UNINTENDED CONSEQUENCES: STORMWATER TO GROUND VS GROUNDWATER DRINKING SUPPLY PROTECTION

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ABSTRACT (500 WORDS MAXIMUM)

In Canterbury, the use of infiltration facilities (basins and rapid soakage devices) for stormwater treatment and disposal is actively promoted and is increasingly important for Territorial Authorities (TA) to manage urban stormwater. This is often to avoid or mitigate network capacity issues and surface waterway quality and quantity impacts. Discharging stormwater to ground (instead of surface water) is also generally preferred by local iwi. These infiltration facilities are typically located in areas of free draining alluvial gravels that contain aquifers that supplies drinking water to communities and private individuals.

Infiltrated stormwater has the potential to affect groundwater quality because it contains contaminants (microorganisms and dissolved metals) that can be transported into and through aquifers. Spillages and discharges of toxic substances from spills to a stormwater catchment can be a significant risk to groundwater quality.

When considering this issue for protection of public water supply bores, the findings of the Havelock North Drinking Water Inquiry (the Inquiry) are relevant to stormwater disposal to ground. The Inquiry indicates that an even greater level of conservatism should be used to protect against contamination than has previously been the case.

Protection of drinking supply protection (both public and private) has always been considered when locating stormwater infiltration facilities in Canterbury. Changes to the sensitivity of the environment and legislation changes, combined with increasing awareness of risks to drinking water supply aquifers, has the consequences that reconsenting existing infiltration facilities and consenting new infiltration facilities is becoming increasingly fraught with conservatism and has potential to have increasing costs associated with their implementation.

This paper will provide an insight of the current and increasingly prevalent issues arising in Canterbury from stormwater infiltration facility use. This will be applicable to other regions that use infiltration for stormwater management where underlying aquifers are also used as a drinking water supply. The paper will also discuss a hierarchy of the risk management controls that TA’s will need to consider to allow the long-term security, of stormwater infiltration assets.

KEYWORDS

Stormwater infiltration facilities, drinking water supply, consenting, risk management hierarchy, asset vulnerability

PRESENTER PROFILE

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1 INTRODUCTION

In todays environment of rapid urban expansion and infilling of existing urban areas, stormwater infrastructure is becoming a critical aspect of servicing the development to mitigate the adverse effects on the environment.

The ability to discharge stormwater to land via stormwater infiltration facilities is an important management tool along with securing the longterm use of these infrastructure assets. Protecting groundwater use and stormwater discharges from reverse sensitivity are interlinked. In Canterbury, and other regions and districts such as but not limited to Marlborough, Tasman (Motueka), and Hawkes Bay stormwater is being discharged into semi-confined and unconfined aquifers that are also used for drinking supply.

In August 2016, there was a major outbreak of campylobacteriosis in Havelock North. The Government established the Havelock North Drinking Water Inquiry (the Inquiry) to investigate and report on the outbreak. The Inquiry identified issues with how we are managing drinking water, and the issues are applicable to the management of stormwater discharges to land.

In addition shifting of the 'goal posts' are impacting on the reconsenting of stormwater infiltration facilities and their discharges.

Asset managers need to establish site specific protection zones for community supply wells but protection should also be afforded to private drinking supply wells, from stormwater infiltration facilities contamainant plumes. There is also a need to consider developing a hierarchy of risk controls to manage risk from stormwater infiltration facilities on drinking supply aquifer.

This paper explores, from a stormwater consenting and asset management perspective, the increasing challenges associated with stormwater infiltration facility availability and vulnerability where underlying aquifers are used for both public and private drinking water supply are concerned. It will also canvass the availability and effectiveness of the risk controls that are being used and considered for stormwater management to protect the drinking supply source and its users.

2 BACKGROUND

It is necessary to provide some background in order to provide context on the issues. The following section discusses:

- The importance of using infiltration facilities for stormwater management
- Vulnerable aquifers that are used for water supply
- Risks to groundwater quality from stormwater disposal to land
- The management practices that are being adopted

2.1 INFILTRATION FACILITIES FOR STORMWATER MANAGEMENT

Stormwater infiltration facilities in Canterbury are routinely used to convey, treat and attenuate urban stormwater prior to discharge into land and entering the underlying groundwater. The advantage of using an infiltration facility is that it promotes and replicates aquifer recharge to maintain or enhance groundwater levels and baseflow to streams.

Properly sited and designed, the infiltration of stormwater provides an opportunity to dispose of a large quantity of water in a controlled manner without causing or exacerbating flooding in, or erosion to, local drains or streams. Discharging stormwater to land (instead of surface water) is also generally preferred by local iwi.

It also provides water quality benefits as the infiltration facility can act as a filter, trapping contaminants in the soil or other infiltration media of the facility. It is generally seen as desirable to manage the stormwater in a way that promotes groundwater recharge where it is practicable to do so, provided that it does not adversely affect the way in which groundwater can be used for abstraction purposes or impact on surface water quality through groundwater and surface water interaction.

There are older parts of townships on the Canterbury plains that have not previously utilised infiltration despite it being feasible to do so. Therefore, opportunities to retrofit an infiltration facility is an option always now being considered.

The application of infiltration techniques for stormwater management meets some of the principles and objectives of water-sensitive urban design.

