PROTECTING EDEN PARK FROM FLOODING DURING RUGBY WORLD CUP 2011

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ABSTRACT

Eden Park has historically suffered from flooding during major storm events. This has ranged from serious flooding as in the historic Maoris vs Springboks test match in 1956, to less serious flooding of playing grounds and corporate areas in 2008. Flooding occurs as the underlying aquifer does not allow the Park's soakage system to work and significant surface flows with an undersized stormwater network.

New Zealand does not want to be embarrassed during the Rugby World Cup (RWC) 2011 due to a typical rainy Auckland day in 2011. A solution to protect Eden Park had to be found. With significant budget cuts to the Stormwater programme and the potential $60m cost to construct a pipeline from Eden Park to Meola Stream, Auckland City embarked on a feasibility exercise to determine a viable option that would meet the tight programme, cost constraints and provide long term flood protection benefits to the wider catchment post the RWC.

Options such as treating the groundwater for potable use, groundwater abstraction to lower the aquifer, 2.0m diameter tunnels in rock to drain the aquifer, 3km long tunnels to the stream were some of the ideas that were investigated by a multi-party stakeholder and technical team. The feasibility study found a short term cost effective solution to protect Eden Park in time for the RWC and a long term opportunity to address the flooding issues in the wider catchment.

KEYWORDS

Eden Park, Rugby World Cup 2011, Stormwater, Groundwater abstraction

PRESENTER PROFILE

Abhishek Sharma

Abhishek is a Technical Director at Beca specializing in Programme Management, Project management and Procurement. For the past eight years he has been working with Auckland City Council to deliver their stormwater capital works programme.

Grant Ockleston:

Grant has worked in the water industry for 19 years initially in the UK with Thames Water research department focused on novel water and wastewater treatment systems. Attaining a management role, lead a team of researchers on water and waste reticulation systems and associated environmental impacts. Grant returned to New Zealand in 1998 and has been instrumental in shaping Auckland's management of stormwater and wastewater systems with the advent of the integrated catchment strategy and assessment guidelines, now the regionally adopted approach. Grant is the

Auckland City manager responsible for delivery of the stormwater, closed landfill capital works and Small Local Improvement Projects (SLIPs) portfolios.

1 INTRODUCTION

Eden Park and parts of the surrounding Meola catchment have a history of flooding due to a reliance on soakage systems for the disposal of stormwater. During periods of high rainfall, the groundwater level in the underlying shallow basalt aquifer rises to ground level, preventing soakage and contributing to surface flooding.

Eden Park Redevelopment Board approached the Auckland City Council (Council) with a request to upgrade the stormwater network in April 2009. This provided a period of 2 years to commence and deliver a project where the scope, cost and programme were undefined. More importantly there was no budget for this project nor was it known whether an appropriate technical solution was feasible.

Council did wish to improve the level of flood protection at Eden Park for the Rugby World Cup in 2011 and has the added objective that this investment also provides additional flood alleviation in the wider Meola catchment or is at least consistent with a longer term solution for the area. A feasibility study was therefore initiated using a multi-skilled team that either had the desired skills and/or experience. A steering committee with key stakeholders was also established for input into the feasibility study and to agree to the recommended option.

