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Report

MAIL Private Plan Change

Assessment of Effects on Groundwater

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1 INTRODUCTION

URS has been appointed to assess the potential effects on groundwater quality that may arise from the proposed rezoning of the Memorial Avenue Investment Limited (MAIL) site bounded by Memorial Avenue (north), Russley Road (west) and Avonhead Road (south). Within the Christchurch City Plan the land is currently zoned Rural 5, which is described as a rural zone with airport influences. The proposed plan change is to create an Industrial Park zone that would allow for a mix of industrial, commercial, retail and guest accommodation activities. Permanent residential activity would be prohibited in the proposed zone.

The assessment provided within this report relies on the Infrastructure Engineering Report produced by David Lovell Smith (DLS, 2014) and the Outline Development Plan produced by Pocock Design Environment.

Section 2 of this report describes the existing groundwater environment and Section 3 goes on to consider the proposed activity on the land in terms of stormwater management and wastewater management on the site. Section 4 provides an assessment of the effects that the proposed activities may have on the underlying and nearby groundwater system.

Conclusions with regard to the groundwater related effects are given in Section 5.

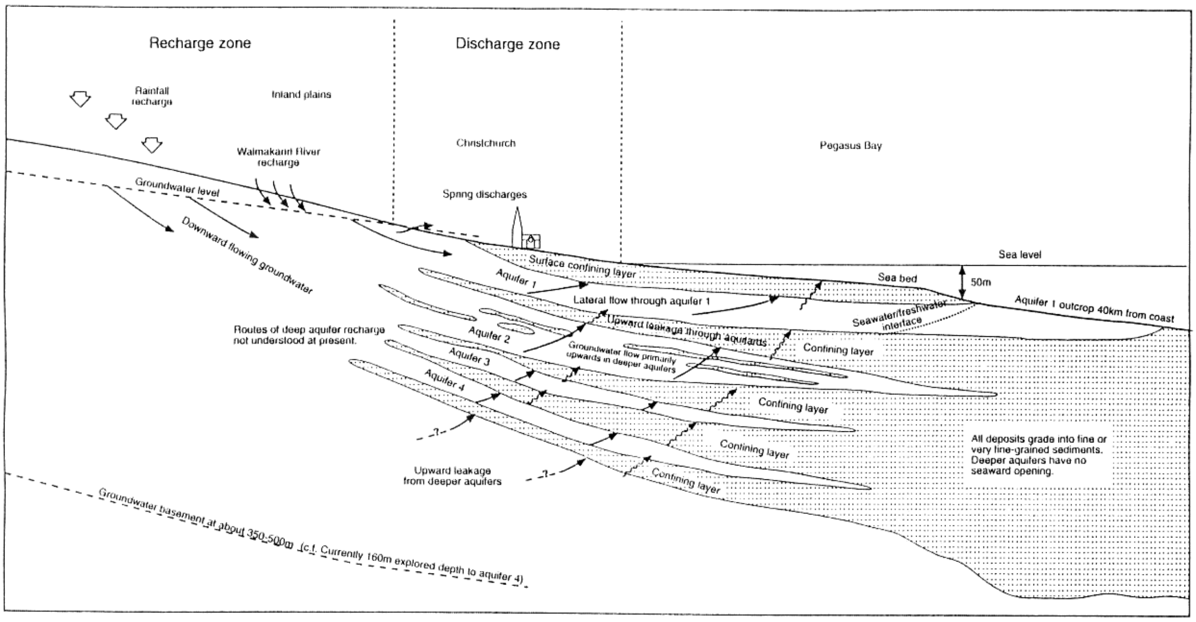
2 EXISTING ENVIRONMENT

2.1 Regional Hydrogeology

The hydrogeological setting of the Christchurch aquifer system is described in detail in various reports (Environment Canterbury technical reports U97/28/01, U07/24, U07/38, U02/13, Brown and Weeber, 1992, Brown, 2001). In general terms, the Christchurch aquifer system comprises layers of permeable gravels and sands that were deposited during glacial periods. The aquifers are interspersed by layers of lower permeable silts and clays that were deposited during interglacial periods which form the aquitards. The successive layering of sediments of varying permeability has created an aquifer system that is reasonably well defined in terms of aquifers and aquitards.

The general sequencing of the geological deposits for the Christchurch aquifer system is shown schematically on Figure 2-1. A table summarising the approximate depth, age and climatic event giving rise to the key stratigraphic units is provided in Appendix A.

Figure 2-1 Christchurch Coastal Aquifer System (Source: Brown and Weeber, 1992)



