# SUCCESS WITH PRESSURE SEWERAGE SCHEME AT GROVETOWN

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## ABSTRACT

Grovetown is a community of approximately 300 people situated in flat and low lying land 5 km north east of Blenheim. The area suffers from difficult ground conditions including poor drainage and a high water table, conditions which had led to the failure of many of the household septic tanks. Several options were considered for upgrading Grovetown's on-site wastewater systems and incorporating conveyance of effluent from the nearby Spring Creek oxidation pond. Marlborough District Council decided to install a pressurised sewer system using grinder pump systems on each individual property, and a common pressure main from Spring Creek to the existing Blenheim Sewage Treatment Plant (STP).

The design and implementation of the system involved unusual and sometimes difficult considerations including Council's ownership of facilities on private land, and installation in a way that was agreeable to each landowner. Pipelines were sized for the ultimate estimated population, so flushing points had to be added around the reticulation where initial velocities would be low. A pump station was installed at the Spring Creek STP to convey effluent to Blenheim STP, collect the Grovetown GPS discharges, and to provide a means of flushing the line to prevent solids build up from low velocities.

## KEYWORDS

**Low Pressure Sewerage, Grinder Pump, Marlborough District Council**

## 1 INTRODUCTION

Difficult ground conditions in the small community of Grovetown, such as poor drainage, high water table and the presence of substantial open drains to control surface water, coupled with failing household on-site wastewater disposal systems, were resulting in effluent discharges into open stormwater drains. The stormwater drains in the area fall eastwards into Grovetown Lagoon, an oxbow waterbody partially cut off from the Wairau River. This lagoon is highly valued by local iwi and ecologists, and is being actively restored to protect its values. Investigations of soil and groundwater conditions in Grovetown, and the performance of on-site wastewater disposal systems found that Grovetown should be reticulated to avoid ongoing public health risks (Pattle Delamore Partners Ltd, 2004).

Spring Creek is located about 3 kilometres north of Grovetown and has a similar population. It had been serviced by a gravity sewerage scheme in 1985, with wastewater then pumped to a single oxidation pond before being discharged to the western side of the Wairau River. Monitoring of the river in the vicinity of the pond discharge had indicated that water quality did not always comply with the 2003 Ministry for the Environment (MfE) Microbiological Guidelines for Freshwater. In 1999 MDC received complaints about skin infections from local rowers who use the river.

Tuamarina is an unsewered settlement approximately 3.5 km north of Spring Creek with about 70 houses. The current population of Tuamarina is not expected to increase significantly in the future due to the lack of developable land available. However, as with Grovetown, high groundwater levels could affect the long term viability of on-site wastewater disposal systems in Tuamarina.

In 1996 Marlborough District Council (MDC) initiated investigations into the feasibility and costs of constructing a sewage collection system to service Grovetown and the townships of Spring Creek and Tuamarina. The aims of the sewerage scheme were to prevent septic tank effluent from entering the environment, cease discharge of effluent from Spring Creek sewage treatment pond to the Wairau River, and provide a sustainable means of treating and disposing of wastewater from Grovetown and Spring Creek initially, and Tuamarina in the future.

# 2 DESIGN OF A LOW PRESSURE RETICULATED SYSTEM

## 2.1 OPTIONS EVALUATION

Many factors were considered when evaluating which type of sewage collection system would best serve Grovetown and surrounding areas. The key advantages and disadvantages of eight collection systems were considered, with the conclusions summarised in Table 1.

*Table 1: Key Advantages and Disadvantages of Systems Considered*

| Type | Advantages | Disadvantages | Suitable for Grovetown? |
|---|---|---|---|
| Conventional Gravity Sewerage **(CGS)**<br><br>No Septic Tanks | ■ Low operations and maintenance cost<br>■ No equipment at house<br>■ All sewage removed from site | ■ If groundwater is high, increased installation costs and ongoing infiltration.<br>■ Greater disruption during construction<br>■ More difficult to repair damage after seismic activity | Yes |
| Modified Conventional Sewerage **(MCS)**<br><br>No Septic Tanks | ■ Smaller pipes, fewer manholes<br>■ No equipment at house<br>■ All sewage removed from site | ■ Increased maintenance<br>■ High cost for installation if groundwater high<br>■ Greater disruption during construction<br>■ More difficult to repair damage after seismic activity | Not recommended |
| Common Effluent Disposal **(CED)**<br><br>With Septic Tanks | ■ Smaller pipes, flatter grades<br>■ Reduced organic load at WWTP<br>■ Reduced peaking factors | ■ Septic tanks must be maintained<br>■ Requires septage facility | Not applicable |
| Variable Grade Sewers **(VGS)**<br><br>With Septic Tanks | ■ Smaller, shallower pipes<br>■ Reduced organic load at WWTP<br>■ Reduced peaking factors | ■ Septic tanks must be maintained<br>■ May need higher maintenance<br>■ Pump and check valves required at low properties<br>■ Requires septage facility | Not recommended |
| Modified Drainage **(MD)**<br><br>With Septic Tanks | ■ Low cost<br>■ Reduced solids load at WWTP<br>■ Reduced peaking factors | ■ Septic tanks must be maintained<br>■ Requires stormwater drainage system<br>■ Requires septage facility | Not recommended |

| Type | Advantages | Disadvantages | Suitable for Grovetown? |
|---|---|---|---|
| Septic Tank Effluent Pumping **(STEP)**<br><br>With Septic Tanks | ▪ Smaller shallower pipes<br>▪ Reduced solids load at WWTP<br>▪ Reduced peaking factors<br>▪ Reduced infiltration<br>▪ Easier to repair after seismic damage | ▪ Septic tanks must be maintained<br>▪ Requires septage facility<br>▪ Large number of pumps to run and maintain<br>▪ Potential for odour and corrosion issues | Yes |
| Grinder Pump System **(GPS)**<br><br>No Septic Tanks | ▪ Smaller shallower pipes<br>▪ Reduced infiltration<br>▪ All sewage removed from site<br>▪ Easier to repair after seismic damage | ▪ Large number of pumps to run and maintain | Yes |
| Vacuum System **(VS)**<br><br>No Septic Tanks | ▪ Smaller shallower pipes<br>▪ Reduced infiltration<br>▪ All sewage removed from site | ▪ Unfamiliar technology in NZ<br>▪ Potential odour nuisance<br>▪ Risks from power outage<br>▪ Some negative comments from overseas users | Yes |

On the basis of the advantages and disadvantages identified, conventional gravity sewerage (CGS), septic tank effluent pumping (STEP), grinder pump system (GPS) and vacuum system (VS), were recommended as feasible sewerage options for Grovetown and surrounding areas. Both CGS and VS had several high and very high risks that could have led to unknown additional cost implications. Risks from the construction and operation of both STEP and GPS were assessed as low to moderate.