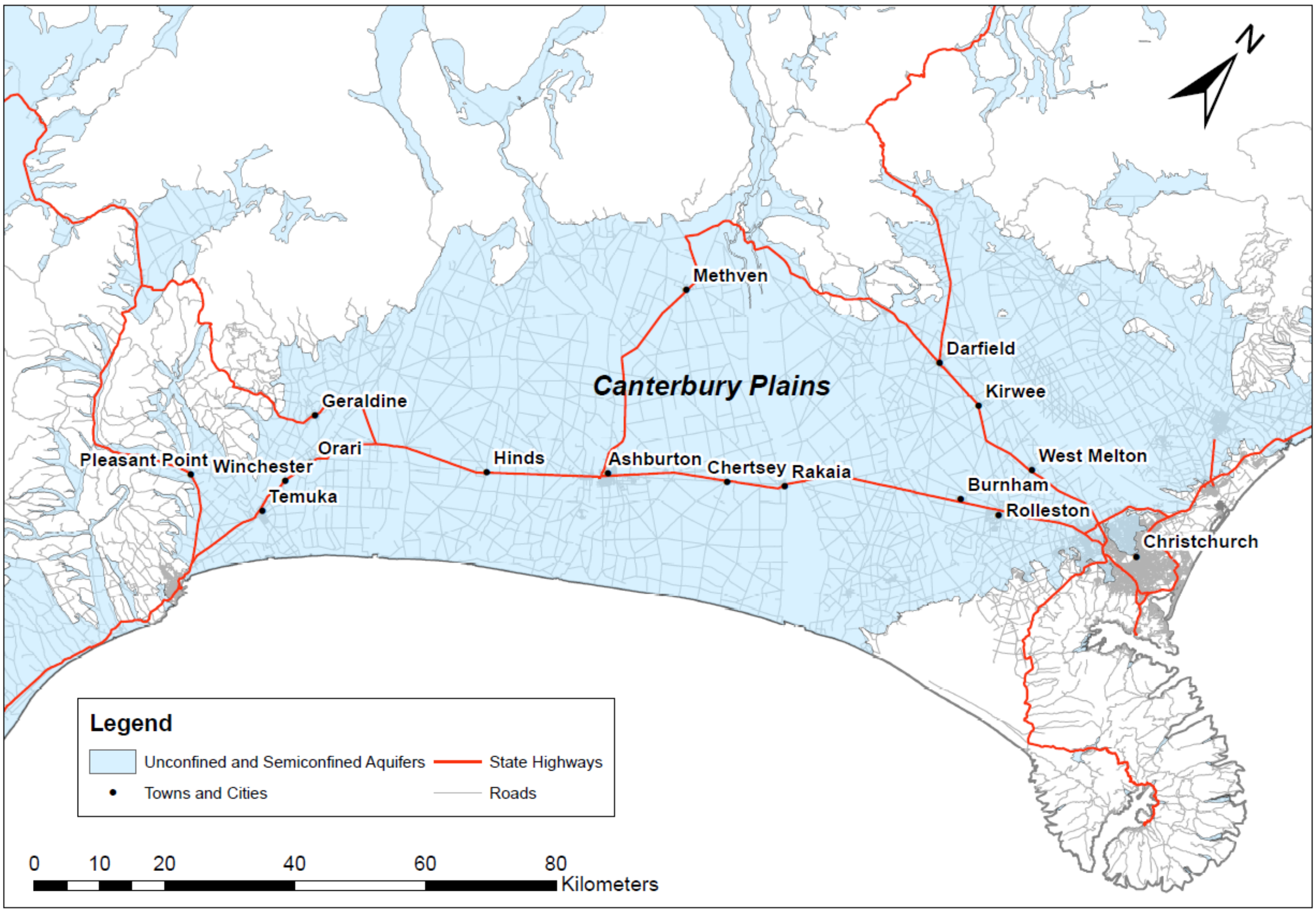
2.2 VULNERABLE AQUIFERS USED FOR DRINKING SUPPLY

Most of the Canterbury plains have an underlying semi-confined or unconfined aquifer that townships and the western parts of Christchurch are located over. This is shown in Figure 1. The often shallow (near the surface) semi-confined and unconfined aquifers supply drinking water supply to communities and private individuals.

These types of aquifer can characterised by the absence of an adequate surface confining layer and the absence of upwards groundwater pressure. As such, contaminants can move downwards into the groundwater system with minimal natural treatment.

Land surface recharge from the infiltration of rain water is also an important component of a semi-confined and unconfined aquifer groundwater system. If this recharge is not replicated through development intercepting and discharging rainfall to drains and rivers then this can also put at risk shallow groundwater wells if groundwater levels were to become lower.

Figure 1: Map of semi confined and unconfined aquifer over the Canterbury Plains



2.3 RISKS TO GROUNDWATER QUALITY FROM STORMWATER FACILITIES

Table 1 provides a direct comparison of typical stormwater quality for metals, nutrients, hydrocarbons, and bacterial from urban development against health standards and aesthetic guidelines in the Drinking Water Standards for New Zealand (MoH 2005) (DWSNZ).

The DWSNZ define the maximum concentrations of inorganic (some metals) and organic (chemicals / hydrocarbons) of health significance (MAVs) in water that, based on current knowledge, constitute no significant risk to the health of a person who consumes 2 L of water a day over their lifetime (usually taken as 70 years).

The DWSNZ give highest priority to health risks arising from microbial contaminants because they can lead to rapid and major outbreaks of illness.

Table 1 indicates that the most significant groundwater quality issue arising from stormwater discharges to groundwater result from bacterial pollution, as indicated by *E.coli*. This is because of the lower concentrations of nutrients, PAHs and metals in stormwater that are less likely to cause a harmful effect in drinking-water supplies.

In contrast, *E.coli* in stormwater is less of an issue when discharging to surface waterways because those waterways already have elevated concentrations due to the effect of waterfowl, and land based animals during rainfall events.

Whilst *E.coli* is the indicator organism in the DWSNZ it is recognised that viruses can potentially migrate further than *E.coli* in groundwater, although their composition in stormwater is less certain and likely to be highly variable. There is also considerable variation between different types of viruses and their infectious limits. With respect to urban stormwater impacts on groundwater quality and drinking supplies, viruses are an area of considerable uncertainty.

