

GROUNDWATER INVESTIGATIONS FOR AUCKLAND CITY COUNCIL

J.P. BURR

Riley Consultants Ltd., P.O.Box 100-253, NSMC, Auckland, New Zealand

SUMMARY

The 1994 Auckland region drought prompted an investigation into the groundwater resources of the isthmus. Auckland City Council formed a team to identify and develop these resources for both potable and non-potable supplies. Large volumes of groundwater are potentially available from the volcanic formations on the isthmus during a drought. Following the lifting of the drought the schemes were re-examined under normal economic and environmental constraints. Only those potable supplies able to comply with these parameters were selected to continue. Three schemes were chosen to be taken to the Resource Consent application stage. These schemes propose to supply a total of 15 000 m³/day of potable water to the council's reticulation network. The applications are currently being reviewed by the Auckland Regional Council.

INTRODUCTION

In 1994 the Auckland region suffered a drought. Reservoir storage levels fell to approximately 30% of total storage in mid 1994 and further low rainfalls over the 1994 winter period could have resulted in drastic action being required during the 1994/1995 summer and possibly beyond. In mid 1994 Auckland City Council (ACC) set up the Water Alternative Supply Action Team (WASAT) to find and develop both potable and non-potable water supplies within the boundaries of the city. Riley Consultants Ltd were engaged by Council to provide geological and geotechnical expertise to the WASAT programme.

Many potential water sources were identified within the Council boundaries. These were generally associated with the areas of volcanic activity on the isthmus. Several of these sources were developed as non-potable water supplies while planning took place for the more complicated potable schemes.

In late 1994 the drought was lifted by high spring rainfalls. The WASAT schemes were re-examined by the Council and a decision was made to cease the non-potable supplies but continued to progress the potable municipal supply schemes under normal economic and environmental constraints.

This paper will give a general overview of the potential water sources in the isthmus as well as providing details on the schemes chosen to proceed.

GROUNDWATER IN AUCKLAND ISTHMUS

Figure 1 is a plan of the Auckland Isthmus showing the locations of the known volcanoes and associated geological activities.

This paper will focus on groundwater found in the volcanic features in Auckland, however further groundwater can be found in the sedimentary Waitemata strata elsewhere. The groundwater from the volcanic areas is easier to locate and abstract and higher volumes are available, hence its greater popularity.

Groundwater is available from two sources within each volcanic area. One source is the scoria cone itself. The volcanic activity creates a relatively impermeable tuff ring around the volcano resulting in essentially a large reservoir within the scoria cone. Many of these cones are large in diameter and capable of holding significant volumes of water, each equivalent to existing reservoirs.

During the drought virtually all of the volcanic cones in Figure 1 were studied to assess their viability as water supply sources. A sustainable yield of approximately 40,000 m³/day and a twelve month emergency yield of approximately 110,000 m³/day were estimated using available data. Some of these schemes would have significant environmental effects and were only added in case of an emergency drought situation occurring. It has been estimated that the total volume of groundwater stored in these cones could be approximately 100 million m³, a similar volume to the existing reservoir capacity of the region. Table 1 gives these possible yields for each volcanic cone.

Table 1. Volcanic cone estimated yields

Site	Description	Sustainable Yield (m ³ /day)	12 mth Emergency Yield (m ³ /day)	Comments
Three Kings	Scoria Cone	2500	15000	Winstones Quarry
Mt Eden	Scoria Cone	1000	5000	
Teachers College	Eruption Centre	?	?	
Mt Albert	Scoria Cone	1000	5000	
Mt Roskill	Scoria Cone	1000	5000	
Domain	Tuff Crater	1000	2000	
Magistrate Court	Scoria Crater	?	?	Centre of Auckland
Mt Hobson	Scoria Cone	1000	5000	
Mt St John	Tuff Crater	500	2000	
Little Rangitoto	Scoria Cone	500	2000	
One Tree Hill	Scoria Cones	1000	10000	Fully Allocated
South Epsom	Scoria & Tuff	1000	1000	
Mt Wellington	Scoria Cone	1000	15000	
Purchas Hill	Scoria Cone	-	-	Quarried Away
Mt Smart	Scoria Cone	1000	5000	Fully Allocated
Taylor's Hill	Scoria Cone	1000	5000	
Mt Richmond	Tuff Crater	1000	5000	Fully Allocated
Sturges Park	Tuff Crater	500	3000	
Rangitoto	Scoria Cone	25000	25000	DoC Park
TOTALS		40000	110000	

The main areas of basalt aquifers are shown in Figure 1. These are:-

1. Western Springs
2. One Tree Hill/Onehunga
3. Mt Wellington
4. McLennans Hill

Both the One Tree Hill/Onehunga and the McLennans Hill aquifers are essentially fully allocated to existing users. The Western Springs and Mt Wellington aquifers were seen as the best areas to investigate further.