2.1.1 Shallow Aquifer Characteristics

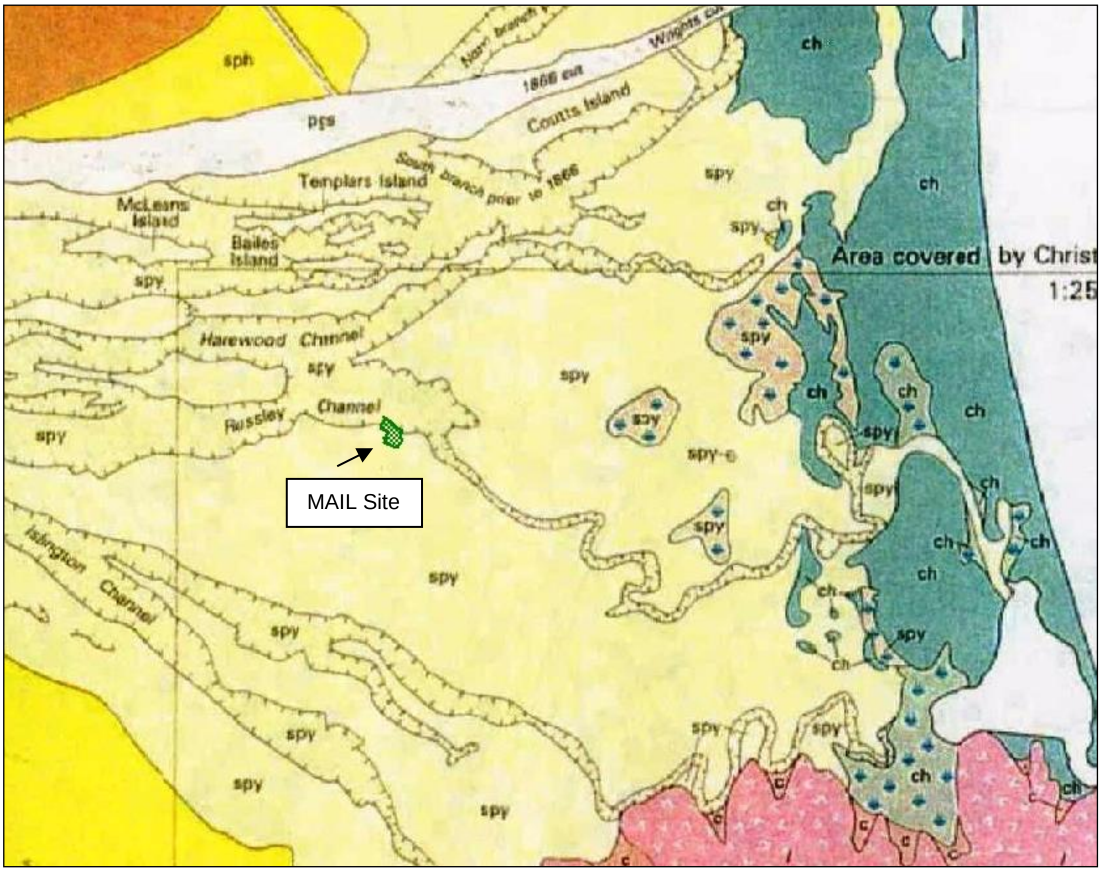
The Riccarton Gravel aquifer is the upper most gravel aquifer unit which underlies the fine sediments of the postglacial marine Christchurch Formation (ECan Report U97/28/1)[1]. This aquifer unit is considered to be the most susceptible to contamination from land use practices given its proximity to the land surface. The Riccarton Gravel aquifer is present in the stratigraphic sequence across the majority of the City, however where the Christchurch Formation (surface confining sediments) is missing, it becomes indistinguishable from the overlying postglacial Springston Formation gravels (ECan Report U97/28/1)[1]. The Springston Formation includes postglacial fluvial channel and overbank deposits that have accumulated

[1] U97/28/1 (1997): Christchurch-West Melton Groundwater: Hydrogeology, Vol 15/3. Environment Court Technical Report

at the inland extent of the Christchurch Formation and forms the water table aquifer (ECan Report U97/28/1)[1].

The spatial extent of the Christchurch formation is commonly shown using the 3 m isopach of surface confining sediments, as provided in Appendix B. The formation contains extensive areas where the surface materials comprise of low permeable silt and clays. The depth of these sediments is greatest at the coast, where coastal estuarine deposits also prevail, and thins towards the western limits of the city. Where post-glacial flood channels of the Waimakariri are evident, higher permeable gravels and sands are present near the surface. These flood channels have generated a preferential vertical pathway for land infiltration into the aquifer system as well as preferential horizontal pathways for the water table aquifer which flows to the spring discharge zone at the edge of the confining sediments. In places these paleochannels have eroded some of the Christchurch Formation (U07/38)[2]. The main flood deposits are the Islington, Russley and Harewood paleochannels, with the margins of the Russley channel found at the north-west corner of the MAIL site (Figure 2-2).

Figure 2-2 Surface Geology and MAIL Site (Source: Brown and Weeber, 1992)



2.1.2 Deep Aquifer Characteristics

The extent of the deeper aquifer units (i.e. Linwood Gravels, Burwood Gravels, Wainoni Gravels and deeper) becomes less evident the further inland you go, as the confining layers that are associated with the post-glacial marine transgressions begin to thin out. Establishing

[2] U07/38 (2007): Identification of Springston Gravel lobes in the Christchurch Formation Environment Canterbury Technical Report. Prepared by White, P., Weeber, J., Minni, G. and Covey, S.

the landward limit of the deep confining layers is difficult due to the lack of information on vertical stratigraphy in and around the MAIL site. The vast majority of wells installed in the local area are shallow wells, with typical depths ranging between 10 – 30 m bgl. However, geological logs obtained from three deep wells located in the vicinity of the MAIL site indicate that the confining layers are present at depth.

Well M35/11800 is a water supply well owned by the Christchurch International Airport. The 107 m deep well is located approximately 1 km north west of the MAIL site. The log shows alternating layers of clay rich gravels and loose sandy water bearing gravels. The near surface geology comprises claybound gravel to 23 m bgl.

Well M35/9439, is a 205 m deep potable supply well located at the Burnside pumping station to the east of the MAIL site. The geologic log obtained during the installation of the well indicates that successive layering of aquifers are present at that location. While the demarcation between the water table aquifer (Springston Gravels) and the first confined aquifer (Riccarton Gravels) is less clear from the well log, the presence of clay layers at or about 70 m bgl, 108 m bgl and 137 m bgl indicate that separation and confinement of the lower Linwood, Burwood, Wainoni and deeper aquifer units occurs at this location.

Well M35/9440, is a 191 m deep potable supply well located at the Farrington pump station to the northeast of the MAIL site. The geologic log from this well indicates that the Riccarton Gravel aquifer is likely to be confined at the surface by the Christchurch formation, with silts and clays identified in the upper 12 m of the log. The log also shows the presence of confining materials at depths that are consistent with the aquitard depths provided in Appendix A.

There are few examples of the extent of the deep aquifers (>50 m deep) currently available in the vicinity of the MAIL site. However, it is considered that distinct aquifers are likely to be present below 50 m at the MAIL site.

2.2 Local Hydrogeology and Geology

2.2.1 Shallow Aquifer Characteristics

Within the vicinity of the MAIL land at Memorial Drive and Russley Road, the groundwater system has been generally characterised by Environment Canterbury as ‘unconfined’ with a downward vertical hydraulic gradient.

Geologic logs obtained from the ECan wells database indicate that, within the immediate area of the MAIL site, wells do not report the presence of a layer of low permeable sediments such as clays and silts within the upper 5 m of the profile. There are a few wells (M35/1492, M35/8526, and M35/9923) located within the Airport area that show a layer of clay and silt starting at or about 8 m to 9 m below ground level. This layer may indicate the demarcation between the Riccarton Gravels and the overlying Springston Formation. However, the layer is not present in all the well logs in the area, suggesting that it is unlikely to be laterally continuous.

