SURREY
CITY OF PARKS

Corporate Report

NO: R099

COUNCIL DATE: May 29, 2006

REGULAR COUNCIL

TO:	**Mayor & Council**	DATE:	**May 25, 2006**
FROM:	**General Manager, Engineering**	FILE:	**1203-511**
SUBJECT:	**Groundwater Program Update**		

RECOMMENDATIONS

That Council receive this report as information.

INTENT

The intent of this report is to provide Council with an update on the Groundwater Supply Strategy and exploration program.

BACKGROUND

In 1998, the City commissioned the first phase of a groundwater supply study to investigate groundwater sources in Surrey in order to supplement water supply currently received from the Greater Vancouver Water District (GVWD). That study concluded that the City should develop a system of wells to supplement the GVRD supply. The highest priority areas identified were the North Surrey and South Surrey Uplands.

In September of 1999, Council authorized staff to proceed with exploratory investigations as the next phase of the groundwater supply strategy. As part of this strategy, a major upgrade of the well in South Surrey was completed.

In 2002, Council authorized staff to secure the City's rights to groundwater as a municipal service area, undertake an environmental assessment for an extensive groundwater extraction program in North and South Surrey Uplands, and notify the GVRD of Council's decision.

In late Fall 2003, Council approved the hiring of a drilling contractor to carry out the exploration and testing phase of the groundwater strategy. Thirteen wells were drilled and tested throughout Surrey (see Figure 1). Several studies were then conducted to assess groundwater quality, the financial feasibility of supplying groundwater,

groundwater optimization and the design of pumping facilities at Sunnyside. Discussions with GVRD staff are ongoing with staff generally supporting the idea of a secondary source of supply, particularly during times of water shortages. A brief description of the accomplishments is provided in Appendix A.

DISCUSSION

The drilling and exploration program was very successful with finding sources of groundwater with sufficient yield for municipal use within aquifers in the Sunnyside, Fleetwood and Clayton areas of Surrey. The results of the drilling activities are summarized in Appendix B.

The quality of the groundwater was checked for potability, with all test results except manganese, meeting the requirements of the Guidelines for Canadian Drinking Water Quality (GCDWQ). The manganese guideline is based on aesthetics and elevated levels may result in possible discoloration of clothing and/or staining of fixtures and appliances. Test results reported concentrations of arsenic in the Fleetwood and Clayton groundwater as being right at the upper limit of the drinking water guidelines. Due to this condition and because arsenic is a health related parameter which may be lowered in the future, lowering arsenic levels should be considered. Results of the water quality study and the impact of manganese and arsenic are described in Appendix C.

Options: Blending vs. Treatment

There are two options to reduce the manganese concentrations in the groundwater to within drinking water quality guidelines:

1. Treatment – removal of manganese and arsenic from groundwater with filters and adsorptive media at a water treatment plant, or
2. Blending - controlled blending of groundwater with GVWD water in a mixing tank prior to distribution.

A financial feasibility study was conducted to review the increase in production costs of groundwater due to treatment and blending. Detailed results are included as Appendix D. The table below summarizes the cost of production of groundwater in the various aquifers.

Table 1A: Financial Analysis – Blending Option

	Capital Cost ($)	O/M Cost ($)	Production Cost ($/m3)	Annual Savings Utility ($)	Annual Savings per Customer Account ($)
South Surrey	1,600,000	150,000	0.10	560,000	4.36
Fleetwood	3,700,000	240,000	0.18	385,000	3.00
Clayton *	2,600,000	115,000	0.24	109,000	0.85
Total				**1,054,000**	**2.74**

Table 1B: Financial Analysis – Treatment Option

	Capital Cost ($)	O/M Cost ($)	Production Cost ($/m3)	Annual Savings Utility ($)	Annual Savings per Customer Account ($)
South Surrey	4,000,000	510,000	0.29	170,000	1.33
Fleetwood	4,400,000	500,000	0.29	160,000	1.23
Clayton *	4,500,000	515,000	0.30	140,000	1.09
Total				**470,000**	**1.22**

* unconfirmed groundwater supply

The analysis demonstrates that more savings can be achieved with the blending option, but that the production cost is higher than previously estimated in 2002 ($0.08-$0.12 per m3), resulting in less than expected overall cost savings. This results from the additional costs related to water quality issues and an analysis of system demands that weren't known at the time of the earlier calculation.

