C.1 TRANSPORTATION SYSTEM

Lori Philps & Shawn Natrasony

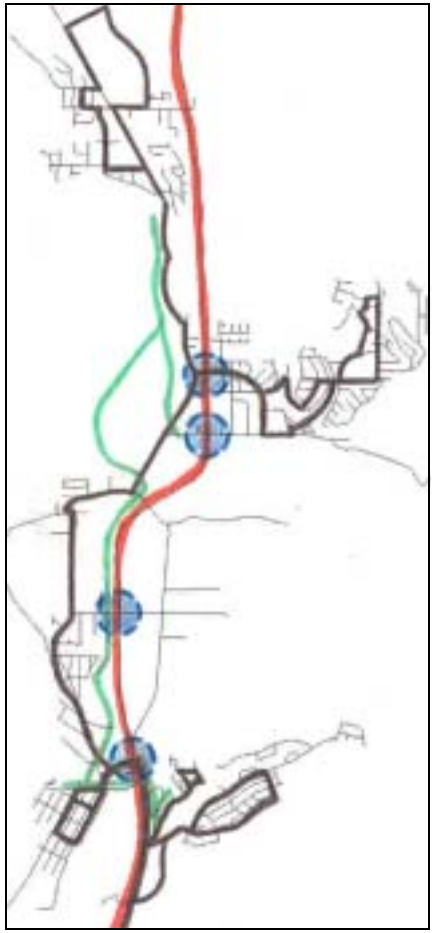
C.1.1 Transportation Corridor

The 307km transportation corridor that runs from Horseshoe Bay to Highway 97 encompasses both Highway 99 North and the CN Rail Mainline and plays an integral role in the provincial economy. The corridor is characterized by poor average travel speeds in many 2-lane rural sections and congestion through urban sections with traffic signals. As well, it has limited resource capacity during peak travel times and highway accident rates and severities which exceed provincial averages. The busiest sections of the corridor are the southern sections between Horseshoe Bay and Squamish and the urban sections between Squamish and Whistler.

C.1.2 Sea to Sky Highway Improvements

The Sea to Sky Highway links communities from West Vancouver to Whistler and is an asset to commuters who travel daily to and from the lower mainland. Vehicle traffic on Highway 99 is expected to increase by 6-7% over baseline estimates for 2010 and 2025. By 2009, extensive highway improvements will make travel through the corridor safer and more efficient. The improvements should accommodate population growth and economic development in corridor communities, as well as the increasing demand for travel and the movement of goods. Such improvements include highway widening and straightening, improved sightlines, passing lanes and capacity. As there are many geographical challenges for expansion of the corridor, cost estimates for upgrading the highway to a 4-lane expressway from Horseshoe Bay to Whistler are measured in the billions of dollars.

In Squamish, the highway will be upgraded to two lanes both northbound and southbound. As well, the intersections at Cleveland Avenue, Industrial Way, Mamquam Road and Garibaldi Way will be upgraded. With an improved highway to Vancouver, there is a possibility that Squamish will become viewed as a commuter-based community for residents who work in the GVRD. Based on high end land use projections, it was estimated that traffic volumes in and out of Squamish will increase by 72% by 2019. The highway upgrade may also include improved access to downtown Squamish, involving the future Valleycliffe-Downtown Connector as part of a long-term (25 year) plan. This connector, which would parallel the highway on the north end of the Mamquam Blind Channel and connect with existing Pemberton Avenue, would allow for easier access to the downtown and may alleviate some traffic congestion at the Cleveland Avenue/ Highway intersection.

