RESEARCH PAPER
HAMNAK PIPELINE

THE HAMNAK PIPELINE – NEW ZEALAND'S LONGEST PVC-O WATER TRANSMISSION PIPELINE

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December 2021

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ABSTRACT

The Hamnak Pipeline Project (formally the H2Our Health project), in New Zealand's Waitaki District, was successfully undertaken in 2017-2018 to connect Oamaru's water reticulation with the Herbert/Waianakarua and Hampden/Moeraki water supplies. The objective was to install a new pipeline that would deliver drinking water to over 1300 permanent residents of these communities and was fully compliant with Drinking-water Standards for New Zealand (DWSNZ).

This was a landmark project for Waitaki District Council as the Asset Owner and Principal, Whitestone Contracting Limited as the Head Contractor and Iplex Pipelines NZ as the pipeline manufacturer. Nearly 34 kilometres of PVC-O pressure pipes in DN200, DN150 and DN100 sizes were utilised in this pipeline - making it the longest continuous PVC-O project in New Zealand's history. Two booster pump stations were also built and commissioned as part of the contract. The final agreed alignment for the pipeline required extensive consultation and approval from more than 42 landowners, along the pipeline route.

Waitaki District Council achieved the highest return for ratepayer dollar by using PVC-O compared to other available pipeline materials, in terms of hydraulic efficiency, strength and impact properties – while achieving a fully conforming cost-effective tender. The tender allowed for alternative materials such as PE100, however PVC-O was the material of choice for the Contractor, as it was lighter than conventional PVC and PE100 pipes of similar diameters and pressure classes – which would maximise installation efficiencies in terms of lay rates & speed of reinstatements.

Construction commenced in late July 2017, with completion and successful commissioning in September 2018, on time and to budget. This was a remarkable achievement given wetter-than-normal ground conditions over two winters and disrupted land access along the pipeline route from a Mycoplasma Bovis detection in the South Island.

Waitaki District Council took ownership of a robust and durable pipeline asset installed to the highest standard. The quality of drinking water delivered by this pipeline meets DWSNZ.

KEYWORDS

Water Supply, Transmission, Molecularly Oriented PVC, Plastic Pipelines, NZDWS

PRESENTER PROFILE

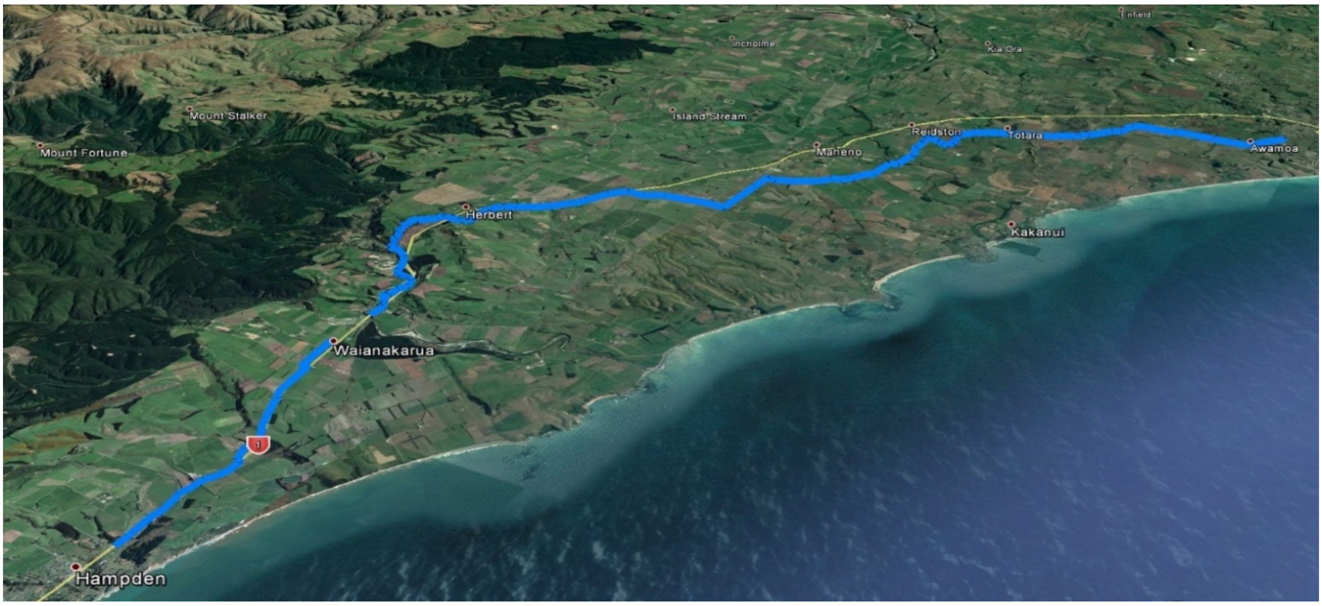
Arup "Jay" Roy B.E. (Hons) MEngNZ, is a Senior Sales Engineer for Iplex Pipelines NZ Limited, and has more than 12 years of experience in delivering complex technical solutions across various industries, internationally. Jay supports both internal and external stakeholders in New Zealand's 3 Waters infrastructure, in development, design, specification and technical support of plastic pipeline systems.