While GPS was not assessed as the lowest cost option in the short term, it was preferred from a technical and risk perspective for these reasons;

- Septic tanks can be taken out of service and removed.
- The shallow installation depths for pressure pipes allow low initial costs in a high groundwater area.
- Ease of repairs after seismic damage.
- All sewage is removed from the property owner's site.
- Costs per lot for GPS are similar to STEP as development increases.

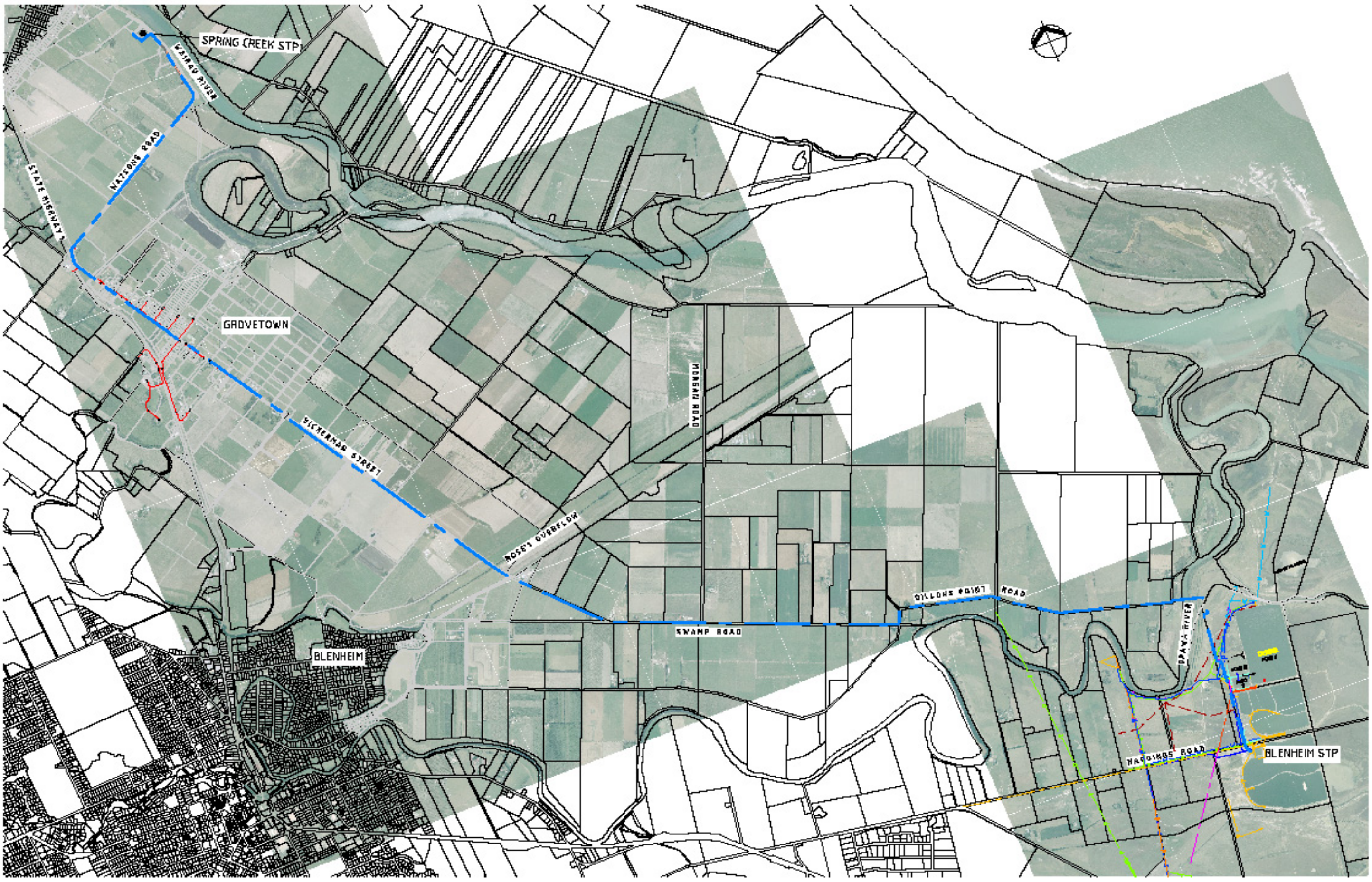
The disadvantage of the GPS is associated with the need to run and maintain a large number of pumps. Because the pumps discharge into a common pressure main, it is important for all pumps to be kept free of partial blockage, and to be able to be replaced when necessary. The pumps are expected to have a working life of approximately 10 years, with mechanical maintenance unlikely in that period. For both technical and cost reasons, GPS was recommended as the option best suited for Grovetown.

## 2.2 OUTLINE OF SCHEME

In addition to the installation of GPS within Grovetown, consideration had to be given to the treatment and conveyance of wastewater collected from Grovetown, Spring Creek and possibly Tuamarina. To achieve cessation of discharge to the Wairau River from the Spring Creek pond, the preferred option was to convey treated wastewater from Spring Creek, via Grovetown, to the existing Blenheim STP. The common pressure main from Spring Creek to the Blenheim STP would also allow the capacity at the centralised STP to be used, instead of developing local treatment plants with multiple discharges of effluent to receiving waters.

An additional oxidation pond was designed and constructed at Spring Creek STP, thereby increasing the treatment capacity at the site to accommodate future population growth, and the possible addition of flows from Tuamarina, and to provide extra flexibility for the operation of the ponds.

*Figure 1: Overview of Grovetown and Spring Creek Sewerage Scheme*




## 2.3 DESIGN CONSIDERATIONS

### 2.3.1 DESIGN POPULATION AND FLOW

Recognising that the installation of a sewage collection system, in any of the townships considered, would result in population growth, an "area for expansion" population prediction method was used. The scheme was designed on the basis of all available lots being subdivided into 450 m² residential lots to allow for higher density residential and commercial development in the future. For Grovetown, this increased the number of connectable properties from the existing 131 to 1,232 in the future, with a design population of 3,326 at 2.7 people per household.