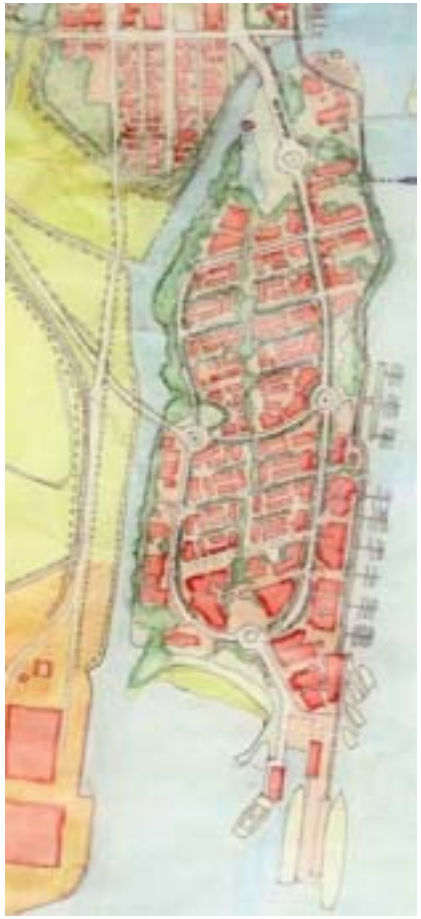


Highway 99 corridor and Squamish street system. Highlighted are local transit routes (brown), bike trails (green) and key intersections selected for upgrades along Highway 99 (blue).

C.1.3 Street Network

Cleveland Avenue, which connects at Highway 99 as a signalised intersection, is the primary access to downtown Squamish. Buckley Avenue/ Government Road parallels the Highway 99 corridor to the north, acting as the secondary access to downtown. Cleveland Avenue, generally aligned north-south, constitutes the main commercial strip within downtown Squamish. It is characterized by a steady flow of daily traffic, controlled by four-way stop intersections. The main parallel roadways include Loggers Lane to the east and 2nd and 3rd Avenues to the west. The industrial zones located south of the downtown area are mostly accessed by Loggers Lane. This two-lane street is distinguished by a high volume of heavy truck traffic.

The Squamish downtown waterfront is expected to see some changes with its street network according to the Squamish Downtown Waterfront Initiative Concept Plan. A modified grid pattern, oriented to maximize solar exposure and mitigate the effects of high winds, is proposed within the waterfront lands. The Cattermole Slough would be connected to the Mamquam Blind Channel, turning the downtown waterfront into an island. A proposed realignment will continue "main street" from the existing downtown to the new downtown waterfront lands, via the Cleveland Avenue Bridge crossing. East of the vehicular bridge, a pedestrian bridge will cross the Cattermole Slough linking the waterfront walkway from the north to the south. A full-service marine terminal with associated infrastructure is proposed for the tip of the waterfront lands for passenger ferries.



The proposed modified grid pattern for the downtown waterfront (Squamish Downtown Waterfront Initiative Concept Plan).

C.1.4 Rail

The Royal Hudson rail line, previously managed by BC Rail, transported travelers from Vancouver to Squamish on a daily schedule. This service was recently cancelled and there are no current plans by the Provincial Government to reactivate it. As the train station was located within the downtown of Squamish, the cancellation of this service has lead to a decrease in pedestrian visitors and economic activity within this immediate area. The reactivation of a pedestrian rail line to downtown Squamish should be explored through a variety of options, including discussions with CN and potential private rail operators.

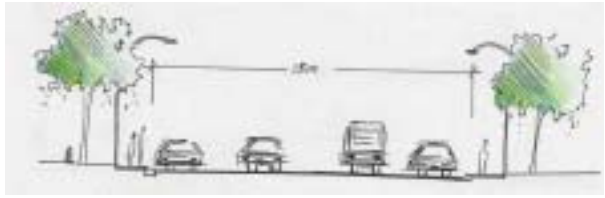
C.1.5 Transportation Alternatives

As Squamish continues to grow as the regional service centre, development of new transportation forms will be desirable. Passenger-only ferry service from downtown Vancouver and the Vancouver International Airport to a new full-service marine terminal at Squamish is planned during the 2010 Olympic. The District of Squamish is also investigating the feasibility of passenger ferry service for commuters and visitors from downtown Vancouver to Squamish.

