UPGRADING OF WAIKATO AND HAURAKI VALLEY FLOOD CONTROL PUMPSTATIONS

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ABSTRACT

This paper outlines the key issues faced by the ageing pumpstations built through 1960's to 1990's to provide flood protection and drainage services in the Lower Waikato, Waihou Valley and Piako River catchments.

Around 120 flood control and drainage services pumpstations are managed by the Waikato Regional Council to provide protection to farmland, townships and businesses across the region. These pumpstations vary in capacity from several tens of litres per second to a several cubic metres per second. They are now requiring significant upgrading to ensure that their useful life is enhanced, operational safety measures are incorporated and the stations are built to current day requirements.

Significant challenges to upgrade these stations include investigating all components requiring upgrading, the varying and poor foundation conditions, integrating operational functions into the upgrade schedule and managing flood risks during construction works.

The paper also outlines the health and safety measures and efficiency considerations that are incorporated into the upgrade of the stations. The upgrading works provide an opportunity for the council as the asset owner to review and where appropriate include any service level changes.

The upgrading will continue to preserve the productive values of the land and assets they protect and will add to the economic outcomes for the Waikato region.

Three to four stations are scheduled to be upgraded each year and successful upgrade works including inlet bay and screen, sump, switchboard and controls, outlet pipes and pump house upgrades have been completed over several years. Lessons from several completed projects with technical issues faced during investigation, design and construction are provided in this paper.

KEYWORDS

Flood control, pumpstations, drainage, inlet bay, and screen

PRESENTER PROFILE

Mohammed Hassan is Chartered Professional Engineer and he has a Bachelor of Civil Engineering with honours from University of Auckland. He has 30 years of experience in civil and environmental engineering in private consulting and public sectors. His experience includes urban and rural stormwater, flood protection and catchment management works. He is currently employed by the Waikato Regional Council and

manages their engineering services team within the Integrated Catchment Management Directorate.

Mike Safey is a Chartered Professional Engineer with Bachelor of Engineering (Civil) from University of Canterbury. Mike has had 30 years experience in local authority engineering including bridging, three waters, land drainage and flood protection, solid waste and policy work. He is currently employed by Waikato Regional Council as a senior engineer/project manager within the Integrated Catchment Management Directorate.

Ryan Mackinnon has a Bachelor of Natural Resources Engineering with Honours from University of Canterbury. Following his study he joined the Waikato Regional Council where he has gained two and a half years experience managing design and construction projects for the upgrades of flood protection assets including pumpstations and stopbanks. He is currently an Engineer within the Integrated Catchment Management Directorate.

1 INTRODUCTION

1.1 Background

The Waikato Regional Council (WRC) owns and operates 120 drainage/flood control pumpstations with a replacement value of around $120m located in the Lower Waikato and the Hauraki plains. The capacity of these pumpstations can vary from less than half a cumec to 12 cumecs. Majority of the stations are fitted with MacEwans long shaft axial pumps while others have submersibles. The Council also has two screw pumps which are located in the Mangatawhiri and Motukaraka catchments in Lower Waikato. The pumpstation locations are shown in Figure 1.