CONCLUSION

The level of manganese and arsenic in the groundwater sources requires blending or treatment to ensure a continued supply of safe, clean and clear drinking water for our residents. The financial analysis demonstrates that although there could be some marginal savings by proceeding with the groundwater program, the uncertainty associated with water quality and related treatment pose a significant cost risk and could eliminate the savings relatively quickly. On this basis staff do not recommend utilizing groundwater as a 2nd supply to supplement GVRD water at this time. Staff will continue monitoring treatment technologies advances in conjunction with the purchase price of GVRD water and will report further to Council on the matter when staff are comfortable that the program will be cost effective and provide overall benefit to the City's customers.

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APPENDIX A
Summary of Works Completed 2003 - 2005

In addition to the Exploration and Testing Program, the following tasks were accomplished:

1) Water quality studies and feasibility analyses for water treatment alternatives have been completed in Clayton, and North and South Surrey to ensure the delivery of high quality drinking water to our residents.

2) An economic comparison of groundwater supply options for each of the aquifers has been completed. Earlier analyses (2002) have reported production costs of between $0.08 - $0.12 per cubic metre. We now estimate the cost to be between $0.10 (blending) and $0.30 (treatment).

3) A groundwater optimization study has been completed in support of the productive aquifer found at the Fleetwood Sports & Leisure Centre. Pumping strategies for the wells and modifications to the existing pumping station controls at Fleetwood and Whalley have been recommended.

4) Design of a new production well drilled near Sunnyside Park in South Surrey is complete and tender documents have been prepared.

5) Staff and management level committees have been established to work with the GVRD on issues involving the incorporation of groundwater to supplement the existing supply. Water quality, water turnover in reservoirs, and long range planning are items of discussion. GVRD staff generally support the idea of a secondary source of supply, particularly during times of water shortages.

6) A water quality monitoring plan to establish baseline conditions within the distribution system before and during groundwater pumping and blending with GVRD water has been completed.

APPENDIX B
Summary of Exploratory and Testing Program

The objective of this Program was to find sources of groundwater yielding adequate quantities and quality of water suitable as municipal drinking water. The Program was very successful in finding sources of groundwater.

Thirteen wells located within City owned lands and close to existing pumping facilities were drilled during 2004 and 2005. Listed below is a summary of the findings of the Program:

- High yield aquifer near Sunnyside Athletic Park near 19 Ave. and 148 St.
- High yield aquifer at the Surrey Sports Complex site near Fraser Hwy. and 166 St.
- Medium yield aquifer at Clayton Pumping Station near 72 Ave. and 190 St.
- Newton, Kennedy and Green Timbers aquifers did not yield adequate quantities of water to pursue any further

Sunnyside Acres/South Surrey Athletic Park

- A 400mm diameter production well was drilled to a depth of 150m below ground surface. The well was tested and then calculated to have a safe yield of approximately 70 L/s. The production well and related works have been designed and tender documents prepared to pump at an interim rate of 28 L/s. This will keep the combined pumping rate with the adjacent well, also located beside Sunnyside Acres, to below the environmental assessment trigger of 75 L/s. Only after completion of a successful environmental assessment can any additional well capacity be brought on-line.
- Drilled and tested a 250 mm diameter test well to a depth of 133 m at the south edge of South Surrey Athletic Park. The calculated safe yield of the well is 30 L/s.
- The combined theoretical flow from the wells exceeds the calculated well field capture volume of approximately 99 L/s. Additional well pumping and monitoring is required to determine the sustainability of the extraction rate and will be a part of any future environmental assessment.

Surrey Sports & Leisure Complex/Fleetwood Booster Station

- A test well, monitoring well, and production well was drilled and tested to depths of 150m.
- A highly productive aquifer was found at the Sports Complex site with a calculated well field yield of up to 185 L/s.
- Additional well pumping and monitoring is required to confirm the sustainability of various extraction rates and will be a part of any future environmental assessment.
- A test well was drilled to a depth of 180m next to the Fleetwood Booster Pumping Station at 9008 Fleetwood Way. Only damp soils were found demonstrating that the same aquifer found at the Sports Complex does not extend into this area.

Green Timbers Urban Forest Park

- Two test wells at depths of 40 m and 135 m were drilled and tested south of Green Timbers Park at 144 Street & 92 Avenue. Neither well was of sufficient yield to consider development as a municipal supply.

Clayton Pumping Station

- Two test wells and a monitoring well were drilled and tested near the Clayton Pumping Station (191 Street & 72 Avenue).
- The shallower aquifer located at a depth of 87m was not found to be productive enough to warrant further consideration as a municipal supply.
- An intermediate aquifer located at 125m is calculated to yield about 34 L/s.
- A deeper aquifer found at 180 m below ground surface could yield an additional 43 L/s.
- Construction of groundwater facilities in this area will not proceed until it is proven economically feasible to develop the existing sites and/or if additional supplies are found to support future growth in the next 5 years.