Average design flows were based on the assumed design populations as shown in Table 2. The peak instantaneous daily flow for Grovetown is based on the probability of the maximum number of grinder pumps operating at one time.

*Table 2: Design Population and Flow*

| | Design Populations | | Design Flows | |
|---|---|---|---|---|
| | **Current** | **Future** | **Average Daily** | **Peak Instantaneous Daily** |
| Grovetown | 353 | 3,326 | 777 $m^3/d$ | 23 l/s |
| Spring Creek | 430 | 1,200 | 346 $m^3/d$ | 5 l/s |
| Tuamarina | 190 | 260 | 87 $m^3/d$ | 1 l/s |

Schematics of the system, including peak flow rates, are shown in Figures 2 and 3. The design of the scheme was based on two different scenarios;

- "Day" flow where there is no flow from Spring Creek STP and unlimited flow from the Grovetown residential area.
- "Night" flow, which occurs for the 4 – 6 hours that the Spring Creek pump station operates, where there is full flow from Spring Creek STP and a nominal flow from Grovetown. The "night" flow rate provides flushing of solids and slime from the pipeline, and removes the need for an additional pump station in Grovetown.

*Figure 2: System Schematic Day Flows*

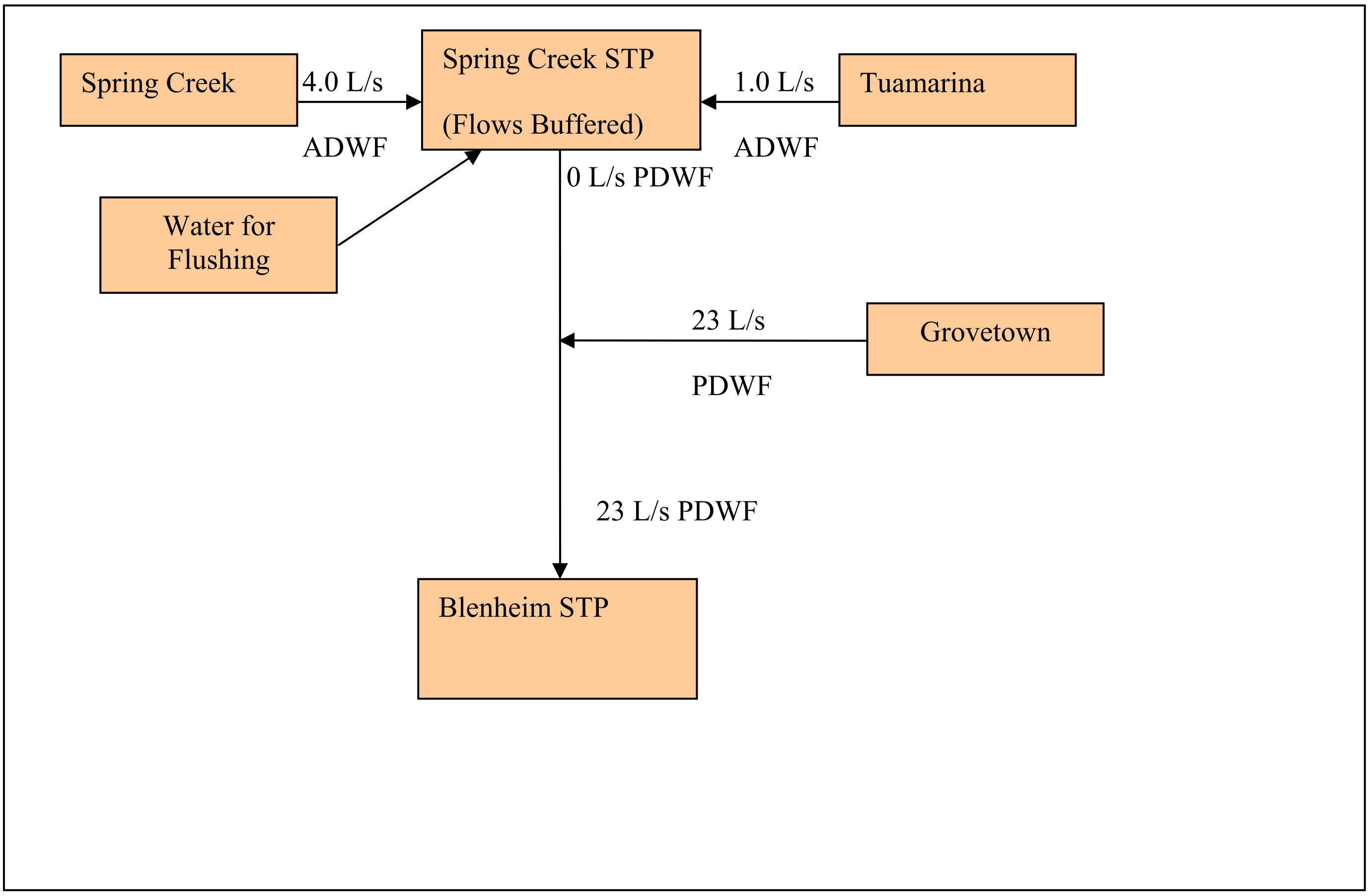
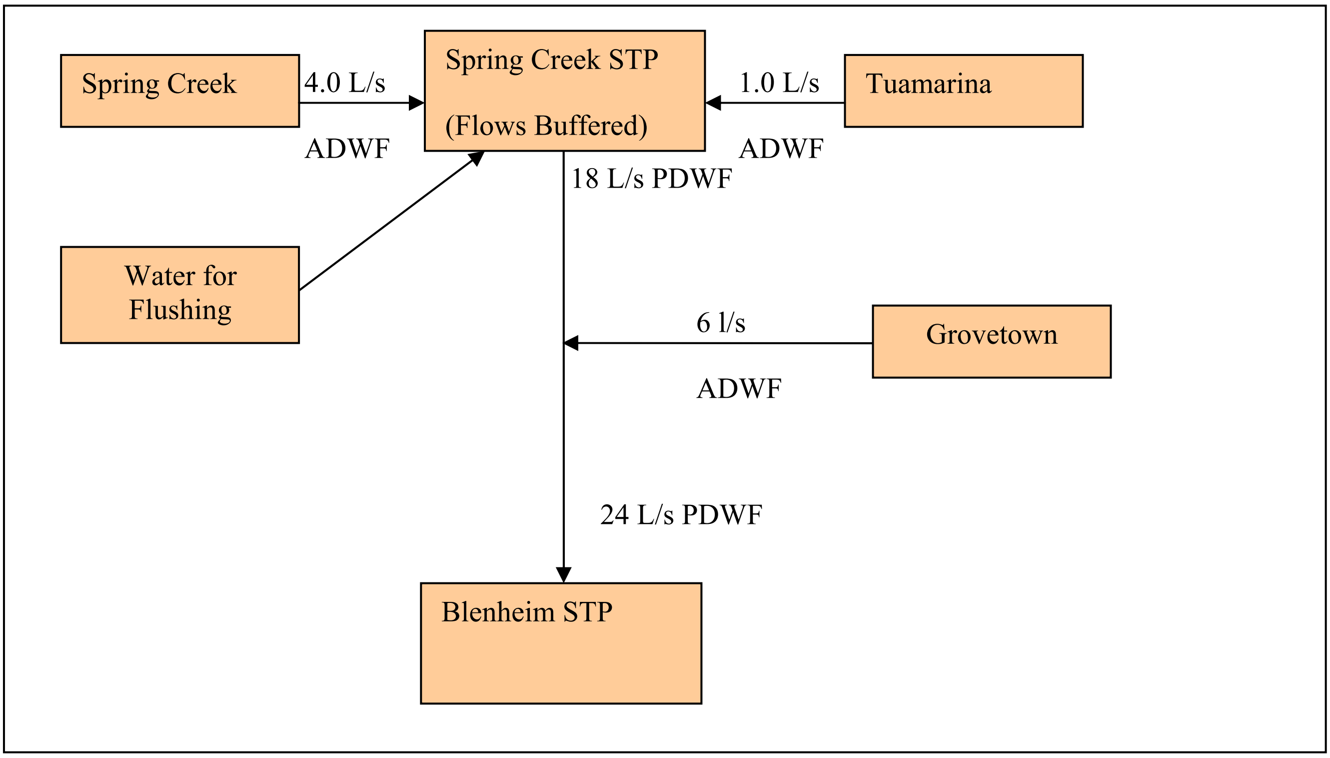