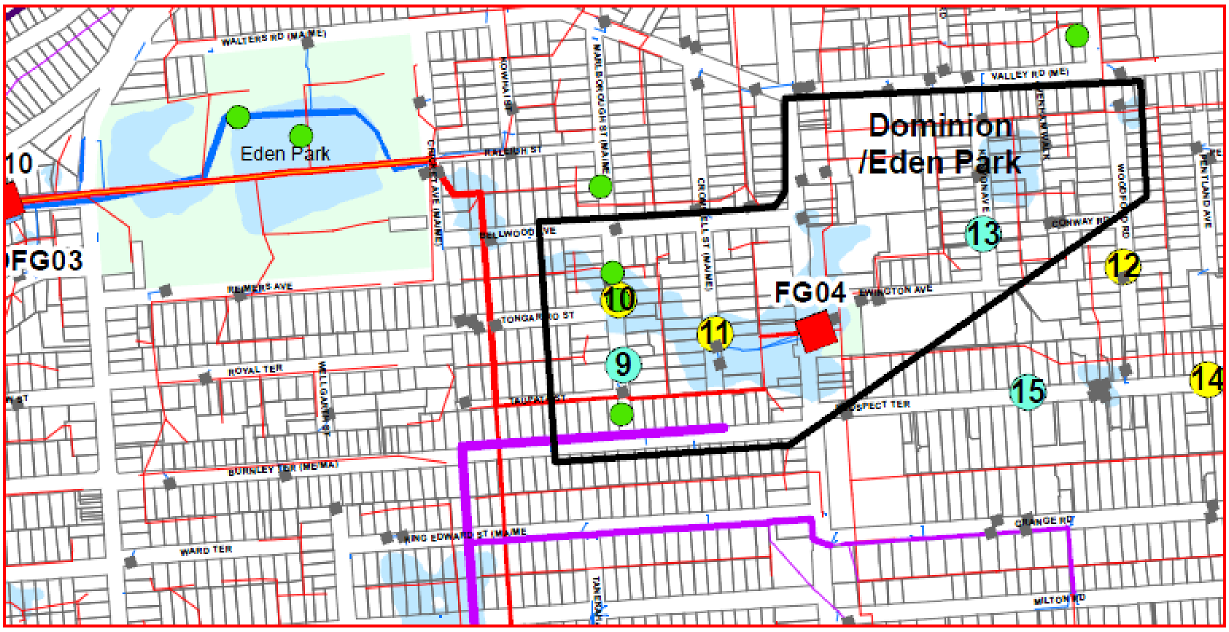

Figure 1: Plan showing the stormwater flood hazard within Eden park and the upstream sub-catchment within the Meola catchment

2 FEASIBILITY STUDY

2.1 OPTIONS

At a workshop in April 2009, a number of solution options were brainstormed. The following four options were selected for further development in the feasibility stage:

- Option 1 – Pipeline to Meola Creek
- Option 2 – Pipeline to Motions Catchment
- Option 3 – Groundwater Abstraction and discharge to stormwater network
- Option 4 – Groundwater abstraction and treatment for potable use

Each of the options is discussed in more detail below.

2.1.1 OPTION 1 – PIPELINE TO MEOLA CREEK

An existing stormwater drain starts at the eastern end of Eden Park, and discharges to Meola Creek. However, this drain has insufficient capacity to convey the peak stormwater flows. All the stormwater from within Eden Park is disposed to ground by soakage due to insufficient capacity in this piped stormwater system. Option 1 is the construction of a larger capacity drain to Meola Creek. This is the conventional approach to resolving stormwater flooding issues. However, construction of a large stormwater drain in this area would be very expensive due to the difficulty of construction through basalt rock and working within the constraints of a congested urban environment. It is considered likely that this drain would need to be constructed by tunnelling to minimise disruption to the public and to pass beneath existing services along the route. Two main route options were considered; a route generally following the existing stormwater drain alignment in a westerly direction to Meola Creek, and a second option going south along Sandringham Road to St Lukes Road, then along St Lukes Road and discharging to Meola Creek. The second option was preferred as it is passes through areas with more significant flooding issues, and hence the stormwater drain could be used to alleviate flooding in these areas if local drainage were constructed at some point in the future. This option would cost approximately $60m and was not considered feasible to be built prior to the RWC 2011.