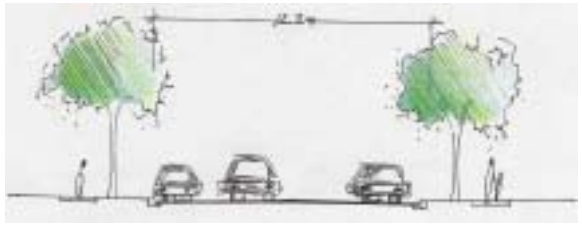
C.1.6 Transportation Policies

The Squamish District Official Community Plan (1998) is a framework for directing future growth and development in the region. The selected policy statements guide transportation decisions in the region:

- The Transportation Plan seeks to encourage non-auto transportation through the development of on-street bicycle lanes.
- Additional north/south road capacity will be required across the Mamquam River, primarily east of Highway 99.
- New developments should be planned in co-operation with B.C. Transit to ensure that proposed residential densities are adequate to meet public transit objectives.
- The placement of commercial development and higher density along collector roadways where transit service is planned shall be encouraged.
- Alternative means of transportation to extend the capacity of existing road infrastructure by reducing single occupancy rates will be encouraged. This will include car and van pooling, and improved local public transit and commuter transit links to Greater Vancouver and Whistler.
- The Transportation Network Plan allowing transit to travel along local and collector streets with a minimal reliance on Highway 99 is supported.



Section depicting existing downtown commercial street.



Section depicting existing residential collector street.

C.1.8 Automobile Dependence

The private automobile is the choice for 86% of work trips in the District of Squamish due in part to the geography of the region and commuting to points outside of the region (BC Stats). In Vancouver, 61% of work trips are by automobile. The number of licensed passenger vehicles in Squamish rose 36% in Squamish from 1993 to 2003; while Vancouver witnessed a 20% increase (BC Stats). During the same period, population growth in Squamish and Vancouver was 13% and 15% respectively (BC Stats).

C.1.9 Transit Provision

The Squamish Transit System provides bus service between downtown Squamish and the neighbourhoods of Brackendale, Garibaldi Highlands, and Valleycliffe. There is limited commuter service to the Woodfibre Ferry. Bus schedules vary, with hourly service in off-peak hours and some additional service in morning and afternoons. There is no Sunday service available.

Mode	Squamish	Vancouver
Automobile	86%	61%
Public Transit	1.5%	23%
Walk	6%	11%
Bicycle	2%	3%

Usual mode of transportation to workplace comparison (BC Stats).

C.1.10 Pedestrians and Cyclists

Downtown Squamish offers a walkable pedestrian environment characteristic of a small town. While the cancellation of the passenger rail service has reduced the number of pedestrian visitors with the downtown area, it is still important to consider the strengthening of pedestrian links between the downtown and the waterfront along Loggers Lane and the Channel precincts. The downtown grid street pattern offers an interconnected system of paths, with both streets and buildings scaled to the pedestrian. In outlying neighbourhoods such as Garibaldi Estates and Valleycliffe, car-oriented streets are the norm with streets engineered to a similar standard found in contemporary residential developments. Here pedestrian activity is minimal as cul-de-sacs reduce connectivity within the street network, and major destinations are remote from new residential developments.

Fronting Highway 99 the number of highway-oriented developments are increasing. Such development is designed for automobile efficiency to the detriment of the pedestrian environment. The District may wish to evaluate existing residential and commercial development forms in terms of the impact upon non-vehicular transportation choices.

The District of Squamish is British Columbia's premier mountain biking community. The area boasts over 1000 km of off-road mountain trails built by volunteers. However, due to the terrain and technical difficulty of these trails they are recreational in nature. Moreover, the majority of these trails are disconnected, built upon private land, and are lost as development proceeds. The District of Squamish Council recently adopted the Squamish Trails Master Plan. The network will complement the existing trails and create links between the dispersed neighbourhoods for non-motorized vehicles. Trails and the access they provide to nature are a significant quality of life issue for the community, and the completed network will provide an exceptional public amenity to Squamish.

