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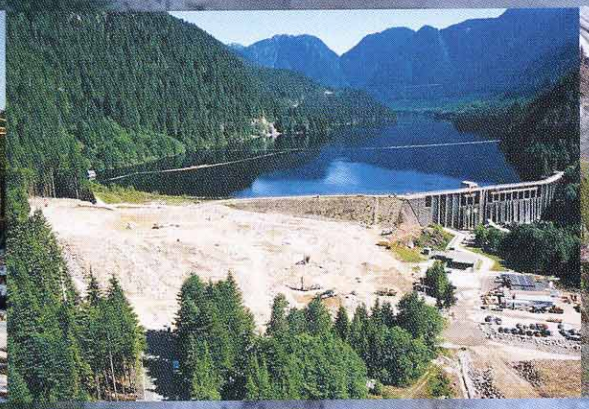

## Greater Vancouver Regional District's Seymour-Capilano Project

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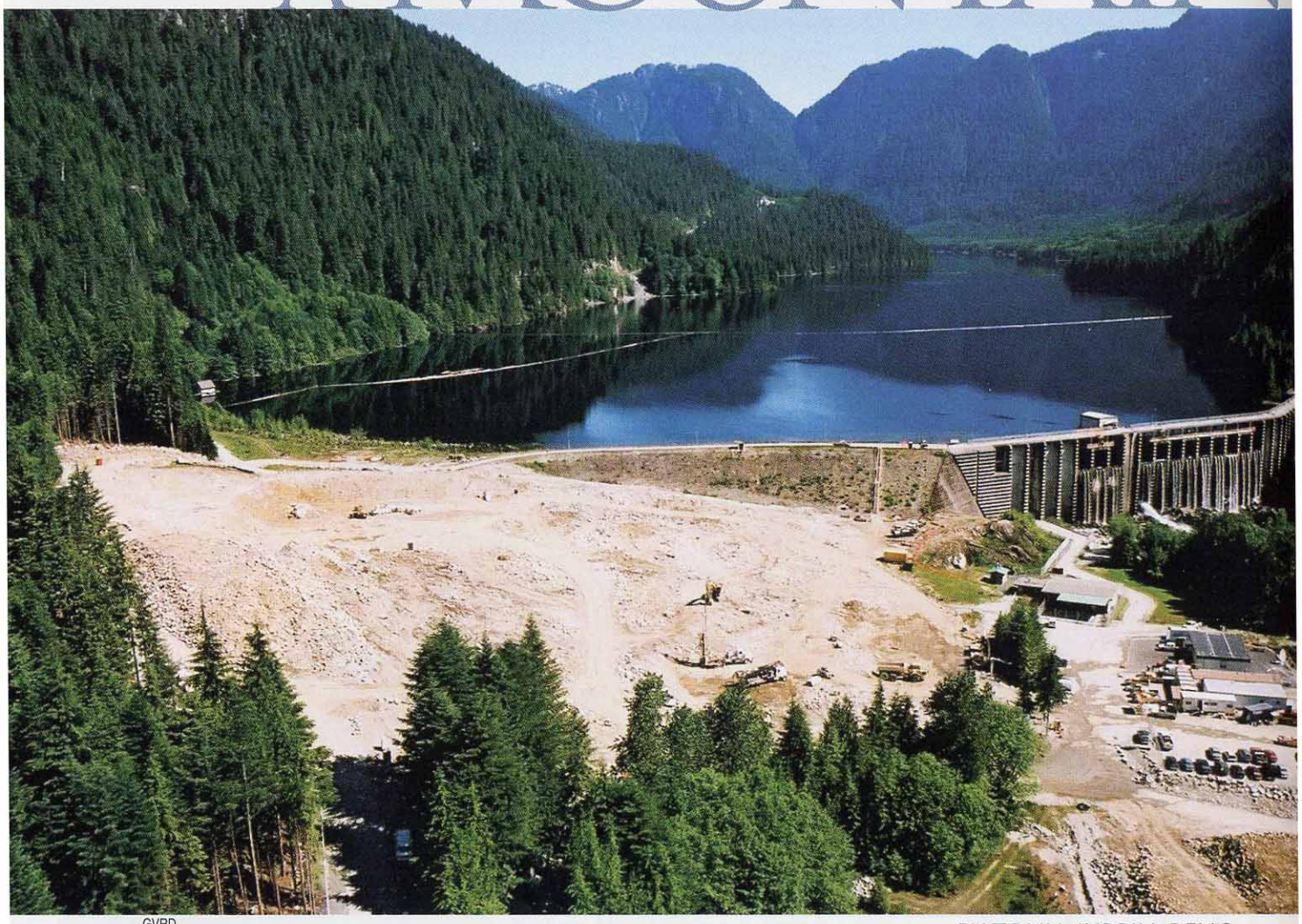
# SEYMOUR-CAPILANO A MOUNTAIN



GVRD

BY TONIA JURBIN, P.ENG.