1 INTRODUCTION

The Hamnak Pipeline Project, formally known as the H2Our Health project by Waitaki District Council (WDC), was originally undertaken to upgrade the water supply of over 1300 permanent residents from the southern fringes of Oamaru to the townships of Herbert, Hampden and Moeraki.

The former water supply infrastructure for the region was struggling. The residents faced ongoing issues such as E. coli contamination, frequent boil-water notices and non-compliance with DWSNZ. Therefore, Waitaki District Council sought to undertake a long-term solution for the region which involved connecting the Oamaru town supply/reticulation with a new transmission pipeline to this region as shown below on Figure 1

Figure 1: Pipeline route
(Image courtesy – Whitestone Contracting Limited)



The successful completion of the project ensured that the community received safe & reliable drinking water, while fully meeting the stringent requirements of DWSNZ. The pipeline design ensures there is supply capacity to cater for a 45% increase in demand growth over 40 years.

2 THE HAMNAK PROJECT

2.1 CHALLENGES WITH FORMER INFRASTRUCTURE

The Hamnak Pipeline Project was originally undertaken to upgrade the water supply for the 1300+ permanent residents from the southern fringes of Oamaru to townships of Herbert, Hampden and Moeraki, servicing a land area of approximately 45,000 Hectares.

The former water supply infrastructure for the region was increasingly becoming inadequate. Two zones in particular: Herbert-Waianakarua and Hampden-Moeraki were non-compliant with DWSNZ and suffered from regular E. coli contamination. This resulted in frequent boil water notices and ongoing health risks for residents.

In addition, the existing pipeline infrastructure was:

- Vulnerable to drought & flood events resulting in frequent supply restrictions (refer to Photographs 1 & 2).
- Undersized for future population and business growth.
- Maintained and governed by local water scheme operators.
- Reaching end of life and susceptible to failures.

Photograph 1: Former Herbert-Waianakarua water supply intake (Normal conditions) (Image courtesy – Waitaki District Council)

Photograph 2: Former Herbert-Waianakarua water supply intake (Flood Conditions) (Image courtesy – Waitaki District Council)

Several solutions were considered to tackle the ongoing water supply issues faced by the affected residents – including dedicated water treatment facilities. However, a transmission pipeline connecting to the Oamaru reticulation enabled the costs associated with the project to be spread across a much larger ratepayer base, greatly improving the affordability of the project.