Any stormwater disposal facility is also vulnerable to contamination arising from accidental discharges. Traffic accidents may result in oil, petrol or other substances being transported by overland flow entering a stormwater facility. Contaminants from commercial and industrial areas may also be accidentally, or deliberately, released into a stormwater network. It is difficult to characterise this type of pollution, but its occurrence should be considered when planning and designing stormwater disposal facilities.

Table 1: Summary of typical stormwater quality (CCC 2003, Shepp 1996, Williams 1993 and Brough et al 2012)

Stormwater Parameter	**Expected Quality of Stormwater**	**Drinking Water Standards for NZ 2005 (revised 2008)**
Suspended Solids (g/m^3)		
Developed (unpaved)	<500	2.5 Nephelometric Turbidity Units
Developed Residential /Commercial	50 -170	
Developed Industrial	<300	
Construction	<4,000	
Hydrocarbons (g/m^3)		
TPH	0.5 – 5	-
PAH	0.007	-
benzopyrene	<0.0001	0.0007
Toxic Organics (g/m^3)	<0.004	
Nutrients (g/m^3)		
Nitrate-Nitrogen	0.4 - 2.0	11.3 as Nitrate-N
Total Nitrogen	1 – 2.5	-
Total Phosphorus	0.4	-
Total Metals (g/m^3)		
Zinc	0.1 - 0.8	1.5 (GV)
Copper	0.015 - 0.02	1 (MAV)
Lead	0.01	0.01 (MAV)
Microbiological		
Faecal Coliform (fc/100 mL sample)	8,000 #	-
E.coli (MPN/ 100 mL sample)	2 – 145 ^	< 1 (*MAV)*

Table Acronyms:
GV - guideline values for aesthetic determinands
MAV – Maximum acceptable values for determinands of health significance

Table Notes
median from (Williams 1993) which is based on Australia, Auckland and the United States urban areas that can have combined wastewater and stormwater pipes, meaning human waste sources can be present in stormwater flows
^ modern residential subdivisions (Brough et al 2012)

Infiltration facilities allow the stormwater to be filtered through the soil and disposed in the shallow aquifer and therefore have the potential to affect the groundwater quality of water used by abstraction bores. Depending on the design, as the water soaks into the ground, some pollutants are trapped in the engineered top-soils, or other constructed media of the infiltration facility and do not reach the underlying groundwater environment. This type of treatment (often referred to as biofiltration) is effective for the removal of suspended solids and heavy metals (Hatt et al, (2009), but only partly effective for other contaminants such as nitrogen (which are very soluble in water) and micro-biological contaminants which can have higher concentrations in stormwater relative to the drinking-water standards.

A review of information on contaminant removal rates through an infiltration basin is presented in Table 2.

Microbiological concentrations in stormwater is not reported as being completely removed by an infiltration basin. One would consider that if basins are designed to capture first flush volumes and have overflows to rapid soakage facilities with inverts close to shallow groundwater, then removal efficiencies for microbiological constituents reported may be less.

Table 2: Reported removal efficiencies (%) through infiltration basins

Determinand	**USEPA (1993)**	**Stormwater Centre (2002)**	**Watershed Protection Techniques (1997)**
Total Suspended Solids	50 - 90	75	95
Total Petroleum Hydrocarbons	-	-	Not detected
Total Phosphorus	50 -100	50 -70	
Total Nitrogen	50 - 100	55 - 60	
Metals	50 -100	85 - 90	Copper - not detected, Lead – 98, Zinc - 99
Microbiological	75 - 98	90	

When the infiltrated water from the infiltration facilities mixes with the groundwater it will tend to migrate initially in all directions from the facility through a mounding effect, and then more laterally in the direction of groundwater flow. There will be a reduction in contaminant concentrations at increasing distances from the point of soakage disposal into the groundwater system due to natural attenuation processes including dilution, dispersion, filtration, adsorption, biological decay and chemical transformation.

In large storm events, any excess or overflow will either be slowly released to surface drains/stream or will be discharged to the groundwater by direct entry through rapid soakage systems situated in free draining gravels/strata. Under these infrequent conditions, it is expected the first flush volume or design storm (e.g. 20 year or 50 year) will have already been treated through the infiltration basin and the remaining flows will be lower in contaminant concentrations.

Stormwater discharges are obviously intermittent and typically for short periods (hours rather than days). The Canterbury plains has typically 8 wet days (>1 mm in depth) per month. Actual analysis of the various hourly rainfall data for Canterbury towns suggest stormwater runoff is only being generated between 5% and 10% of the time per annum. In comparison, there are risks to shallow drinking water supplies from onsite wastewater systems that discharge 1 to 2 m3 every day and that these are often poorly treated and disposed directly into gravels via soakpits. Practically, for every private domestic supply drinking well in Canterbury there is an onsite wastewater discharge for the dwelling as it is unlikely that a wastewater network is available if a water supply isn't.

2.4 MANAGEMENT BY SEPARATION DISTANCES (BARRIER)

There are some public drinking supplies from groundwater wells that are not treated in Canterbury. Private drinking supply wells in the Canterbury plains are prevalent within and near existing urban boundaries in rural-residential zones and are often shallow (<30 m in depth) and are untreated. In the absence of a treatment barrier, as the Inquiry highlighted, the protection of the source of drinking water provides the first, and most significant, barrier against drinking water contamination and illness.

The first approach to providing a barrier with respect to implementing stormwater discharges to ground is to determine and provide for a separation distance from the discharge and the water source.

Heavy metal concentrations in stormwater when mixed with groundwater can have potential to be over the drinking water standards, however there is often significant attenuation of the concentrations through migration through groundwater suchthat they would no longer pose a threat to the drinking-water standards at short distances. This is not the case for microbiological contaminants due to higher concentrations and lesser reduction rates over the transport distance.

