DISCUSSION PAPER

Capital Regional District
Core Area Wastewater Management Program

Integrated Resource Management Strategy

Discussion Paper – Water Reclamation and Re-use
031-DP-7

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1 Objective

This Discussion Paper provides an overview of reclaiming water from wastewater and its subsequent beneficial reuse. Topic areas discussed include reuse categories and trends both the in technology used to reclaim water and regulatory requirements associated with reuse. The paper also examines the regional reuse potential for water reclaimed from wastewater generated within the Capital Regional District in the context of the Core Area Wastewater Management Program.

2 Topic Area Overview

2.1 Reuse Categories

Water reuse can be defined simply as the use of treated wastewater (i.e. effluent) in a beneficial manner (Asano et al. 2007). Such reuse is dependent on water reclamation (Section 2.2), where wastewater treatment provides product water that meets definable criteria for reuse.

On the basis that suitably high-quality water can and is produced from municipal wastewater, the potential for reclaimed wastewater reuse spans a broad category range. Table 2-1 summarizes water reuse categories, and typical applications, based on historic and current practices. As noted in Table 2-1, the information is presented in descending order of volume of use.

The most common use of reclaimed water is for irrigation, a form of direct non-potable reuse (NPR), where many examples can be found around the world and in western Canada. The communities of Vernon, BC, Taber, AB and Moose Jaw, SK have long-standing agricultural irrigation programs using reclaimed water. Vernon also provides reclaimed water for golf course landscape irrigation, as does the Regional District of Nanaimo via the French Creek Pollution Control Centre.

At the other extreme of reuse implementation, only Windhoek, Namibia exists in the world as an example of a commercial-scale operation of direct potable reuse (DPR), where reclaimed water is directly piped to a potable water supply system (Asano et al. 2007). However, there are several

Table 2-1
Water Reuse Categories and Typical Applications (adapted from Asano et al. 2007)

Category	Typical Application
Agricultural Irrigation	
	crop irrigation
	commercial nurseries
Landscape Irrigation	
	parks
	school yards
	freeway medians
	golf courses
	cemeteries
	greenbelts
	residential
Industrial Reuse	
	cooling water
	boiler feed
	process water
	heavy construction
Groundwater Recharge	
	groundwater replenishment
	saltwater intrusion control
	subsidence control
Recreational / Environmental Uses	
	lakes and ponds
	marsh enhancement
	streamflow augmentation
	fisheries
	snowmaking
Non-Potable Urban Reuse	
	toilet flushing
	fire protection
	air conditioning
Potable Reuse	
	blending in water supply reservoirs
	blending in groundwater aquifers
	direct pipe to water supply

descending volume of use

examples of planned indirect potable reuse (IPR) schemes, where reclaimed water is blended with natural waters in surface water reservoirs or groundwater aquifers, the latter also being a form of groundwater recharge. Singapore's Public Utilities Board recent NEWater program is an example of IPR using surface water augmentation. California's Orange County Water District has practiced groundwater recharge and IPR with reclaimed water for several decades.

In the mid-range of reuse implementation is industrial applications. Again, many examples can be found around the world, but examples in Canada are still limited. One example is the City of Edmonton, which owns and operates the Gold Bar Wastewater Treatment Plant Industrial Water Reuse Facility. This 15 ML/d facility provides reclaimed water to Petro-Canada for use in its refinery process and, at the moment, is the largest industrial reuse program in Canada.

Section 2.3 provides details on specific reuse application examples.