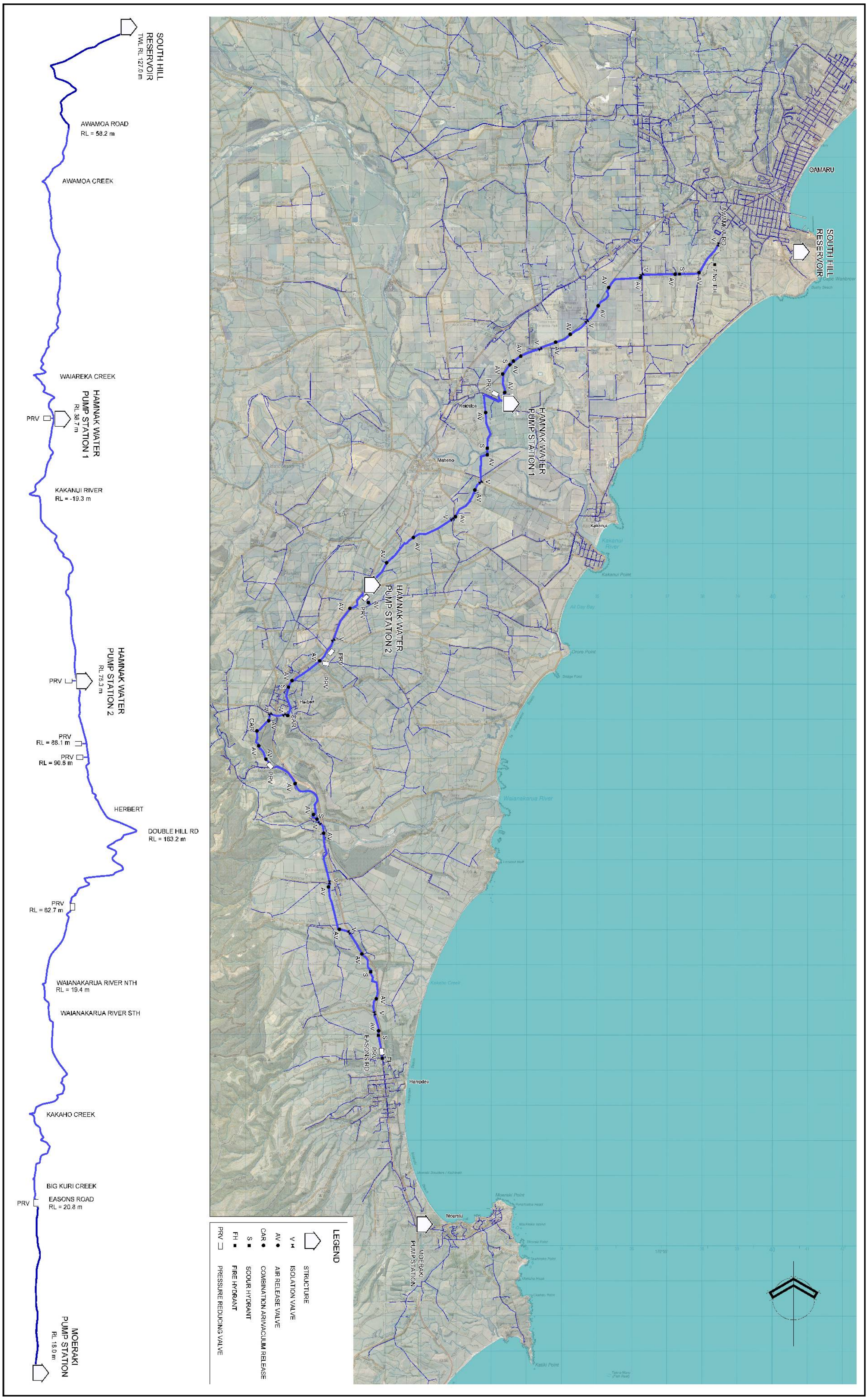
2.2 THE DESIGN

The pipeline is the longest continuous PVC-O project in New Zealand's history. To ensure a successful installation outcome, significant engineering and installation expertise was required.

The bulk of the pipeline was constructed in PVC-O in sizes DN200, DN150 and DN100 with a pressure class of PN12.5. Sections of the pipeline under existing waterways and roadways were installed by Horizontal Directional Drilling (HDD) using PE100 pipe in sizes DN180 & DN250 with a pressure class of PN16.

Figure 2 shows the final pipeline route and the associated reticulations. Two booster pump stations were included in the final design. Comprehensive hydraulic and network flow modelling was carried out by the Designers to ensure that an optimum pipeline route was selected.

