

CASE STUDY FOR SEALING OF FAILED JOINT AT SOUTH TOWN OUTFALLS, DARTMOUTH.

Location: South Town Pump Station, Dartmouth.
Date: April 2008
Client: Black & Veatch/ South West Water.
Contractor: Exjet Services.

Overview.

As Part of operation “Clean sweep” implemented by South West Water, the existing foul water outfalls from riverside properties adjoining the River Dart (which historically have discharged directly to the river), were to be connected to the main sewerage system allowing the effluent to be fully treated prior to discharge.

For this to be carried out successfully a new PE SDR 100 pipe was laid along the base of the river allowing the connection of the existing outfalls to a newly constructed pump station. The pump station was constructed by sinking a shaft to a depth of approximately 9.6M with a nominal diameter of 2.4M and driving a thin wall stainless steel header pipe from the wet well to connect the new PE sewer. The header pipe was surrounded in hand packed concrete to provide a rigid interface with the PE pipe.

As part of the final phase testing of the system a CCTV survey was carried out of the newly laid pipe in order to assess the structural and service condition of the pipe prior to full operation.

The survey clearly identified a failed joint at approximately 2.25M upstream of the pump station. This was subsequently identified as the joint between the stainless steel header from the pump station and the new PE Pipe.

Exjet services were then tasked with finding and implementing a suitable “no-dig” solution to remedy the problem.



South Town Pump Station, Dartmouth.z

Design Criteria.

Two options immediately became apparent that could possibly offer a suitable outcome:

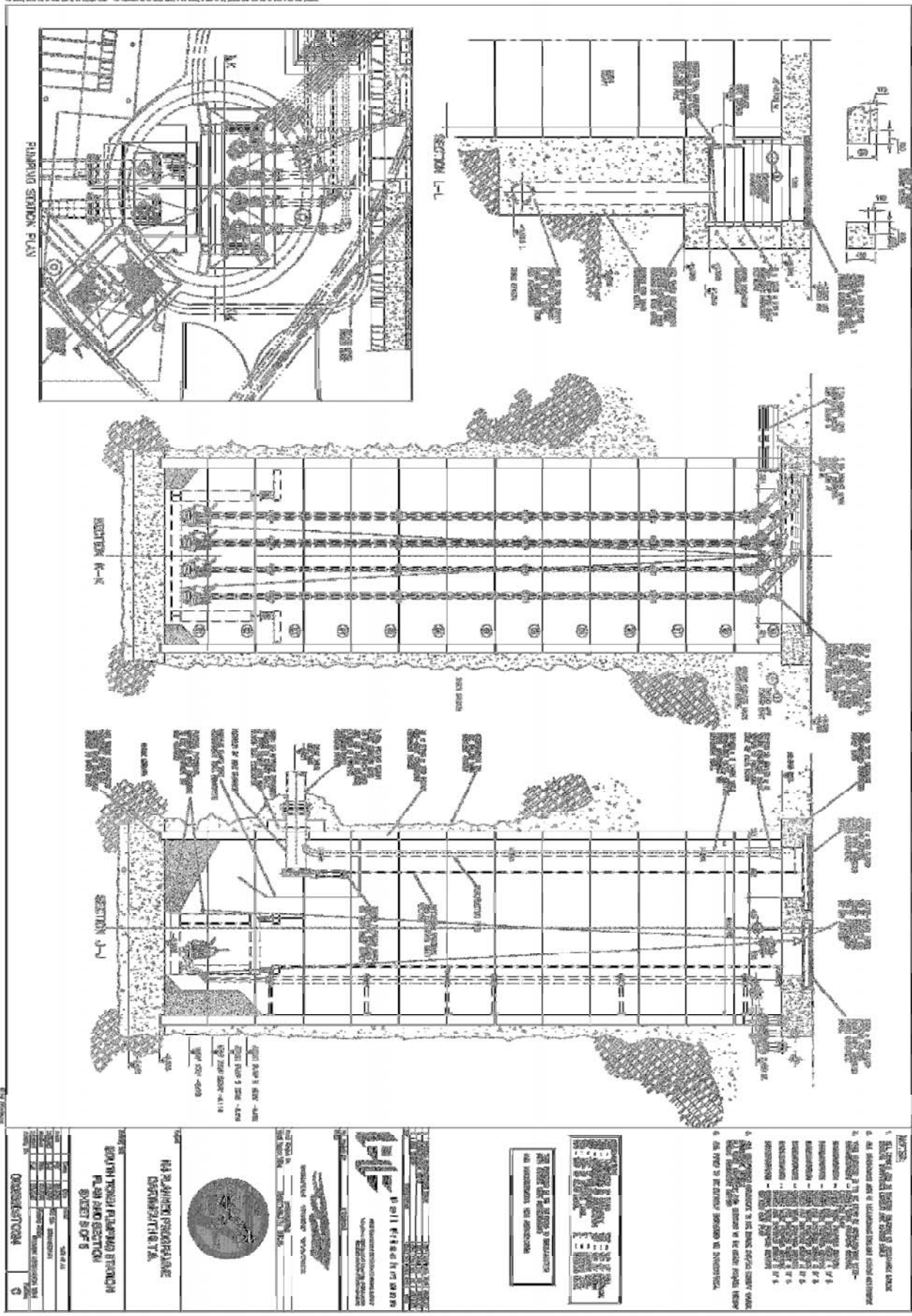
1. Cured in Place Pipe lining
2. Pressure Grouting to the failed joint.

