SCIRT Rebuilding Infrastructure LEARNING LEGACY

Lessons learned from one of New Zealand's most challenging civil engineering projects: rebuilding the earthquake damaged pipes, roads, bridges and retaining walls in the city of Christchurch 2011 - 2016.

Well-grounded solution to soggy sites

Story: Dewatering

Theme: Construction

A document which describes best practice for dewatering guidelines.

This document has been provided as an example of a tool that might be useful for other organisations undertaking complex disaster recovery or infrastructure rebuild programmes.

For more information about this document, visit www.scirtlearninglegacy.org.nz

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Well-grounded solution to soggy sites

Silty, sandy soils and problematic peat proved particularly challenging during Christchurch's horizontal infrastructure rebuild.

Soggy situation: Water is removed from a site so excavation can begin.

Prone to liquefaction, the poor soil conditions – with water at ground level in many areas – made repairing underground pipework a soggy and often costly exercise.

High groundwater levels could undermine site stability during excavation work as foundation soils failed to support a structure. However, several methods could control groundwater. Considering the site "dewatering" risk and potential solutions were all part of the design process for SCIRT.

By "dewatering" – or removing naturally occurring groundwater from a construction site – a dry area suitable for safe access and excavation could be created.

Pressure points

However, the first hurdle was a geological one as much of the Christchurch landscape was subject to variable artesian pressures.

Pre-earthquake, the amount of drainage repair or replacement work was able to be managed by local contractors familiar with the soil conditions.

Post-earthquake – with more than 600 kilometres of pipe to repair or replace – an influx of new drainage contractors raised other issues.

While the outside contractors were experienced, they were not familiar with the complexities of working in the city's unique soils.

In Canterbury, gravel aquifers were recharged by Waimakariri River seepage north-west of the city and by rainfall on the plains to the west. The uppermost artesian aquifer, Riccarton Gravels, was found at a depth of 20 metres to 30 metres in Christchurch. The sandy gravels contained a lot of water, usually under pressure. As a result, upward leakage could occur during major excavation work.

Generally, artesian pressures could be expected two metres to five metres below the surface in the city's west and up to two metres above ground level in the east.

From river-derived gravel layers in the west to marine and estuarine sediments in the east, the soil formations were complex. The permeability of the soils affected the groundwater release during site pumping. Recognising the terrain and pressure state helped determine the dewatering methodology. Contacting contractors who had worked in a project area also informed any assessment of the dewatering risk.

Consent to dewater

In an effort to carry out the SCIRT programme in a coordinated and cost-effective manner and in accordance with relevant legislation, SCIRT, the Christchurch City Council and Environment Canterbury staff developed a suite of global resource consents and planning approvals. Global consents approved in the post-disaster environment covered groundwater extraction and discharge disposal into water or storm water systems.

Each dewatering system needed to suit the characteristics of the aquifer at a site. Recognising the traits of Christchurch aquifers informed planning and avoided adverse effects on an excavation site and the surrounding environment.

By controlling groundwater that could seep from the slopes or the base of a work area, the creation of stable soil conditions would ensure better and safer excavation.

Calculating risk

Considering potential risks and possible dewatering solutions was vital to the project design. Defining site conditions was paramount because appropriate dewatering procedures usually resulted in overall project cost savings. However, poor dewatering decisions could cause construction delays or result in additional costs for remedial work.

Dewatering covered two areas:

1. Removal of groundwater
2. Discharge of water

Soil types, groundwater levels, nearby waterways and network capacity dictated the dewatering methodology.

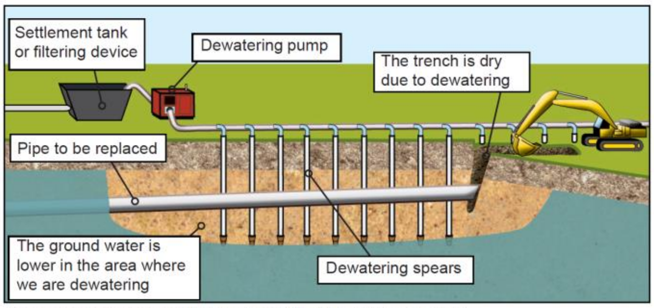
The most common methods were:

- Wells or bores
- Well points or spears
- Submersible pumps

After drilling spears or well points into the ground, water was pumped out. It could take several days to lower the water level at the construction site. All water had to be filtered before being discharged into a waterway.

Soil permeability affected the pumping of groundwater. In the initial stages of dewatering, pumping rates were higher before being reduced to hold groundwater at the necessary level.

For high to moderate permeability soils such as gravel and sand, sump pumping was ideal. In tandem with



Please note: diagram is not to scale, for illustration purposes only.

sheet piles, it limited the volume of inflow.

However, there could be issues regarding the potential removal or instability of soils under the water table and discharge water needed to be put through a sedimentation tank.

Make a point

While sump and pump systems were low cost and very mobile, there was the potential for sediment discharge into the environment.

“Well-pointing” proved highly effective in sand-size soils or sites with sand inter-layers. A well-point – a pipe with a perforated section near the bottom covered with a screen – could be inserted into the ground and water removed by a dewatering pump. Pumping could take the groundwater into the well points – through a header pipe – and then discharge the water into a storm water system.

While the system delivered a clean discharge, dewatering needed to take place close to the excavation site.

A specially drilled dewatering well with a screen or slotted pipe section presented a third option. While excellent for large excavations and longer time frames, this method could take more water than necessary, prompting issues for surrounding areas.

In general, dewatering methodology was determined by the soil type and permeability, the site size and groundwater depth, excavation plans and nearby structures and waterways.

While it was standard practice to discharge into the environment, several factors needed to be considered, including the impact on the discharge location and the ability of the environment to cope.

Several methods of discharge treatment were utilised by SCIRT.

Sediment control using settling tanks was the most popular method. A filter at the suction inlet limited sediment extraction from the ground.

Sediment could be removed with suction trucks and the water could be used for dust suppression. However, this method did not suit settlement periods for clay or fine particles.

Filter feature

Another option – filtering discharge via vegetation – meant water could soak through the soil and recharge the groundwater table.

A third method – collection with sediment control bags – filtered larger sediments from the discharge. While ideal for gross silt contamination within a small area, it could not cope with high-pressure discharges.

Finally, flocculent settlement ponds were generally used for large-scale sites.

Dewatering had to follow set procedures to prevent soil erosion. It was also important to choose the best discharge location.

Guiding principle

In November 2014, a Dewatering Guideline was introduced by SCIRT. It detailed the assessment and implementation stages of dewatering. The guideline set out the “options for effective construction dewatering” and detailed “method selection, design and monitoring”. It also covered the “assessment of the relative risk of a dewatering project”.

It further highlighted the need to “control, stop, and seal groundwater flow during excavation” to avoid:

- Piping of sands into the excavation site or heave of silts.
- Heave at the base of the excavation.
- Excessive silt-laden discharge.

Lessons learnt

- The maintenance of dewatering equipment was paramount, along with the appropriate sieve size for the ground conditions.
- The use of environmentally friendly flocculant paid dividends in the use of sediment tanks on size-restricted sites.
- It was important to be aware of soil conditions across a site.
- When it came to dewatering, it was vital to take the compliance team along for the ride.

Pipe away: Water is removed from a work site in Christchurch’s East.