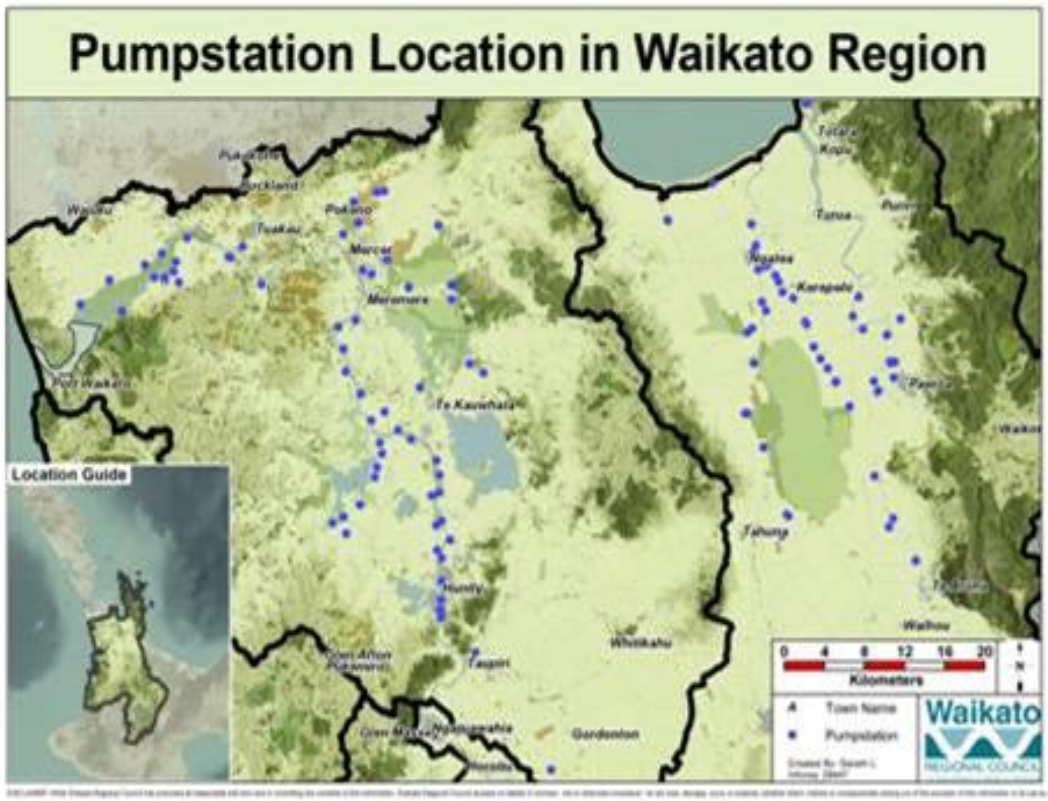

Figure 1: Waikato Regional Council Drainage and Flood Control Pumpstations

These pumpstations were constructed between 1960s to late 1990s and are now requiring renewals and upgrading to bring them to current day requirements. The key components of the stations that are being programmed for upgrading includes:

- Inlet bay, platforms, screens and sumps.
- Switchboard and controls.
- Outlet pipes including gibaults, siphon breakers and outlet structures.
- Pump sheds and general site safety.

1.2 Levels of Service and Objectives of Upgrading

1.2.1 Levels of service

The WRC flood pumps were designed to provide the following levels of service:

- To clear 20 to 38mm of runoff from the pumped catchment within 24 hours.
- To clear a 10 year rainfall event within 24 hours over three days (72 hours).

The key level of service was to clear the design runoff within three days to prevent killing of pasture. Experience shows that pasture generally is not recoverable once it has been submerged by floodwaters for more than three days. This level of service forms a performance measure for the council and is a key design requirement for all flood pumps protecting rural farmland provided by the council. Where practical a combination of floodgates and pumpstations are utilised to achieve the level of service.

1.2.2 Objectives of pumpstation upgrades

The objectives of the upgrade include:

1. Renewing components of pumpstations that are at the end of their useful life.
2. Ensuring that the stations are continuing to provide the required levels of service for the drainage catchment they serve.
3. Meeting the current day health and safety requirements.
4. Improving the operational and maintenance efficiency of the pumpstations.
5. Improving the overall performance of the pumpstations to minimise running costs and efficient clearance of the floodwaters.

2.0 UPGRADE WORKS

2.1 Prioritisation of upgrade works

The majority of the flood protection assets that Council operate have been inherited from previous territorial authorities, including former catchment boards, valley authorities and district councils. The condition in which these assets were handed over is variable at best, notwithstanding the considerable age of some of the flood pumps and flood gates.

The process of prioritising which assets are upgraded is based on their condition, age and operational requirements. The operational requirements are largely driven by health and safety compliance. The Council employees operate and maintain the pumps. The local

drainage district members and landowners undertake weed clearance during flood events and they provide input into the health and safety aspects during upgrade design works.

Council utilises an asset management system called CONQUEST which holds all of the records of each asset, including audits, previous inspections completed, design/asbuilt plans and depreciation accumulated. It is this information that assists in developing the capital works programme for the year. This programme is scrutinised by staff in order to refine the list based on on-the-ground experience, landowner feedback and other factors. From there the programme is confirmed and detailed investigations and designs are undertaken.

It had been common to have the ambitious expectations of completing the investigation, design and construction of an asset all within one year. This tight timeframe was too often the cause of unsuccessful projects and poor delivery of work programmes. The process is now a mandatory two year procedure, with investigation and design completed in the first year ready for construction in the second. This also allows fluidity in the works programme in following years, because if there is a change in circumstances then that design can sit ready to be picked up for construction in subsequent years.