Figure 2: Pipeline route with associated reticulations.
(Image Courtesy: Fluent Solutions & Waitaki District Council)



2.3 PVC-O AS A PIPELINE MATERIAL OPTION

The project construction specification permitted the use of PVC-O pressure pipe to AS/NZS 4441 or PE100 pressure pipe to AS/NZS 4130. This gave Tenderers the freedom to offer alternative pipeline material choices and construction methodologies that would be commercially viable and achievable within the stipulated 14-month project construction timeframe. The Principal was looking for the most cost-effective option for the supply and installation of the pipeline which was fully compliant with the specifications set out in the tender. Various combinations of pipe size and pipe material were considered.

Table 1 summarises the various options considered for pipe material and size in the project (excluding road and river crossings)

Table 1: Material specifications & options for bulk of the project

Size	*Size 1*		*Size 2*		*Size 3*	
Option	A	B	A	B	A	B
Material	PVC-O	PE100	PVC-O	PE100	PVC-O	PE100
Nominal Diameter	DN200 Series 2 CIOD	DN250 Series 1 Metric	DN150 Series 2 CIOD	DN180 Series 1 Metric	DN100 Series 2 CIOD	DN125 Series 1 Metric
Pressure Class	PN12.5	PN12.5	PN12.5	PN12.5	PN12.5	PN12.5
Mean OD* (mm)	232.25	250	177.40	180	121.90	125
Mean ID* (mm)	218.4	212.4	166.8	152.8	114.5	106.1
Mean WT* (mm)	6.9	19.4	5.3	14.0	3.7	9.7

** Based on published product information from Iplex Pipelines NZ Limited and/or relevant manufacturing standard (AS/NZS 4441 or AS/NZS 4130)*

Materials specified for river and road crossings are shown on Table 2

Table 2: Material specifications for waterway and roadway crossings

	Size 1	*Size 2*
Material	PE100	PE100
Nominal Diameter	DN250 Series 1 Metric	DN180 Series 1Metric
Pressure Class	PN16	PN16
Mean OD* (mm)	250	180
Mean ID* (mm)	203.4	146.3
Mean WT* (mm)	23.9	17.3

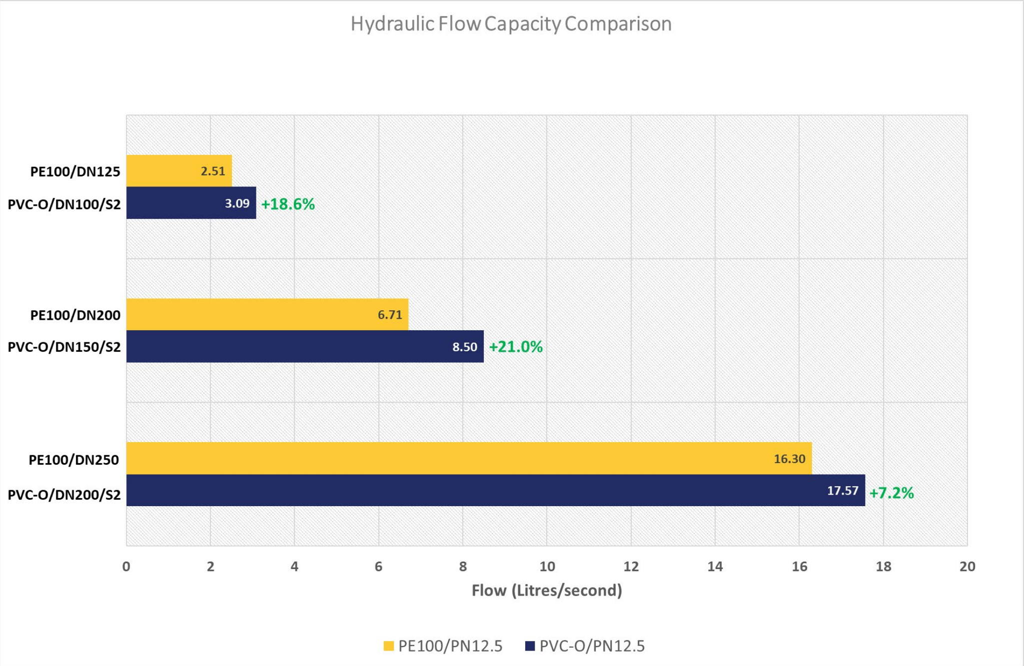
** Based on published product information from Iplex Pipelines NZ Limited and/or relevant manufacturing standard (AS/NZS 4130)*

