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Report to Utility Services Committee
From Alastair McCarthy, Asset and Quality Manager

Water Quality Risk in the Hutt Valley Aquifer

1. Purpose

The purpose of this report is to advise the committee of the risks to the quality of drinking water derived from the Hutt Valley Aquifer, and to gain its endorsement of the various measures and mechanisms which exist to combat them.

2. The Hutt Valley Aquifer

In simple terms the Hutt Valley aquifer is a layer of gravel approximately 50 metres thick overlain by materials of low permeability about 25 metres thick, called an "aquaclude". This upper layer prevents water escaping to the surface, creating an "artesian" or pressurised aquifer. A well drilled into the aquifer in the lower areas of the valley will bring water up to and above the surface without pumping. The bulk of the water in the aquifer comes from the Hutt River "recharge" area between Taita Gorge and the Kennedy-Good Bridge.

The aquifer has a long history of use for public water supply. Modern history dates from the mid nineteen thirties, when the Gear Island pumping station was built. During the year ended 30 June 2001, the aquifer supplied approximately 43% of the water produced by the Wellington Regional Council. About half of this water was supplied to the Hutt Valley and half to Wellington. Water pumped to the Hutt Valley is unchlorinated while water supplied to Wellington is chlorinated at Gear Island.

The aquifer is actively managed by the Environment Division of the Wellington Regional Council. In particular they permit and monitor very closely any drilling work that penetrates the aquaclude, to ensure that no leakage occurs. They also monitor the quality of the water.

3. The Waterloo Treatment Plant

The Waterloo Water Treatment Plant raises the pH of the water to reduce corrosion of pipelines and plumbing fittings. It has a Ministry of Health B Grading (see footnote[1]) because there is no disinfection with residual. The grading system is intended to reflect not only the level of compliance with the Drinking Water Standard for NZ:2000 (DWSNZ:2000), but also the level of risk associated with the plant or distribution network. There is a standby chlorination system at Waterloo, but it has never been used.

4. Requirements of the Drinking Water Standard for NZ:2000

The Drinking Water Standard for NZ:2000 (DWSNZ:2000) contains detailed requirements for all aspects of water quality. There are separate sections covering protozoa (Giardia and Cryptosporidium) compliance, e-coli compliance (e-coli is an indicator of possible faecal contamination) and chemical compliance. At present compliance is voluntary, but it is expected that the Health [Drinking Water] Amendment Bill (HDWAB) will make compliance mandatory.

In the case of groundwater, e-coli compliance can be achieved by daily testing indicating that e-coli is not present. We test daily for faecal coliforms, an alternative indicator of faecal contamination. Over recent years, occasional isolated coliforms have been detected but no pattern has emerged, and most are thought to be the result of sample point contamination of other spurious causes.

Effective testing for Protozoa is much more difficult and compliance can only be achieved by one of the following:

- proving that the groundwater is secure.
- providing membrane filtration, or
- providing full treatment including chemical coagulation, and
- meeting the performance requirements for these processes.

We have concentrated our efforts on proving that the aquifer is secure (from contamination) and recent results of tritium based age testing have confirmed that the water is greater than one year old, thus meeting one of the criteria for security. Tritium is a rare form of the water molecule which has three atoms of hydrogen instead of the usual two.

Waterloo therefore meets the criteria for microbiological compliance with DWSNZ:2000.

Every three months a wide range of chemical and pesticide tests are conducted. In addition the conductivity of the water from the aquifer is continuously monitored. Conductivity is a useful broad-brush indicator of any chemical changes in the water. Chemical contamination has never been known to have been a concern in the Hutt Aquifer.

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[1] The MoH Grading system has been under review for some time. The final outcome of this review is expected to be known within by mid 2002.

5. Public Health Risk Management Plans

The Health [Drinking Water] Amendment Bill (HDWAB) currently being drafted imposes a duty on all water suppliers to prepare Public Health Risk Management Plans (PHRMPs). These PHRMPs must be prepared for each process or element involved in the collection, treatment, storage and distribution of water, and will include:

- Possible causes of contamination
- Possible measures to prevent contamination
- Parameters to be checked to see if contamination has occurred or is likely to occur
- Signs that indicate corrective action is or may be required
- Corrective actions available in the event that contamination is observed or possible
- Contingency actions to be taken if contamination does occur.

The Ministry of Health has prepared a comprehensive series of templates that will provide an excellent basis for the preparation of PHRMPs for our system over the next few months.

6. Risks Associated with Supply of Water from the Hutt Aquifer

The PHRMPs bring emphasis to the fact that although compliance with DWSNZ may be demonstrated, most test results are of a very small sample only, and risks still remain. In the case of the Hutt Aquifer the main potential areas of risk to water quality are as follows:

- Contamination of the source (that is, the Hutt River)
- Contamination through the aquaclude.
- Contamination during abstraction (that is, at the well head)
- Contamination during treatment
- Contamination at service reservoirs
- Contamination during maintenance (primarily of the Hutt City reticulation network)
- Contamination by backflow from consumers premises or systems.