While the geologic logs obtained from wells near the site do not appear to support the presence of surface confining sediment, it is noted that the logging of the upper 2-3 m the core can be unreliable, especially when rotary percussion rigs have been utilised. In many of the logs, the upper profile is given a description of ‘soil’, which is consider to be an inaccurate description for the subsoil strata (soil is typically less than 0.5 m deep, particularly in the western margins of the city). Therefore, caution should be applied when using well logs to determine the presence of confining layers.

In this instance, further testing of the MAIL site using CPT indicated that the underlying sediments varied in terms of lithology and thickness of the deposits across the site. None of the test logs indicated the presence of a thick (>3 m) layer of clay present at the site. However, in all cases the sediments near the surface are characterised as comprising silty sand with lenses of silt of varying thickness (generally <2 m), overlying sands and gravels (and occasionally a thin lens of clay). The site testing indicated that silt and sand was typically present in the upper 2 m of the log, and whilst this may not act as a confining layer, it will act as a highly effective filter.

The depth to groundwater in the vicinity of the MAIL site is typically more than 4 m below ground level, with groundwater flowing approximately to the southeast. The MAIL site is within a transitional area where the hydraulic head in the Riccarton Gravels begins to show an upward trend.

Testing of shallow wells in the vicinity of the MAIL site indicate that the shallow aquifer system exhibits very high values of transmissivity, with specific capacity values ranging from 18 l/s/m to 125 l/s/m for the Burnside, supply wells. In addition, analysis of water samples for age and source characteristics indicate that the shallow water in the vicinity of the MAIL site is sourced from the Waimakariri River (ECan Report U02/30)[3].

2.2.2 Deep Aquifer Characteristics

There are very few deep wells located in the vicinity of the MAIL site. The nearest well is M35/11800, which is located at the airport (which is described in section 3.1).

The Linwood Gravel aquifer and deeper aquifers are likely to be confined beneath the MAIL site, and are therefore protected from landuse activities that are proposed to occur on the site. There is little information currently available from deeper wells from which to determine aquifer characteristics. However, testing of groundwater samples for age and source indicates that the deeper groundwater sourced in the Christchurch Aquifer system is predominately sourced from the Waimakariri River (ECan Report U02/30)[3].

2.3 Existing Groundwater Use

The MAIL site is located to the western extent of the Christchurch City Council’s reticulation network. It is located in the Christchurch – West Melton Groundwater Allocation zone as defined by the operative and proposed Regional Plan. The Regional Council has yet to determine an allocation limit for this zone, and therefore it is considered to be a ‘Special Zone’, which aims to manage groundwater allocation in such a manner to minimise the potential adverse effects on the City Council’s existing supply network.

The following section details the local groundwater use.

[3] U02/30, April 2002. Age and source of Canterbury plains groundwater. Prepared by Stewart,M. et al IGNS.

2.3.1 *Existing Council City Supply*

Given the number of potable supply wells that draw their water from the Riccarton Gravels, consideration of the risks of contamination of this aquifer unit from land use is important.

The City Council utilises all aquifers within its network of potable supply wells across the city. However, there is a heavy reliance on the first confined aquifer (namely the Riccarton Gravels), with approximately 30% of the potable supply wells located in this formation (based on ECan database of consented potable supply wells - 25 of 83 potable supply wells located in the Riccarton Gravel aquifer).

The nearest public supply well field is located approximately 1,000 m down-gradient from the eastern boundary of the MAIL site. Four of the five Burnside public supply wells are all installed in the Riccarton Gravel Aquifer, at depths of 16.4 m to 20.5 m below ground level. Pump test results from the wells installed in the Riccarton Gravel aquifer at this site indicate a very high yielding aquifer unit, with well specific capacities in the order of 22 l/s/m to 125 l/s/m. This indicates an aquifer unit that has a high capacity to transmit water. The fifth well is installed in a deep unnamed aquifer unit between 197-203 m bgl. The specific capacity of the deep well is less than the shallow Riccarton wells, with a value of 2.4 l/s/m.

2.3.2 *Private Well Supply*

There are 204 privately owned active wells identified by Environment Canterbury wells database that are located within 2 km of the MAIL site. The breakdown of the various uses for the wells is provided in the table below. A significant number of wells (102) have been installed as part of geotechnical or water level/water quality investigations. A number of wells have been classified as “other” use, a check of the well cards indicates that these wells are used for air conditioning purposes. The significant majority of the private wells are less than 20 m deep.

Table 2-1 Well information

Well Use	Number
Domestic	39
Irrigation	43
Public Water Supply (airport)	3
Geotechnical/water observation	102
Commercial/Industrial	5
Other (air conditioning)	13
Total	**204**

2.4 Existing Groundwater Quality

Environment Canterbury (ECan) technical report U02/47[4] "Christchurch - West Melton Groundwater Quality" provides a comprehensive assessment of the status of groundwater quality in the Christchurch aquifer system as of 2002. In addition, ECan report U05/12[5] provides a discussion on the contaminants of concern to the Christchurch aquifer system associated with a proposed residential development in Recharge Zone 1. Groundwater sampled from wells located in the Springston and Riccarton Gravels generally showed a high standard of water quality, with levels of contamination generally well below maximum allowable values and/or detection limits. However, there are areas that exhibit lower quality groundwater. These areas are located in the north-west near Harewood, and in the south and south-west near the industrial areas of Islington to Hillmorton. The main sources of contamination identified in the ECan report (U02/47)[4] are nitrate from land use and private wastewater disposal systems, bacterial contamination from wastewater disposal systems and poorly constructed well head works, heavy metal contamination from timber treatment plants and industry, and saline intrusion in the Woolston - Heathcote area. The report notes that:

".. trace elements are rarely detected in the groundwater and in most cases where detected, concentrations are most likely to be well below relevant drinking water standards"

Monitoring of groundwater quality down-gradient of the closed landfills by URS has generally indicated a low level of contamination of shallow groundwater associated with these features. Investigations undertaken by PDP on landfill leachate plumes associated with landfills in the Canterbury Region indicate that the leachate is quickly dispersed and diluted by the rapidly moving water flowing through the aquifer unit (Callander, 2006)[6].