A greater emphasis is placed on the separation distance between stormwater infiltration facilities and community drinking water supply wells because those pose the greatest risk from a contamination incident.

The appropriate separation distances between stormwater infiltration facilities and public supply bores are often determined by the Community Drinking Water Supply Protection Zones (CDWSPZs) that Environment Canterbury and other regional councils are specifying in their reginal plans. These specify default zones around community drinking-water supply bores. Environment Canterbury's range for shallow wells is 100 – 400 m in any direction around a bore and 100 – 2,000 m in an upgradient direction from the bore, depending on their depth and degree of confinement. The Environment Canterbury CDWSPZs are defined based on microbial contamination protection, and they do not account for chemical contaminant transport distances, which can be much longer.

Whilst stormwater discharges may not be directly within a CDWSPZ of deeper bores (>70 m with a 100 m radius zone), they can influence shallow groundwater quality. Bores may allow contamination in aquifers to enter the abstracted water, as cracks and holes may form in well casings.

This loss of bore security may allow levels of pathogens that are sufficient to cause infection to enter the bore such that waterborne contamination and disease outbreaks arise.

Typically, it is expected that a reticulated water supply would be available in the vicinity of a new urban stormwater infiltration facility due to expanding development. The reticulated water supply can therefore provide an alternative water source to any property with a private water supply bore, thereby avoiding the contamination risk. However, from my experience in Canterbury, in reality this is not always the case, water supplies ae not extended far enough. After installation of an infiltration facility, there does not appear to be any methods to prevent more private supply bores being installed in close proximity to these facilities or at inappropriate (shallow) depths.

Various district councils in Canterbury, are using expert advice and site-specific assessment to determine a capture zone to identify private supply wells (that do not have protection zones under NES Regulations). Approaches being applied are considering, amongst other things the:

- Design and operational details of a particular infiltration facility
- Likely frequency and discharge strategy for overflows beyond the capacity of the infiltration facility
- Hydrogeologic characteristics of the local area
- Location and depth of nearby water supply bores.

When considering this issue of protection of any water supply bores, the findings of the Inquiry are relevant and indicate that an even greater level of conservatism should be used to protect against contamination than has previously been the case.

3 CATCHMENT/NETWORK MANAGEMENT PLANNING AND CONSENTING

Canterbury and its districts, like other regions of New Zealand, have been moving towards the integration of urban stormwater management planning. Much of this change has been driven by the regional planning framework that specifically requires all network discharges to be consented. These legislative requirements have led to Territorial Authorities (TA's), including those in Canterbury, having to invest in the preparation of resource consent applications for discharges from their stormwater networks (typically supported by stormwater management plans (SMPs)), and their implementation after granting.

This section discusses the RMA / resource consent planning issues with respect to protecting groundwater quality whilst enabling stormwater discharge to land.

3.1 EXISTING CONSENTS AND THE EXISTING ENVIRONMENT

Regional discharge permits are subject to a limited duration (maximum of 35 years) and if the activity needs to continue beyond its expiry (as stormwater from development does) the activity will need to be reapplied for in the future, unless a new regional plan permits the activity.

Most new development in Canterbury townships, and some other districts in New Zealand without stormwater catchment /network consents, often have multiple individual stormwater discharge permits (to groundwater or surface water) for post Resource Management Act 1991 (RMA) developments. These are sometimes obtained by developers or the council when a centralised stormwater management facility is being developed (for multiple developers). Where a developer obtained the discharge permit, and following the development, the infrastructure is vested with council, and the associated stormwater discharge permits are subsequently transferred to the council. The outcome of this approach is often multiple discharge permits being held by the TA.

With recent lodgment of stormwater network discharge permits by TAs for existing and future urban development, the existing discharge permits are often to be superseded (i.e. surrendered) on the granting of the more comprehensive district /catchment township wide network discharge permit. The existing discharge permits being superseded can often have 5 to 30 years left until their expiry. Potentially, the duration for the network discharge permit can be significantly reduced and may be only for 10 to 20 years.

The RMA case law focuses on the fact that in a re-consenting process (i.e. for discharge permits that are expiring or being superseded), new consents are granted rather than a 'renewal'. Although there is some RMA caselaw that supports that lawfully established discharges that cannot be ceased form part of the environment.

"Environment" is defined in the RMA, as:

***Environment** includes –*

(a) Ecosystems and their constituent parts, including people and communities; and

(b) All natural and physical resources; and

(c) Amenity values; and

(d) The social, economic, aesthetic, and cultural conditions which affect the matters stated in paragraphs (a) to (c) of this definition or which are affected by those matters.

The leading statement on what constitutes the "environment" for the purposes of section 104 of the RMA remains the Court of Appeal's decision in Queenstown Lakes District Council v Hawthorn Estate Limited. In Hawthorn, the Court held that:

[84] … In our view, the word "environment" embraces the future state of the environment as it may be modified by the utilisation of rights to carry out a permitted activity under a District Plan. It also includes the environment as it might be modified by the implementation of resource consents which have been granted at the time a particular application is considered, where it appears likely that those resource consents will be implemented. …

In some cases, regional plans may have expressly allowed (i.e. a permitted activity) existing stormwater discharges for several decades and only recently did the activity or requirement to obtain a network discharge permit come in to affect.

In the context of applying for stormwater discharges from established urban areas, there is scope under case law for 'the environment' (for the purposes of assessing effects) to include the effects of discharges where it can be established that it would be fanciful or unrealistic to assess the existing environment without those discharges continuing.

Arguments to establish it is fanciful or unrealistic to cease a stormwater discharge are:

- Existing urban areas are zoned or permitted, as such under the district plan the land use is not going to change to a rural state.
- Stormwater networks servicing these urban areas and subsequent discharges have existed for a significant time period.
- It is actually not feasible for councils to cease these existing network discharges. They cannot prevent rainfall coming into contact with the urban area, nor can it block up its network pipes to prevent a discharge as this would cause damage to property, and discharges would occur via secondary flow paths to either the same receiving environment or another receiving environment.
- Typically, most regional plans promote disposal of stormwater by way of a reticulated network.