The Greater Vancouver Regional District's water supply is in the midst of a $600-million dollar upgrade. The work includes a filtration plant that when complete will be Canada's largest, twin 7-kilometre long tunnels that will carry water from one reservoir to the filtration plant and back, a pump station and an energy recovery plant. All three of the major dams — Cleveland, Seymour Falls, and Coquitlam — are in some stage of a major structural retrofit as well.

Serving over two million people in 17 municipalities, the Greater Vancouver Regional District's system draws its water from three protected sources in the mountainous watersheds to the north. So how did this mega-project to upgrade the system come about? In 1984, the city of Vancouver, one

THE WORK TO UPGRADE THE WATER SYSTEM SERVING TWO-THIRDS OF THE GREATER VANCOUVER REGIONAL DISTRICT IS VAST AND MULTI-FACETED. IT INCLUDES BORING TUNNELS BELOW THE NORTH SHORE MOUNTAINS AND DESIGNING THE COUNTRY'S LARGEST FILTRATION AND ULTRAVIOLET TREATMENT PLANT.

# OF A PROJECT

GVRD

Far left: earth works at the Seymour Dam built in 1961 to make it seismically sound. Left: form work at the Capilano pump station.

of GVRD's member municipalities, had determined that the Canadian drinking water standards were not consistently being met. Though non-pathogenic bacteria were present, the presence of bacteria re-growth in the distribution system was a strong indicator that there were systemic problems.

Doug Neden, P.Eng., GVRD's division manager for water treatment engineering, describes other problems with the system. "The pH at 6.0 was consistently lower than the Canadian standard of 6.5-8.5," he says. "And with chlorine as the primary disinfection, the value was being driven down even further, increasing pipe corrosion throughout the system."

Neden continues, "The turbidity of the water was also a concern. The standard at the time was 5 NTU (nephelometric turbidity units); at Capilano and at Seymour it was often higher."

In 2000 Health Canada released statistical data linking water turbidity and gastro-intestinal problems. They looked at correlations between periods of high turbidity and visits to doctors and hospitals. By April 2001 a few months before the Liberals took power in B.C., the New Democrats brought in the Drinking Water Protection Act in which it became law to meet the Canadian Drinking Water standards. At that time the turbidity standard was lowered from 5 NTU to 1 NTU. Turbidity is not only an aesthetic concern. Particles in the water interfere with the disinfection process, allowing micro-organisms to "hide" in silt and causing the chlorine to break down before it reaches the parasite or bacteria.

The GVRD board had already committed to a staged process of improving the drinking water quality. By 1998 an interim upgrade of the chlorination plant, along with pH adjustment, was completed at the Seymour reservoir. Eight chlorine booster stations for secondary disinfection were soon added to the system. In 1999 the Coquitlam reservoir to the east had a major upgrade with a $40-million ozone disinfection plant, upgraded chlorine secondary disinfection and pH adjustment. It currently produces the highest quality water in the system.