Overall, the existing quality of shallow groundwater within the Christchurch aquifer system is considered to be very high. Areas where groundwater quality has been adversely affected coincide with closed landfills, or heavily industrialised areas. The effects of intensive land use from agricultural practices may also have resulted in higher nitrate concentrations being observed in the southern part of the aquifer system. There is no evidence of widespread reduction in groundwater quality as a result of urbanisation over the unconfined aquifer.

In summary, the quality of groundwater within the shallow Christchurch aquifer system is very high, and largely unaffected by urbanisation. The exceptions are typically associated with specific areas of known high risk contaminant discharge sources. However, even in these areas, the lateral extent of the contamination is limited.

2.5 Surface Water

The site is observed to direct any significant surface runoff during large rainfall events to lower areas of the site, where ponding and eventual infiltration to ground occurs. Parts of the MAIL site may also contribute runoff to roadside swales that run adjacent to Memorial Drive. These swales capture road runoff, which percolates to ground. Further detail on current surface water conditions and drainage of the MAIL site are provided in DLS 2014[7].

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[4] U02/47 July 2002; Christchurch-West Melton Groundwater Quality: A review of groundwater quality monitoring data from January 1986 to March 2002. Prepared by SA Hayward. Environment Canterbury Technical Report.

[5] U05/12 April 2005; Christchurch-West Melton Aquifer System: Contamination of Groundwater from Land Use. Environment Canterbury Technical Report.

[6] Callander, P.F. June 2006: Statement of Evidence of Peter Francis Callander in the Environment Court, Env C 308/05.

3 PROPOSED ACTIVITY

3.1 Outline Development Plan

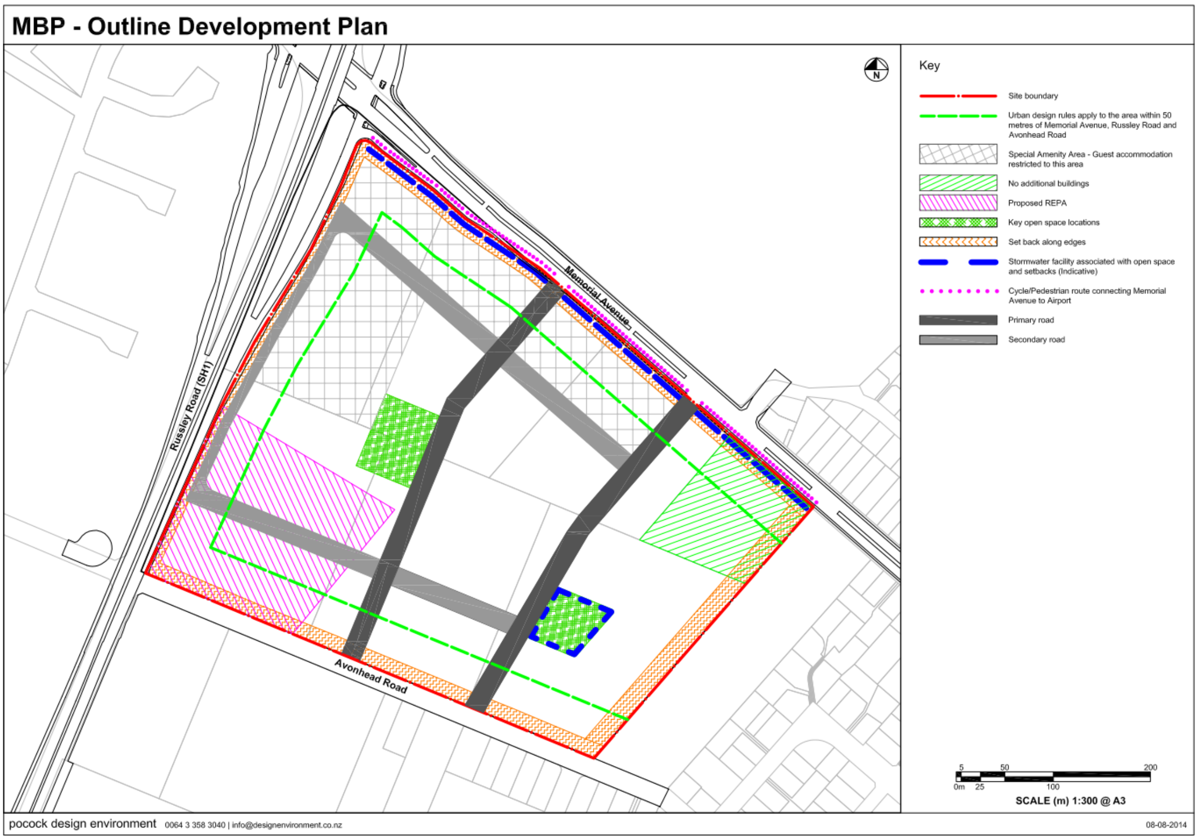
The engineering infrastructure required to support the proposed development is discussed in DLS 2014[7].

The overall layout from the Outline Development Plan (ODP) is shown in Figure 3-1. This includes a mix of retail, commercial and travellers' accommodation. On-grade parking is provided throughout the development and there are also parking buildings/floors. The main access is from Memorial Avenue with secondary access from Avonhead Road.

The specific components of the proposed land use change at the MAIL site, which have the potential to affect the quality and / or availability of groundwater resources in the vicinity of the site include:

- Stormwater generated from roof and paved areas.
- The reticulation of wastewater and the potential for on-site wastewater storage during the initial phase of development.

Figure 3-1 Outline Development Plan



7 Davie Lovell Smith: March 2014 Infrastructure Engineering Report – Memorial Avenue Investments Limited.

These aspects of the site development will need to be assessed as part of the resource consent process under Part II of the RMA. The consents that are likely to be required as a result of the proposed development that are associated with the groundwater environment are:

- Discharge Consent for Stormwater Disposal (Section 15, RMA).
- Store and use of a specified hazardous substance in the Christchurch Groundwater Protection Zone 1. (WQL55 of PNRRP: Note: likely to be permitted activity under Rule 5.179, LWRP).

3.1.1 Stormwater Disposal

The proposed development of the site will require onsite disposal of stormwater as there is no capacity in the Christchurch City's stormwater network to accommodate the volume of water that is expected to be generated. This is confirmed in the detailed provided in Section 5.2 of DLS (2014).

