline was analysed with gas release valves located at approximate chainages 558m and 1080m, together with surge vessels at both the sewage pump station discharge and near Devine Road (approximate chainage 1210m).

Fatigue and temperature re-rating was considered in the initial selection of a PN16 pipe pressure rating.

The maximum and minimum hydraulic grade line (HGL) envelope is shown in Figure 2 below.

The peak transient head at the pumps is 97.81m.

Figure 2 - PVC-O PN16 Transient Plot

Collapse due to buckling is also a consideration with pipes subject to negative (lower than atmospheric) surge pressures. This can result from ovality due to incorrect installation as well as vacuum pressure during filling & draining.

To provide a more comfortable margin against buckling, we recommend the adoption of PN20 MRS 500 pipe.

The maximum and minimum hydraulic grade line (HGL) envelope for PN20 pipe is shown in Figure 3 below.

The slightly smaller internal diameter and increased celerity result in a peak transient head at the pumps of 115.82m.

Figure 3 - PVC-O PN20 Transient Plot

Although the minimum transient pressure reaches the -1 bar limit, any vaporisation of the liquid either reforms or at least does not result in air pockets being formed.

The top plot in each of the above transient plot screen grabs above illustrates air pocket volumes along the profile. The air pocket shown at the end of the graphs represents the discharge manhole.

4. Conclusion

The analysis demonstrates that PVC-O comfortably handles power fail pump stop surges.

A sealed surge tank with a bladder at the sewage pump station and an air valve vented surge tank near Devine Road have been shown to eliminate air/vapour pockets forming along the length of the pipeline.