2.2 Water Reclamation – Technology and Regulatory Trends

As noted previously, water reclamation refers to provision of wastewater treatment that produces product water that meets definable criteria for reuse. Based on this definition, technology and regulatory requirements are implicit with water reclamation and reuse. Asano et al. (2007) sums up the industry trends succinctly:

> *Technical advances in wastewater treatment processes and microbial and chemical contaminant detection technology, coupled with decreased costs as the technologies mature, undoubtedly will be reflected in future regulations.*

The benefits of technical advances are already leapfrogging current regulatory requirements. For many utilities, the minimum technology standard for water reclamation has evolved towards use of membrane systems for solids separation, often in a membrane bioreactor (MBR) configuration as opposed to tertiary effluent filtration, with ultraviolet (UV) irradiation used for effluent disinfection. Such a configuration provides a multi-barrier approach to pathogen removal, and enhanced removal of other conventional contaminants, that cannot be matched by more conventional systems. These benefits have been recognized by regulatory agencies and have been instrumental in the development of distributed wastewater management strategies that include water reclamation and reuse (Clerico 2007).

The MBR-UV configuration also provides maximum flexibility to respond to reuse opportunities as they develop, and can accommodate both unrestricted and restricted public access applications. For example, many industrial water reuse applications require further treatment (i.e. reverse osmosis, RO) of reclaimed water before use, typically in a treatment system located at the industrial site. High-quality feed water is needed for RO systems, which can be provided by MBR-UV treatment of the original wastewater.

Finally, the topic of micro constituents or contaminants of concern, many of which are the xenobiotic products of the industrial revolution (e.g. prescription and non-prescription drugs, veterinary and human antibiotics, industrial and household products, sex and steroidal hormones, other endocrine disrupting compounds), is another technology evolution driver. Although much remains to be learned, MBR-based treatment systems using UV irradiation appear to provide enhanced removal of micro constituents through a variety of physical-chemical and biological processes (e.g. Anderson 2005). Such performance may benefit not only irrigation reuse applications from a public health perspective, such as crop irrigation, but also recreational/environmental uses such as streamflow augmentation. Small urban creeks that are effluent-dominated do not offer the environmental buffer that can provide some constituent removal through natural degradation processes, in addition to dilution, that may minimize risks to both human and non-human receptors. A combination of MBR and UV technologies may prove advantageous in this situation.

Consistent with these technology and regulatory trends, the Core Area Wastewater Management Program, as described in The Path Forward document, recognizes the importance of MBR and UV technology in the context of water reclamation and reuse.

2.3 Reuse Application

As noted in Section 2.1, there are many examples of water reclamation and reuse programs around the world. The following case studies describe reuse applications of direct relevance to the CRD situation. They were selected for their diversity in scale and reuse application.

Brightwater Wastewater Treatment Facility, King County, Washington
The Brightwater facility, currently under construction, offers an example of a large-scale MBR (193 ML/d) facility that has significant flexibility to accommodate water reclamation and reuse. King County is currently building a reclaimed water distribution system into the Sammamish River basin that will terminate at a reservoir, which will provide the Willow Run golf course with irrigation water. The system will initially convey reclaimed water from the treatment facility under gravity flow conditions, with a capacity of 26 ML/d. In the future, the addition of a reclaimed water pump station at the Brightwater site will allow up to 76 ML/d of reclaimed water to be transported into the Sammamish River basin for agricultural and landscape irrigation, as well as commercial and residential reuse. Surplus effluent is discharged to the marine environment for disposal.

Dockside Green Development, Victoria
At the other extreme of the size scale, the Dockside Green Development will use a MBR-UV based system to treat wastewater generated by a new residential, commercial and light industrial development. Reclaimed water will be used for toilet / urinal flushing, on- and off-site landscape irrigation, and water features (e.g. ornamental fountains). Surplus effluent will be discharged to the environment. The treatment system will have an initial capacity of 0.19 ML/d, increasing to 0.38 ML/d as the development expands (www.docksidegreen.com).

Compared to the other examples presented in this section, the Dockside Green Development is unique in that it is a private development that is supplying reclaimed water for on-site recycling or reuse. This contrasts with the other examples where the reclaimed water is supplied by a public municipality or utility. Given this ownership, the regulatory authority required that a back-up connection to the City of Victoria sewerage system be available.