When it comes to the inlets of Council's pump stations, there has been a large push to bring them up to health and safety standards appropriate for anyone operating the site. This includes installing handrails and gates, ladders to provide access out of the wet well, redesigned screens to increase ease of cleaning, wider and stronger platforms to allow room for debris storage and machine access. The initial investigation involves obtaining all available information on the asset in question. This in itself can prove difficult. As a large number of the assets are inherited, a lot of the designs, drawings and plans were misplaced in the transfer from the previous authorities. This means that often all there is to work off is what can be seen above ground and the operational history that council staff have gained since the transfer. This increases the risk to Council and to the designer due to the lack of information about the structure, the methodology used to construct the original asset and the ground conditions.

All information that can be gleaned from our archives is used to better understand the asset and determine the full extent of the upgrade required. This leads into a site visit with internal staff so that the asset can be seen firsthand, allowing everyone to be on the same page about what the issues are with that asset. A scope of works is then able to be developed which is provided, via a tender process, to an external consultant. This scope of works usually includes a full site survey, geotechnical investigation and full design suite (drawings, costs estimates, construction specifications). Even if there is some information about what the ground conditions are like, an investigation is insisted upon so that the information can be confirmed and updated.

It is not uncommon for an asset to be included on the works programme with not much known about it, and it is not until the investigation is begun and an initial site visit is completed that it is discovered that much more work is are required. For example at Drent's pumpstation in Waihou it was found that forty-year-old timber sump was falling apart and station had to be totally rebuilt. This increased the scope of the upgrade far beyond the initial platform and screen renewal.

After the investigation and design are completed, construction works are scheduled. Depending on the complexity of the scope and expertise required, the works will either be tendered externally or undertaken by Council's operations team. It is not uncommon for our staff to complete at least one medium-sized construction job a year, as a way to

increase their experience with building the pumpstations and attempt to keep procurement costs down.

2.2 Health and Safety

As mentioned earlier, health and safety improvements are a major driving force behind the upgrades to pump station sites. Most of the attention is focused on the screens and platforms, as this has the largest risk due to people cleaning the screens in danger of falling into the inlet. Hand rails and fencing are now standard features at all sites. Across the front of the screens, gates are installed. This is to allow operators to remove large amounts of debris, as it is not uncommon for dead cattle to be caught on the screens after a storm. If permanent handrails were blocking the screen entrance this would make the removal process much more cumbersome.

In the unlikely event that someone does fall into the water in front of the pump station, there is a requirement that access is made available for them to get out. This is provided by installing ladder rungs in the inside of the wingwall of the inlet. In some smaller sites a set of stairs can be built into the concrete-filled sandbags which are used as a facing on the banks and retaining walls.

Floodlights are attached to the platform or building that can be easily operated during the likely night time flood. More recently these have been hinged at the base so that they can be lowered to not hinder machinery movements.

2.3 Inlet Bay and Platform

The new platforms are designed to be of a minimum width of three metres. This is particularly prudent at sites that generate a lot of debris (predominantly water weed) as previously screen cleaners would have nowhere to pile the weed except beneath their feet, while still attempting to clean the screens. The new platforms now allow for safe movement on the inlet bay deck while cleaning and to place the debris.

This extra width also permits machine access to aid in the cleaning. Platforms are now being built to allow tractors to drive across and clear the debris left by the staff. A general platform design will incorporate a hollowcore deck placed on foundations (which are sited independently) that can hold five tonnes. If a station is likely to have digger access then the weight limit will be increased to 10 or 15 tonnes, as appropriate. At some stations the finish level of the inlet bay platform is raised as they currently can be drowned during flood events.

Photograph 1 Old and upgraded inlet bays, screens and platforms

The inlet bays are easily extendable using precast concrete U units. The U units are supported by piles or concrete foundations. This speeds up the construction works and hence the downtime of the pumpstation is kept to a minimum.