C.1.11 Regional Bus Service

Scheduled bus service is provided by a number of carriers from Vancouver to Squamish and points beyond. Greyhound Canada offers six daily bus departures from Vancouver, and Perimeter Transport offers eight. Snow Bus is scheduled to begin service in November of 2004 with two weekday and four weekend departures.

What we see:

The District of Squamish seeks to reduce automobile reliance by encouraging non-automotive modes and promoting higher residential densities in support of these modes. Trends, however, point to a continued dispersal of development as land use policies seem to run counter to transportation objectives. In particular the OCP projects that 72% of new residential dwellings will be accommodated in the auto-oriented neighbourhoods of Brackendale, Garibaldi Estates/Highlands and Valleycliffe.

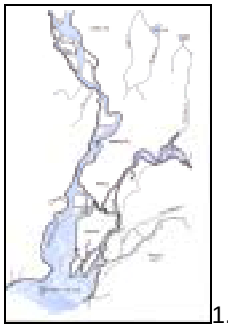
It can be expected that automobile use within the District will increase as the distance between residences and employment centres increase. Automobile dependency can only be reduced if land-use decisions reinforce stated transportation policies.

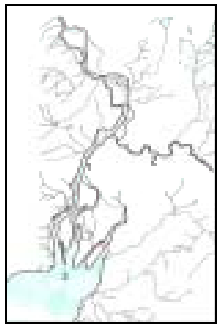
C.2 DRAINAGE and STREAM SYSTEM Lin Lin & Xu Erlu

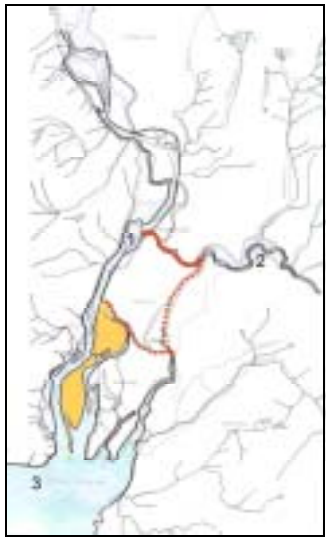
Squamish is wonderfully situated between the Howe Sound and the Garibaldi Mountain range in Squamish Valley. It is the drainage point of six glacial rivers. The Squamish and Mamquam Rivers are important waterways in our study area. A couple of watersheds connect to these two rivers and Howe Sound. Since our focus is on Squaimish downtown, which lies mainly within the Cattermore watershed, and Garibalidi Estate, which lies in the Mashit Creek watershed north of the Mamquam River, this discussion will focus on these two drainage areas (Figure 4).

C.2.1 Justification and History 1

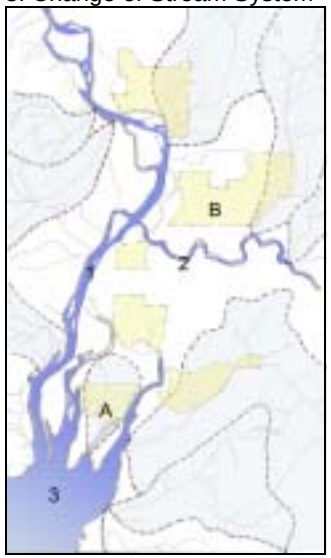
The end of the ice age saw the emergences of the Squamish valley from the crushing weight of tons of ice. When development of the valley began at the end of the 19th century, the Mamquam turned south after it entered the valley (Figure 1). In the early 1920's, a flood event and new development caused the Mamquam to shift from what is now the Civic Center, and cut west across the valley to join with Squamish River (Figure 2). Together with the sediment moving into the Squamish River, a new island was formed and the east-west connection between Squamish River and Mamquam Blind Channel was filled. And in the early 1950's the Squamish River abandoned the East Slough to take up a more westerly channel (Figure 3).