3.2 CHANGES TO THE SENSITIVITY TO THE ENVIRONMENT

Often the sensitivity of environment has changed either through physical material changes (more drinking supply wells installed) and non-physical changes such as legislation controls being amended (i.e. CDWSPZ changes), changes in the perception of risk, and the better understanding of science in relation to transport of contaminants through aquifers.

The provisional CDWSPZs that are in place for most public supply wells in Canterbury under the regional plans since 2007 have been subject to change through reassessment in 2015, and this has often changed the upgradient zones' orientation. It is expected with more site and use specific risk assessments to occur, these protection zones will become spatially larger. This could potentially inhibit the use of infiltration facilities for future and existing urban development, and the use of existing infiltration facilities. Basically the 'goal posts' are consistently shifting.

With respect to obtaining comprehensive district / catchment township wide stormwater network discharge permits, the adverse effects of lawfully established discharges on groundwater quality and human health (drinking supplies) is often revisited. Existing infiltration facilities are also vulnerable to reverse sensitivity effects from new drinking wells being installed in their vicinity.

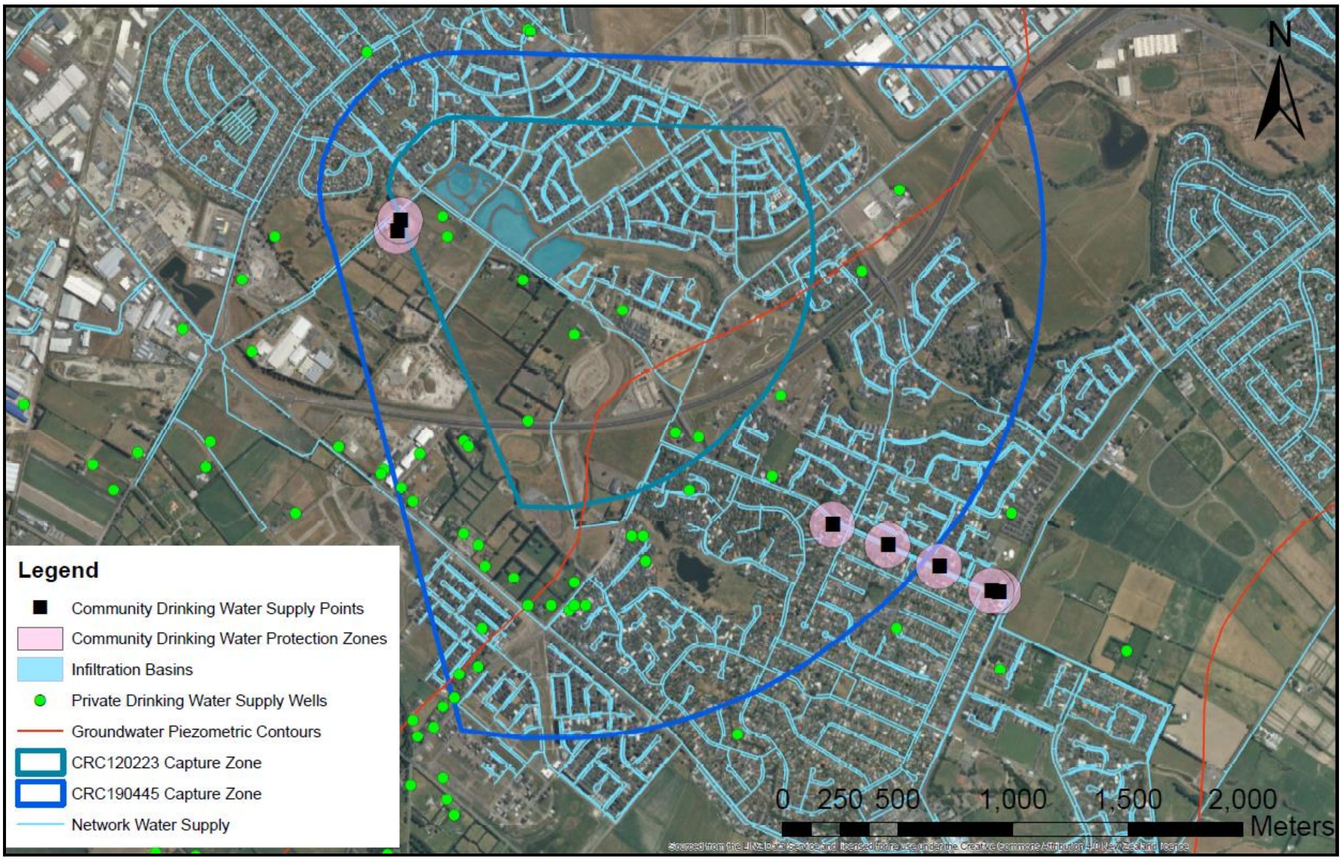
Examples of the issues discussed above are given below for different scales and approaches to stormwater management by TA's.

3.3 RECONSENTING EXAMPLE ONE – AWATEA ROAD BASINS

The Christchurch City Council (CCC) has been dealing more recently with urban expansion by adopting a bulk or centralised stormwater infrastructure approach, as this is often the most practicable option to service greenfields development areas. Opportunities are always taken to retrofit existing urban development.

Figure 2 shows existing soil lined first flush basins with underlying rapid soakage facilities for treated and overflow stormwater for a new and retroffited urban development at Wigram (Awatea Road), Christchurch. The catchment includes industrial, commercial and residential land uses. This is the largest infiltration basin facility in Canterbury.

