ITEM	3
MANAGER'S REPORT NO.	51
COUNCIL MEETING	93/09/07

TO: CITY MANAGER **DATE:** 1993 09 01

FROM: DIRECTOR ENGINEERING **FILE:** 42-01-07

SUBJECT: **WATER DISINFECTION UTILIZING OZONE**

PURPOSE: To provide Council with a review of ozone as a disinfectant in the drinking water supply.

RECOMMENDATIONS:

1. **THAT** the GVRD in its Stage 3 Environmental Impact Assessment Report respond to the issues raised in Section 9.0 of this report; and

2. **THAT** a copy of this report be sent to the following:

   a) Greater Vancouver Water District, 4330 Kingsway, Burnaby, B.C., V5H 4G8; and
   b) Ms. Om Sairam, 1852 Rosswood Place, Burnaby, B.C., V5A 3V5.

REPORT

1.0 BACKGROUND

Council has received several recent reports and presentations on the issues associated with drinking water quality and more specifically the issues of secondary disinfection. In particular, Council at its meeting of 1993 June 28 received a presentation from Ms. Om Sairam, 1852 Rosswood Place, Burnaby, B.C. regarding the use of ozone as a water disinfectant in various areas of the world. Council directed that staff report on the use of ozone in water treatment.

2.0 WATER TREATMENT PROCESSES

The degree of treatment required for drinking water is dependent upon the quality of the raw source water. The quality of the source water determines the solutions and costs for water treatment processes. Consequently, water treatment processes are site specific.

The GVRD has a surface water supply (ie. runoff and lakes) rather than a groundwater supply (ie. wells). Surface water quality problems are defined as those associated with particulate content, colour, taste, odour and microbiological content. The basic treatment processes may include some or all of the following - screening, primary oxidation/disinfection, coagulation, flocculation, sedimentation, filtration and secondary disinfection. Oxidation/disinfection is used to control bacteria content, algal growth, colour, taste and odour. Coagulation and flocculation are the chemical and physical actions which agglomerate the very fine particles which allow them to settle or be removed by filtration.

ITEM 3
MANAGER'S REPORT NO. 51
COUNCIL MEETING 93/09/07

At present, GVRD source drinking water is screened and has chlorine added as a primary disinfectant. The GVRD Drinking Water Quality Improvement Plan (DWQIP) proposes upgraded water treatment facilities.

3.0 GVRD - Improvement Plan

The GVRD has described the DWQIP as follows:

> *"...The ultimate objective of the Drinking Water Quality Improvement Plan is to provide water to GVWD member municipalities and residents that meets all of the requirements of the Guidelines for Canadian Drinking Water Quality (Health and Welfare Canada, 1989), and the B.C. Safe Drinking Water Regulations. Meeting these guidelines requires solutions to four primary issues:*
>
> - *Potential for waterborne diseases in the source water reservoirs, namely Giardiasis (Beaver Fever).*
> - *Turbidity levels that exceed 5 nephelometric turbidity units (NTUs), thereby reducing the disinfection effectiveness.*
> - *Seasonal bacterial regrowth in the water distribution systems.*
> - *Water corrosivity which has resulted in health, economic and aesthetic concerns.*
>
> *The Water Quality Improvement Plan proposes a three phased solution to these issues, as follows:*
>
> - ***Phase 1** - Upgrade source chlorination for giardia reduction at lower turbidity; construct transfer facilities to reduce turbidity by moving less turbid Coquitlam water to either the Seymour or Capilano service area; construct corrosion control facilities; and secondary disinfection for maintenance of a distribution system residual.*
> - ***Phase 2** - Construct a water filtration plant for the Seymour service area to eliminate turbidity and giardiasis concerns.*
> - ***Phase 3** - Construct a water filtration plant for the Capilano source service area to eliminate turbidity and giardiasis concerns."*

ITEM 3
MANAGER'S REPORT NO. 51
COUNCIL MEETING 93/09/07

4.0 OZONE IN WATER TREATMENT

The DWQIP proposes upgraded primary disinfection facilities as well as the introduction of secondary disinfection. Ozone is a powerful oxidant and disinfectant and therefore is a candidate for consideration for use in the DWQIP.

Ozone is an unstable gas whose chemical symbol is O_3. Ozone is manufactured by circulating oxygen and/or air through a high voltage electrical discharge which ionizes the oxygen molecules. Ozone cannot be stored or transported and is manufactured for immediate use. The use of ozone in water treatment has been employed since the turn of the Century.

Ozone is highly reactive which makes it a powerful oxidant and disinfectant however this highly reactive characteristic causes it to dissipate rapidly leaving little or no residual effect in water. Ozone is therefore not suitable as a secondary disinfectant.