*Figure 3: System Schematic Night Flows*




### 2.3.2 SUBSURFACE CONDITIONS

Geotechnical investigations were carried out as part of the design process. The results of the field testing showed the extent of the high water table and the medium dense, blue grey fine sand (running sand). The sand collapsed when exposed, confirming the concerns of unstable ground conditions. A report outlining test pit locations and depth to water level and sand level was provided to the main contractor.

*Photograph 1: Running Sand in a Trench During Installation*

### 2.3.3 SEISMIC CONSIDERATIONS

There had been a number of investigations conducted for MDC on the Wairau section of the Alpine Fault. Geotech Consulting Ltd (2005) identified possible future earthquake hazards in the area, including an active fault travelling parallel to Watsons Road between Spring Creek and Grovetown.

# 3 GRINDER PUMP AND PRESSURE MAIN SYSTEM

## 3.1 GRINDER PUMP SYSTEMS

Two options were considered for grinder pump systems in Grovetown;

- Individual pump stations for each property.
- Shared pump stations placed in road reserve servicing 2 to 4 properties.

Each option was analysed for cost and risk to MDC and property owner and the analysis showed that individual pump stations were the preferred option due to;

- Greatest return and least risk on investment.
- Lowest risk of inflow and infiltration.
- Simplification of responsibilities for maintenance issues and supply of power to the units.
- Simplicity of construction.
- Assets for future infill installed as development occurs.

Grinder pumps have been used for individual houses and groups of houses from the 1980's in New Zealand. In recent times a number of suppliers of low pressure systems have come onto the market in New Zealand. Following the tender process, EcoFlow Ltd (NZ Agent for EOne) was selected as the preferred supplier.

## 3.2 RETICULATION IN GROVETOWN

During preliminary design, the reticulation within Grovetown included the installation of a central pump station to collect discharges from the GPS. This proposed pump station had emergency storage facilities, and was planned to pump from Grovetown to the Blenheim STP. This concept was deleted as design progressed as aesthetic considerations and local roading authority requirements meant that the preferred construction of the pump station would be at least partially below ground, in an area of high water table. Such a pump station would have been difficult and expensive to construct. The GPS could produce sufficient head to enable each individual unit to pump the approximately 10 km from Grovetown to the Blenheim STP, without the need for an intermediate pump station. Therefore the pump station and associated costs were able to be removed from the design, although provision was made for it to be retrofitted in future if required.

Design of the low pressure reticulation system with the GPS pumping to the Blenheim STP was based on the predicted maximum number of grinder pumps operating simultaneously. The system was broken into zones and sized to achieve the desired minimum velocity of 0.6 m/s, while maintaining the total head loss below 55 m everywhere in the system. The EOne units selected are able to operate above 55 m head for intermittent use only. Each unit consists of a grinder pump and tank – the tank comes in two standard sizes, 630 litres and 1,264 litres. Where some grinder units on the outer extremities of the network were predicted to operate at greater than 55 m head during day operation, larger storage tanks were installed. With a larger storage tank the pumps would operate less often, therefore reducing the chance of these particular grinder pumps operating at times of peak inputs and high head.

A hydraulic analysis of the system was carried out to identify where areas of low velocity could occur based on current population flows. Due to very low velocities, a much higher k value than historically employed, had to be used in the analysis. Hydraulics checks were undertaken for both the current and future populations, and a sensitivity analysis was carried out using different friction coefficients (1.5 and 3.0 as per the Wallingford and Barr (2006) design guidelines). Flushing points were installed at these points and others to allow the system to be flushed periodically to minimise the risk of pipe blockages. In addition, tapping points for pressure loggers were fitted at critical points (those with the greatest dynamic head) to allow the scheme operators to monitor and assess performance with time.

The design included for the installation of air release valves at all high points, and at a spacing not exceeding 500 m. The Grovetown reticulation passes under State Highway 1 and the Main Trunk railway in two places. Directional drilling was used to install a 225 mm OD SDR13.6 PE100 encasement pipe for the crossing adjacent to Annie's Café, and a 280 mm OD SDR11 PE100 encasement pipe was installed under the State Highway at the Grovetown Tavern where long term development was likely to be greater. The size of the sub-main at each crossing was 50 mm and 75 mm respectively. In each case approval was granted by NZTA and Ontrack.