In order to find a suitable solution a number of mitigating factors that could affect the repair needed to be taken into consideration within the design criteria prior to a decision on final remedial options being taken.

These included:

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- The nature of the original design of the header and connecting pipe i.e. rigid to flexible construction, combined with alluvial geology of the surrounding area meant that cyclical differential movement between the PE pipe laid within the trench and the rigid steel pipe within the heading had to be considered. The PE pipe by its very nature allows for cyclical flexural movement within the river system and any design criteria and subsequent repair implemented also had to allow for significant movement.
- Temperature change within the river which was estimated at a 5 degree C differential through seasonal change. This became particularly relevant due to the position of the defect, hence a significant difference in expansion and contraction between the Thin wall Steel pipe and the PE pipe had to be considered. For design purposes it was calculated that thermal expansion for the PE pipe would be 10 times that of steel per degree C of water temperature. These were calculated from the physical properties of both pipe materials.
- Variations in external hydrostatic pressure through tidal movement and subsequent pore pressure variations within the surrounding sub-strata. Any repair method utilised had to be designed to allow for movement to ensure that failure due to fatigue or strain corrosion would not occur.
- Any repair had to offer a long term water tight solution that would ultimately pass a pressure test of 2 Bar.
- The constructed pipe detail also included a deviation of approximately 15 degrees within the steel section consisting of a mitered and welded joint and a stepped flanged joint with an internal diameter variation of 40mm between the Steel and PE pipes.



Method.

After extensive consultation with Cured in Place Pipe lining suppliers including Karl Otto Brawn and Trelleborg Epros, the design criteria exceeded the parameters normally suitable for pipe liners. Whilst it was theoretically possible to achieve the desired flexural e-modulus with a pipe liner, guarantees could not be given to cover the expected design life span.

In addition, after consultation with Pell Frischmann it was decided that if the lining process was implemented and subsequently failed at a later date the only option for remediating the defective pipe would be by means of excavation and replacement, exactly the scenario that was trying to be avoided.

This left one suitable method of repair, pressure grouting of the defect with a flexible reinforced acrylic grout.

This had two distinct advantages; firstly this was a proven method of repair previously utilised in tunnels and header shafts to seal against ground water infiltration at depths greater than those which we would encounter, and secondly if for any reason the grout failed at a later date i.e. the header construction details proved to be incorrect, the pipe could easily be accessed and the repair reapplied.

The method of repair consists of encompassing the opposing joints either side of the defect with an inflatable packer and pumping an acrylic grout to a proscribed pressure into the void and subsequently through the defective joint and into the surrounding concrete.

In order to carry out this repair successfully a suitable grout with high flexible properties that would withstand the known parameters needed to be selected.

The product selected was “Superflex AR” a two part poly-acrylic gel that offered exceptional flexibility characteristics and had greater penetrative properties than the water which had to be driven out of the defect in order for the repair to be successful.

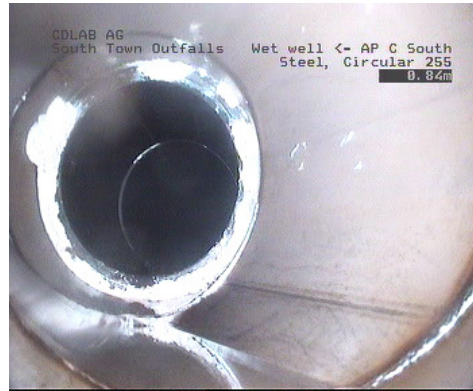
It was also noted that the gel times of the product could be altered to ensure that the defect within the concrete surround was fully penetrated with the gel prior to curing offering the best chance of success.

Once some minor alterations to the inflatable packers had been made to allow for the differential in pipe diameters and the gel time set at 26 seconds the repair was initiated.

It was subsequently decided that in order to reduce the risk of future failure the repair should be carried out during a spring tide (highest possible external hydrostatic head of pressure) and whilst the ambient temperature of the river was still low allowing the applied grout to take full expansion into the defect rather than in warmer temperatures and a lower head of pressure which would encourage the defect to effectively close and subject the grout to a required greater expansion through the tidal cycle.



Leak prior to sealing



Completed Works

The repair was carried out on the 24th April 2008 and successfully passed a 2 Bar pressure test on the 27th April.