The second source is the basalt flows that were produced by the volcanic activity. These lava flows generally followed the ancestral valley systems in the existing Waitemata Series formations. The groundwater also flows along these pathways from the volcanoes to the harbours. The basalt is very fine grained and impermeable, however the highly fractured nature of the rock combined with more scoriaceous layers and occasional lava tunnels produce an overall geological feature with high permeability and good groundwater storage characteristics.

Of the two sources the basalt flows provide greater volumes of sustainable groundwater due to the larger surface areas open to rainfall recharge. While the scoria cones contain large volumes of water their comparatively small catchments restrict the yield available on a sustainable basis.

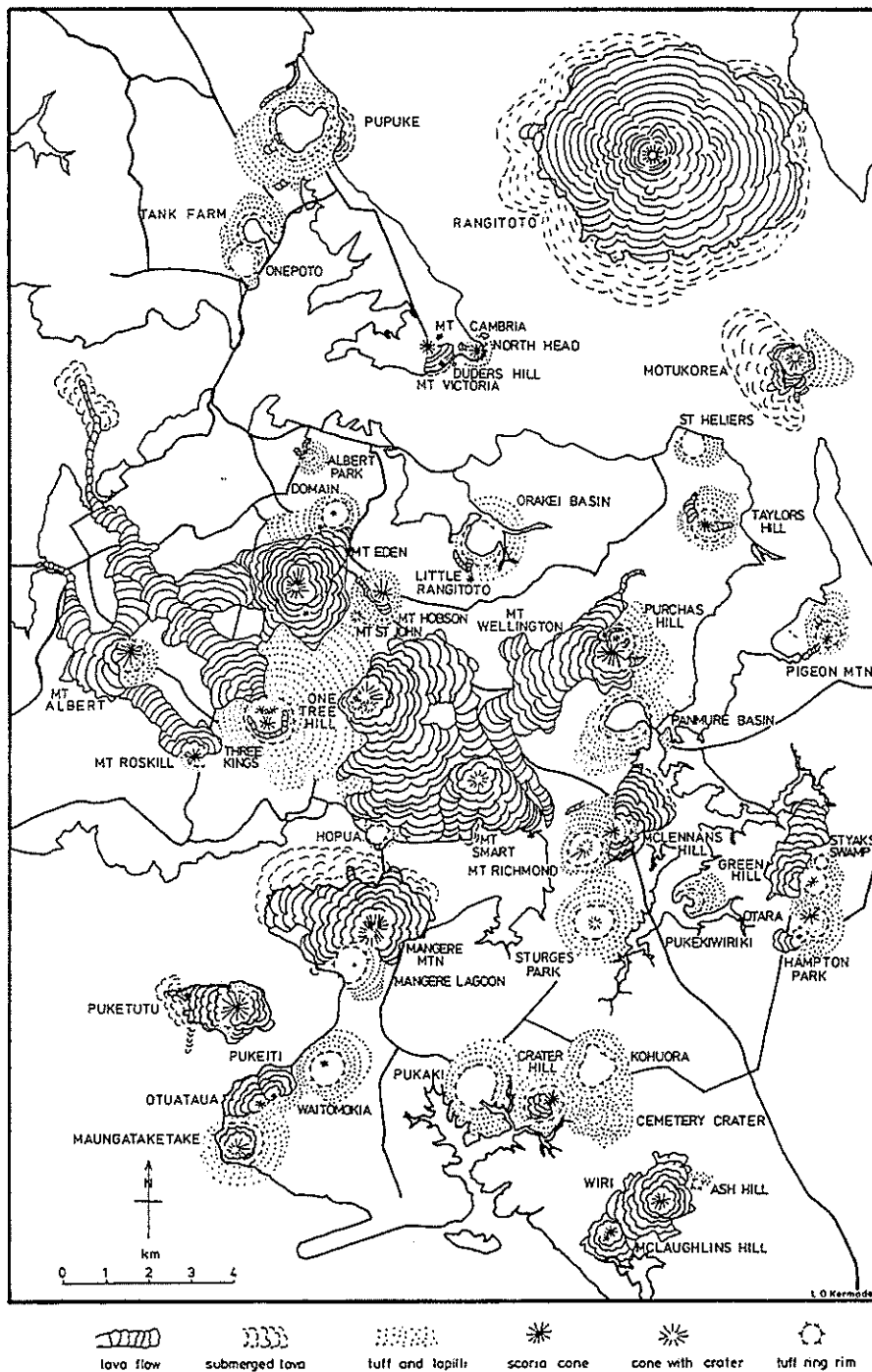


Figure 1. Map of Auckland Volcanoes. (Source: Searle, 1981 [4]).