A simple comparison of hydraulic flow capacities carried out based on the Lamont S3 formula (O'Callaghan, 1983) using a Hydraulic Gradient (i) of 0.001 and assuming full bore flow illustrated the advantages of PVC-O as an alternative material over a similar nominal diameter of PE100 pressure pipe. This is shown on Figure 3.

$$Q = \frac{d^{2.6935} i^{0.5645}}{2304}$$

Where:
Q = Flow (Litres/second)
d = Internal Diameter (mm)
i = Hydraulic Gradient (dimensionless)

Figure 3: Hydraulic flow capacity comparison for given material choices



The Contractor elected to use PVC-O in its tender submission to achieve an advantage in cost effective constructability:

- An open-cut installation methodology was specified for much of the tender which meant no obvious benefits to using PE100 which would be optimal for trenchless installations.

- Simple in-trench jointing of PVC-O with factory fitted, locked-in-place composite seals assisted with quick installation of the pipeline and immediate reinstatement of any excavation – lay-rates of up to 200 metres per day were achieved with minimum disruption to landowners.

- The Contractor did not need to allocate significant budget to fusion jointing in the pipeline – limiting this only to the river and road crossings keeping overall costs down.

- The Contractor and Council were familiar with PVC-O as a plastic pipeline material from previous successful application in regional water projects

PVC-O has been widely used in Civil Infrastructure and Rural Water Projects in Australia and New Zealand for more than 13 years with a broad manufacturing base. The history of PVC-O extends back to the 1970s when Yorkshire Imperial Plastics in the United Kingdom commercialised its manufacture. Molecular orientation is achieved by stretching a PVC-U feedstock pipe at just above its glass transition temperature, greatly improved the mechanical & physical properties of the pipe (Nijland, 2016)

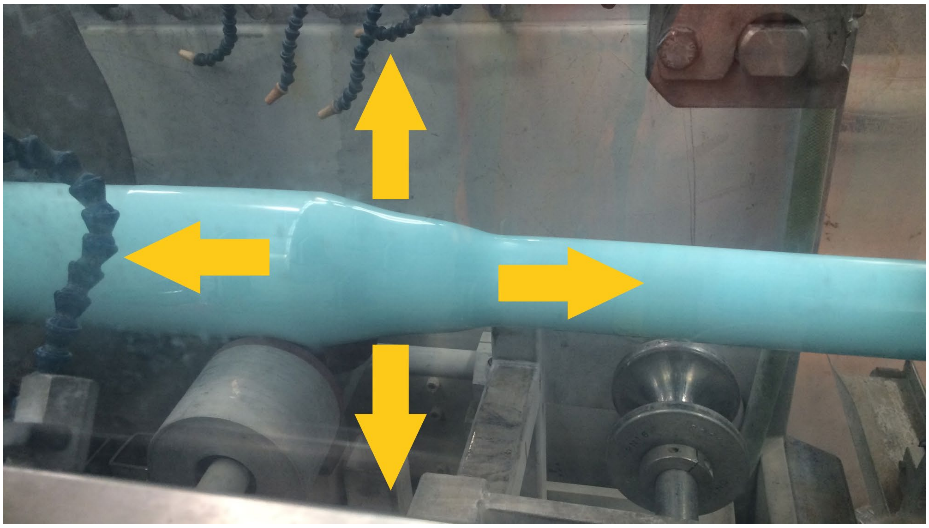
PVC-O pressure pipe installed in Kaiapoi in October 2010 to replace a pressure pipeline destroyed in the September 2010 Darfield earthquake, remained undamaged, during the Christchurch and Lyttelton earthquake events of 2011 and subsequent aftershocks (O'Callaghan, 2014 & 2015)

In the 1990s European manufacturers developed and commercialised different PVC-O technologies that achieved molecular orientation of the PVC-U feedstock. These are classified as:

- Mono-axial batch process: lengths of PVC-U feedstock are blow-moulded by air or water. Molecular orientation in the radial direction is achieved.

- Bi-axial continuous process: PVC-U feedstock pipes are continuously stretched over a mandrel achieving orientation in both radial and axial directions. See Photograph 3.

