Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Memo

Date	20 February 2019
To	Andrea Richardson, Senior Planner
CC	Carl Hanson, Groundwater Science Manager
From	Lisa Scott, Senior Groundwater Scientist

Effects of cleanfill deposition on groundwater quality and recommendations for LWRP Omnibus Plan Change 2019

I have been asked to provide advice on the effects of the deposition of cleanfill on groundwater quality in Canterbury. The information is to inform possible changes to the provisions around deposition of cleanfill in the Land and Water Regional Plan (LWRP) for the next Omnibus plan change 2019.

My experience in this subject comes from working on technical advice for several resource consent applications since 2011 as well as a recent groundwater investigation I conducted in the Miners Road quarry area near Christchurch. I have prepared:

- evidence for Environment Court on groundwater quality impacts from gravel quarry and cleanfill operations (ENV-2011-CHC-78, Road Metals, Burnham, consent number CRC110671);
- reports for resource consent hearings on deepening quarries and cleanfill deposition (Canterbury Aggregate Producers Group, consent applications CRC155160 to CRC155169) as well as more than 20 smaller pieces of advice on matters relating to quarrying and cleanfill deposition;
- implementation advice on the 'seasonal high water table' elevation to assist with managing quarry and cleanfill operations at Yaldhurst; and
- a recently published technical report "*Groundwater quality investigation at Miners Road quarries, Yaldhurst Christchurch*".

My key conclusions and recommendations are:

- that cleanfill materials can generate an associated discharge of contaminated water, but the concentrations of contaminants are generally low and mainly affect the aesthetic quality of groundwater.
- that deposition of cleanfill poses a low risk to groundwater quality, if the quality of fill is stringently controlled
- that cured asphalt containing coal tar poses a higher risk to groundwater quality than other types of cured asphalt
- that waste slurries (e.g. concrete slurry and hydro-excavation slurry) pose a risk to groundwater quality
- to consider adding the requirement for site rehabilitation plans and future land use restrictions to cleanfill deposition activities

- that the LWRP definition "*Seasonal High Water Table*" should be replaced with "*highest groundwater level*" in the LWRP rules that cover excavation and deposition of material.

Effects on groundwater quality of discharges associated with cleanfill deposition

The LWRP defines cleanfill as follows:

Cleanfill is *"material that, when buried, will have no adverse effects on people or the environment. Cleanfill material includes virgin natural materials such as clay, soil and rock, and other inert materials such as concrete or brick that are free of: 1. combustible, putrescible, degradable or leachable components; 2. hazardous substances; 3. products or materials derived from hazardous waste treatment, hazardous waste stabilisation, or hazardous waste disposal practices; 4. materials that may present a risk to human or animal health, such as medical and veterinary waste, asbestos, or radioactive substances; or 5. liquid waste".*

I have been asked whether there are currently cleanfill materials listed in this definition that have a risk of leaching. During resource consent processing, various concerns have been raised by Consent Planners and members of the public about man-made materials, especially concrete and asphalt, and the amount of vegetative matter that should be allowed in cleanfill.

I found from an investigation of cleanfill deposition sites (Scott, 2019) that the associated discharges from fill do have a measurable effect on the quality of groundwater in an alluvial gravel aquifer. Dissolved ion concentrations in groundwater beneath and downgradient of the deposition sites are measurably higher than in groundwater upgradient. The most notable changes are in alkalinity, hardness (calcium + magnesium), chloride and sulphate concentrations. There are also areas where dissolved oxygen in groundwater was depleted.

I consider that contaminants released from cleanfill may cause some degradation in the aesthetic properties (e.g. hardness, taste, potential discoloration) of high-quality groundwater below the deposition sites. This contamination is generally localised and dissipates within a few hundred metres of the fill areas. I am not aware of any sites where cleanfill deposition has had a significant adverse effect on groundwater quality or caused exceedances of health-based drinking-water limits.

The materials in cleanfill most likely to cause observed changes in the groundwater quality include:

- uncured concrete slurries causing increases in hardness (calcium + magnesium) and alkalinity
- gypsum board – causing increased hardness and sulphate concentrations, and decreased dissolved oxygen from reaction with decomposing cellulose
- vegetative material in soils – causing decreased dissolved oxygen from decomposing organic matter

Unacceptable materials for cleanfill

Concrete slurry

Concrete starts off as a slurry with a high water content and then hardens as it cures. Uncured concrete contains pore water with very high pH and high concentrations of calcium. which can leach from deposition sites and contribute to elevated groundwater hardness. Once the concrete is cured, the calcium is bound in the solid and cured concrete does not leach more than minor amounts of calcium, unless exposed to acidic solutions. Concrete pipes and reservoirs, for example, are commonly used for water supply with no harmful effects. Most groundwater in Canterbury is considered soft water, because of the low concentrations of calcium and magnesium in our alluvial aquifers. To minimise noticeable effects on the hardness of the groundwater water, uncured concrete slurries and concrete truck wash water could explicitly be excluded from the LWRP definition of ‘Cleanfill’, although they may already be implicit in the definition’s exclusion of liquid waste. The exclusion would be clearer if the LWRP Cleanfill definition was modified to specify materials that are free of “liquid waste *or slurries*”.