Research reported in a recent American Water Works Association Journal found that in America since 1996 45% of disease outbreaks attributable to the water supply, have been caused by reticulation system deficiencies, and 20% by inadequate treatment of groundwater.

6.1 **Contamination of the source**.

Farming activities and stormwater runoff are the most likely sources of contamination of the Hutt River. Gross contamination from a road tanker accident or similar incident is not impossible but highly unlikely.

The *Annual Freshwater Quality Report for the Wellington Region* states that *Generally all streams in the Hutt Catchment showed good compliance with aquatic ecosystem guidelines.* Macroinvertebrate Community Index values are generally high, with those in the recharge reach of the Hutt River suggesting *Possible mild pollution.*

The average number of e-coli in the river between Silverstream and Melling measured between Aril 2001 and March 2002 was 360, although the range was from 2 to 6800.
A recent spot check of protozoa numbers at Taita identified 0.3 cryptosporidium ocysts per 100 ml and 1.2 Giardia cysts per 100 ml. These numbers are similar to those encountered at Kaitoke, and are considered surprisingly low.

In short, there is microbiological contamination in the Hutt River, but generally at low levels.

The main barrier against contaminants from the river reaching the Waterloo wells is the filtering effect of the gravels and the travel time. The water travels three to four kilometres through the gravel and takes a little over a year to reach the Waterloo wells.

6.2 Contamination through the Aquaclude

The aquaclude is a thick layer of very fine sediment of low permeability. Over most of the valley it is under positive pressure from below, so that any breach would tend to let water from below escape rather than admit pollutants to the aquifer. Any drilling or piling work that penetrates the aquaclude must be authorised by the Environment Division of the Wellington Regional Council and is closely monitored to prevent leakage or pollution.

The Avalon Television Studios use groundwater for cooling, and re-inject the discharge from the heat exchanger into the aquifer. This is a sealed system and is regularly inspected, so that the risk of contamination is very small.

A few years ago a petrol leak from a service station in Avalon threatened to contaminate the aquifer. However investigation of the incident indicated that the petrol was contained within the upper gravels and did not reach the deeper aquifer.

6.3 Contamination during Abstraction.

Well head security is specifically covered in DWSNZ:2000 as a criteria for establishing the security of the supply. During construction, the wells are sealed as they pass through the aquaclude. They are also sealed into a chamber at the surface, so that surface runoff cannot enter the wells or delivery pipeline.

The water in the collector main is monitored daily for faecal coliforms. One was found on 10 May 2001, but the repeat test showed clear. A one off test for protozoa in 2001 found none.

6.4 Contamination during treatment

During treatment the water is held in mixing tanks, and chemicals (lime and fluoride) are added. There is therefore some potential for contamination. The management of the treatment plant is conducted in accordance with a system accredited under ISO9002:1994 *Quality Systems – Model for Quality Assurance in Production, Installation and Servicing.* This system fully documents all procedures describing chemical purchase, delivery, management and dosing, process details and quality monitoring. Automatic response mechanisms will shut down the plant automatically if key parameters are breached. Should a con-conformance be detected it is recorded and reported. The

system is subject to regular internal audit, six-monthly external surveillance audits and three yearly re-certification audits.

6.5 Contamination at Service Reservoirs

Service Reservoirs in the Hutt Valley are owned by the Hutt City Council and are closed with locked access hatches. The main reservoirs are directly supplied by the Regional Council bulk system, and it is our responsible to keep them full above agreed minimum levels. The Wellington Regional Council has equipment in the reservoirs to achieve this. In the Service Reservoirs, the water is no longer in a sealed system, and is exposed to air. There is therefore the possibility of contamination, and security of the reservoirs is very important.

6.6 Contamination during Maintenance

All elements of the system are subject to maintenance, and great care must be taken during any type of maintenance to ensure that contamination does not occur. However the greatest risk exists in the reticulation network. Frequent maintenance and repair work is required on the reticulation because of the number of fittings and connections, and regular installation of new connections occurs.

6.7 Contamination by Backflow from Consumers Premises or Systems

Backflow is an ever present risk in any water supply, and with an unchlorinated system the risk is significantly higher. Normally with a pressurised delivery system backflow cannot occur, but if the reticulation is shut down for maintenance purposes negative pressure may be created which can suck contaminants into the system. Backflow incidents involving sprays and dry cleaning chemicals have been recorded in the region in relatively recent times. At premises where a potentially hazardous situation exists, normal practice is to install a backflow prevention device to protect the reticulation from contamination. However, maintaining an effective backflow prevention regime requires accurate up to date knowledge of land use, and regular testing of backflow prevention devices. The legislative basis for backflow prevention measures is also unclear, with some conflict between the Building Act and the Water Supply Regulations.