The stormwater runoff from the hard stand areas will be managed by a series of covered drains reporting to a rapid infiltration area. A swale will also extend along the northern site boundary, adjacent to Memorial Avenue. The site can be earth-worked to ensure that the majority of the potential development will fall to stormwater treatment area located within the eastern open space area. Further detail on the proposed stormwater reticulation and disposal and a plan showing the proposed layout is provided in DLS, 2014[7].

To note, DLS (2014) identifies two options for stormwater treatment from the hardstand areas. The option to convey stormwater via sumps and pipes to a single rapid infiltration basin where treatment will occur prior to disposal to ground will be designed in accordance with the CCC WWDG. The second option involves the use of propriety stormwater treatment devices before discharging to ground.

Roof runoff will be disposed of via direct soakage as described in Section 5.4 of DLS (2014).

3.1.2 Wastewater Disposal

The proposed development is unlikely to have access to the City Council's reticulated sewage system until 2019. DLS (2014) provides details on the existing wastewater infrastructure, constraints of the current system, and opportunities for the MAIL development to use the existing CCC system during periods of low demand. This could involve the integration of wastewater holding tanks on the MAIL site to overcome the capacity issue in the short term.

No wastewater discharges to land are proposed as part of the MAIL development, given the potential to use onsite holding tanks and connection to the CCC reticulation system. Therefore, no assessment is required. However, the storage of hazardous substances over the unconfined aquifer system would require a consent, which would involve an assessment of effects at that time. At this stage there is insufficient detail on the size and duration of the storage to enable a meaningful assessment to be undertaken.

3.1.3 *Potable Supply*

It is proposed that the site will be serviced from connections to the existing infrastructure. The existing water mains on Avonhead Road and Memorial Avenue will be connected with new pipework throughout the MAIL site. If it is determined there is a shortfall in water supply pressure in the vicinity of the site, supply can be improved by a number of means as set out in DLS, 2014.

4 ASSESSMENT OF EFFECTS

4.1 Effects on Groundwater Quality

The aquifer system that underlies Christchurch provides the City's residents with a high quality, high yielding, potable water supply which does not require treatment for contaminants. Therefore, the protection of this resource from contamination and / or overuse is of paramount importance to both the City Council and the Regional Council.

DLS (2014) provide background to the management of wastewater and stormwater from the future use of the site, which includes a summary of the feedback received from the Christchurch City Council asset engineers and Canterbury Regional Council consenting staff. The following assessment has been undertaken on that basis.

4.2 Stormwater Generation on the Site

MAIL is seeking zoning permission to allow for business uses (i.e. industrial, commercial, retail and guest accommodation) on the site. This type of development of Greenfield sites result in an increase in impermeable surfaces from roofs and sealed surfaces such as car parks and walkways, and as a consequence generates more rainfall runoff.

The generation of rainfall runoff from hardstand areas and roofs typically contains suspended sediments, heavy metals, and hydrocarbons. The concentration of contaminants in stormwater from land use similar to the proposed MAIL development vary significantly depending on the number of vehicle movements, the intensity of rainfall events and the duration of the period between events.

Concentrations of suspended sediments will vary over the site with runoff from sealed surfaces having relatively low concentrations. Unpaved surfaces will have higher concentrations depending on grading of the gravel surfacing and the intensity of rainfall events.

Due to the nature of the groundwater resource beneath the MAIL site any discharge of stormwater to ground will require a high level of treatment / protection to maintain the existing groundwater quality down-gradient of the site.

4.2.1 Sources of Potential Contamination

The principal sources of contamination of stormwater associated with the proposed commercial development at the MAIL site are:

- Vehicular Movements on the site which generate suspended sediments, zinc, copper, and lead from tyre and break wear-and-tear, and hydrocarbons associated with oil leaks or spillages.
- Roof runoff which can contain zinc and copper depending on the roofing and guttering material used. Roof runoff can also contain microbiological contamination and nutrients from birds.
- Accidental release of hydrocarbons from vehicles or other hazardous substances .

The relative concentrations of contaminants in stormwater from any future development of the MAIL site are not able to be definitively quantified prior to finalisation of the detailed site layout and selection of building materials. However, vehicle movements on the MAIL site are expected to be the primary source of the contaminant load, with roof runoff less likely to contribute contaminants. Furthermore, compared to the road runoff on the adjacent Russley Road and Memorial Drive, the contaminant load that could potentially be generated from the MAIL site re-development is comparatively low.

4.2.2 *Stormwater Treatment and Disposal*

Stormwater management treatment and disposal options that could be utilised at the MAIL site to reduce the contaminant load discharging to groundwater include:

- At source control of contaminants
- Low Impact Design
- Stormwater treatment devices
- Monitoring and Maintenance

At source control of contaminants

"At-source controls" are practices that prevent contaminants entering the stormwater system. In addition, Low Impact Design (LID) also incorporates elements of at-source controls.

Roof runoff is cleaner than other stormwater sources when contaminants such as sediment, nutrients, organic material and bacteria are considered. However, recent research indicates this does not necessarily apply with respect to dissolved and particulate metals, such as copper, lead and especially zinc. Products used in roofs and guttering appear to have a direct influence on the potential for release of these metals to stormwater.

Studies undertaken by the Auckland Regional Council (ARC, April 2004)[8] have highlighted the influence of building products and in particular roofing materials on the metals content in stormwater. Unpainted galvanised roofs have been identified as a significant source of zinc. Copper gutters are also identified as a potential source of copper in stormwater.

While there is potential for nutrient discharge from a commercial land use from the site, the loading rate associated with the proposed development is likely to be less than the nutrient load than could typically occur under the current rural land use.

Low Impact Design

LID is a design philosophy that can be applied at both a local and catchment level. The LID approach takes the natural features of a catchment and focuses on enhancement and protection being incorporated to the design.

The "Low impact design manual" (TP124) prepared by the ARC (2001)[9] provides detail information on this design approach (mainly for residential land development). LID works to include multiple site-specific stormwater controls that work with the natural landscape and are

[8] Auckland Regional Council (2004): Technical Publication 213. A study of roof runoff quality in Auckland, NZ. Implications for stormwater management.
[9] Auckland Regional Council (2001): Technical Publication 124. Low Impact Design Manual for the Auckland Region.

cost effective, in the design process. Most of the LID methods try to control runoff at the source in order to replicate the predevelopment hydrology.