Figure 2: Awatea Road, Wigram - Stormwater infiltration facilities, capture zones and surrounding drinking water supply wells



The basins were designed and constructed by the CCC in 2011 and the discharges were authorised under an existing consent (CRC981968) granted in 1998. This granted consent authorised discharges from any new infiltration facilities for new development within the "Upper Heathcote River Catchment Christchurch", a several thousand hectare (ha) combined natural and physical boundary area of free draining gravels within Christchurch. This consent was granted in 1998 for 25 years (expiry 08 Oct 2033). The consent required that monitoring of the first basin constructed and two subsequent representative basins under the consent through a monitoring borehole to sample groundwater within 50 m down gradient of the rapid overflow soakage chamber. It is not known if the Awatea Basin was monitored under this consent.

Following a hearing, in 2012 the Awatea Road basins discharge consent was superseded by a new consent (CRC120223) granted for the South West Christchurch Area (approx. 8,000 ha area). This new consent had monitoring requirements for groundwater quality in relation to the adjacent and downgradient at risk shallow drinking supply wells within 200 m radius of the basins and 1,000 m downgradient (e.g. a capture zone). Groundwater monitoring wells were required to be installed adjacent to the basin and quarterly sampling and analysis for *E.coli*, metals and hydrocarbons. Private drinking wells within the capture zone were to be monitored every quarter for *E.coli*. Where feasible, samples were to be taken within two days of a storm event of at least 12 mm.

This basin facility is now subject to another consent application process (CRC190445) as the CCC have applied for a comprehensive district wide consent. At the time of the hearing in late November 2018, a default well capture distance of 400 m adjacent and 2,000 m downgradient was being proposed by the applicant in light of risk of virus transport and the Inquiry findings. The consent authorities' groundwater quality scientist was recommending a 2,500 m downgradient distance as a default.

This example demonstrates that even in a short time period between reconsenting a facility three times the risk approaches are becoming increasingly onerous to implement.

3.4 RECONSENTING EXAMPLE TWO - CANTERBURY TOWNSHIP

Most of the other district councils with townships located over the Canterbury plains are not developing centralised stormwater infrastructure and are having developers cater for their urban expansion with smaller subdivision specific stormwater management infrastructure. As the Canterbury plains are relatively flat and infiltration is feasible, managing stormwater closer to the source is often also more practicable.

Figure 3 shows existing soil lined infiltration basin facilities for a 20 ha residential development area. The soil lined basins have a 50-year capacity with secondary flows to overland flow paths.

The original discharge permit application in 2007 did not identify any zone of influence from the discharges on groundwater quality, nor any nearby private domestic supply wells as being potentially affected. The public water supply well was considered to be unaffected as the discharge was not within their CDWSZ. The consent authority did not require any groundwater monitoring as part of the conditions of consent. A 35-year term was granted.

Figure 3 shows the existing wells in the area at the time of granting (green round dots), and the subsequent new private wells (round red dots) since the discharge permit was granted in 2008 that have been installed nearby to the basin. All the new wells are <30 m in depth. The discharge permit was transferred to the TA 2016 and expiries in December 2042. The TA is now going through the process of seeking a stormwater network consent for the existing discharge along with many other lawfully established discharges, along with future development within the zoned urban area (refer Figure 3).

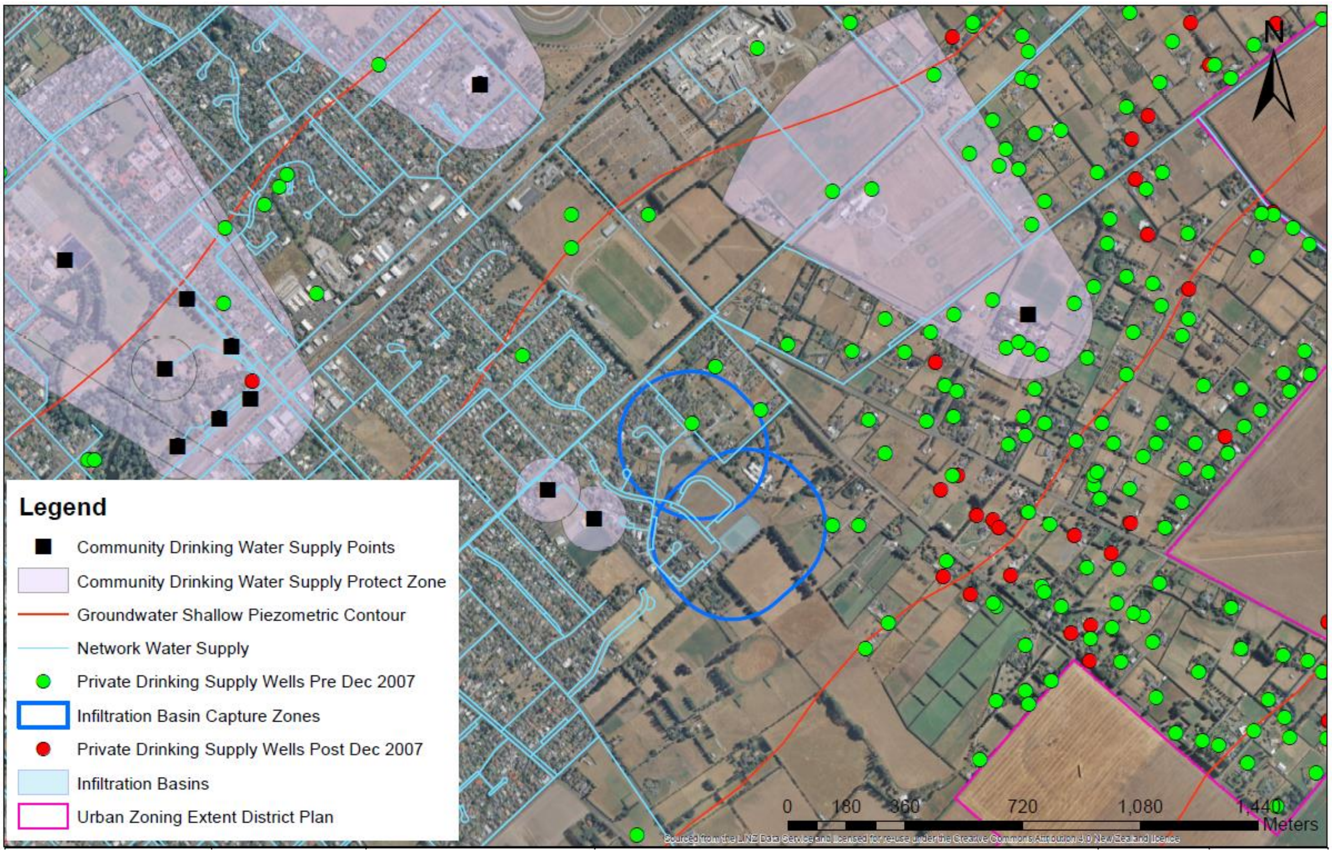
Figure 3 shows the newly assessed zone of influence (the basins capture zone) of the discharges based on expert assessment of the reduction rates and distance to 1 microbe/100 ml (or 1 *E.coli*) being achieved in shallow groundwater.