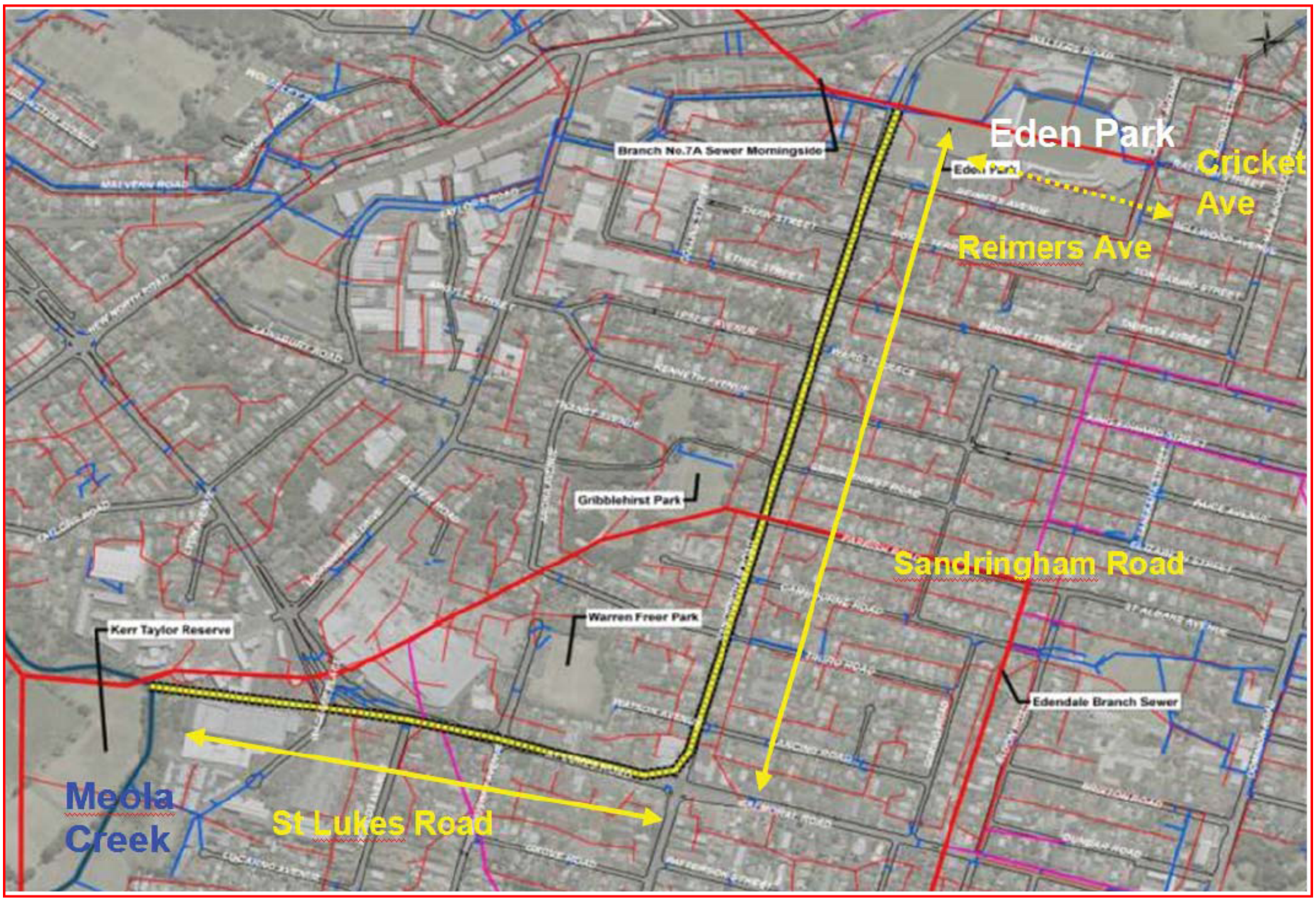

Figure 2: Route of Option 1

2.1.2 OPTION 2 – PIPELINE TO MOTIONS CATCHMENT

A large diameter trunk stormwater drain has recently been constructed in the neighbouring Motions catchment. Option 2 involves constructing a new stormwater drain from Eden Park to this Motions stormwater pipeline which is located on the south side of the north-western motorway. This new stormwater drain would be constructed by tunnelling. The length is short by comparison with Option 1. It is predominantly through Waitemata series rock, which is relatively easy tunnelling material, and has a relatively short length of construction in basalt. The Motions pipeline has however little surplus capacity as it was designed for the stormwater flows from within its own catchment. That means that this new pipeline cannot be used for disposal of peak stormwater flows from around Eden Park. Option 2 is therefore to predominantly use this new pipeline to lower the groundwater levels around Eden Park by discharging at a lower rate over a longer period of time. The lowered groundwater level provides storage for stormwater entering the aquifer via soakage systems. It is estimated that Option 2 will provide storage for a 1 in 10 year return period storm event. This option would cost approximately $16.5m and could be constructed prior to the RWC 2011. However this option does not provide the opportunity to address the wider catchment flooding issues in the future. This option also included the discharge of stormwater from one catchment to another and would therefore be more challenging to obtain consents.