This compares to conventional development strategies which concentrate stormwater runoff in a drainage network and deliver it to a few large ponds for treatment at the end of the pipe. In an LID approach treatment and attenuation of runoff might occur through multiple practises throughout the catchment with more focus on managing affects at, or close to the source.

Management principles that are relevant to and will be adopted as part of the MAIL development include:

- Minimising disturbance of soils.
- Preserving and recreating natural landscape features, where possible.
- Disconnecting impervious surfaces.
- Utilising conveyance and stormwater treatment methods that also provide ecological and amenity benefits (e.g. swales, rain gardens).

Stormwater Treatment Device Options

There are numerous options available for treatment of stormwater. Table 4-1 summarises the main stormwater treatment devices that are suitable for use at the MAIL site. Device information presented in this table is sourced primarily from Transfund New Zealand Research Report 264 (Hartwell and Welsh, 2005)[10]. URS developed the information in this table in conjunction with the North Shore City Council through an extensive literature review and the numbers have also been adopted by the ARC (ARC, 2005)[11].

There is limited performance data available for soakage systems. However, it is expected that contaminant removal efficiencies would be similar to that listed for bio-retention devices.

Table 4-1 Approximate Percentage Removal Efficiency of Various Treatment Devices

Treatment Device	Annual Flow Treated	SS	Zn	Cu	TPH
Swale	100%	75%	47%	57%	47%
Bioretention Device (80% rain garden and 20% Swale)	100%	83%	59%	62%	65%
Rain Garden	90%	84%	51%	63%	48%
Propriety Device Type 1 –Gross Pollutant Traps	74%	30%	9%	18%	10%
Propriety Device Type 2 - Filtrations Systems	90%	84%	44%	59%	48%
Propriety Device Type 3 (Catchpit Filter Systems)	90%	42%	13%	25%	10%

[10] Hartwell, S and Welsh, C (2005): Development of a Benefit Evaluation Technique Applicable to Treatment of Road Runoff, Transfund New Zealand Report No. 264.
[11] Auckland Regional Council, (2005): Technical Publication No. ARC04104 – Sources and Loads of Metals in Urban Stormwater.

4.2.3 Monitoring and Maintenance

Systems for conveyance and treatment of stormwater need to be inspected at regular intervals to ensure they are operating as they should. CCC has set operation and maintenance requirements for swales and soakage systems in their Waterways, Wetlands and Drainage Guide (WWDG, February 2003)[12] which will be followed.

With appropriate maintenance of the treatment system the overall effectiveness of the stormwater treatment system can be maintained. Part of any maintenance programme will require regular inspection and reporting. The design philosophy for the stormwater management system at the MAIL site combined with the limited amount of hazardous substance storage proposed for the site mean that any adverse environmental impact associated with stormwater disposal to ground is expected to be minimal.

[12] Christchurch City Council (2003): Waterways, Wetlands & Drainage Guide; Part B: Design.

5 SUMMARY

5.1 Stormwater

Development of the land for the purposes proposed by MAIL will result in higher volumes of stormwater being generated and a change in the type of contaminants present in stormwater at the site. The nature of the proposed on-site activities is likely to result in increases in concentrations of suspended solids, heavy metals, and hydrocarbons. However, it is considered that the stormwater that is generated on the site can be managed in such a way to minimise the contaminant load that finally enters the ground. Furthermore, the subsurface materials and depth to groundwater at the site will enable further treatment via natural attenuation processes.

Other discharges of stormwater from larger sites have been authorised by the Regional Council in recent times. For example, CIAL obtained consent to discharge stormwater immediately up-gradient of the MAIL site. A joint statement issued by expert witnesses who were considering issues surrounding the discharge of stormwater from the Christchurch International Airport (ENV C 308/5) stated:

"If all other factors remain the same (such as the type of land-use and stormwater management) then further development of the airport site will increase the risk that the stormwater discharge could affect groundwater quality, unless measures are implemented to reduce this risk. Such measures could include site stormwater management, control of contaminant sources and stormwater treatment."

Stormwater management at the MAIL site will utilise at source contaminant controls measures, low impact design methods, treatment devises, monitoring and maintenance to minimise the potential for adverse effects on groundwater quality beneath the site.

The proposed method of addressing the lack of capacity in the existing CCC wastewater network is still to be determined. However, DLS (2014) indicate that discussions with the CCC are currently investigating the potential to store wastewater onsite, discharging it to the reticulated system during periods of low usage. This approach is could require consent for the storage of hazardous substances over the Christchurch unconfined aquifer. However, the proposed rules in the Land and Water Regional Plan suggest that consent may not be required, subject to meeting the specific clauses of Rule 5.179.

At this time, no specific assessment of wastewater storage on the MAIL site has been undertaken. However, it is likely that any storage facility would be able to accommodate the requirements of Rule 5.179 LWRP.

6 LIMITATIONS

URS New Zealand Limited (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Memorial Avenue Investment Limited (MAIL).

It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this Report.

It is prepared in accordance with the scope of work and for the purpose outlined in the contract dated 6 August 2014.

Where this Report indicates that information has been provided to URS by third parties, URS has made no independent verification of this information except as expressly stated in the Report. URS assumes no liability for any inaccuracies in or omissions to that information.

This Report was drafted between May and November 2009, and updated between 6th and 7th of August 2014, and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

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Any estimates of potential costs which have been provided are presented as estimates only as at the date of the Report. Any cost estimates that have been provided may therefore vary from actual costs at the time of expenditure.