## 3.3 PRESSURE MAIN SYSTEM

The pressure main installed between Spring Creek and the Blenheim STP is approximately 12.7 km long and was constructed from PE100 SDR17 PN10 225 mm OD pipe. This pipe material was selected as giving the best performance across the predicted operating conditions and risks associated with the scheme. The pipe was laid within the berm of the road reserve where possible, with pipe depths minimised and the pipe essentially laid flat with local gradients to avoid other services. A riser pipe was specified for where the pressure main discharges into the Blenheim STP to maintain full pipe flow conditions.

The route selected for the main required two major waterway crossings – firstly at Roses Overflow and secondly at Opawa River. Directional drilling was used to install the pipe beneath Opawa River, whereas at Roses Overflow the pipe was able to be temporarily supported until the old bridge crossing was replaced with an Armco culvert, and the pipe bedded over the top of the culvert.

The design of the line included for installation of air release valves at every 500 m and at high points in the pipeline (defined as being 0.1 x OD above the average constructed grade line over a 50 m length of pipeline). Isolation valves were installed at approximately every 1,000 m to allow the pressure main to be isolated for maintenance, or in the event of a breach of the line. The placing of the isolation valves also gave the ability to send Grovetown wastewater in the reverse direction to Spring Creek if the pressure main downstream of Grovetown needed to be shut off. Both a hydraulic review and a surge analysis were undertaken on the proposed line.

## 3.4 SPRING CREEK PUMP STATION

The size of the pressure main from Spring Creek to Blenheim STP in relation to the contributing flows from the Grovetown network meant domestic flows from Grovetown were below scouring velocity in the main line, and were likely to result in solids settling. To counter this, the pump station at Spring Creek was designed with two duties in mind – firstly to convey wastewater from the Spring Creek STP to the Blenheim STP, and secondly to generate a scouring velocity in the pressure main to remove settled solids. The added advantage of this approach was the reduction in retention time of sewage held in the system, reducing the likelihood of septicity.

Specification of the pumps used at the Spring Creek pump station involved consideration of the higher friction factor (k value) specified by the latest Wallingford and Barr (2006) charts. The 12 km of pressure line resulted in significant head losses along the length of the main, and so the pumps specified were fitted with 60 Hz variable speed driven motors in order to achieve the required operating curve for the system.

The initial operation philosophy of the pump station was to pump a total volume equivalent to the approximate volume of the pipeline from downstream of Grovetown to the Blenheim STP once every 24 hours. As the starting domestic load on the system was likely to be less than this volume, a source of make-up water had to be identified and consented to reach the daily target volume and therefore make sure sufficient velocity was reached during pumping. The pump station was planned to operate at night to reduce electricity costs, and avoid peak incoming flows from Grovetown, therefore allowing significant savings through minimising pipe friction losses.

## 3.5 SPRING CREEK OXIDATION POND

An additional oxidation pond was constructed at Spring Creek to allow treatment of future combined flows for both Spring Creek and Tuamarina. The new pond was designed to fit into the existing site boundary, and be able to run in either series or parallel with the existing pond. This allowed for greater flexibility of operation such that one pond could be taken out of service while the other pond was being desludged.

A review was undertaken to assess the likelihood of overflows occurring to the Wairau River from the new pond system. This showed that for current wastewater flows, running the pumps for a longer period of time would be sufficient to control the design wet weather event.

# 4 IMPLEMENTATION OF THE SCHEME

## 4.1 OVERVIEW

Installation of the scheme – both within the Grovetown township and of the main pressure line – involved a number of interesting and sometimes challenging aspects. Close co-operation was required between the Council and the main contractor when liaising with local property owners and regulatory bodies such as the Historic Places Trust, NZTA and local iwi.

## 4.2 OWNERSHIP OF COUNCIL FACILITIES ON PRIVATE LAND

The original scheme proposed by MDC followed the Grovetown township boundaries. On further discussion and investigation, a number of outlying property parcels were also included within the finalised boundaries of the scheme. Several public meetings were held by the Council with Grovetown residents to describe the principles of the scheme, and how access for Council owned facilities on private land would be dealt with.

With some schemes, the GPS are owned by the property, however in this case MDC decided to retain ownership of the pumping units as given the duty requirements of the grinder pumps (up to approximately 10 km pumping duty), there is the potential the pumps would need to be maintained and a significant number of them replaced at one time.

MDC had their solicitor develop a licence agreement that would be recorded on the title of each property, allowing Council to install and access the GPS on private property. The use of a licence agreement was favoured by the Council for the following reasons;

- Reduced costs for establishing an agreement that could be used for all properties – saving the cost of generating easements for each installation. The cost per property of a licence agreement versus an easement was approximately $550 and $1,500 respectively.

- No survey costs, as the exact position of the grinder pumps did not need to be included in the licence agreement.

- The agreement was recorded as a limited effect caveat on the property title so prospective property owners could quickly identify that an alternative sewerage system was linked with the property, thereby reducing the risk of a misunderstanding with a new property owner.

All property owners within the scheme boundaries were identified, and a Council representative visited each property owner to obtain their signature on the developed licence agreement. The landowner was required to have signed the licence agreement prior to the contractor undertaking work on their property.

## 4.3 CO-ORDINATION AND LIAISON WITH LANDOWNERS

Before installation of the individual grinder pump stations, the contractor conducted a site visit with the property owner present. At this visit the contractor went through the criteria as agreed with the client for installation of the GPS. This included the recommended position of the GPS to allow line of sight between the control panel and the grinder unit and, where possible, positioning the grinder unit within 3 metres of the existing pipework running between the septic tank and the dwelling.

Photographs were taken of the area to be affected by the installation, with any existing defects noted. Hydrostatic testing of the condition of the existing pipework running between the septic tank and the dwelling was undertaken to make sure this pipework was in acceptable condition for connection to the GPS. This testing was put in place to minimise the amount of inflow and infiltration from private property into the new scheme. If the pipework failed the hydrostatic test, CCTV was then used to identify the nature and location of the failure(s). As any defects identified became the responsibility of the homeowner to rectify prior to connection to the GPS, use of CCTV proved very useful in showing the homeowner exactly what the issue was and why it needed fixing.