Photograph 3: Bi-axial orientation of PVC-O during manufacture
(Image courtesy – Iplex Pipelines NZ Limited)

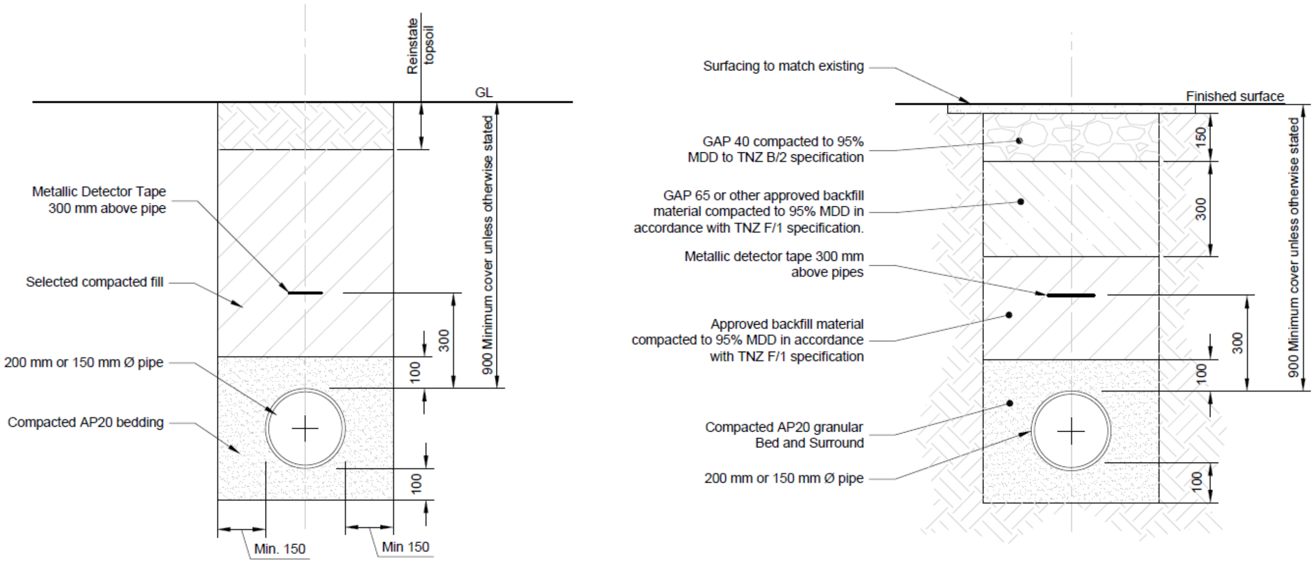


PVC-O supplied to the project was manufactured using the bi-axial process.

2.4 CONSTRUCTION

An open-cut installation methodology was used for most of the installation with typical fill and cover requirements for non-trafficable and trafficable conditions – shown on Figure 4.

Figure 4: Trench specifications for the pipeline
(Image courtesy – Fluent Solutions and Waitaki District Council)



TYPICAL PIPE TRENCH CROSS SECTION - PVC PIPE

TYPICAL PIPE TRENCH IN ROAD

The Contractor had two (2) pipelaying crews operating to ensure that pipelaying continued at pace (up to 200 metres/day dependent on conditions). The open-cut methodology, combined with light weight pipe, enabled quick installation and reinstatement of excavations as the work face advanced through. Typical examples of pipelaying activities with PVC-O pipe are shown in Photographs 4 to 6.

Photograph 4: Site handling a 6.5 m length of DN200 Series 2 PVC-O
(Image courtesy – Iplex Pipelines NZ Limited)

Photograph 5: Application of bactericidal pipe jointing lubricant to the locked-in-place seal ring
(Image courtesy – Iplex Pipelines NZ Limited)

Photograph 6: Compaction of embedment zone above pipe
(Image courtesy – Iplex Pipelines NZ Limited)

Horizontal Directional Drilling (HDD) with PE100 pressure pipe was used for some crossings of waterways and trafficable roadways, to eliminate open cut disruption in the crossing.