1.Before 1920's


2. Present



3. Change of Stream System



4. Watershed and Development

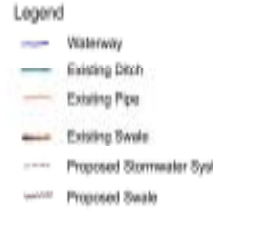
C.2.2 Squaimish Downtown: Watershed and Drainage Systems 2

The Squamish Downtown is part of Squamish/Mamquam alluvial fan roughly defined by the BC Rail spur line on the west, the Mamquam Blind Channel on the north and east, and Cattermole Slough to the south. The total area is about 104ha. Half of it is greenway right now. The remaining half is consisting of a combination of urban residential, institutional, commercial and industrial. As downtown Squamish has had a history of drainage problems mainly due to its flat topography, low elevation and tidal influence, this area is protected from high tide levels by a dyke system and tide gates.

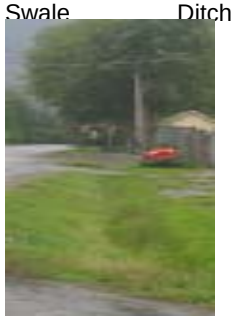
At present, about a third of the downtown Squamish stormwater drainage flows to a detention pond within the dykes. The remainder drains to a storage channel just downstream of Pemberton Avenue, between the dyke and railway storage during high tide. Both the pond and the storage channel are equipped with flap gates at the culvert outlets and provide storage during high tides. The current drainage system consists of a combination of roadside ditches, swales and drain pipes (Figure 5).

Future development will be twice the size of town. Therefore the increase runoff will make the drainage problem worse. In Squamish 2000 plan, to deal with this problem, the engineers propose to increase the capacity or redirect flow of the trunk sewer network. In addition, installing a pump on Cattermole Creek is considered. But to really solve the drainage problem is applying a new environmentally friendly way of dealing with surface water runoff. Therefore, the principle is infiltration. Consideration of increasing retention ability is fundamental.

5. Downtown Drainage System



Swale Pipe Ditch



C.2.3 Garibaldi Estate: Watershed and Drainage Systems

Unlike Squamish downtown, the road and land use pattern is network which the drainage channels are interconnected; the Garibaldi Estates is developed as dendritic pattern which looks like the branches of tree. Therefore, the drainage pattern is dendritic in terms of land use and road pattern. Constructed on the site which is relatively flat and has the similar subground materials, tributaries joins larger sewer trunk at acute angle and collecting the water flow through pipes under dyke into the Squamish River. Therefore, the trunk sewer of dendritic pattern needs to be bigger than the one of network pattern (Figure6).

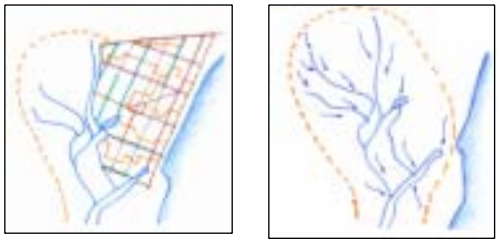
6. Garibalidi Drainage System

Network Dendritic

C.2.4 The Wonderful and the Weird

The following is a comparison between the existing drainage pattern within the Squamish downtown area and estimates of the predevelopment watershed drainage networks. Natural drainage networks have a characteristic branched stream pattern. The runoff, interflow and deep ground water flow follow the natural contour and topography into the nearest branches and slowed down by small depression within the landscape to the superior branches and gradually follows it way to the main stem.

In the existing drainage infrastructure, a significant change is the total channel length adds a lot compared to predevelopment condition within the watershed. Grading and artificial storm drains have intercepted natural flows and redirected them into detention pond and storage channel. Therefore, the nature stream and its branches have diverted into ditches and storm drains, flowing at right angles to the slope as following the new grading of roadways, gradually feed to the creek.