After testing had been completed another site visit was undertaken and the proposed position of the GPS was again discussed with the homeowner. The main contractor found that it was common for the homeowner to have changed their mind about where they wanted the GPS located, and so this second visit was an important step in maintaining ongoing relations. A Quality Assurance (QA) sheet was developed for each property including a drainage plan showing the agreed location and installation of the GPS, photographs of the property and a list of the condition of the lawn, pavements, driveways etc that would be affected. The homeowner was then asked to sign off on this QA sheet as evidence of the work agreed. The drainage plan was submitted to MDC for approval as part of the building consent process. Building consent costs were paid for by the Council.

As the GPS control panel required a power supply from the property house, electrical assessment of the suitability of the house power supply was also undertaken by the contractor's nominated electrical installer. This visit was important in establishing rapport with the homeowner as on subsequent visits the internal cabling within the house had to be installed, and a position for installation of the control panel agreed. Much of the work and communication regarding the supply of power to the GPS unit had to be undertaken out of hours when the property owner was home – all discussions, site visit reports and lengths of cable installed were recorded on a file for each property.

*Photograph 2: Minimising Impact on Private Property by Using Boards*

Connection of the GPS to the pressure sub-mains in the street was made using directionally drilled laterals wherever possible to again minimise the impact on the property. However, the issue of reinstatement around the installed GPS, and where the septic tank was removed, was a key factor for many of the property owners that needed to be dealt with in a co-operative and timely manner. On completion of the reinstatement works the contractor issued a letter to all homeowners asking for feedback on the project and a list of any remaining issues with areas of reinstatement. Where requests were reasonable, and within the scope of the contract, the contractor returned to the property to rectify the concerns raised.

*Photograph 3: Top of Grinder Unit After Reinstatement*


Feedback from property owners was generally positive, with the main point of concern being the level of communication when installation on the property was occurring. The main contractor used letter drops and regular phone calls to keep homeowners advised of work to be completed, however for each property there was a time when several sub-contractors were working on the property at any one time. This was a conscious decision to try and minimise disruption to the homeowner by carrying out all aspects of the installation together – rather than extending the period of disruption by undertaking the works in a sequential manner.

Sub-contractors were instructed to always knock on the door of the property to advise the homeowner of works occurring, but the main contractor found that there was a fine line between giving the homeowners what they considered to be a sufficient level of communication, and contacting them so frequently it became an annoyance.

Significant involvement from MDC staff was also vital to the installation of the project. As well as working through the licence agreements with homeowners, any individual concerns with regard to the property owners' rights regarding positioning of the GPS, results from the testing of existing installations or future building plans for a site were often directed to MDC.

*Photograph 4: Installed Grinder Unit and Control Panel*

## 4.4 MAIN PRESSURE LINE AND AIR RELEASE VALVES

Although some geotechnical assessment and survey work was undertaken during the design phase, the exact pipe routes and alignments were left to the contractor to determine, based on ground conditions and services location as potholed during installation. The main line pipe was essentially laid flat, and localised high points of less than 10% of pipe diameter were allowed without air release provision. The static head difference between the start and end elevations of the pipe is negligible, a riser was installed at the discharge of the line to keep an overall rise from suction to discharge.

When the pond levels operate at higher than design, there is a risk that the column of fluid within the main line pipe could continue flowing for a time after the pumps are stopped due to the momentum of the fluid and flatness of the line. This is an undesirable situation as it could result in the line partially draining and pulling in air through the air release valves (ARV). This issue was avoided by utilising the variable speed drives fitted on the pump station transfer pumps to slowly ramp the pumps down during shutdown, therefore reducing the momentum of the wastewater in the line. The inclusion of ARVs helped prevent possible vacuum issues that would have arisen from such situations.

Air release valves were nominally included at a rate of one every 500m in the design, but the final number and positioning of the ARVs was determined during installation. The installed scheme included some 37 ARVs, all of which will require regular maintenance to prevent the risk they become blocked and therefore ineffective. Additional carbon filters were included on ARVs installed within the township itself where air valve discharge could cause a nuisance. As the initial wastewater velocities are too low to move air along the pipe, it is possible for air to be sucked in the air release valves on shutdown, but not released on startup. In addition the EOne pumps introduce a pocket of air into the pipe each time they operate. Consequently, the flushing from Spring Creek in conjunction with correct operation of ARVs, becomes an important factor in the ongoing operation of the system.