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APPENDIX A STRATIGRAPHY BENEATH CHRISTCHURCH CITY

Depth (m) (Approx.)	Geological Unit	Hydrogeological Significance	Age ('000 years)	Climatic Event (Stage)
0-40	Christchurch Formation-Springston Formation	Confining material	0-10	Aranuian (Marine progradation, Marine transgression, Sea level rise, Glacial retreat
40-55	Riccarton Gravels `(Burnham Formation)	1st Aquifer (confined)	10-70	Otiran (Glacial advance, Interstadial warming, Glacial advance)
55-70	Bromley Formation	Confining material	70-120	Kaihinuan (Glacial retreat)
70-100	Linwood Gravels (Woodlands Formation)	2nd Aquifer (confined)	120-200	Waimean (Glacial Advance)
100-120	Heathcote Formation	Confining material	200-250	Karoroan (Glacial retreat)
120-130	Burwood Gravels (Hororata Formation)	3rd Aquifer (confined)	250-310	Waimaungan (Glacial advance)
130-140	Shirley Formation	Confining material	310-350	Scandinavian (Glacial Retreat)
140-155	Wainoni Gravels	4th Aquifer (semi-confined)	350-380	Nemonan (Glacial Advance)
175-240	Unnamed Gravels	5th/6th Aquifer (semi-confined)	380+	Unnamed Glacial
240-433	Deeper Quaternary Units		380+	Unnamed Glacial

Source: Brown and Weeber, 1992

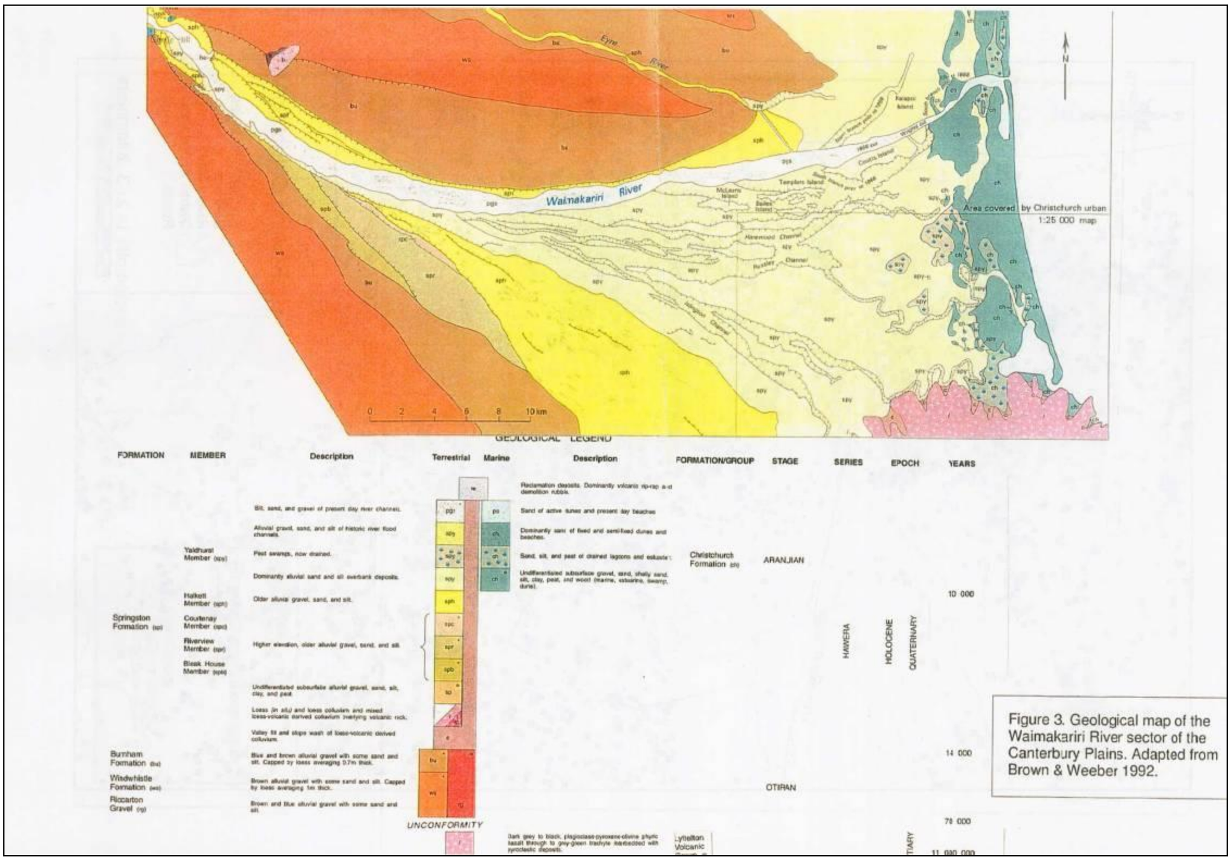
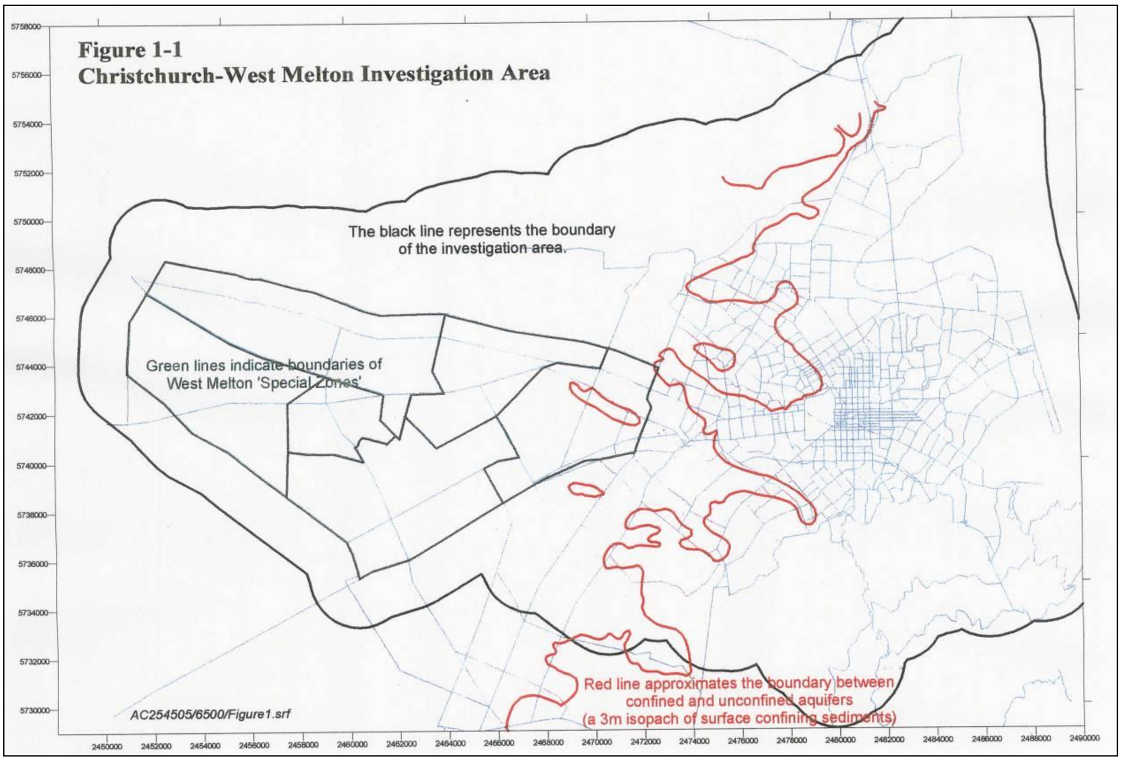


Figure 3. Geological map of the Waimakariri River sector of the Canterbury Plains. Adapted from Brown & Weeber 1992.