Existing Drainage Infrastructure

Predevelopment Drainage Network

C.2.5 Traditional Drainage System

Conventional drainage system approaches a single design objective—flooding control during large stormwater periods. This management focuses on conveyance the removal of stormwater as quickly as possible. Urban runoff is collected through roadside gutters, catch basin and a network of underground pipes. This single flooding control objective fails to address the environmental effects of increases in runoff volume and velocity caused by development. The conventional drainage system tends to impact negatively on urban stream hydrology, morphology, and water quality and stream ecology. Increased runoffs washing sediment and other constituents into downstream impair the downstream use by people and wildlife.

Curb and gutter system

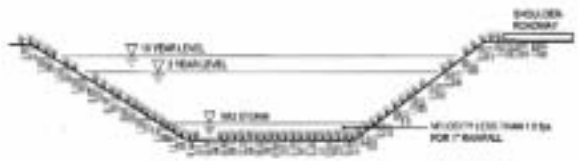
C.2.6 Alternative Drainage Systems 3

Today's drainage systems must cost-effectively manage flooding, control stream bank erosion, and protect water quality. Alternative drainage systems focus on mirroring the natural drainage and deals with runoff where it occurs.

Runoff flowing to detention pond and open channel via swale and ditch are one of the most alternative **infiltration technique** used in Squamish. In the further development, these waterways can be designed to fit into their **environmental setting**, adding considerably to **local amenit**y and / or **local biodiversity**. Alternative drainage systems are typical designed to convey at least 10-year 24-hour rainfall event. The systems will enhance the landscape and help to reduce storm water processing costs, in addition to protecting surface water quality.

Detention Pond

Note: 1. Natural Drainage Restoration Plan for Squamish and Mamquam Rivers, October 1999
2. Squamish Downtown Drainage Study, January 2004.
3. Important Natural Areas and Streams of Squamish, June 1999.



Open Channel Section

C.3 Water and Sanitary Systems

Nastaran Moradinejad

C.3.1 Water System

Presently, water is supplied from two surface water sources and from one well. The well site is the principal water supply, while the intakes on Mashiter Creek and the Stawamus River are mainly used during the summer.

The reservoirs contain water conditioned for drinking by chlorination. In the case of the well site, chlorine treatment is applied at the source; from the surface sources on the other hand, the water is conveyed untreated to chlorination stations further afield. Water from the Stawamus River intake south of downtown Squamish is treated within one kilometre of the source, while Mashiter Creek water is piped to a treatment facility 3.2 kilometres to the south.

To meet increased water demand, the District of Squamish is currently proposing two measures: the first is to install two more pumps at the existing well site (Powerhouse Springs); the second is to develop a second well site adjacent to the Mamquam River.

The availability of water is not anticipated to constrain future development in the District of Squamish. The District has developed a Capital Plan that allows for a population increase to 30,000 with commensurate upgrades to the water supply and conveyance infrastructure. The upgrading includes the decommissioning of obsolete infrastructure, the improvement of other, and new construction.

C.3.2 Wastewater Collection System

The District of Squamish sewage system operates by gravity, assisted by pumps at lift stations located throughout the system.

There are currently two sewage treatment plants in the District of Squamish, one downtown and another – the principal one – at the junction of the Mamquam and Squamish Rivers. The downtown plant is planned to be decommissioned and replaced with a pump house as soon as next year; the Mamquam sewage treatment plant is meanwhile being upgraded. The Mamquam treatment plant is located next to the Public works yard on Government Rd at Centennial Way. A second sewage treatment plant is under construction in the same area, which is expected to be operational early in 2005.

The District of Squamish's sewage is presently treated to the secondary level before being discharged into the Squamish River, just downstream of the Mamquam River. The downtown treatment plant currently discharges into the Squamish River at some point immediately west of the downtown into the eastern fork of the Squamish River estuary, but this discharge point will be decommissioned along with the treatment plant.