Newton & Kennedy Reservoirs

- Two deep wells were drilled which resulted in insufficient yield. One well was drilled to a depth of 165 m next to the Newton Reservoir at 128 Street & 62 Avenue. The other well was drilled to 180m beside Kennedy Reservoir, at 122 Street & 90 Avenue.
- No further activities are planned in this area.

APPENDIX C
Groundwater Quality Study and Impact of Manganese and Arsenic

The quality of the groundwater was checked for potability, with all test results except manganese, meeting the requirements of the current Guidelines for Canadian Drinking Water Quality (GCDWQ). The manganese guideline is based on aesthetics and elevated levels may result in possible discoloration of clothing and/or staining of fixtures and appliances.

Test results reported concentrations of arsenic in the Fleetwood and Clayton groundwater as being right at the drinking water guideline. Due to this condition and because arsenic is a health related parameter which may be lowered in the future, arsenic removal is considered in the financial analysis (Appendix D).

Potential problems related to manganese in water and information on arsenic in drinking water is discussed below.

(i) Manganese

The manganese concentration in the water from all of the aquifers tested, exceed the aesthetic guideline of 0.05 mg/L (refer to Table 2). Elevated manganese concentrations in groundwater are naturally occurring. It has been reported that as many as 25% of drinking water systems in Canada exceed the guideline (AWWARF, 2002). Dissolved manganese can come out of solution under the following conditions:

- when combined with an oxidant like bleach,
- when the pH of the water is changed by adding soap to the water when washing, or
- if the temperature is increased like in a hot water tank.

This may result in discoloured water and the formation of precipitate which in turn can stain clothing and household fixtures and appliances. This can also result in dirty water complaints from the consumer and the need for more frequent flushing of mains by the City. Langley Township has been experiencing cloudy and murky water from the manganese and iron found in some of their wells. As a result of many complaints, they have implemented interim measures like discontinued chlorination, reservoir cleaning, improved reservoir circulation, modifications to the reservoir outlet, and reducing the turnover time in the reservoir by adding GVRD water.

Over time, manganese can accumulate on the inside walls of the watermains within the municipal distribution system. When flow conditions change, the material can become re-suspended and flushed into the consumer's plumbing system. This typically results in dirty water complaints during the peak water demand season when velocities within the pipe are high.

Manganese exists in different forms in the groundwater found under Surrey. In South Surrey, laboratory controlled results have demonstrated that the manganese

oxidizes relatively quickly, and after controlled blending with GVRD water, will unlikely be of concern to the residents. A field sampling and testing program will be necessary to confirm the results and determine if operating adjustments are needed. In Fleetwood and Clayton, higher concentrations of dissolved manganese exist. In the lab the manganese from the Fleetwood aquifer remained in solution for a longer period of time. This could result in problems at the consumer's tap as the residence time in the system increases.

(ii) Arsenic

Arsenic is found naturally in rock formations and there are trace amounts of it in all living matter, however it has been documented as a human carcinogen. When the groundwater program started, the guideline for arsenic was 0.025 mglL. At the time the current guideline was approved by the Committee on Health and Environment this spring, an even more stringent guideline of 0.005 mg/L was proposed. Because the guideline value is restricted by measurement limitations, the current guideline of 0.01 mg/L is considered a realistic limit to measurement and has been termed a provisional or interim guideline value. The proposed value was considered to reduce our lifetime cancer risk to a near "essentially negligible" level.

In the interests of long term protection of the consumer, blending and treating arsenic to even less than the proposed guideline of 0.005 mglL has been evaluated in Appendix D. Table 2 reports average, measured concentrations of arsenic in the groundwater.

Table 2

Aquifer	Average Manganese (mg/L)	Average Arsenic (mg/L)
Clayton	0.12	0.012
Fleetwood	0.058	0.011
South Surrey	0.07	0.005
GVRD	0.002	< .001
GCDWQ limit	0.05 (aesthetic)	0.01 (health related)

APPENDIX D
Financial Feasibility of Treatment Versus Blending

Due to the concentration of manganese and arsenic found in the groundwater, either treatment or blending with GVRD water is needed. An economic comparison of groundwater supply options for each of the aquifers has been completed. While earlier analyses (2002) have reported production costs of between $0.08 - $0.12 per cubic metre, we now estimate the cost to be between $0.10 (blending) and $0.30 (treatment).

The costs to fully construct new wells, provide all pumping, treatment, disinfection, and standby power facilities have been included in the following financial cost analysis. Treatment costs are based on filters and adsorptive media technology with a plant capacity of 75 L/s. The economics of groundwater production beyond this capacity will improve if a larger treatment facility is constructed in anticipation of approval of an Environmental Assessment.