Coal tar

Waste asphalt may be a component of cleanfill. Asphalt is a roading material comprising a mixture of aggregate and a binder cement. The binder used today is bitumen, but historically coal tar was used. Many older residential streets in Christchurch contain coal tar (NIWA, 2005).

Modern asphalt waste may contain some hazardous components, including heavy metals and polycyclic aromatic hydrocarbons (PAH), but international studies have shown that cured and weathered asphalt has low leachability. Cured asphalt material is not classed as hazardous waste (Townsend, 1988; Brandt and De Groot, 2001; Legert *et al*., 2005). If placed above the water table, the risk of leaching contaminants is low.

Coal tar, on the other hand, is hazardous and can contain high levels of PAH which could pose a risk to groundwater. The LWRP deposition Rule 5.177 provides for cured asphalt to be used in cleanfill,but does not provide a mechanism to ensure that the material placed will be tested to ensure it does not contain coal tar.

Hydro-excavated waste

Some cleanfill operators have asked whether hydro-excavated waste is acceptable cleanfill material, given that it comprises mainly soil and sediment. Hydro-excavation uses water to create a slurry of soil and sediment that can be pumped into tankers and removed. It can be used to access underground services for repair or replacement. I have two main concerns about the associated discharges of hydro-excavated waste on groundwater quality:

- the potential effects of increased leachate generation from adding a slurry containing liquid to the cleanfill
- uncertainty about the levels of contaminants in both the solid and liquid components of the slurry waste

Hydro-excavation slurries have the potential to affect groundwater quality and should be excluded from cleanfill deposition. This could also be covered by amending the LWRP cleanfill definition to allow materials free of “liquid waste *or slurries*”.

Effects on groundwater quality of future land use activities over cleanfill deposition sites

Some cleanfill deposition sites have been found to have faecal bacteria contamination in shallow groundwater. It is unlikely that cleanfill materials would be a significant source of faecal material and the bacteria are likely coming from other sources such as stormwater, animals, septic tanks, etc. However, the deposition of fill material does have the potential to increase the vulnerability of groundwater to bacterial contamination, especially at sites where the soil and most of the unsaturated zone above the groundwater that helped to adsorb and filter out bacteria have been removed.

This also has implications for the rehabilitation and use of the land after quarrying. The availability of cleanfill material is limited and more quarries are deciding not to fill excavations back up to the original ground surface but to contour the sides of the excavated sites and leave them as a depression in the landscape. It is not always recognised that the groundwater below such sites is more vulnerable to contamination than in was prior to excavation. Activities over these modified landforms could pose a greater risk to groundwater quality than the surrounding land uses which occur over unmodified ground. High loading of bacterial contamination (e.g. intensive grazing or effluent discharges) and high volumes of water applied (inefficient irrigation) over rehabilitated fill, especially fill with the separation to groundwater decreased, could lead to groundwater contamination after the sites are closed. It would be good if these effects could be taken into consideration in rehabilitation and post-closure plans at the time that the original activities are proposed.

Seasonal high water table

LWRP Rule 5.177 refers to a “seasonal high water table”. According to the plan this term is defined as follows:

Seasonal high water table *means, at the time the activity is established, the highest elevation that the water table has reached between the months of June and August inclusive*

In my experience the definition is ambiguous to plan users and may not be meeting its intentions.

Groundwater levels fluctuate over time, responding to inputs (rainfall, river losses, irrigation) and outputs (pumping) from the system. The intention of using a high water level benchmark is to estimate the highest level to which groundwater could rise at a particular site so that activities can be managed to minimise the risk to groundwater.

LWRP excavation Rule 5.175 requires a separation of more than 1 m of undisturbed material between the deepest part of an excavation and the seasonal high water table level to minimise the risk that of excavation into groundwater. LWRP deposition Rule 5.177 similarly requires a 1 m separation to any cured asphalt deposition to minimise the risk of groundwater levels rising and saturating this material. The rule also requires a 5 m separation to the high water table level for cleanfill deposition in deeper excavations (greater than 5 m deep), to provide an unsaturated buffer zone above the groundwater.

However, the seasonally wet times of year (June - August) referenced in the definition are not always the time of highest groundwater levels. Many monitoring wells in Canterbury have their highest recorded groundwater levels outside the stipulated period. This means that the seasonal high water table is not the best estimate of how high groundwater levels may rise. Strict application of the definition where higher levels have been recorded outside the winter period, could increase the risk that groundwater will rise into excavations or deposition sites.

There is also a lesser risk that plan users will interpret the definition as applying only to the period from June to August in the one year prior to the activity being established. If that happens to be a dry winter, the highest potential level to which the groundwater may rise could be more severely underestimated.

Instead of the seasonal high water table, I suggest that we use "*highest groundwater level*" which could be defined as "*the highest elevation to which groundwater has historically risen, based on all available local hydrogeologic and topographic information*."

References:

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Scott, L. 2019: Groundwater quality investigation at Miners Road quarries, Yaldhurst Christchurch, Environment Canterbury Technical Report R19/05, January 2019, 69 p.

Townsend, T.G. 1998: Leaching characteristics of asphalt road waste, Florida Center for Solid and Hazardous Waste Management, University of Florida, Report #98-2, 61 p.

Reviewed by:	Maureen Whalen, Groundwater Science Team Leader	February, 2019
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Attachments: None

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