The existing environment has historically poor shallow groundwater quality even prior to installation of a new stormwater infiltration facility, with exceedances of drinking water standards for nitrate nitrogen and *E.coli* found in several shallow wells <30 m in depth. The majority of the dwellings with wells in the rural-residential fringe are also not connected to a wastewater network so will have on-site wastewater systems. Most older dwellings will have basic single chamber septic tanks that discharge to land via a soakpit.

Monitoring of the basins influences on groundwater quality is now being required through the consent process with some limits to validate the assessment / and provide some protection of the existing shallow wells. If the monitoring identifies any groudwater quality issues, the TA is now potentially going to have to monitor and remedy any private drinking water supply wells.

This examples again demonstrates that in a short time period between reconsenting the risk approaches are becoming increasingly onerous to implement. If the risk to individual supply wells had been identified initially the TA could have required more of the developer to address or contribute to eliminating or minimising the risk.

Figure 3: Existing stormwater infiltration basins, capture zones and surrounding drinking water supply wells in a Canterbury town.



It should be noted that the community supply wells that are within the capture zone are screened at depth of approximately 90 to 96 m so are considered to be deep. These supplies receive treatment by chlorination.

4 RECOMMENDED CHANGES TO RMA LEGISLATION FROM THE INQUIRY

The Inquiry outcomes signal change is coming and the impact of this on the RMA legislation is discussed briefly in this section.

4.1 THE RESOURCE MANAGEMENT ACT 1991

The purpose of the RMA is to promote the sustainable management of natural and physical resources, including water. It does this through the use of national environmental standards, national policy statements, regional policy statements and regional plans, district plans, and monitoring and enforcement mechanisms.

The Inquiry recommendation was that Sections 6 and 30 of the RMA should be amended urgently to expressly recognise protection and management of drinking water sources as a matter of national importance and as a function of regional councils, respectively.

The Inquiry also noted that the NES Regulations (a RMA piece of legislation) alone do not provide adequate direction, particularly in their current form.

4.2 NES FOR DRINKING WATER SUPPLY

The Resource Management (National Environmental Standards for Sources of Human Drinking Water) Regulations 2007 (NES Regulations) contain minimum requirements for protecting sources of human drinking water and impose responsibilities primarily on regional councils. The NES Regulations came into effect in June 2008. They were described at the Inquiry by a representative from the Ministry for the Environment as the "response to first barrier protection".

The NES Regulations were intended to plug the legislative gap in the resource management regime, which had no express recognition of the need for protection and management of drinking water sources. The intention was to remove the "no responsibility" mindset and bring the issue of drinking water source protection "front and centre" for regional and district council decision makers.

Based on the submissions and evidence received, Stage 2 of the Inquiry (New Zealand Government 2017) identified a number of significant problems with the NES Regulations in their current form. Key problems in the context of this paper can be summarised as:

- **Non Application to Land Use Activities** – The regulations apply only to water and discharge permits. They do not apply to land use activities. This was another example of the NES Regulations applying naturally to surface water sources, but not addressing the significant risks posed to groundwater sources by land use activities.

- **Prospective Application** – The regulations apply only to future applications for water and discharge permits. They have no implications for existing consents and activities. It was suggested that the NES Regulations should seek to address existing activities that might be adversely impacting on a drinking water source. The Inquiry agrees with this.

- **Size of Supply** – The main regulations only apply to activities with the potential to affect a registered drinking water supply that supplies no fewer than 501 people. It has been suggested that the scope be increased to apply to all drinking water supplies of no fewer than 26 people.

The recommendations from the Inquiry was to accelerate the review of the NES Regulations to address the significant issues identified.

4.3 IMPLICATIONS OF CHANGES BEING IMPLEMENTED

If the recommended changes to RMA legislation were adopted, especially making the protection of drinking water supplies a matter of national importance, and the application of the NES Regulations to existing discharge permits then this could have significant impacts on stormwater infiltration facility assets in terms of their consenting.

It is foreseeable that regional councils may be required to undertake a comprehensive review of all existing stormwater discharge permit conditions to implement more stringent controls.

5 DEVELOPING A HIERARCHY OF RISK MANAGEMENT CONTROLS

As discussed, the sensitivity of the groundwater environment can change either through physical material changes (more drinking supply wells installed) and non-physical changes.

In most circumstances it now appears to be critical to be proactive to secure the long-term use of stormwater infiltration facility assets.