Artists rendering of Dockside Green Development

Source: www.docksidegreen.com

Municipal District of Lesser Slaver River No. 124, Alberta

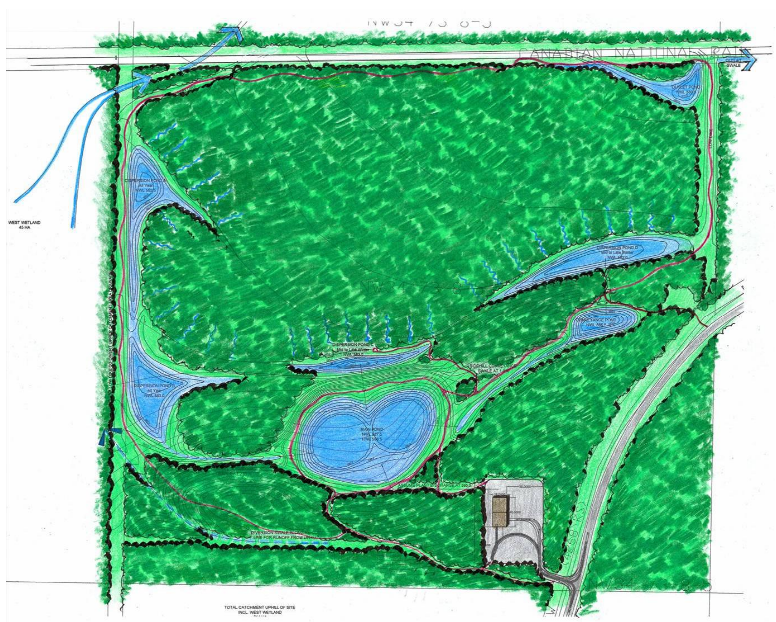
The recently commissioned Southshore Water Reclamation Facility (1.5 ML/d) provides a small-scale example of direct NPR in the form of marsh enhancement and streamflow augmentation. This facility, which uses an MBR-based process with UV disinfection of effluent, discharges effluent to an engineered and enhanced forest wetland. The wetland not only provides a community amenity, but also acts as an environmental buffer to the sensitive Lesser Slave Lake that ultimately receives the effluent.

Photograph of Southshore Water Reclamation Facility Forest Wetland

Source: Associated Engineering

Artist Rendering of Southshore Water Reclamation Facility Forest Wetland System

Source: Associated Engineering



3 Reuse Potential

3.1 Unit Basis

The reuse potential depends on opportunities available to use reclaimed water. Table 3-1 identifies what are likely the most feasible opportunities for reuse within the CRD in the near-term. This list is not intended to be exhaustive, but is provided for illustrative purposes at this time.

Landscape irrigation of a limited number of large green spaces, such as golf courses, parks and school yards, can be viewed with a high reuse potential at this time. Reclaimed water could be pumped in dedicated pipelines from spatially distributed wastewater treatment / reclamation facilities to the desired locations. Residential landscape irrigation also has a high potential in the near-term, but would be limited to new developments, or redeveloped areas, where dual water distribution systems have been installed to supply both potable and non-potable water to individual residences.

The peak summer irrigation requirement for turf grass in the Victoria area is approximately 19 mm per week, which includes an assumed application efficiency of 70% (Irrigation Industry Association of British Columbia 2008). On this basis, the unit irrigation potential of effluent is approximately 53 m^2 of irrigated land area per 1 m^3 of effluent, as applied on a weekly basis.

If dual plumbing systems were installed within the residences themselves, reclaimed water could be used for toilet flushing. This type of “purple pipe” situation is consistent with the intent of Provincial policy described in the recently released *Living Water Smart – British Columbia’s Water Plan*. This reuse application also has a high potential in the near-term, but, similar to residential landscape irrigation, would be limited to new developments or redeveloped areas. For low-volume toilets using 6 L of water per flush (British Columbia 2007), and an assumed average number of five toilet flushes per day per person (Mayer et al. 1999), the unit toilet flushing water requirement is 30 L/d-p.