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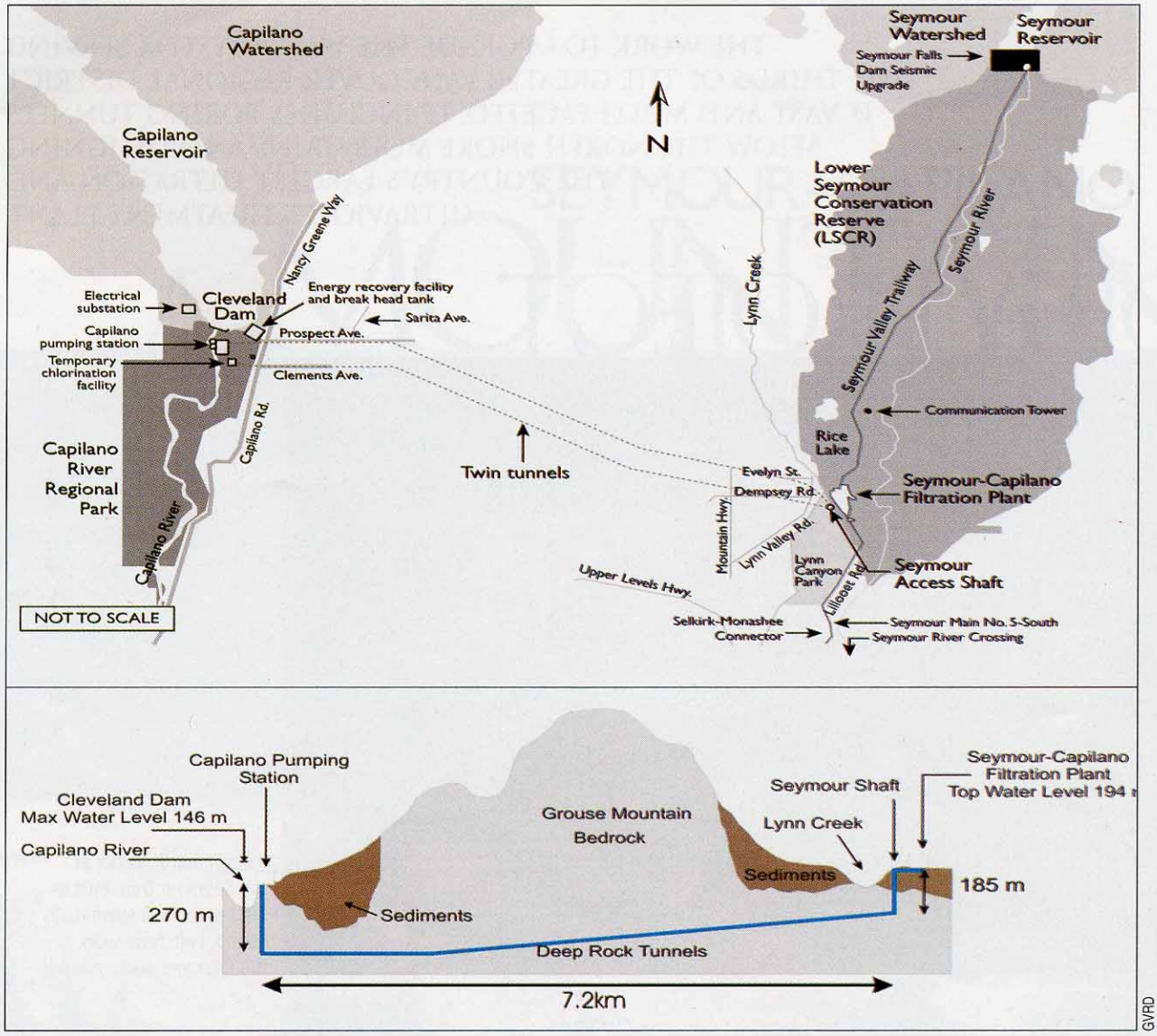


Top: components of the Seymour-Capilano filtration plant project. Above: elevations for the twin tunnels, which at one point are 650 metres below the surface.

The 90-year old hydraulic fill Coquitlam Dam itself, however, does not meet current safety standards nor is it practical to retrofit. The dam's owner, BC Hydro, will be constructing a new earthcore rockfill dam just downstream of the existing dam at a cost of about $40 million.

## Seymour-Capilano Filtration Project

At the centre of the work to upgrade the Seymour-Capilano system is a large filtration plant being designed for a location at the base of Rice Lake to the south of the Lower Seymour Conservation Reserve. After analyzing the social, environmental, economical and technical issues, the GVRD decided to expand on its plans to build a new plant at Seymour so that it would not only treat water from the Seymour reservoir but also water from the Capilano reservoir to the west. Water from Capilano will be conveyed through a tunnel to the Seymour plant, and returned to Capilano through a parallel tunnel by gravity.