2.3.1 Screens

The screen designs have also evolved over time based on the experience of the operational staff during clearing of weeds. The old sites tend to have near-vertical

screens which include cross-bars for strength, but these inhibit the cleaning as they get in the way of the rakes. This is also the case at the top of the screen where it is attached to the platform. In order to avoid this and allow the rakes a clear path from the bottom of the screen to the top, the cross-bars are set back from the screen itself as a 'strong back', far enough away that the rake tines cannot reach it. The screen slope is set at 1H: 2V and the top of the screen has a turn down: a bend in the screen so that it attaches level with the platform. The screen spacing is no more than 49mm to prevent fence battens entering the pump. Generally 16mm galvanised bars are used at 65mm centres for corrosion resistance and to reduce the risk of damage by careless machine operators. The open area through the screen is sized so that the velocity is less than 0.3 metres per second at the lowest efficient pumping level.

The screen attachment at the top of the deck has been modified to achieve flush finish so that tripping hazard is eliminated. Previously the screens were bolted to the top of the platform with bolts projecting out of the surface and during cleaning were a trip hazard. The screens are now hung over a set of hooks bolted into the front face of the deck. This allows for easy installation, removal and maintenance of the screens.

Photograph 2 Inlet bays showing old and newly installed screens

One modification which has been used only sparingly is to electrify the screens to deter fish from entering the pump. This is done at sites where fish (particularly eels) are highly abundant. This not only decreases fish mortality through the pump but also increases the life of the pump as long eels can cause significant damage.

2.3.2 Sumps

The pumpstation sumps can vary in condition, structural integrity and material makeup. The most common are concrete and sheet piles but some older stations had timber sumps. In most circumstances the concrete sumps are able to be reused with very little remedial work. However, this is not always the case. Often it is uneconomic to dewater sites as part of the investigation phase, so issues can remain hidden under water until dewatered to facilitate construction works. For Example it was discovered at Patterson's pumpstation that the floor of the original concrete sump had been poured underwater which had caused scouring beneath the concrete. The sump upgrade works can range from total replacement to sandblasting and repainting steel members to remove rust and extend the useful life of the sheet piles, removing loose concrete from the floors and resurfacing and fixing floors to the sheet pile walls and providing reinforced concrete covers to the sheet piles where exposed to increase their useful life.

Photograph 3 Old and rebuilt sumps

2.4 Switchboards and Controls

2.4.1 Switchboards

Around five years ago, Council embarked on a programme of switchboard upgrades at its flood pump stations. The main objectives were to improve safety, reliability, and to improve the operational efficiency of these facilities.

2.4.2 Safety

As indicated earlier in this presentation, most pump stations were built by county councils during the 1960s and 1990s, and some still contained the original switchboards and electrical wiring. Given the harsh environment and operating conditions that these facilities are exposed to, it is not surprising that many switchboards and electrical services had deteriorated quite badly over the years. Dampness, heat, vermin, frequent direct-on-line (DOL) pump starts, among other things all take their toll on the equipment over time.

A review of 33 pumpstations in 2006 and a subsequent electrical compliance audit of all Council pumpstations uncovered a plethora of electrical safety and non-compliance issues. These ranged from easily resolved problems such as poor earth connections, exposed conductors, low-hanging wires, to more complex issues which could only be resolved by replacing the entire switchboard, mains cables and all electrical services at the site. For example, the mains contactor switch on one particular type of ancient switchboard had a reputation for exploding violently when operated, cabinets had corroded. The cavity behind a large switchboard can also provide a warm, dry habitat for rats and nesting birds, which has resulted in numerous fires over the years.

Council took on board the safety issues identified by the audit and carried out immediate electrical repair work at any sites where the more straight forward problems could be easily resolved.

For the more decrepit sites, Council embarked on a five-year programme of switchboard replacements and electrical upgrades, during which time around 30 switchboards were replaced.

Photograph 4 Old and newly installed switchboards

2.4.3 Process

To kick off this programme, an electrical engineer was engaged to develop a standard electrical specification and switchboard design. This was done with a view to standardising systems as much as possible to facilitate future operation and maintenance. Standardisation was seen as important, given that new electrical systems tend to become ever more complex as time goes on, but they still need to be operated by non-electricians.

The switchboard replacement and electrical upgrade works were tendered out in batches of generally four to eight sites per year. It was found that five or six switchboards per

year was an optimal number from a project management point of view, and also allowed smaller electrical contractors to bid on the works.

Installation work was done during dry periods and was coordinated so as to minimise the pump downtime. The installations generally took about one week depending on the size of the job, with only two to three days during which the pumps were off-line.