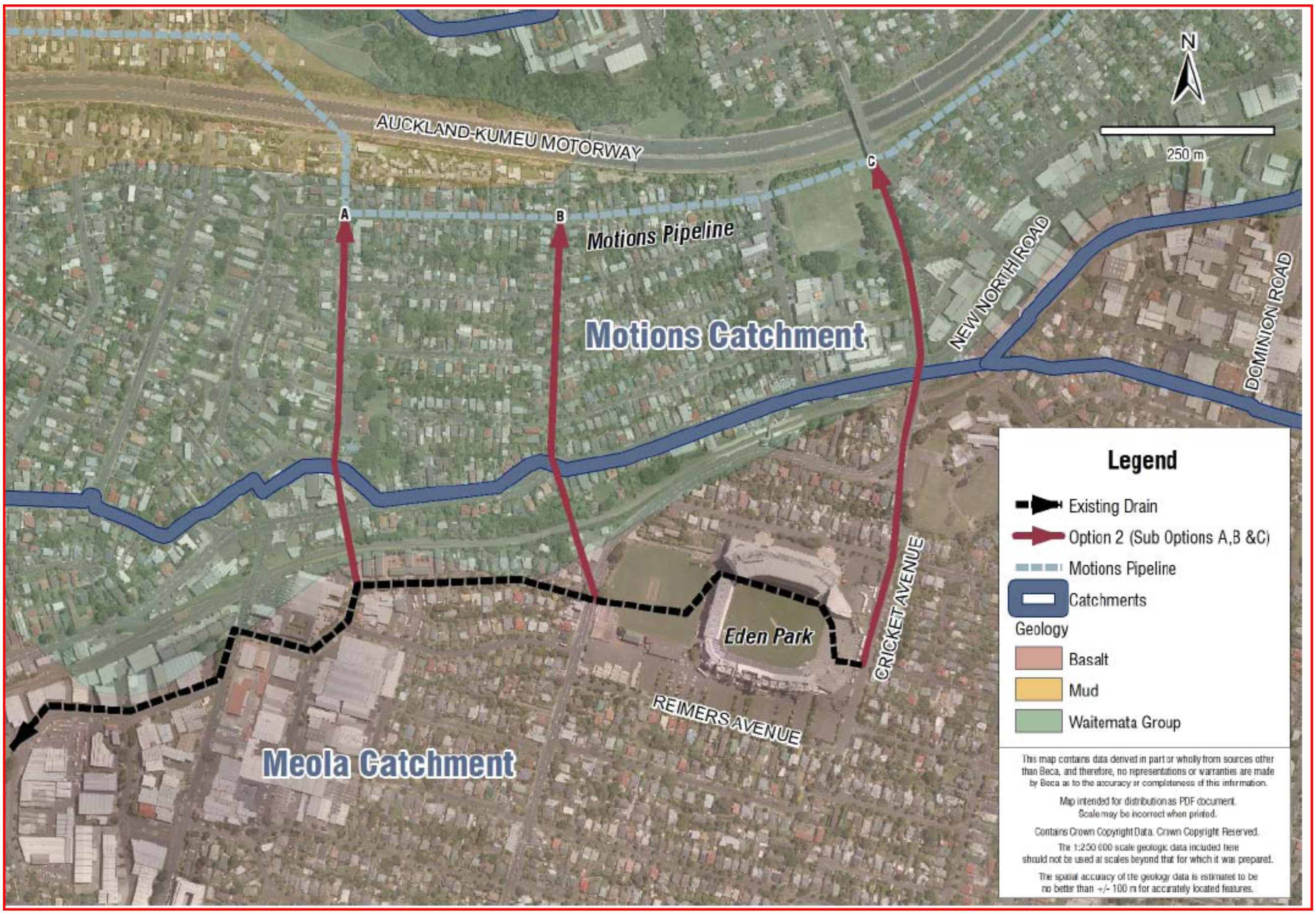

Figure 3: Three route options for Option 2

2.1.3 OPTION 3- GROUNDWATER ABSTRACTION AND DISCHARGE TO STORMWATER NETWORK

Four boreholes would be constructed within the boundary of Eden Park and groundwater would be pumped out for a period of around two weeks prior to the Rugby World Cup to lower the groundwater levels and create underground storage for stormwater. The required rate of groundwater abstraction has been estimated based on a pumping test and groundwater model at 200 L/s. This is significantly lower than the peak stormwater flow and is therefore able to be discharged to the existing stormwater drain at Eden Park. Pumping would cease during significant rainfall to avoid exceeding the capacity of the existing stormwater drain. During a significant storm, the stormwater would enter the aquifer via soakage systems and normal infiltration and recharge the aquifer. The amount of aquifer storage that can be created by pumping would be limited to maintain groundwater levels above natural summer low levels. Option 3 will provide storage for a 1 in 10 year return period storm event. This option would cost approximately $9.6m and could be constructed prior to the RWC. Majority of the construction would be within the current Eden Park redevelopment site and would need to be coordinated with this construction activity. This option provided limited wider catchment benefit but did provide the opportunity to be integrated with any future catchment strategy. This option also has an ongoing operation and maintenance cost.