GROUNDWATER INVESTIGATIONS

At the height of the drought Resource Consent Applications were submitted for the seven most feasible schemes. In addition, to these a further opportunity arose to use groundwater from the proposed dewatering of the Three Kings quarry, located in the scoria cone. As the prospect of a drought decreased these were eventually culled to four schemes:

1. Western Springs Aquifer
2. Mt Wellington Aquifer (Beside Southern Motorway)
3. Mt Wellington Cone
4. Three Kings Quarry

Scheme 2 was the first to be physically investigated. This scheme was abandoned following adverse water quality results. Its location downstream of an old established industrial area resulted in high levels of iron and zinc in the water. It was found to be uneconomic to treat this water to the required standard.

The loss of the Mt Wellington aquifer scheme in combination with the potential difficulties apparent in drilling in the public reserve on the Mt Wellington cone led to the decision to relocate the Mt Wellington cone scheme. The well locations were repositioned to abstract groundwater from the eastern edge of the aquifer beside Mt Wellington itself. This allowed the utilisation of a large catchment created by the dewatering of the nearby Mt Wellington Quarry.

Three boreholes were drilled in this area to provide both further information on the local geology and for possible use as future abstraction wells. Figure 2 is a plan of the area of the proposed scheme. Using this geological data and hydrological information gained from pump tests of the holes the effects of proposed abstraction scenarios were estimated. This information is given in detail in Riley Consultants Ltd. report on the scheme [2]. A volume of 5000 m³/day of groundwater was chosen as the most economically and environmentally appropriate abstraction rate for this site.