The predominant early use of ozone in water treatment was for disinfection purposes (bacterial kill and viral inactivation). However ozone is also a powerful oxidant and this property is utilized to improve the aesthetic qualities of water by colour removal as well as taste and odour control. Oxidation with ozone often leads to a transformation of organic matter, making many non-degradable compounds biodegradable which may increase bacterial growth. Therefore ozonation should be used in conjunction with filtration.

Ozone aids the process of flocculation in water pretreatment prior to filtration. This is an advantage because it reduces the amount of chemical coagulants required and speeds up the filtration process. However studies on ozonation have shown that dissolved organics will be converted to more highly oxygenated materials that can and do flocculate, resulting in an increase in turbidity which must be removed by filtration. Further, dissolved organics will be converted to more highly oxygenated materials that are more readily biologically assimilable resulting in elevated bacterial growth in the distribution system. Biological filtration can be utilized to remove these products.

It should be noted that ozonation in water treatment has a high capital cost and is energy intensive.

5.0 HEALTH ASPECTS OF OZONATION

From a public health perspective, evidence to date does not indicate any deleterious health hazard to be associated with ozonation in water treatment, either as an oxidant or as a disinfectant.

Any excess gas from the treatment process must be recirculated or destroyed. Safe handling procedures must be employed to prevent release of ozone gas.

ITEM 3
MANAGER'S REPORT NO. 51
COUNCIL MEETING 93/09/07

Ozonation of drinking water does not result in the formation of trihalomethanes (THMs). THMs are disinfection byproducts that are formed when water containing organic matter is disinfected with chlorine. THMs are suspected carcinogens. Using ozone as a primary disinfectant before chlorine or chloramine is added as the secondary disinfectant reduces the potential for forming THMs.

6.0 OZONE APPLICATIONS

As stated previously, ozone in water treatment has been utilized since the turn of the Century. Its use is commonplace in Europe and is gaining prominence in North America.

6.1 EUROPEAN EXPERIENCES

Ozone is currently used in over one thousand water treatment systems in Europe. Throughout Europe ozonation is used in conjunction with filtration and secondary disinfection.

The exception to secondary disinfection is in Holland where about 90% of their water is distributed without a secondary disinfection residual. They accomplish this by using ozonation as the primary disinfectant followed by biological filtration. This reduces the assimilable organic carbon in the water which statistically reduces the regrowth of bacteria. This philosophy does not provide any safeguard against external contamination from pipe breaks, back siphonage, or cross connections.

6.2 NORTH AMERICA

Ozone has not been used as extensively in North America however its use is increasing.

The increase in the use of ozonation may be due in part to the introduction of the U.S.E.P.A. Surface Water Treatment Rule. Filtration of surface water is mandated by the U.S.E.P.A. Surface Water Treatment Rule unless certain stringent criteria can be met. This has meant that many cities have installed filtration plants which allowed them to consider the use of ozone.

Several major U.S. Cities however still do not utilize filtration including:

New York City
Seattle
Portland

Locally the CRD (Victoria) and, of course, the GVRD do not filter drinking water.

ITEM 3
MANAGER'S REPORT NO. 51
COUNCIL MEETING 93/09/07

6.3 CITY OF LOS ANGELES (L.A.)

L.A. has two major suppliers of bulk water:

- Los Angeles Department of Water and Power (L.A.D.W.P.); and
- Metropolitan Water District (M.W.D.)

The LADWP operates the Los Angeles Aqueduct Filtration Plant. This plant, built in 1987, has a treatment process which includes screening, ozonation, coagulation, flocculation, filtration and chlorination for disinfectant residual. LADWP selected ozonation to increase flocculation, improve filtration, increase disinfection and lessen byproducts. The LADWP have 25 rechlorination stations however there are no reported fish bearing streams in the service area and no mitigative measures are taken to prevent fish kills.

The MWD operates 5 water treatment plants, 2 of which provide water to LADWP. All five plants use filtration, 4 of the 5 use chloramine only for disinfection, the fifth is a pilot plant utilizing ozone as the primary disinfectant and chloramine as a secondary disinfectant. MWD supplies water to approximately 15 million people in Southern California including parts of L.A.

6.4 MONTREAL

Montreal obtains its water from the St. Lawrence River. Montreal has two water treatment plants:

- The Atwater Plant; and
- The Charles - J. Des Baillets Plant

The Atwater Plant which was initially built in 1918 and subsequently upgraded has a treatment process which includes screening, filtration and chlorination as a disinfectant.

The Charles - J. Des Baillets Plant treatment process includes screening, filtration, ozonation as primary disinfection and chlorination as secondary disinfection. This plant was designed in 1973 and became operational in 1978. During that time the water quality of the Great Lakes and the St. Lawrence River was very poor and so, for fear of further deterioration of the water quality, ozone was used because of its good bacterial killing property.