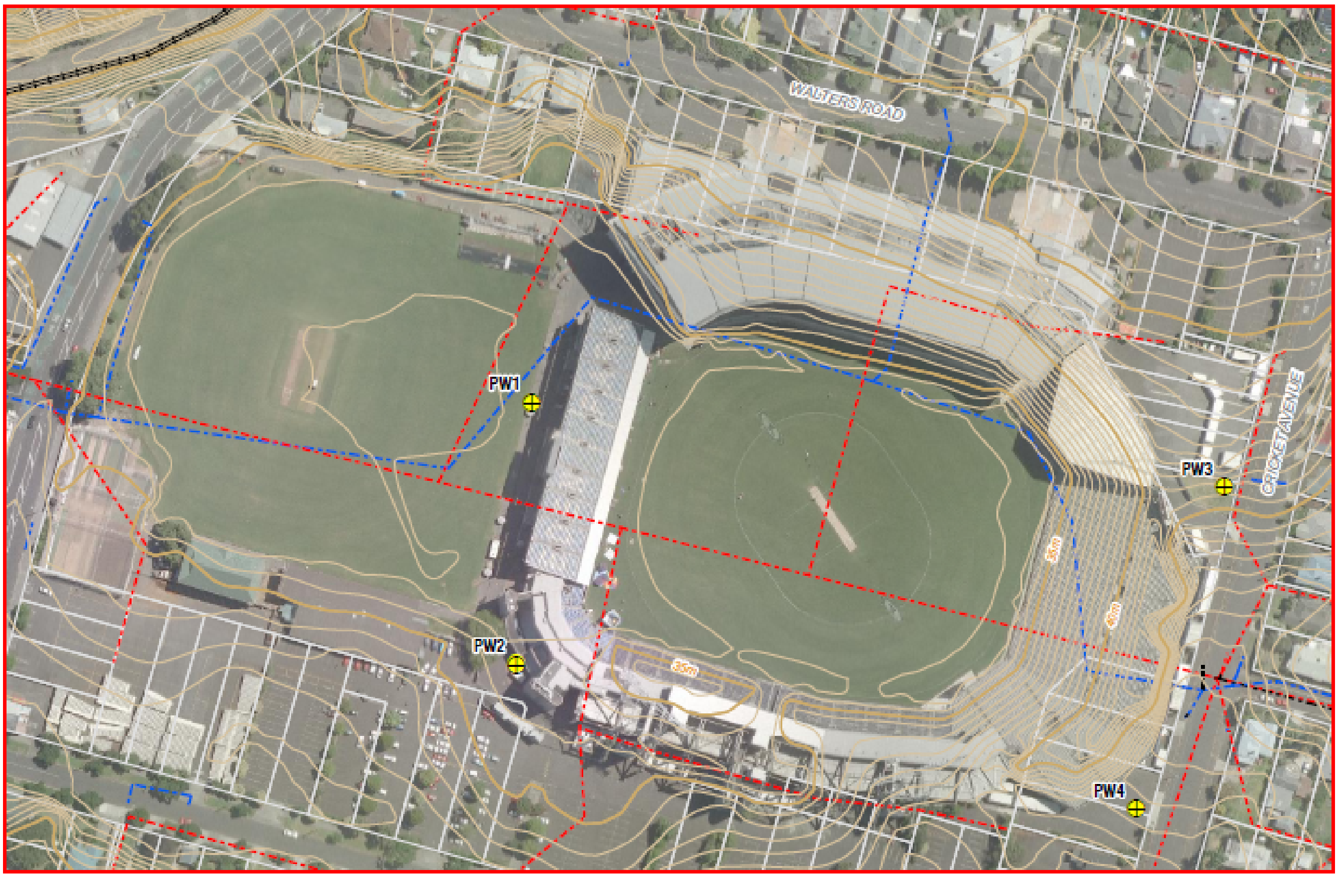

Figure 4: Location of the pumping wells within Eden Park that are required to create the aquifer storage

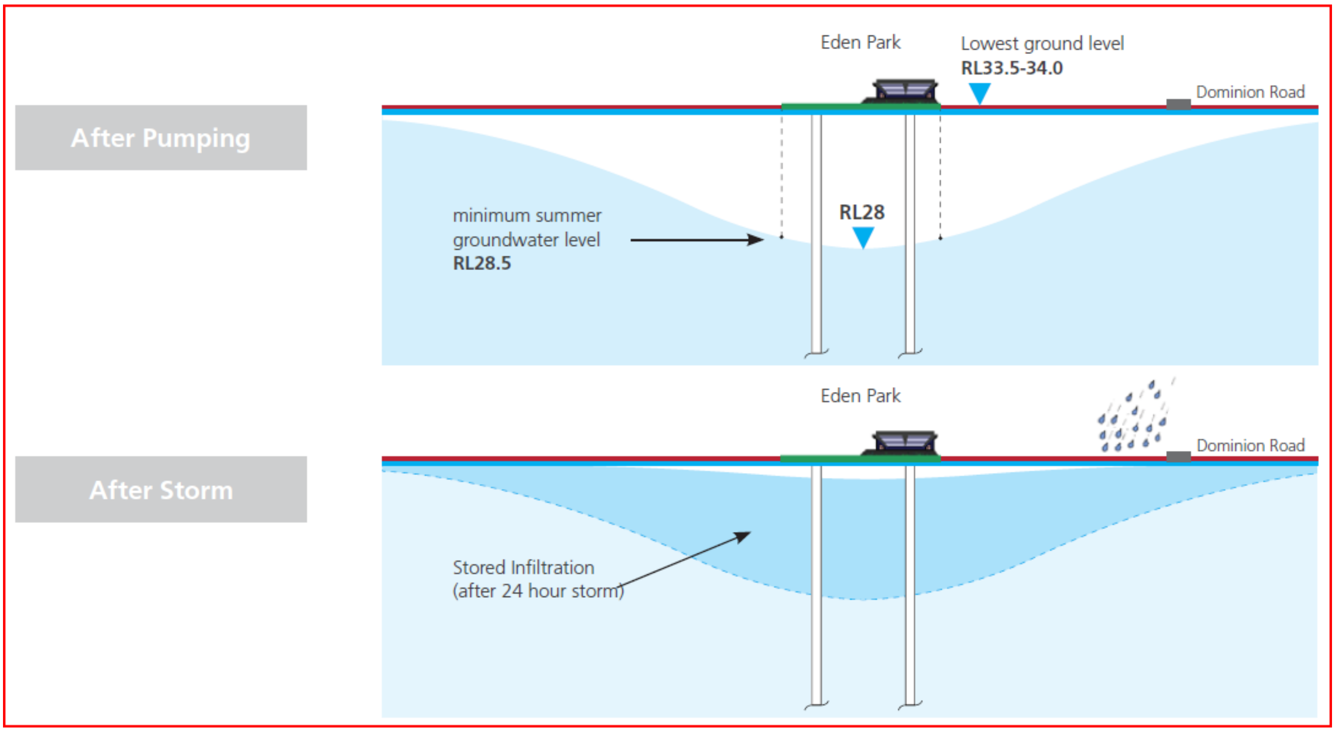

Figure 5: Schematic showing utilization of the aquifer storage created by the abstraction process