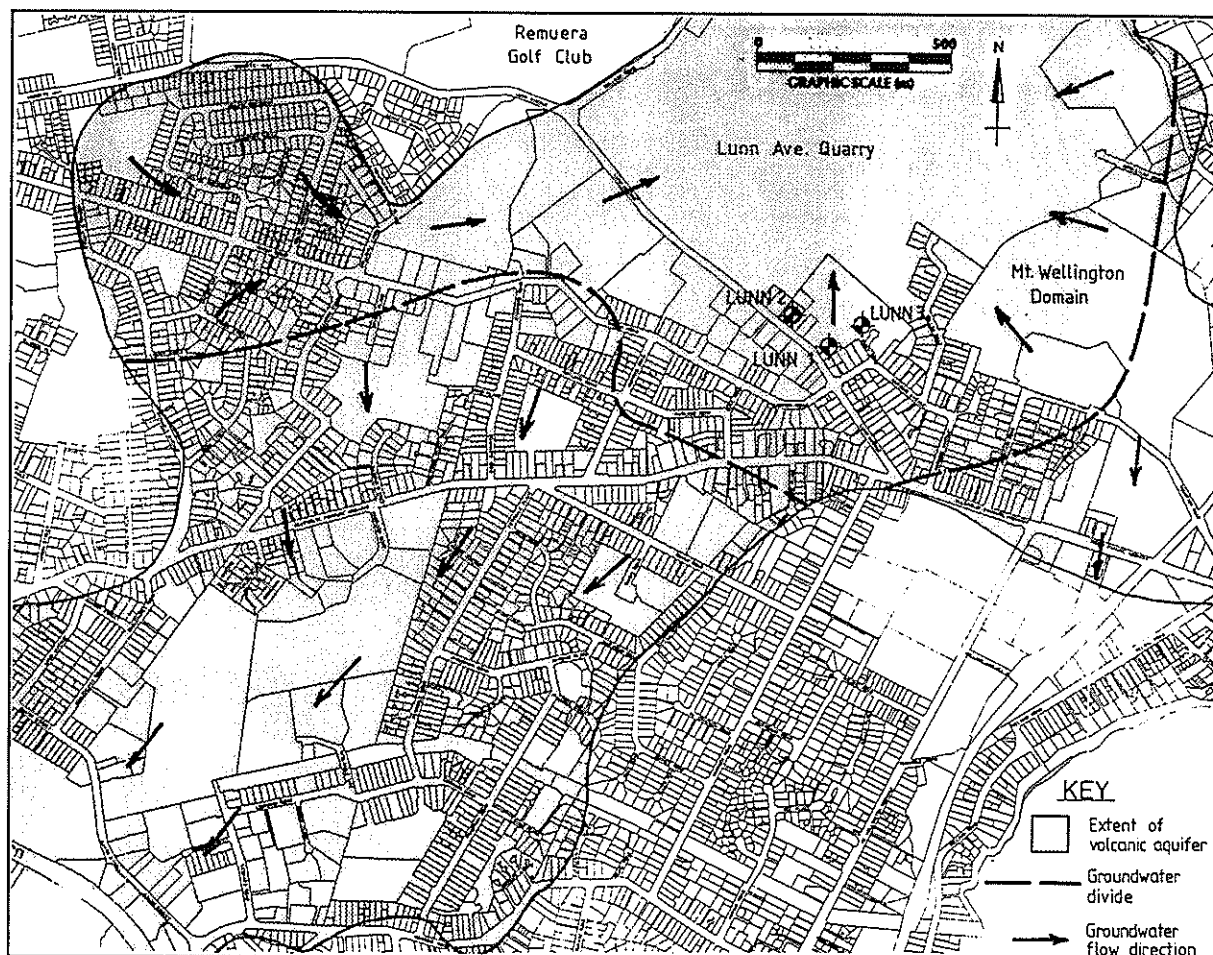


Figure 2. Plan of Mt. Wellington scheme area

The Mt Wellington and One Tree Hill/Onehunga aquifers have undergone hydrogeological investigations previously due to their high usage and proposed developments in their regions. However, the Western Springs aquifer is relatively unused and has not been the subject of any significant studies into its behaviour.

The team were therefore required to undertake a full groundwater investigation in this area to provide the Auckland Regional Council (ARC) with enough information to justify the proposed abstraction rate. The investigation consisted of a ten day (1000 m³/day) pump test on each of the three proposed wells with observation of the effects recorded at the two unpumped wells, three new observation bores, Western Springs lake, the Zoo well and both Meola and Motions Creeks. Figure 3 is a plan of the general area of the scheme.

From these tests a model of the lower section of the aquifer was developed using the finite difference programme MODFLOW. This model was calibrated against the recorded data and the proposed groundwater abstraction scenarios were then modelled with the programme.

The model was able to predict the effects of pumpage on the downstream creeks as well as Western Springs lake. This information was vital to the study on the effects on biota being performed by a subconsultant.

It was determined that abstraction rates of 5000 m³/day to 7000 m³/day were feasible from both technical and environmental viewpoints. A decision was made by the ACC to apply for 5000 m³/day for municipal supply as this would allow all three schemes to use the same water purification works design as well as being a long term economically viable rate. Riley Consultants Ltd. [3] report on the proposed scheme contains details of the investigation and modelling.



Figure 3. Plan of Western Springs scheme area.

The Three Kings scheme was developed in conjunction with the quarry operators, Winstone Aggregates Ltd. Much of the required information for this scheme was already available from their previous geological studies on the site. The proposed abstraction rate is influenced by the quarry requirements to dewater the cone. It is envisaged that an initial rate of 5000 m³/day will be abstracted to lower the groundwater level. This should take approximately 17 years to complete. Thereafter the scheme will reduce to abstracting the sustainable volume of approximately 2500 m³/day to keep the groundwater level in the cone constant.

The quality of the raw groundwater in the three final schemes was good. As the catchments are generally in established urban areas there was some initial concern that they may have been adversely effected by the activities directly above them. However, only in 2 of 141 potential contaminant tests performed on each of the 7 wells were the 1995 Drinking Water Standards [1] Maximum Allowable Values (MAV) were exceeded. These two values are not expected to affect the final potable water produced by the treatment plants, and the schemes will have an A rating in accordance with the 1995 Drinking Water Standards.

The total of 15000 m³/day from all three schemes will provide approximately 15 % of Auckland City Council's municipal supply. The above abstraction rates have been calculated for the average rainfall recharge of the aquifers. During a 1 in 200 year drought (the current Watercare Services Ltd design drought) the available volume of potable water from the three schemes combined is estimated at approximately 12,500 m³/day compared with 15,000 m³ in an average day. These rates will be subject to ARC regulation during such a drought. It has been estimated that this volume will defer the need for a new regional water supply scheme for 2 to 3 years.

Applications for Resource Consents have been made for all three schemes. These are currently being processed by the ARC. It is anticipated that if the consents are obtained construction of some or all three schemes will take place in the 1996/1997 ACC financial year.

CONCLUSION

Large volumes of groundwater are potentially available in the volcanic formations in the Auckland isthmus. The numerous volcanic cones in the area contain huge volumes of stored water while the extensive basalt flows are capable of producing significant sustainable volumes of groundwater. Four potable water schemes were identified by the WASAT as worthy of feasibility studies. Following these initial investigations three of the potable schemes were further investigated with geological, hydrological and environmental data gathering, collating and finally the production of reports on the Assessment of the Effects on the Environment. It is proposed to abstract a total of 15 000 m³/day of groundwater for use as municipal supply from the three schemes. Resource Consents have been applied for and these are currently being processed by the Auckland Regional Council.

ACKNOWLEDGEMENTS

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