3.2 Regional Potential

First consider effluent used for landscape irrigation. Based on the Core Area Wastewater Management Program, the total effluent generated within the core area will equate to approximately 95 ML/d and 160 ML/d presently and in Year 2065, respectively. Using information from Capital Regional District (2006), the irrigable area of a single-family home lot was estimated to be approximately 300 m^2. Using these values and the unit irrigation value from Section 3.1, the reclaimed effluent could potentially be used to irrigate approximately 116,000 residential lots at the present time, increasing to about 196,000 residential lots in Year 2065. Looked at another way, such volumes of reclaimed effluent could be sufficient to irrigate 70 golf courses at the present time, increasing to 118 golf courses in Year 2065. This potential is based on golf courses with an area of 50 ha, which is typical of those existing within the CRD. Currently there are 10 golf courses within the CRD Core Area.

Table 3-1
Near-Term Potential Water Reuse Applications with the CRD

Category	CRD Application Potential
Agricultural Irrigation	
	crop irrigation
	commercial nurseries
Landscape Irrigation	
	parks
	school yards
	freeway medians
	golf courses
	cemeteries
	greenbelts
	residential
Industrial Reuse	
	cooling water
	boiler feed
	process water
	heavy construction
Groundwater Recharge	
	groundwater replenishment
	saltwater intrusion control
	subsidence control
Recreational / Environmental Uses	
	lakes and ponds
	marsh enhancement
	streamflow augmentation
	fisheries
	snowmaking
Non-Potable Urban Reuse	
	toilet flushing
	fire protection
	air conditioning
Potable Reuse	
	blending in water supply reservoirs
	blending in groundwater aquifers
	direct pipe to water supply

Potential Rating

high
moderate
low

Of course, in both situations, turf grass irrigation requirements vary significantly throughout the year. This situation means that not all effluent, or at some times no effluent, could be used for irrigation purposes. In turn, surplus effluent would need to be released to the environment during these periods.

One particularly interesting perspective involves consideration of the amount of wastewater generated per person in a residential household relative to the irrigation requirements of a single-family home. A unit wastewater generation rate of 225 L/d-p has been used for planning purposes in the Core Area Wastewater Management Program. Assuming 2.2 persons per household on average for the Victoria area (British Columbia Statistics 2007), the amount of wastewater (i.e. effluent that originates from that wastewater) generated by the household would be 495 L/d or 3,500 L/wk. Based on the values presented earlier, the weekly irrigation requirement for the lot would be 5,700 L/wk. Therefore, at least for part of the year, the typical household generates a deficit volume of wastewater relative to the household lots irrigation requirements. Effluent originating from households without yards would help to overcome this deficit.

Examining the potential for reusing effluent for residential toilet flushing requires a different perspective. As noted in Section 3.1, the unit toilet flushing water requirement is about 30 L/d-p. This value represents about 13% of the total amount of wastewater generated per person in a residential household (225 L/d-p). In other words, of all the wastewater generated in a household, only about 13% of the reclaimed water originating from that household could be used for residential toilet flushing. The regional ADWF flow values discussed above include a base groundwater infiltration allowance for the sewer system, which increases the unit wastewater generation rate to about 250 L/d-p and, in turn, reduces the relative amount of water used for toilet flushing to about 12%. This means that of the 95 ML/d of effluent that would be generated at the present time, only 11 ML/d of reclaimed effluent could be used for residential toilet flushing. This daily volume would increase to 20 ML/d in Year 2065.

4 Summary

Water reclamation and reuse has a long, albeit limited, history in wastewater management. Ongoing technology development has increased the feasibility of reuse programs, and frequency of their implementation, particularly in the context of distributed wastewater management schemes as envisioned in the Core Area Wastewater Management Strategy. One of the key challenges is the alignment of opportunities with resources. However, new community development, and redevelopment, can be planned to maximize this alignment and thus reuse potential. Another key challenge is disposal of surplus effluent, to the environment, that cannot be reused. Again, this challenge can be overcome with appropriate planning. Overall, given the opportunity afforded by its currently limited investment in wastewater infrastructure, the CRD is well positioned to integrate water reclamation and reuse in the implementation of its wastewater management strategy.

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