7 Possible Risk Reduction Measures

7.1 Disinfection

Several processes are available to disinfect water. By far the most common is the addition of chlorine, but chloramine, chlorine dioxide, ozone and ultra-violet light can also be used. Disinfection will combat viruses, bacteria and Giardia, but apart from Ozone and Chlorine Dioxide are ineffective against Cryptosporidium. Chlorine, chloramine and chlorine dioxide have the advantage of providing a residual concentration which will combat any low levels of microbial contamination which may enter the system after treatment.

However this same residual, and by-products associated with it, may taint the water, sometimes to an unpalatable extent. A significant proportion of taste complaints in chlorinated water supplies are related to the chlorine residual. Another disadvantage of introducing chlorine into a previously unchlorinated reticulation network is that it may

react with biofilm on the inside of the pipes, causing taste and odour problems. Recently when the Petone supply was temporarily converted to chlorinated water, considerable flushing of the system had to be undertaken to remedy this problem.

There is a standby chlorination plant at Waterloo, but it has never been used.

Use of chlorine, chloramine or chlorine dioxide would potentially increase the grading of the Waterloo Plant from B to A1.

7.2 Microfiltration

Many new water treatment plants are adopting this technology. It is a mechanical filtration system which will effectively filter out particles as small as Cryptosporidium ocysts. However it will not combat viruses and is not a substitute for disinfection. Installation of microfiltration would not improve the plant grading.

8. Hutt City Council Officers Comment

We have discussed this paper with HCC Officers and their comments are as follows:

Hutt City Council officers agree that the risks of bacteriological contamination are greater in unchlorinated water supplies but believe that good management practices can limit these risks to low levels.

The approach adopted by Hutt City Council to managing the unchlorinated artesian water supply in the Hutt Valley has four main components as follows:

	Component	***Reason***	***Example***
1	*System Design*	*Design standards intended to minimise the risks of contamination entering the system*	• *All new reservoir hatches are sealed – only filtered air can pass through air vents* • *Higher standards required for backflow prevention than elsewhere in the Wellington area*
2	*Operations & Maintenance*	*Operations and maintenance procedures intended to minimise the risk of contamination*	• *Requirement to chlorinate locally after repairs* • *Requirement for service personnel training* • *Requirement for contractors to have formal quality processes (such as ISO)* • *Accreditation of contractors permitted to work on Hutt City water system* • *Backflow installation inspection & testing programme*

3 Monitoring	*It is essential to know promptly if despite system design and operations and maintenance procedures intended to minimise risk some contamination may have occurred*	• *Routine monitoring is substantially in excess of that required under the New Zealand Drinking Water Standards and approved by MOH* • *All reservoir hatches fitted with alarms which are monitored for unauthorised access 24 hours/day*
4 Response	*There must be a prompt and effective response to any indication of contamination even if there is no health risk*	• *Procedures for emergency chlorination and system flushing* • *Public notification procedures* • *24 hour response to issues (Hutt City Council staff and principal contractor)*

Hutt City Council officers believe that the Hutt City unchlorinated water supply is managed to a standard which is significantly higher than is generally the case for chlorinated supplies where chlorine in the water supply can in fact mask "a multitude of sins".

Other Councils in New Zealand including Christchurch City Council and Hastings District Council which operate unchlorinated water supplies also consider that good management practices can reduce the risk of contamination to low levels. Unchlorinated water supplies are also common in parts of Europe such as the Netherlands and Germany where acceptance of a low level of risk is considered preferable to the negative aspects of permanent chlorination of public water supplies.

Officers of Hutt City Council advise that the unchlorinated Hutt Valley artesian water supply was the subject of a report to Hutt City Council in 1996 and that this issue is already programmed to be considered further by Hutt City Council later in 2002.

9. Summary

The lack of a treatment process at Waterloo means that the risk associated with water supplied from that plant are probably greater than from other sources. However the Hutt Valley groundwater has been regarded as a safe secure natural supply for many decades, and there is little or no evidence to the contrary. Recent sophisticated water age testing has confirmed the security of the aquifer. A wide range of management and monitoring practices are in place to guard against contamination during any of the processes under Wellington Regional Council Control. It is apparent that the Hutt City Council are also aware of the risks inherent in an unchlorinated supply, and their management practices reflect this.

10. Recommendations

It is recommended that the Committee:

(1) notes the risks associated with the water supplied from the Waterloo Water Treatment Plant, and the measures in place to combat them.

(2) invites The Hutt City Council to advise its preference as to whether or not the water supplied from the Waterloo Water Treatment Plant should be unchlorinated (as at present) or chlorinated.

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