A number of refinements to the standard design, specification and particularly the programmable logic controller (PLC) control software have made during the 5-year programme. These refinements have dealt with a number of typical teething issues, plus have added extra functionality as a result of feedback from operations staff.

2.4.4 Operational efficiency and reliability

Many pump stations are situated in remote areas, at the back of farms sometimes with difficult access. Heavy rainfall events are notorious for happening at night time which is when a number of problems can occur that stop a pump station from doing its job.

In the past, our operations staff have been blissfully unaware that the pumpstation is experiencing a problem until a call is received the next morning from an agitated farmer complaining that his paddocks are under water, and what is the Council going to do about it.

Typical faults included power outages, motors tripped out, blocked screens to name but a few, but all these required someone to drive to the site, diagnose the problem, then call out the appropriate repair person.

Fortunately, the solution was not too difficult. All new switchboards are fitted with GSM text messaging and a simple but robust PLC. This means that the nature of any fault can usually be identified immediately by the duty staff via text message. He can then phone up either the power network provider to notify a power supply fault or an electrician to fix an on-site electrical issue, or the farmer to tell him to go and clean accumulated weed off the pump screens.

The savings in cost and time have not been rigorously analysed, but all parties agree that the system is very efficient, easy to use, and works extremely well most of the time.

Another benefit has been that the adjustment of pump operating levels has become more difficult by use of ultrasonic level control, rather than the old-style water level probes. In the old days, it was a simple matter for a landowner to adjust the pumping levels by extending the stop control probe using a piece of wire. This dubious practice would immediately improve the drainage to low-lying paddocks – which seems like a great idea. Unfortunately this has also led to accelerated peat shrinkage in some areas, and in some cases serious damage to axial flow pumps due to cavitation or loss of water lubrication to the bottom cutlass bearings. The introduction of ultrasonic level control at most sites means that unauthorised level adjustment now cannot be easily done except by an authorised operator.

Stop probes are still installed at each site as a backup measure to ensure that pumps do not run dry in event of a problem with the ultrasonic level control.

Photograph 5 Pump controls – electric probes and ultrasonic level control

Soft starters have also been incorporated on electric pump motors in all new installations. These devices allow the pump motor speed to gradually ramp up over several seconds at start-up, and ramp down again when switched off. This greatly reduces the start-up electrical current and minimises the wear and tear on pumps, and associated pipes and flapgates.

In some specific situations, variable speed drives (VSDs) have been used instead. These have been used where high flows are being handled up to six cumec, or where generator power supply is used to run the pumps. The VSDs act similarly to the soft starts in controlling the starting and stopping of pumps, but much more gradually. They also have the advantage of allowing the pump running speed to be adjusted. This has proven effective at the Mill Road No.2 pump near Paeroa, where the existing pumpstation was experiencing cavitation issues and recurrent major mechanical failures. The cost of repairing the failures has been in the range of $40,000 to $80,000. At this site, the VSD's were installed to reduce the motor speed from the standard 50Hz down to 45 Hz, thus solving the cavitation problem. The gradual start/stop transitions have significantly reduced mechanical loading on the pump. A side benefit has been to reduce the peak start-up current drawdown from 2000amps to around 500amps. This greatly reduced the demand on the generator power supply, and also opens up the possibility of using the same generator to power the adjacent mains-powered Mill Road No.1 pump station. This option will be investigated shortly as a possible means of avoiding the high standing charges for mains power supply to this site, currently around $90 per day. The price of VSD has come down considerably in recent years and is now an affordable solution.

Photograph 6 Soft starters and variable speed drives

2.4.5 Switchboard sheds

Most electrical upgrade work has taken place at pump stations containing axial flow MacEwans-type pumps. Previously, the old switchboards tended to be located in the same room as the pumps. This meant that they were subject to heat from the motors, humidity from the pump well below, occasional water splashes, and birds and rats. Where no pump building existed, such as site with submersible pumps, some exterior switchboards were mounted in a waterproof cabinet attached to timber poles.

In most cases now we have adopted the practice of installing all new switchboards in separate buildings which are either attached to the pump building or a stand-alone steel clad, ply-lined shed. This provides a stable, dry and vermin-proof environment for the

sensitive electrical equipment. The building is generally 2.4m x 2.4m with an inward opening door located away from the prevailing wind direction wherever possible.