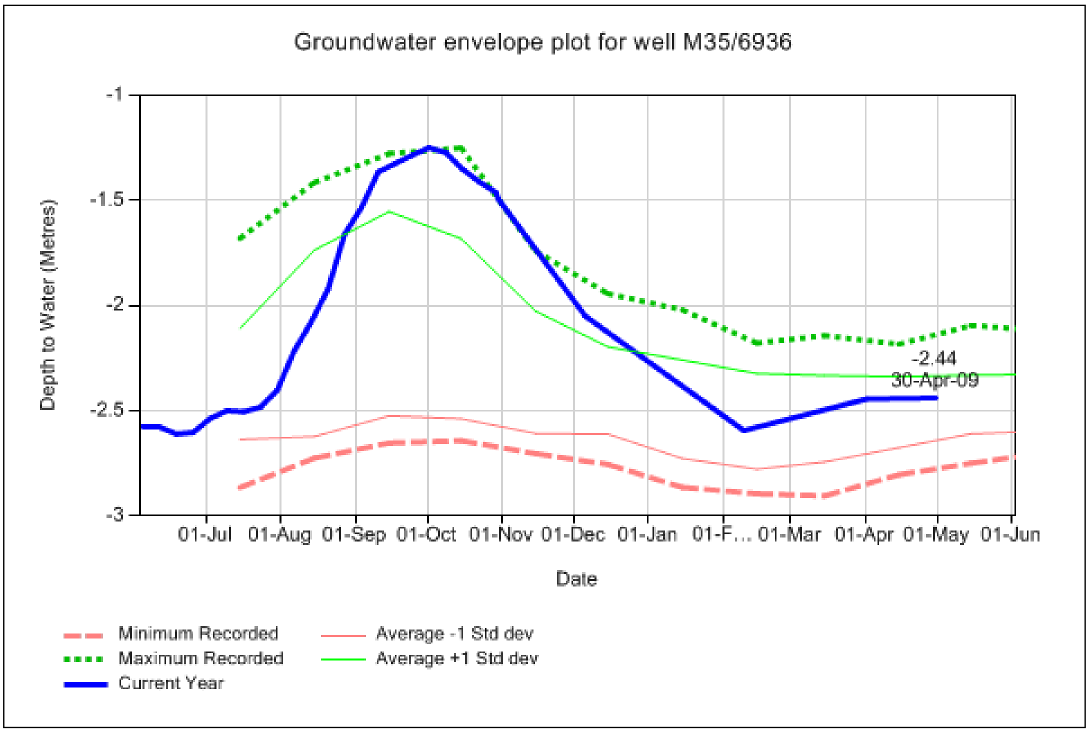
Source: Brown & Weeber, 1992

APPENDIX B CHRISTCHURCH FORMATION ISOPACH MAP

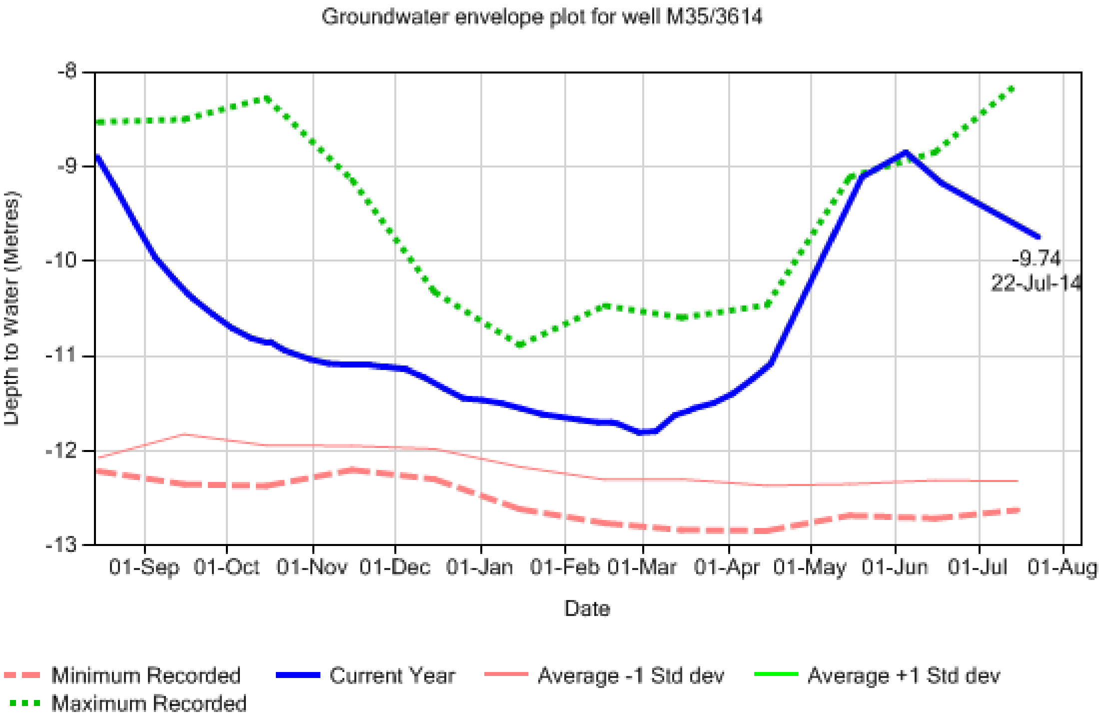


Source: Environment Canterbury Technical Report U07/38 (2007)

APPENDIX C GROUNDWATER LEVEL HYDROGRAPHS



Hydrograph for M35/6936 (19m deep)



Hydrograph for M35/3614 (24.5m deep)

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