In the case of the Waianakarua River crossing where open excavation was used to install the pipeline, the Contractor gained engineering approval to install the PE100 DN180 pipeline section using an innovative methodology. Eight (8) repurposed concrete power poles were strapped onto the PE100 pipe with rubber sheathing to protect the pipeline as shown on Photograph 7. This prevented the pipeline from floating, during placement in the excavation. The challenging site conditions included both mobile alluvial river bed materials within a sandstone dish – and a continuously flowing river.

Photograph 7: Waianakarua River Crossing utilising concrete poles for anchorage.
(Image courtesy – Waitaki District Council & Whitestone Contracting)

Special accommodations were made for PE to PVC transition connections – wherein the Ductile Iron flange assembly on the PVC side was secured onto vertical brackets permanently set into a large concrete anchor-block under the assembly. The anchor block extended a minimum of 300 mm past the trench walls on both sides supported against undisturbed ground. This provided post-installation surety that the assembly was well restrained and protected against lateral movement. Examples of how this was achieved in the field are shown in Photographs 8 to 10.

Photographs 8, 9 & 10: PE to PVC Flange transition joint assemblies with associated restraint brackets.
(Images courtesy – Whitestone Contracting Limited)

2.5 PROJECT EXECUTION

The project commenced in late July 2017 and continued for 14 months over two winters – with the final handover in September 2018. The Contractor recognised from the very outset of the project that continued landowner consultation was critical to the project timeline and consequently appointed a dedicated landowner liaison resource to this end. The focus of this role was to implement a management tool in the form of an agreement document - which noted all communication and agreements around access, health and safety issues, risk identification and reinstatement requirements. This also needed to consider the timing of construction activities to suit landowners' use and operations of their farms. It also included agreement on storage and retrieval of plant and materials on-site.

The liaison and agreement were undertaken well in advance of construction crews arriving on site. This also occurred while staff were on site to provide updates on progress. Once all works were completed a final walkover meeting was carried out with the property owner, and final sign-off obtained.

To add to the complexity of managing relationships with landowners, construction of the pipeline involved a diverse range of sub-contractors (including Directional Drillers, electrical, building and mechanical engineers, and subcontractors) used to complement the Contractor's pipe laying and construction crew.

During construction, the cattle disease Mycoplasma Bovis was detected in South Canterbury in July 2017. Two properties within the pipeline route were on an MPI watchlist - which meant that the Contractor had to work close with the Ministry of Primary Industries to ensure all required precautions and measures were incorporated into the Project Management Plan, to allow pipelaying to continue unencumbered.

The project was delivered on time and on budget (NZD5.7M + contingency) The Contractor reported that in excess of 50,000 man-hours went into the project with zero (0) notifications to WorkSafe New Zealand.

Environmental concerns were identified, managed and controlled. The Contractor successfully planned river crossings around consent timeframes and conditions. This meant disestablishing on some sites and mobilising to a river site in order to complete it within the expected timeframe.

Trench lines were reinstated as construction through each property was completed. This minimised dust issues and runoff concerns. There were zero (0) breaches of consent conditions or environmental non-conformances occur during the project.

3 CONCLUSIONS

The Hamnak Project was on time, on budget, and delivered exactly what the Principal had set out to achieve. The 1300+ residents involved gained affordable access to clean drinking water which met DWSNZ standards for the long term.

The project was carried out using the latest generation of PVC pressure pipe – molecularly oriented PVC (PVC-O). which provided the best outcome for the project in terms of cost-effectiveness, hydraulic-capacity and constructability – including quick reinstatement and minimal disruption to landowners.

Open and transparent consultation with landowners ensured continued buy-in and prevented any unnecessary delays in the project delivery. Environment, Health and Safety responsibilities were taken seriously by all parties involved during challenging external circumstances including the Mycoplasma Bovis detection. The work carried out by the Contractor received New Zealand industry recognition and was awarded a Civil Contractors of New Zealand Construction award in June 2019.

ACKNOWLEDGEMENTS

The author wishes to thank Iplex Pipelines NZ Limited for its continued support, as well as key project stakeholders - Waitaki District Council, Fluent Solutions and Whitestone Contracting Limited who were all interviewed by the author in preparation for this paper. Humes Pipeline Systems are also acknowledged as the Civil Merchant and materials supplier to this project.

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