A clear-light plastic roof panel can improve natural lighting. However this can increase heat build-up during summer and plastic has a reduced service life compared to colour coated steel. Given the minimal time that the switchboard shed is occupied, artificial lighting is generally adopted as the standard solution.

2.5 Outlet pipes, gibaults, siphon breakers and outlet structures

2.5.1 Outlets Pipes

The term "outlet" is used here to describe all downstream components between the pump and the point of discharge. Generally Council pumps will have either a ***Through-bank or a siphon discharge*** *system.* When replacing a through-bank discharge pipe it is often worth re-visiting whether to re-configure the pump station with a siphon discharge instead, particularly for a high stopbank. Replacing a through-bank discharge requires excavation of the stopbank and it can in some situations be expensive and problematic to reinstate high stopbanks to a well-engineered standard. Siphon outlets have the advantage of avoiding excavation through the stopbank, and also avoid the need for a flap gate at the outlet. Where a wide berm exists at the discharge point, a rock-lined stilling basin can be constructed rather than a concrete wing-wall and slab type arrangement. This can be a cost effective solution in some situations. On the other side of the argument, the pumping requirements will be different in order to achieve the greater head required to start the siphon.

Photograph 7 HDPE siphon pipe outlet with a siphon breaker at the top of stopbank

Existing discharge pipes were typically constructed using reinforced concrete rubber ring joint (RRJ) pipes or spiral welded steel. These materials have a limited service life and are vulnerable to damage by farm vehicles, corrosion and differential settlement.

End-of-life discharge pipes are generally replaced with welded high density polyethylene (HDPE) pipes. While the supply cost for HDPE can be more expensive than other materials such as concrete or steel, there are other benefits in terms of increased asset life and ease of construction.

In many situations, such as long discharge pipes or high discharge head, air vents may be required to protect against negative pressure and water hammer effects when the pumps start and stop and flap gates slam shut.

2.5.2 Gibault connections and discharge structure

In most cases, the connection between a pump and its discharge pipe needs to be designed to accommodate considerable vertical displacement. Pump stations are often built on piled foundations, whereas discharge pipes often have soft foundation conditions and are buried in a very heavy stopbank. This combination invariably lends itself to differential settlement. The connection must also be easily dismountable from the pump to allow its removal for maintenance.

Photograph 8 Installed gibaults and outlet protection works

WRC generally uses a double-gibault arrangement with an offset reducer section to achieve these objectives. This combination can accommodate considerable misalignment during construction, and ongoing differential movement in both vertical and horizontal directions over time. Its flexibility will also help protect the integrity of the outlet system in the event of an earthquake.

The point of discharge must be designed for safety, ease of maintenance and to resist erosion.

2.6 Pump sheds and general site safety.

2.6.1 Pump sheds

On the subject of buildings, it is worthwhile to point out a few features of recently constructed pump room buildings.

- New pump buildings are constructed as steel-clad, timber framed buildings with plywood lining. During the design process, consideration is given to providing sufficient working space inside to carry out all anticipated operation and maintenance tasks safely and conveniently.
- Fibreglass web-grate floors are now generally used instead of steel grating. The fibreglass floor panels are light-weight and easily removable to allow maintenance access to the wet well, such as for pump removal. The grating provides ventilation as well as allowing a visual check on water level and what's happening in the wet well.
- Roof ventilators are provided to assist with air circulation though the building.
- Pump building roofs are removable and fitted with lifting lugs and bolted connections to the walls so that the entire roof or sections of roof can be easily craned off to allow removal of the pumps for servicing. This avoids the need for staff to climb on top of the roof at any stage.
- Lighting of the entire site is designed for safe operation and easy access for replacement of lamps.
- Careful attention to detailing at the design stage ensures that the building is vermin-proof.

Photograph 9 Existing and new pump sheds

2.6.2 General site upgrade works

The general site upgrades include improvement to site access, fencing for security, metalled areas for equipment parking and storage during maintenance and areas for crane and truck access for pulling out pumps for servicing. Power supply lines are buried and poles and transformers can be relocated to keep clear of future plant and machinery use areas.

Timber retaining walls and ground improvement is undertaken to ensure that the areas in front of the inlet bays are stabilised and suitable for maintenance machine and plant access.