2.1.4 OPTIONS 4 GROUNDWATER ABSTRACTION AND TREATMENT FOR POTABLE USE

Option 4 is similar to Option 3, except that the abstracted groundwater is treated and piped into the public water supply. This is a novel solution and seemed attractive as it not only provides a sustainable re-use of the aquifer water but could also provide Council with an ongoing revenue source. To be economical, a water treatment plant needs to be available to meet water demand under drought conditions. The estimated 1 in 100 year drought yield for the aquifer is estimated to be in the range of 3,750 to 7,500m3/d. When groundwater abstraction rates are required to be above the chosen flow rate of 7,500m3/d to maintain groundwater at the required level for flood protection, the excess flow would be discharged to the existing stormwater drain as described for Option 3. The Eden Park Redevelopment Board preferred the treatment facility was located outside of Eden Park and therefore approximately four adjacent residential properties would need to be purchased. This option would cost approximately $25.7m and the abstraction system could be constructed prior to the RWC but the water treatment plant would have to be constructed in the future due to that time required to acquire and designate the site and to construct and commission the facility. This option also included a number of significant risks namely that it was likely that building such a facility in an urban environment may meet with local opposition and there is potential for water quality security issues from this urban shallow unconfined aquifer. This option also provided limited wider catchment flood mitigation benefits.

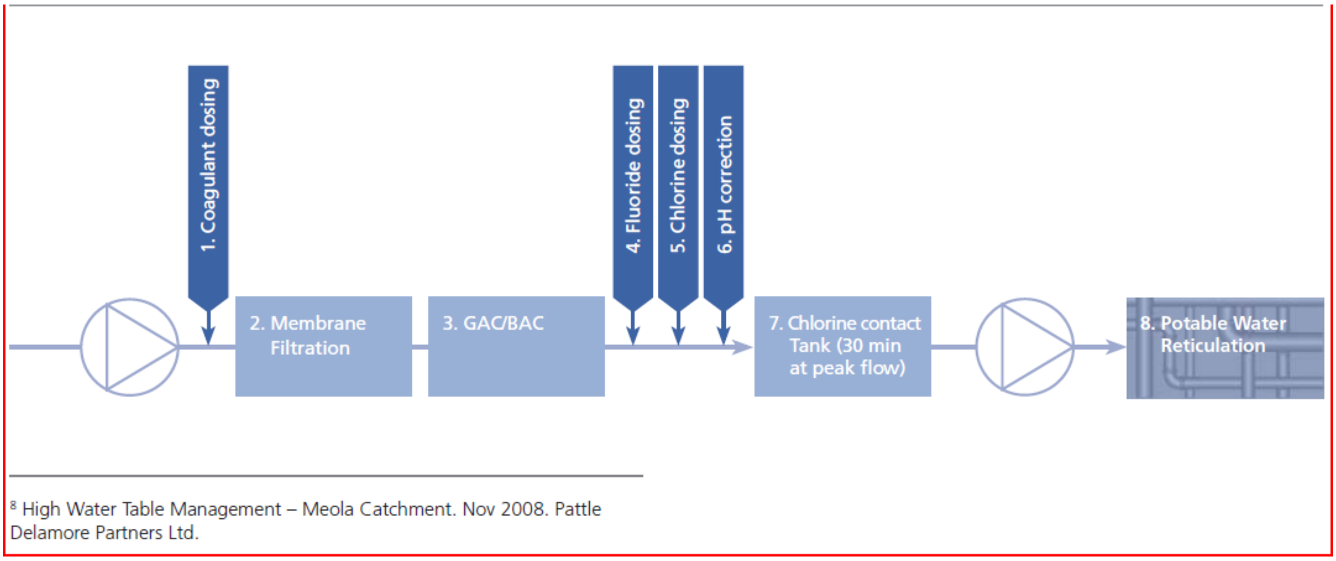

Figure 6: Treatment Process Schematic

2.1.5 HYDROGEOLOGICAL MODELLING

Options 2, 3, and 4 rely on the ability to abstract groundwater and create adequate storage in the aquifer for the local Eden Park drainage to operate. The Council has a Global Aquifer System (GAS) Model which is able to advise on potential for abstraction and discharge in aquifers at a macro level. This GAS model however was not refined enough to determine the aquifer response in the immediate vicinity of Eden Park. A pump well was constructed within Eden Park and tested. A hydrogeological model for the site was developed. This model determined the amount of storage required to protect Eden Park for a 10year storm event and the abstraction flowrate that would be required. The GAS model was also updated with the latest geological and pump testing data. The GAS model was able to advise on any catchment impact due to this abstraction. This information was required to support the long term abstraction consent.