The District of Squamish Capital Plan calls for sewerage infrastructure improvements in order to accommodate an increase of population to 30,000. These improvements include decommissioning obsolete infrastructure, improving other, and building new. New developments are expected to be connected to the District's sewer system, and are not required to treat waste water on-site.

District of Squamish
Wastewater Collection System
Capital Plan
Proposed Infrastructure
Potential Development
Syphons

C.4 ENERGY SYSTEM

Shaun Smakal & Liana Evans

Current primary energy sources for Squamish include traditional and independent hydro power delivered through BC Hydro and natural gas service delivered by Terasen Gas.

C.4.1 Hydro

There are four hydro power generating stations in close proximity to Squamish: Cheakamus, Mamquam, Brandywine Creek, and Furry Creek. Cheakamus is a traditional hydro project (dam) operated by BC Hydro with a capacity of 140,000 kilowatts. Mamquam is a large run of the river hydro project with a capacity of 50,000 kilowatts. The Mamquam facility is operated by Northern Utilities. Brandywine Creek is a small hydro, run of the river project producing 7,600 kilowatts of electricity. Furry Creek, is a small hydro, run of the river power generation station that is operated by Furry Creek Power and has a capacity of 10,458 kilowatts.

While BC has been fortunate to be able to rely on relatively clean hydroelectric power to meet 94% of the province's energy needs, it is currently operating at capacity. New power sources will have to be developed in order to meet the growing demand for energy.

C.4.2 Natural Gas

The majority of natural gas power is provided by Terasen Gas, but the pipeline location is not disclosed. Natural gas is extracted in Northeastern BC and Alberta and piped into the Lower Mainland for processing. Most of Squamish has access to natural gas piped right to the site. Gas prices are on the rise and have doubled in the last decade. (Smart Growth on the Ground. June 2004. *Energy Management in Maple Ridge*, Technical Bulletin, http://www.sgog.bc.ca/uplo/mr4energy.pdf, accessed Sept 11, 2004).

Rising gas costs may lead people to switch to electric heating, putting additional pressure on hydroelectric power to meet greater energy demands. High gas prices and market instability are predicted to continue for the foreseeable future making natural gas a less affordable and therefore less attractive source of energy. (Ibid).

As supplies of natural gas run out, prices will only get higher, making this source of energy a less viable choice for consumers and increasing pressure on cheaper hydro-electricity to meet the shortfall. (http://www.bcsea.org/sustainableenergy/wind.asp, accessed September 14, 2004).

Existing Known Energy Flows

C.4.3 Renewable Energy Sources & Independent Power Projects

In November 2002, new BC Energy Policy identified independent power projects (IPPs) as the primary source of new electricity. By 2012, BC Hydro projects that 42% of its new energy resources will come from IPPs. (2004 Independent Power Producers Regional Meeting Power Point Presentation, February 24,2004, *BC Hydro's Resource Stack Forecast (2002-2012)*, p. 5, link from: http://www.bchydro.com/info/ipp/ipp956.html, accessed September 17, 2004) The new provincial policy also set a voluntary target of 50% of new power to come from 'clean' sources such as small and micro-hydro, wind, biomass, solar, and geo-thermal generating stations. The Squamish-Lillooet Regional District has also adopted a detailed policy document to guide IPP development in the area and address some of its citizens' concerns about independent power projects. (Squamish-Lilooet Regional District. April 2003. *IPP Development in the Squamish-Lilooet Regional District*. http://www.slrd.bc.ca/SLRD-IPP-POLICY.pdf, accessed Sept 14, 2004)