3 PROJECT IMPLEMENTATION

3.1 Dewatering

A dewatering methodology is required at all sites during construction. Cofferdams are utilised to block drains and waterways and facilitate dewatering of the inlet bays. In clay and mud areas earth bunds or sheet piles are used to construct cofferdams relatively quickly and cost effectively. Sheet piling is used to span wider waterways and to isolate a work area. For earth bund construction, locally sourced clay is used to minimise costs.

In the Lower Waikato sandy foundations exist where groundwater and/or seepage control is required. This is where well-pointing and by-pass pumping is more effective in keeping the works site dry. Well-points are quick to install and can easily be extended to the areas required. Water pumped from well-points is generally 'clean' water, and can be discharged directly to receiving waterways.

Photograph 10 Coffer dams and dewatering during pumpstation upgrade

During construction works it is essential to have contingency plans for pumping flood water should the weather conditions deteriorate. Pumpstation inlet upgrade works are generally scheduled for construction between October and April. Works are scheduled for this time of the year as it is a low rainfall period, therefore mitigating the risks of adverse weather conditions, such as by-pass pumping and contract time extensions. If works cannot be completed by the end of April then construction will usually be programmed for the following construction season. It is imperative that pump downtime is minimised through the construction methodology, so that if adverse weather conditions do arise then the pumpstation can still serve its purpose to the local landowners and provide flood relief.

In most cases by-pass pumping will be provided to keep the upstream water level below the crest height of the cofferdam. This is done by installing mobile pumps upstream of the cofferdam. Water pumped from upstream of the cofferdam (by-pass pumping) is also 'clean' water. Weather forecasts are actively assessed in the period leading up to the cofferdam construction to mitigate the risk of adverse weather causing cofferdam failure, overtopping or the need for by-pass pumping. In large flood events the Council reserves the right to be able to take control of the construction site, lower the cofferdams

and switch on the pumpstation to provide the flood water clearance service. This right is included in the contracts and tenderers are made aware at the time of tendering.

3.2 Foundations

The ground conditions vary vastly from station to station and between Waikato and Hauraki Valley pumpstations. The Hauraki Valley stations have very soft marine muds and require piled foundations while the Waikato area has a mixture of clay, silt and sandy foundations where compacted fill with reinforced concrete foundations can be implemented.

In highly sandy environments well-pointing is required to enable stability during excavation, as trenching alone will not work. Piles in the Hauraki Valley can be in excess of 15m deep in marine sediments and fine river deposits. H5 treated timber piles are usually used with H6 in marine and tidal areas.

Trench shields are also used to keep the excavation stable and safe during construction works. Open cut excavation is undertaken in clay and mud formations and the batter slopes are formed at stable angles.

Photograph 11 Foundation works during construction

The sump floor is extended past the screen to by a metre and a cut-off lip is formed to avoid entrainment of sediment from beneath the floor slab during pumping.

3.3 Project management

Each pumpstations upgrade job is put through the full project management procedures so that proper planning and risks to the project and Council are well managed. Where required, resource consents for the works and the temporary damming (cofferdams) are obtained. Similarly every site has a flood contingency plan to ensure that the Council can continue to provide flood water removal during construction works. Flood contingency plans are put in place to allow Council to take control of the site if a flood event does occur during construction and perform the activities to meet the flood protection level of service.

The health and safety measures are applied to the project right throughout the life of the project. At the design stage health and safety input is sought into the project from a range of staff and the design consultant.

4 CONCLUSIONS

The WRC pumpstations play a vital role by providing floodwater clearance from farmland in the Waikato and Waihou-Piako catchments. This flood management activity of the council supports the ongoing viability of farming in the area and generates economic activity and wellbeing of the people.

The ageing flood pumpstations in the region have successfully provided the flood control services since around 1960s but are now in need of substantial upgrade to bring them to current day standards. This has provided an opportunity to incorporate current day health and safety requirements, improve the operational and maintenance efficiency of the pumpstations and improve the overall performance of the pumpstations to minimise running costs and ensure efficient clearance of the floodwaters.

The Council's upgrade programme will ensure that these pumpstations continue to meet the current standards and safe operation of the stations. The investigation, design and implementation works also provides an opportunity for the staff to work together and collectively achieve good appropriate health and safety outcomes at each station.

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