It is considered the current legislation / regulation with respect to public drinking wells supply, when properly implemented, can address the risk; it is also beyond the author’s expertise to discuss controls in detail in relation to stormwater infiltration facilities and the risk management of these supplies. It is noted from the examples provided that often, deep community supply wells are located in capture zones, which places greater emphasis on bore casing security and treatment.

One should consider prioritising the establishment of a site-specific protection zone (do not rely on a default one) as required under the NES Regulations. Especially where these are currently or potentially in the future likely to be affected by urban public stormwater infiltration facilities. This will enable more informed decision making.

Private water supply bores protection is less regulated, but of concern. Table 3 provides a hierarchy of controls for the risk management for the protection of private water supplies from urban development. The hierarchy has been adopted from Health and Safety legislation but seems appropriate for a high-level option discussion.

It is expected that the elimination options are not practicable.

The minimisation risk controls considered to be most practicable are highlighted in grey, and a more innovative control (that has not yet been tested) is highlighted in blue that aims to stop reverse sensitivity from more shallow wells being installed adjacent to and downgradient of stormwater infiltration facilities.

The substitution option of extending the reticulated network water supply beyond the urban area appears to cover the areas that may be affected by plumes from infiltration facilities and it appears to be the most logical option. Also, if groundwater rises over time, existing old septic tanks and soakpits on the urban fringes might also pose a public health risk to water supplies drawing from shallow bores. Providing a reticulated water supply network might be a solution to both threats.

Asset managers need to work through these types of options, their pros and cons, including time to implement, cost of implementation, feasibility, etc. It may be that a combination of the other minimisation controls would need to occur.

The minimisation - personnel protection control that details onsite treatment - is considered least effective due to an assumption that treatment was unlikely to be used long term or maintained correctly by private users. Further, the personnel protection monitoring option is also considered least effective due to difficulties in obtaining access to private properties, timing of the monitoring (following a discharge from a stormwater facility) and establishing whether any exceedances such as *E.coli* are attributable to a network stormwater infiltration facility not some other sources and activities (e.g. onsite wastewater, farming, or local industry). Generally, TA’s would not be wanting to rely on personnel protection controls as they are both logistically difficult and costly to implement.

Table 3: Risk Management for Protection of Private Drinking Supplies from Development, and Stormwater Infiltration Facilities Use

<table>
<tr><th>Level</th><th colspan="2">Hierarchy of Controls</th><th>Solutions</th></tr>
<tr><td rowspan="17">Most Effective
↓
Least Effective</td><td colspan="2" rowspan="2">ELIMINATION</td><td>Don’t allow development over semi confined or unconfined aquifers used for drinking water</td></tr>
<tr><td>Don’t discharge stormwater to land from development</td></tr>
<tr><td rowspan="15">MINIMISATION</td><td rowspan="2">Substitution</td><td>Establish a capture zone for infiltration facilities and provide network water supply extension beyond urban limits to provide drinking supply to existing and future private owner /occupiers</td></tr>
<tr><td>Provide / fund a tanker supply to existing and future owner /occupiers</td></tr>
<tr><td rowspan="3">Isolation</td><td>Locate new infiltration facilities outside a CDWSPZ and where the least capture or no capture of private drinking supply wells occurs</td></tr>
<tr><td>Deepen existing wells or provide an alternative local supply from outside a capture zone</td></tr>
<tr><td>Create a Bylaw under the Local Government Act, to make it conditional on building consent to make new wells for private drinking water supply to be deeper to ‘have a supply of potable water that is adequate for its intended use’ (i.e. not insanitary).

Make a district plan rule that requires the same outcome as above.</td></tr>
<tr><td rowspan="3">Engineering Controls</td><td>Soil lined basins with 50 year event capacity i.e. do not allow basin overflows to rapid soakage chambers or use of soakpits. Or at least maintain option to increase basin size in future.</td></tr>
<tr><td>Ensure no wastewater network overflows can occur into a stormwater catchment that has an infiltration facility.</td></tr>
<tr><td>Design facilities to capture and contain as much as practically possible any spills of positively buoyant contaminants (i.e. hydrocarbons) and other contaminants.</td></tr>
<tr><td colspan="2">If risk remains</td></tr>
<tr><td rowspan="2">Administrative Controls</td><td>Public information and education of general public to install appropriate depth private wells and treatment using Council websites, Land Information Memorandums, and targeting real estate agents and well drillers etc</td></tr>
<tr><td>Basin monitoring wells - investigate and advise potentially affected users if an exceedance of a limit in groundwater near the infiltration facility boundary.</td></tr>
<tr><td colspan="2">If risk remains</td></tr>
<tr><td rowspan="2">Personnel Protection</td><td>Treatment of water at the tap (e.g. application of ultraviolet light UV)</td></tr>
<tr><td>Sample and analysis of potentially affected drinking supply routinely (monitor)</td></tr>
</table>

6 CONCLUSIONS

Stormwater disposal to land (where practicable) assists in meeting water sensitive design goals. In Canterbury as would in other parts of New Zealand, it is an important disposal method to avoid adverse effects on stormwater network capacity, surface water ecology and flooding, for future development and mitigation (i.e. retrofit) of existing urban areas.

The ability of infiltration facilities to be a key stormwater management approach in Canterbury is potentially at risk from the findings of the Inquiry and the implementation of their reform recommendations.

Reconsenting stormwater infiltration facilities is vulnerable to changes to the environment and legislation. TA’s could be subject to having to increasingly remedy public and private drinking-supply wells from existing and future stormwater infiltration facilities.

Whilst RMA legislation is focused on community drinking supply protection, private individual drinking supplies can be considered and there is a moral /ethical obligation to ensure these are protected.

Finally, asset managers need to be proactively reviewing existing and future infiltration facility use by assessing risk in a conservative way and actively either, through elimination, or minimisation reduce the potential for increased costs for their long-term operation that could in some cases be avoidable.

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