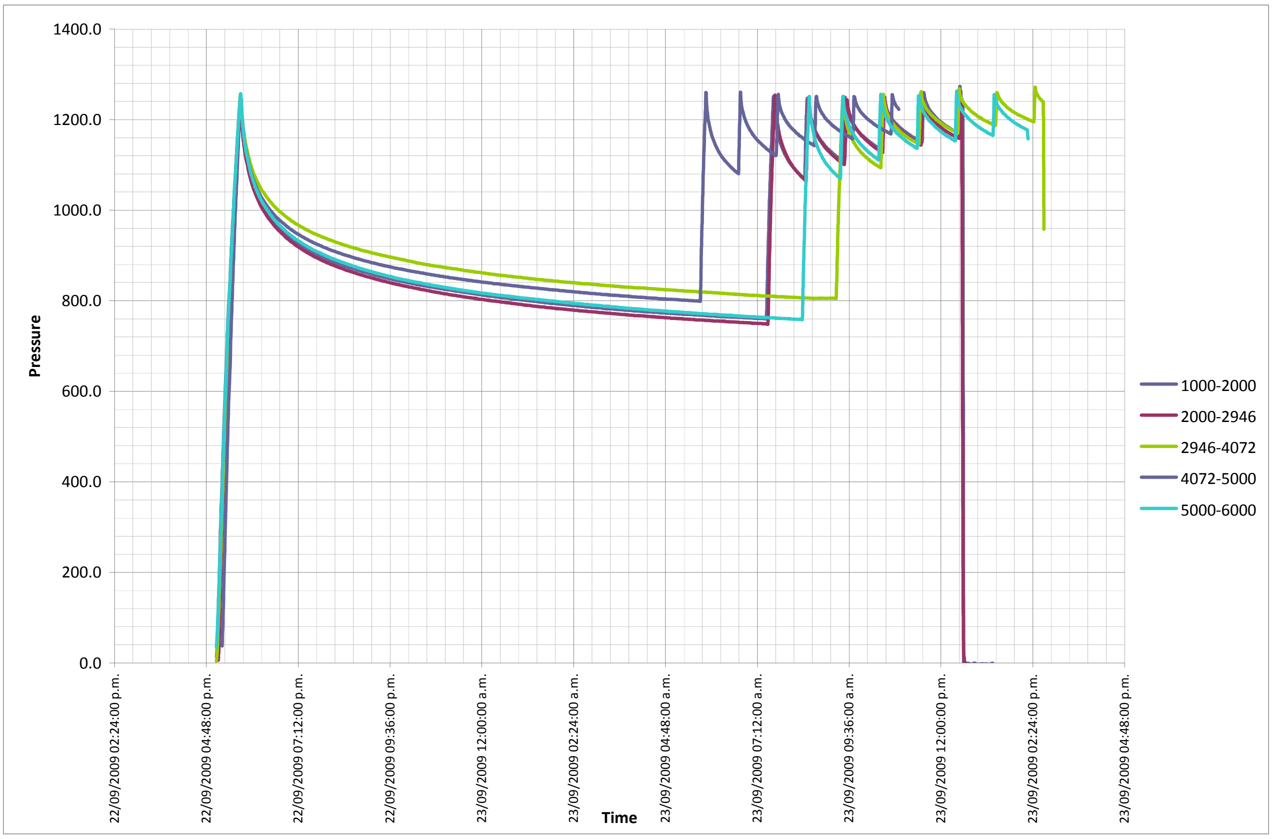
## 4.5 PRESSURE TESTING OF PE PIPE

Pressure testing of PE pipe is recognised as often being problematic. The specification for the contract gave the contractor the option of three types of pressure testing that could be used, as recommended by AS/NZS 2566.2 – the pressure drop or rebound test (for pipes of 110 mm OD or less), the volumetric test or water loss method (constant stress), or the pressure decay test (constant strain).

Testing of sections of the 225 mm OD main line was commenced using the decay test. This test looks for a non-linear decay in pressure due to creep response and stress relaxation of the PE material. When converted to logarithmic co-ordinates, the result is expected to be a straight line – a change to a steeper slope indicates leakage in the system, a flatter slope indicates air entrapment. The slope at two points in the test line (n1 and n2), when plotted logarithmically, is compared and if the n values lie within the range specified for the type of pipe support being used, the test is considered a pass.

It was found that while the decay test n values did not meet the specified pass criteria for the first set of tests carried out, they were highly consistent and a combined plot of the results showed very similar slopes for all tests undertaken (Figure 3). The conclusions drawn from this were that either the five sections tested all had a very similar leak (highly unlikely) or none had a leak and the rate of decay was a function of the specific pipe length, pipe material type, pipe thickness, and backfill characteristics.

*Figure 3: Main Line Decay Pressure Test Results*

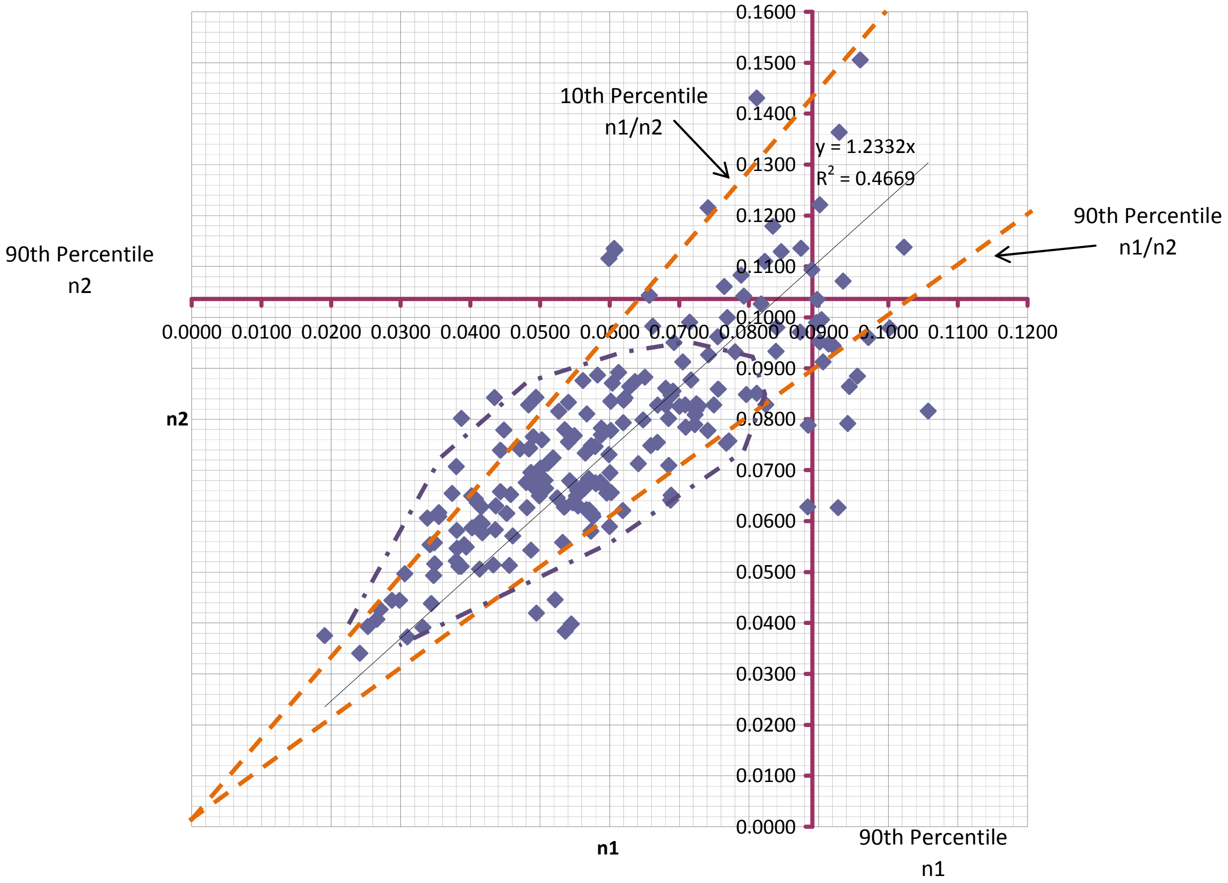



The volumetric test was then used as a repeat on some of the sections of line already tested. This test looks at the amount of water addition required to maintain the PE pipe at test pressure over time. It is generally regarded as independent of soil support and is sometimes referred to as a reference test. As logged pressure data was gathered during each test, a decay test could be analysed from the volumetric data, effectively enabling two tests in one. Again a mix of pass and fail results were recorded.