The original intent for the filtration plant was to tender a design-build-operate contract, but by June 2001 the GVRD had decided to use the conventional design, bid, build approach. Derek Corrigan, mayor of the city of Burnaby and chair of the GVRD Water Committee, explains: "We need flexibility during the design because we need to know exactly what we want before we start construction. We may overconstruct when we do it ourselves, but we have to keep running these facilities for the foreseeable future, so longevity and maintenance are important issues. It is also important to realize that when we contract out for expertise in our core areas, we may lose the ability to do these functions and be-

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come dependent on the private sector company. This leads to sole-sourcing, as opposed to competitive bidding."

In September 2002 a subsidiary of SNC-Lavalin known as Pacific Liaicon & Associates was hired as project management consultant for the entire $450-million Seymour-Capilano filtration project. A consortium called "SSBV," which consists of Stantec, AMEC and Black & Veatch, is designing the filtration plant itself and the clearwells. Construction is due to be completed in 2007.

One of the driving forces behind the Seymour-Capilano project schedule is the complicated funding formula. An $18-million dollar provincial grant must be spent on the pumping station at Capilano by March 2005. A further $100 million dollar grant through the Canada-British Columbia infrastructure program must be spent on the filtration project by March 2006.

The filtration plant is located about 11 kilometres south of the Seymour Falls Dam. Once complete it will be the largest filtration plant in Canada and the largest ultraviolet drinking water disinfection plant in the world until a plant in New York comes on line in 2009. Up to 200 million litres of water will be stored in clearwells that will be topped by a landscaped roof.

The plant will have the capacity to filter up to 1.8 billion litres of water per day. The excavation for the clearwells is complete and the contract for the ultraviolet disinfection equipment was awarded in September 2004.

To pump 1.1 billion litres of water from the Capilano reservoir upgrade 65 metres through 7.2 kilometres of tunnel takes power, lots of power. The pumping station is located below the Cleveland Dam and is one of Canada's largest at 16,000 HP. Designed by the SSBV consortium, the station is almost complete. When treated water comes back down the twin tunnel from Seymour to Capilano it will power a 1.8 MW turbine that will be used to supply part of the pump station's power needs.

The twin tunnels to convey water between Capilano and Seymour are designed by engineering consultants Hatch Mott MacDonald and Golder Associates. The 185-metre deep tunnel entry shaft at the Seymour end began construction in late 2004. The exit shaft 270-metres deep at the Capilano end will be excavated by raised boring, with completion due in 2008.

## Seymour Falls Dam

Part of the seismic upgrade of the Seymour Falls Dam is being done using explosive compaction techniques. Built in 1961, the dam is being upgraded to withstand a 1:10,000 year, or the maximum credible earthquake. Both the concrete and earth portions have to be strengthened. Klohn Crippen is the consulting engineer, with Pieter Kiewit as prime contractor.

The dam could not be taken out of operation during the upgrade, so the strategy is to extend the existing earthfill section downstream by about 70 metres and allow the existing earthfill dam to deform during an earthquake. To build the new portion, variable granular soils in front of the existing dam must be improved to a depth of about 30 metres. The bottom 10 metres are being compacted using the explosion compaction technology, the middle 10 metres will be compacted using dynamic compaction and the

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## SEYMOUR FILTRATION PLANT & TUNNELS

The new direct filtration plant will be the largest in Canada and will have the largest ultraviolet disinfection capacity in the world. Located on a 16-hectare site near Lillooet Road in Lynn Canyon Park, the plant will be able to process 1.8 billion litres of water a day from the Seymour and Capilano Reservoirs. It will supply 70% of Greater Vancouver's two million people.

The plant's treatment processes are coagulation, flocculation, direct deep bed anthracite media filters, followed by UV primary disinfection. There is also lime and carbon dioxide corrosion control, and sodium hypochlorite chlorine secondary disinfection.

The alignment of the twin tunnels to carry water to and from the Capilano Reservoir to the filtration plant at Seymour Lake was decided after a year of test drilling. Two rock tunnel boring machines have begun from an entry shaft at the Seymour end. The boring machines will continue west underneath Mount Fromme and Grouse Mountain, burrowing through bedrock up to 650 metres below the surface. Each tunnel will be 7.2 kilometres long and approximately 3.7 metres in diameter, in portions lined with welded steel liner pipes.

Because of the rising grade, a pumping station in Capilano River Regional Park is required to push the water towards Seymour. On the return journey water will flow by gravity back to Capilano, and the water pressure will be used to power a 1.8-MW turbine for energy recovery.

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top layers will be placed with compacted structural fill.