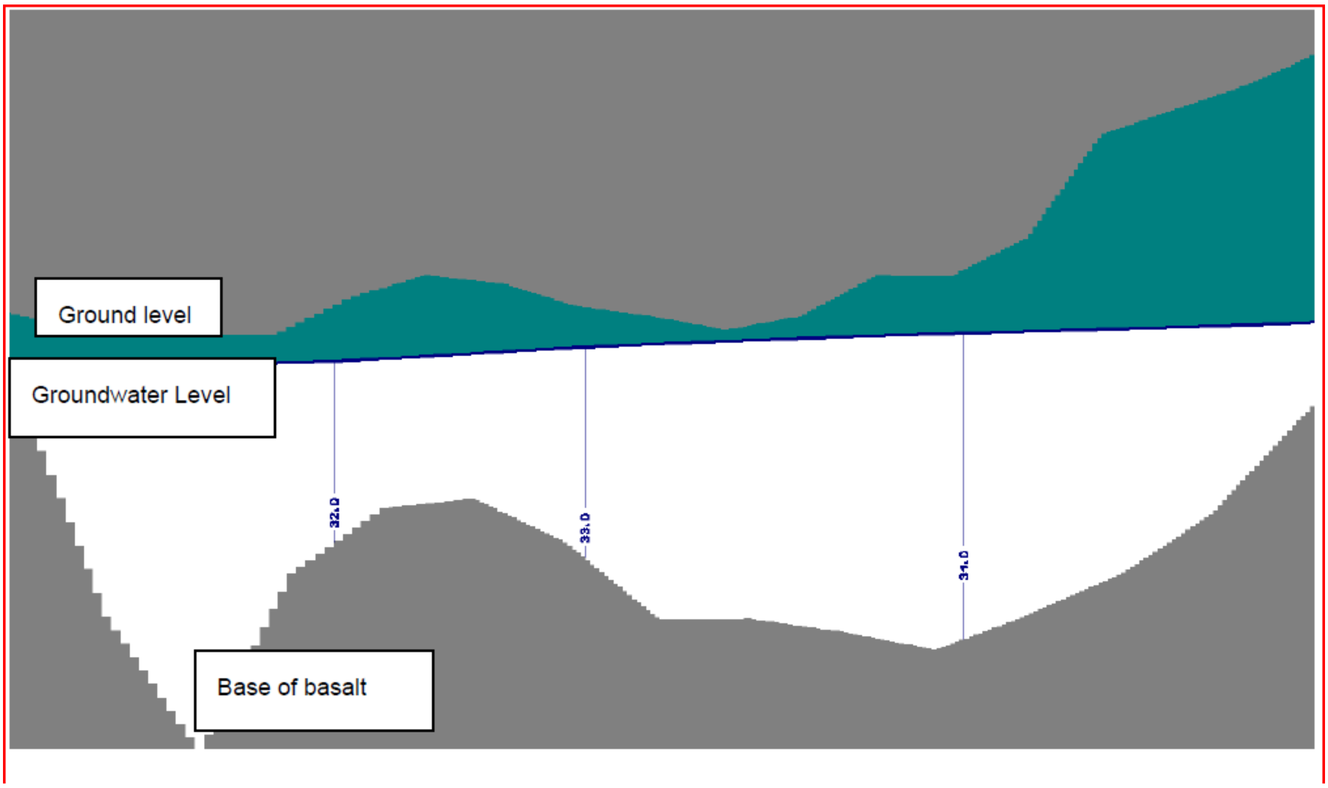

Figure 7: Output of the Hydrogeological model showing cross-section through Eden park (West – East)

2.1.6 OPTION ASSESSMENT

A Multi-Criteria Analysis (MCA) methodology was used to compare the important benefits and risks of each of the options as described below:

- Selected assessment criteria against which options are assessed
- Weighting applied to each criterion
- Each option was given a score from 1 (lowest) – 5 (best) against each criterion, and multiplied by the weighting
- Scores added for each criterion to give a total score for the option
- Sensitivity analysis undertaken by adjusting weighting given to criteria to assess how relative ranking of options changes.

Only high-level risks were considered and an analysis for both short-term and long-term objectives was carried out to compare the options against the drivers of providing Eden Park with flood protection in time for the 2011 RWC, and providing drainage solutions for some of the problem areas in the wider Meola catchment.

The assessment criteria are shown in Table 1 below:

Criterion	Reason for inclusion
Construction cost of option	Level of capital expenditure required has a strong bearing on its feasibility (particularly in the short term) for Council
Potential for construction cost to increase due to unforeseen issues	Acknowledging that some options cannot be fully scoped at this initial stage, and that the level of uncertainly varies between options.
Option provides Eden Park with flood protection	The ability of the option to meet the main purpose of the scheme.
Constructability & technical feasibility	Assessment of the degree of difficulty in design and construction of each option.
Feasibility of completing before the Rugby World Cup	The option must be functional by the time the RWC starts in September 2011. Includes the design, consenting and construction of option.
Option provides upstream stormwater benefits in Meola sub-catchment	Options providing surface flooding mitigation in the upstream Eden/Dominion sub-catchment are preferred as this provides additional justification for the money spent and benefit to the wider community.
Option provides downstream stormwater benefits in Meola sub-catchment	Options providing surface flooding mitigation in the Macdonald and Parrish/ Eldon sub-catchments are preferred as this provides additional justification for the money spent and benefit to the wider community.
Ease of obtaining Resource Consents/regulatory approval	The degree of difficulty and risk associated with gaining the necessary approvals for the option to be functional in 2011. By implication, includes a measure of stakeholder interests as it is assumed these will manifest during the consenting process.
Public disruption	The level of public disruption inform the construction of each option.