Montreal has very few pressure zones and only two rechlorination stations.

ITEM 3
MANAGER'S REPORT NO. 51
COUNCIL MEETING 93/09/07

6.5 SEATTLE

Seattle receives its water supply from the Tolt River and Cedar River. The Seattle system meets the Surface Water Treatment Rule without filtration therefore filtration is not mandatory. The water has chlorine and fluorine added and the pH is adjusted upwards to 8.

Seattle has 12 rechlorination stations. Fish bearing streams are present in the Seattle area and two incidents of fish kills have been reported in the past 4 years. Both incidents were the result of chlorinating newly constructed pipe rather than watermain breaks.

Seattle utilized chloramine in the past however switched to chlorine in the 1960's to obtain improved disinfection. The switch was apparently not undertaken for environmental reasons.

7.0 GVRD PROGRAM AND PLANNING STUDIES

On the Council Agenda for the meeting of 1993 August 20 was a letter from the GVRD advising that Predesign and Planning Studies Report for the DWQIP had been completed. This summary report included the engineering planning studies for the possible future water filtration plants, including evaluation of ozone, at Capilano Lake and Seymour Lake (Phase II and III of the DWQIP).

The summary report stated that a *"...pilot filtration plant study program was conducted over a one year period on both Capilano and Seymour sources. The purpose of the program was to establish unit processes and conceptual design criteria for future filtration plants for both sources. A number of different process options, including ozonation, were considered...*

The primary conclusion from the program is that filtration without the use of settling tanks using high flow rate filters with free chlorine or chloramine as a secondary disinfectant will meet the current and foreseeable Canadian Drinking Water Quality Guidelines...

Sedimentation and ozonation are not required for effective treatment of Seymour and Capilano sources. However, provision should be made for future addition of high rate sedimentation, ozonation and granulated activated carbon adsorption or operation of an expanded filtration system such as biologically active filters to maintain maximum treatment flexibility for source condition and regulatory changes. In addition, some of these more advanced processes could result in a reduced requirement for secondary disinfection and therefore less disinfection byproduct formation."

ITEM	3
MANAGER'S REPORT NO.	51
COUNCIL MEETING	93/09/07

As a response to the recent publicity on secondary disinfection, the GVRD has prepared a short discussion paper on the topic. The discussion paper is attached for the information of Council. It includes the GVRD position on the potential use of ozone and provides estimates of premium costs associated with using ozone.

In the discussion paper, cost estimates are provided for filtration at all three water sources, Capilano, Seymour and Coquitlam. Recent analysis of turbidity records by the GVRD concluded that all three sources do not meet the Canadian Drinking Water Guidelines and the US EPA Surface Water Treatment Rule for turbidity. Future changes in Provincial regulatory requirement conceivably may require filtration at all three sources. At present the DWQIP anticipates filtration at Capilano and Seymour only.

If filtration is ultimately imposed for the Coquitlam source (estimate $360 million) then for the use of ozonation and biological filtration to achieve the disinfection objective, it is estimated that an additional capital and operating cost of $460 million would be required.

8.0 CONCLUSION

Ozonation is a known and proven technology in water treatment. Ozone is a powerful oxidant/disinfectant. Ozone should be used in conjunction with filtration systems to obtain maximum benefit. The GVRD has studied the potential for ozone use and concluded that the current guidelines and regulations can be met without assuming the premium costs associated with ozonation.

Ozonation combined with biological filtration will produce a very high quality drinking water supply. This would significantly reduce the requirement for residual disinfection because it would remove the food material for bacterial growth. Secondary disinfection would still be required to provide a residual disinfectant to protect against cross connections and/or sanitary breaches.

9.0 RECOMMENDATION

Council has previously provided comment to the Stage 2 Environmental Impact Assessment Study and has posed questions to be answered in Stage 3. The Stage 3 report will develop recommendations regarding the secondary disinfectant alternatives.

ITEM 3
MANAGER'S REPORT NO. 51
COUNCIL MEETING 93/09/07

It is recommended that the Stage 3 report assess and respond to the environmental aspects of utilizing ozonation combined with biological filtration in the water treatment process. More specifically would the use of ozonation and biological filtration reduce the need for a disinfectant residual to a level which would eliminate risk to the environment from accidental water releases? If this concept is viable, then a cost/benefit analysis should be conducted.

W.C. Stoner

DIRECTOR ENGINEERING

WCS:mp
Attachment

cc: ( ) Director Administrative & Community Services
( ) Director Planning & Building
( ) Medical Health Officer
( ) Chief Environmental Health Officer