It was decided to employ a rebound test as a check for an unacceptable amount of air on a section of line already tested. This test passed the criteria with ease and it was decided that all mainline tests showing similar make-up volumes and decay slopes to those already recorded would be deemed to have passed. Any decay slopes or make-up volumes differing significantly required further investigation or testing, as this was likely to indicate either air inclusion or a leak.

With testing of the property laterals (relatively short lengths of 40 mm OD pipe) similar issues were experienced with the n values recorded falling marginally outside the specified values, but the pressure vs. time results generally indicating there were no issues with the pipe. In this case it was decided to take all the decay plots for the individual laterals, and calculate the average values of n1 and n2 as well as the 95th, 90th, 10th and 5th percentile values for all test data as shown in Figure 4. Any test found to fall outside the 90th percentile values was considered a fail and had to be repeated. This methodology was found to be effective and pragmatic, and failures were easily identified.

*Figure 4: Lateral Tests n1 and n2 Decay Gradient Plots*




Testing of the sub-mains introduced another issue where sub-main sections could be made up of a mix of different diameter pipes at varying lengths. It was unknown if the rebound test could be used successfully for such situations. However, a spreadsheet was developed (Tim Smit) that allowed the input of the various lengths and diameters in the section of pipe tested. Using this spreadsheet to analyse the pressure logger and water addition data, successful passes were achieved. Used in this way the rebound test also produced first time pass results for the main line when tested as a whole (approximately 12.7 km), and the system when tested as a whole (combination of main line at 225 mm OD and sub-mains ranging in outside diameter from 50 mm to 110 mm).

The use of a foam pig to help expel air prior to the testing was specified, and found to be beneficial in obtaining consistent test results. The control of loading time and pressure was also important in achieving a successful test result and, for this reason, using one person familiar with the need for accurate time keeping and pressure control to carry out all the tests also assisted in producing successful results.

## 4.6 INVOLVEMENT OF HISTORIC PLACES TRUST AND IWI

One section of the pressure main from Spring Creek to the Blenheim STP passed through an area of cultural significance. As such, the involvement of the Historic Places Trust (HPT) and local iwi was required. Historic Places Trust approval had to be obtained prior to commencing any work in this area, and no work was able to be carried out from east of the Opawa River to the Blenheim STP without an HPT approved archaeologist in attendance. The contractor was also required to co-operate with the local iwi, Rangitane, when working in the area.

## 4.7 DIRECTIONAL DRILLING

Directional drilling was used to install the laterals into private properties, the majority of sub-mains within the Grovetown network, and for crossing of the State Highway and Opawa River. While this methodology was used with relative ease and success for the large diameter pipelines under the river and State Highway, and for the laterals where the gradient and alignment of the pipe were not critical, one of the major hurdles of the project was the accuracy of drilling when installing the sub-mains.

Sub-mains were sized for all future connections so with low initial velocities it was important to lay them to a grade and alignment that would prevent build up of either air pockets or solids within the line. Tight tolerances were specified on both horizontal and vertical alignment of the sub-mains. Initially, sub-mains of diameters between 40 mm and 110 mm were installed by directional drilling, however collection of as-built information on the sub-mains drilled during the installation process showed that the specified tolerances were not being met when installing such small diameter pipes by directional drilling. As a consequence the sub-mains had to be removed, inspected and laid again using open cut trench methods to achieve the desired alignments. An unfortunate consequence of pulling the sub-mains from the ground was that longitudinal gouging occurred on the exterior surface of some of the pipe. The manufacturer's guidelines specified that if the depth of any surface notching was less than 10% of the wall thickness the pipe could be reused. Approximately 5% of the sub-main pipe was rejected, the majority of this being 40 mm pipe.

## 4.8 CHECK VALVES

Ball check valves were specified downstream of the duty and standby pumps at the Spring Creek pump station, to prevent undesired backflow from the Grovetown network to the Spring Creek ponds. Upon commissioning of the pump station it was found that some flow was passing back through the ball check valves when only a small number of grinder units were operating. Investigations identified that the ball check valves had a minimum back pressure requirement that was unable to be met due to the very low hydraulic gradient of the pipe, and the low pressures generated when only a few grinder pump units were pumping into the large diameter pressure main. This back pressure requirement is not generally highlighted in standard check valve literature, and applies to most types of check valve that would be utilised in a wastewater pumping situation.

MDC has trialed an alternative form of check valve, the Swing Flex manufactured by Val-Matic, and has found that even with the very low back pressures experienced by the check valve, they operate successfully.

## 4.9 COSTS

The project capital cost came in on budget; approximate costs are given in Table 3. The installed cost of a complete grinder pump unit per household, including all liaisons, decommissioning and reinstatement, was approximately $11,000 per property (excl GST). The cost of the project was shared between Grovetown and Spring Creek ratepayers, and included a 50% subsidy by MDC of total project costs. The cost for excess capacity to accommodate future growth was included as part of the total project cost. Grovetown ratepayers covered reticulation costs and the majority of the pipeline costs, while Spring Creek ratepayers paid for the new Spring Creek pond, pump station, and a portion of the pipeline. In addition to the subsidy MDC paid for costs associated with obtaining resource consents and building consents.

*Table 3: Project Costs (July 2010, excl. GST)*

| **Description** | **Capital Cost ($)** |
|---|---|
| Preliminary and General | 250,000 |
| Spring Creek STP Upgrade and Pump Station | 750,000 |
| Grovetown Reticulation | 1,600,000 |
| Main Line to BSTP | 1,900,000 |
| **TOTAL** | **4,500,000** |

# 5 CONCLUSIONS

Despite the difficult ground conditions in Grovetown, the contractor was able to rapidly install large lengths of pressure main and significant numbers of grinder pump systems (GPS) within the new Grovetown network. Frequent and amicable contact by both the contractor and the Council with residents was essential, and assisted in successful installation of Council owned GPS in private property. The installed scheme has successfully stopped discharge to the Wairau River from the Spring Creek oxidation pond, and failing septic tanks systems are no longer a problem since all on-site systems in the Grovetown service area have been decommissioned.

The project highlighted some important lessons with regard to higher friction factors for low velocity pipelines, directional drilling of small diameter pipes, and pressure testing of PE pipe.

*Photograph 4: Laying PE Pipe Adjacent to Open Drains with High Groundwater*

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