Explosive compaction is used to densify loose, saturated, medium to coarse materials. The method requires installing plastic casings ranging in size from 3" to 5" diameter, theoretically up to any depth. The holes are charged with multiple prepackaged explosive cartridges separated by gravel stemming, and the explosions and vibrations are controlled by methods such as limiting the charge weight per delay and using electrical sequential blasting methods.

The specialized work is being carried out by Explosion Compaction of Surrey based on full-scale field trials. The challenge to use the specified method rests with the contractor. The loose saturated sands and gravels with cobbles and boulders make for difficult drilling, and typical confirmation cone penetration testing is not practical, nor would the results be reliable. Densification results were accepted based on extensive monitoring of the settlement. The contractors are using a combination of three methods to ensure detonation of every charge of about 38,000 kilograms of explosives.

Klohn-Crippen were also the consulting engineers on a $25-million program to upgrade the Cleveland Dam at the Capilano reservoir, which was completed earlier in January 2002.

## Ecosystem approach

The watersheds of Vancouver's North Shore mountains are an environment the GVRD wants to conserve, so the greatest care has been taken to minimize the projects' environmental impact. Community plant salvage, wildlife surveys, the use of EcoSmart concrete, stormwater management, green roof technologies, geothermal energy, and site revegetation make up some of the environmental approaches. As well, to minimize project costs and the impact on the host municipalities, all the gravel, riprap and concrete aggregate in these massive projects are taken from quarries in the watersheds, and all the overburden removed is stored in gravel pits and other sites in the same watersheds. The disposal sites will be reclaimed.

Whitepine Resources of Vancouver won the contract to do environmental auditing for all these projects for GVRD. They adopted GVRD's ecosystem approach and initiated a comprehensive preconstruction site inventory and habitat ranking program. The site restoration should result in more biodiversity over a shorter period of time. Franck Berry, President of Whitepine elaborates, "Instead of planting a uniform landscape, or a monoculture, we planted woody debris, plant clusters, a mix of wetlands areas and dry zones. By doing this we hope to accelerate the process and create habitat for small birds and animals right away. In a monoculture this biodiversity would take at least a generation."

## A boost for engineers

According to the GVRD, the Seymour-Capilano project will bring significant benefits to the region. It will improve the quality of drinking water by removing microorganisms,

organics, silts and clays caused by heavy rainfall. The filtration process will reduce the amount of chlorine required. As well, the water will be treated to reduce corrosion in pipes and the staining of plumbing fixtures. Besides the large filtration plant and other components, the distribution system is being upgraded, including more than 13,000 metres of new water mains to be installed from Seymour Falls Dam to Burrard Inlet.

Mayor Corrigan also sees this project as important to the local engineering community: "There has to be a desire for B.C. engineers to lead in this infrastructure work and it's up to the politicians to support them. I want our engineers to give us their best and to showcase their management skills. I don't want these projects to be taken over by international consortiums just because our engineers can't organize international financing. When that happens the projects are quickly taken out of the hands of engineers — whom we've entrusted with our infrastructure — and put into the hands of accountants and financiers. We want the world to come to B.C. for our expertise. We need to become a centre of knowledge because that is the greatest renewable asset we have to export. I believe that we have the potential to become the new Athens of the 21st century. We are highly educated. We have a neutral and advantageous location and we are one of the most multicultural cities in the world. Vancouver can become a centre where our product will be our knowledge and our creativity." CCE

*Tonia Jurbin, P. Eng. is a freelance writer and geotechnical engineer based in Vancouver, www.toniajurbin.com.*

***Owner:*** *Greater Vancouver Regional District (Tim Jervis, P.Eng., Doug Neden, P.Eng.)*
***Seymour-Capilano project management, overall:*** *Pacific Liaicon & Associates (subsidiary of SNC-Lavalin) (Brian Gardner)*
***Seymour-Capilano Filtration Plant:*** *SSBV (a consortium of Stantec, AMEC and Black & Veatch)*
***Twin Tunnels:*** *Hatch Mott MacDonald, Golder Associates*
***Capilano Pumping Station:*** *SSBV*
***Capilano Energy Recovery Plant:*** *Knight Piesold*
***Cleveland Dam upgrade:*** *Klohn Crippen*
***Seymour Falls Dam upgrade:*** *Klohn Crippen*
***Environmental consultant:*** *Whitepine Resources*

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