When evaluating the blending option, the average day demand was calculated in order to estimate the maximum supply to meet selected water quality criteria for manganese and arsenic concentrations within the distribution system. It was determined that in Clayton and Sunnyside the manganese concentration determines the required GVRD flow volumes to meet the selected water quality criteria, and in Fleetwood the arsenic concentration is the target parameter.

A summary of the flows required from the GVRD system is shown on Table 3. Average day water demands in the Fleetwood and Sunnyside zones are high enough to accommodate the additional supply from groundwater. The groundwater supply for the Clayton area is limited at this time by the average day demand. However, by the time a groundwater facility could be constructed in Clayton (2-3 years), it is forecasted that there will be a sufficient average day demand.

Table 3
Summary of Flows for Blending

Aquifer Area	Groundwater Supply (L/s)	GVRD Supply (L/s)	Total Supply (L/s)	Blend Ratio (% Groundwater / % GVRD)
Clayton [(1)]	17	48	65	25 / 75
Fleetwood [(2)]	75	90	165	45 / 55
Sunnyside [(2)]	75	100	175	43 / 57

Notes:
1. Requires 250mm diameter connection from GVRD.
2. Requires 300mm diameter connection from GVRD.

South Surrey

The results of the financial analysis are summarized in the table below for the year 2008 when GVRD bulk water rates increase to $0.37/m3.

	Capital Cost (75 L/s facility) ($)	Annual Operating Maintenance Cost ($)	Production Cost ($/m3)	Annual Savings Utility ($)	Annual Savings/ Customer Account ($)
Treatment	4,000,000	510,000	0.29	170,000	1.33
Blending	1,600,000	150,000	0.10	560,000	4.36

The blending option offers the City a greater cost savings when compared to treatment. Because the manganese was found to oxidize rather quickly, and due to the lower concentrations of arsenic, blending may be an appropriate option at this location. Blending is recognized as a viable mitigation strategy by the USEPA. Controlled blending of the groundwater with GVWD supplied water has appeared effective at the lab at diluting the overall manganese and arsenic concentrations to below existing guidelines. The blending option will dampen the potential nuisance impacts of manganese by lowering the concentration to 0.03 mg/L.

Monitoring and testing of the control measures and the effectiveness of the blending option, even with changes in water quality resulting from pumping the aquifer, will be required.

If existing Well #2 (currently off-line) is put back into operation on a full-time basis, it is expected that construction costs will be paid back within 2 years. It is further calculated that subsequent annual savings of approximately $500,000. could be realized.

Fleetwood

The results of the financial analysis is summarized in the table below for the year 2008 when the works could potentially be operational, and GVRD water rates are expected to increase to $0.37/m3:

	Capital Cost (75 L/s facility) ($)	O/M Cost ($)	Production Cost ($/m3)	Annual Savings Utility ($)	Annual Savings/ Customer Account ($)
Treatment	4,400,000	500,000	0.29	160,000	1.23
Blending	3,700,000	240,000	0.18	385,000	3.00

Both options will provide savings and reduce the overall cost of purchasing GVRD water. The cost savings may be further increased with additional groundwater pumping.

Treatment is recommended in Fleetwood because of the slow oxidizing nature of the manganese and the possibility of precipitate forming in the internal plumbing systems of residences. Accumulations of manganese deposits over time could be expected.

However, treatment provides a relatively low annual cost savings to our customers. This combined with the need to hire certified and experienced operators with an accompanying change to the classification of the water system, further reduce the benefits of this option. This option can be reviewed in the future as treatment technologies advance and possibly become more affordable.

Clayton

The results of the financial analysis is summarized in the table below for the year 2008 when the works could potentially be operational, and GVRD water rates increase to $0.37/m3.

	Capital Cost ($)	Annual O/M Cost ($)	Production Cost ($/m3)	Annual Savings Utility ($)	Annual Savings/ Customer Account ($)
Treatment (75 l/s)*	4,500,000	515,000	0.30	140,000	1.09
Blending (30 l/s)*	2,600,000	115,000	0.24	109,000	0.85

* unconfirmed groundwater supply

When considering the blending option, the water quality in the Clayton aquifer requires a higher proportion of GVRD water to lower the manganese concentration to below guideline levels. The water demands in Clayton will need to increase rather significantly and the groundwater supply and pumping rates confirmed, in order to improve the economics of implementing a blending program.

Treatment provides a relatively low, annual cost savings to our customers.

Additional exploration work and testing is necessary to confirm the quantity, quality and cost effectiveness of groundwater development in Clayton. The nature of the manganese found in this aquifer has not been evaluated to know whether it has slow or fast oxidizing qualities.