Table 1: Options assessment criteria

It was considered that the importance of each of the attributes in Figure 1 varied according to whether the short or long term objectives were being considered. Therefore different weightings were applied to each criterion for the short term and long term scenarios.

In the short term, the groundwater abstraction and discharge to existing drainage option is preferred by a substantial margin. This reflects that it has a relatively low capital cost, simple construction requirements, will result in minimal public disruption and it is likely that it can be constructed, installed and commissioned prior to the Rugby World Cup. A sensitivity analysis was carried out whereby the weighting applied to the criteria was adjusted in 10 different scenarios. This analysis showed that the relative ranking of the highest and lowest ranked options did not alter regardless of the weighting applied to the different criteria.

The long term scenario is the addition of the Meola pipeline option (Option 1) to all the other three options, as Option 1 provides the greatest opportunity for resolving catchment wide flooding issues.

Therefore in the long term, the preferred long term solution for the Eden Park and the wider catchment is to construct the Meola pipeline in conjunction with groundwater abstraction and discharge to existing drainage. The combination of these two drainage systems is advantageous because it maximises the relatively low cost storage for stormwater in the aquifer and provides benefits to the wider catchment through reticulation of flows unable to be accommodated within the aquifer. This may enable the size of the Meola Pipeline to be reduced compared with the 2.8m diameter pipeline assumed in the feasibility study. Option 3 has the lowest estimated cost and has the highest combined attribute score, primarily because it is likely to be the quickest and most straight-forward to construct and because cost is one of the significant criterion included in the multi-criteria analysis.

Benefit Afforded	**Option 1** **(Meola Pipeline)**	**Option 2** **(Motions Pipeline)**	**Option 3** **(Pump groundwater to drainage)**	**Option 4** **(New WTP using groundwater)**
Provides groundwater drainage of Eden Park to give protection against 10% AEP event	•	•	•	•
Improves surface water drainage along northern edge of catchment by reducing aquifer flow	• •	•	•	•
Allows inletting at Cricket Ave to be improved to accommodate a 10% AEP service level for surface water without causing flooding downstream	• •	•	•	x
Provides for future drainage of Eden/Dominion sub-catchment	•	x	x	x
Provides for drainage of wider catchment	•	x	x	x

Table 2: Options versus their benefits

Option	**Short Term Objectives Assessment**	**Long Term Objectives Assessment**	**Estimated Cost (short term only)**
Option 1 Pipeline to Meola Creek	2.6	4.1	$58.8 million
Option 2 Pipeline to Motions Catchment	3.3	3.8	$16.5 million
Option 3 Groundwater Abstraction and Discharge to Stormwater	4.4	4.1	$9.6 million
Option 4 - Groundwater Abstraction and Treatment for Potable Use	2.3	3.6	$25.7 million

Table 3: Benefit scores for both short and long term objectives

3 PROJECT DELIVERY

The feasibility study was completed in December 2009 and the Council Executive team approved the recommended option and project budget in February 2010. The standard process for an abstraction project would have been to construct the additional pumping wells required, test them and confirm using the hydro-geological model that the desired aquifer drawdown is being achieved. If not, either additional wells could be created. Due to the advanced stage of construction at Eden Park this was not feasible. In order to not delay the completion of the Eden Park development, the civil work design had to be fast-tracked and the pumping well chambers, discharge pipelines and the ducting for power and communications constructed prior to construction and testing of the pumping wells. The positions of the pumping wells were therefore fixed with the risk that any of the bores may not produce the desired abstraction rate.

The boreholes are currently being constructed as the civil infrastructure is being completed. In parallel to this the controls design has been undertaken and operation and maintenance responsibilities between Eden Park Redevelopment Board and Council is being agreed. The Council will undertake the operation and maintenance of the constructed boreholes and associated assets during the RWC. The Eden Park Redevelopment Board will meet the electrical costs during the RWC. Post the RWC, Eden Park Redevelopment Board will take over the operation and maintenance of the assets while the Council retains ownership.

The project will be constructed and commissioned by October 2010. In November 2010, the new Eden Park facility will have a trial run in which the abstraction system will be x operated and tested. The hydro-geological model will the updated with the data obtained during the commissioning and trial run phases and a resource consent application lodged with the Auckland Regional Council for the use of the pump wells during the RWC and beyond.

4 CONCLUSIONS

Through a consultative process and utilizing the appropriate expertise from a wide range of organizations a cost effective novel solution that can be delivered within the tight timeframe was able to be determined during the feasibility stage. Due to the need to build this solution in the middle of a busy construction site and also not delay the Eden Park development, the project is being delivered while managing a number of calculated outstanding risks.

At the time of writing this paper, the solution option was still being constructed and its effectiveness is yet to be tested and proven. Further information will be provided at the conference presentation.

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