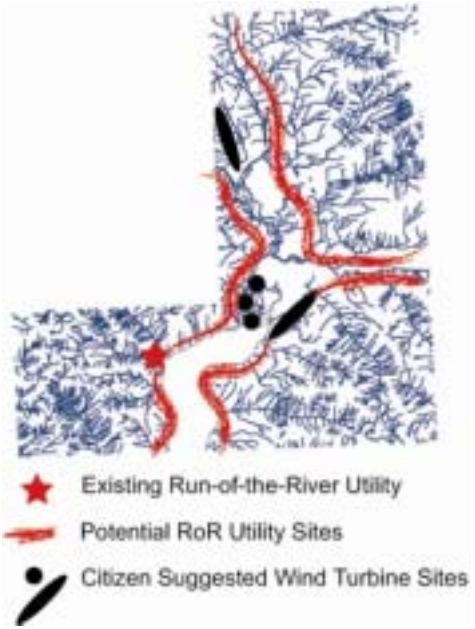
Given its abundant wind and water resources and mountainous terrain, Squamish has great potential for the development of green and renewable energy sources. Many of these renewable energy sources produce power that is as inexpensive as conventional hydro and significantly less expensive than natural gas.

C.4.4 Small & Micro-Hydro

Squamish lies near the confluence of the Squamish, Mamquam and Stawamus rivers. There are many other creeks with sufficient flows in at least three of the four seasons to make micro-hydro / run of the river projects viable. BC Hydro and Canadian Cartographics Ltd. produced a series of Green Energy maps indicating significant potential for the development of small hydro projects around the Squamish area. (Skoda, Lou. 2002. *Green Electricity Resources of British Columbia* http://www.canmap.com/green.htm, Accessed Sept 22, 2004).

C.4.5 Wind

The Town of Squamish is currently investigating wind energy as a potential form of economic development for the community. The hope is that both wind energy and the technology to harness the wind and produce electricity will both be produced in Squamish in the future.



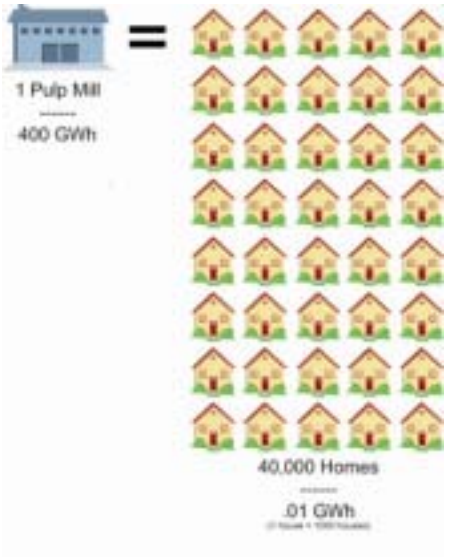
Potential IPP locations

Today's wind energy costs from 7 to 9 cents/kWh CAN at windy sites (8 metres/sec, or 29 km/hr) to 12/kWh CAN at slightly less windy sites (6 metres/sec, or 22 km/hr). Canada's federal Wind Power Production Incentive provides a production incentive of 1 cent/kWh to qualifying wind turbines.
www.canren.gc.ca

Wind power is advantageous in that in provides price stability because the fuel it uses – the wind – is a free and renewable supply. Though large upfront capital investment is required, annual operating expenses are only a fraction of those for conventional thermal projects. (Sea Breeze Power Corp. & Dillon Consulting, April 19, 2004, *Report: Phase One Squamish Wind Power Project*, p. 24) In addition, there are a number of energy production credits available for green energy projects, including the Wind Power Production Incentive (WPPI). Good wind projects can produce energy at prices better than gas generated electricity given current prices. (Ibid, p. 24) Finally, the Pembina Institute found that in comparison with investment in conventional energy green energy investment provides 50% more jobs per dollar invested. (Campbell, B., L. Dufay and R. Macintosh. 1997. *Comparative Analysis of Employment from Air Emission Reduction Measures*. Report for Environment Canada, Global Air Issues Branch. Drayton Valley: Pembina Institute, p. 10)

Squamish is well known for its consistently windy conditions. Windsurfers and kite boarders come to Squamish for its favourable winds which blow consistently between 14 – 20 knots/hour (7 – 10 m/s). These wind speeds are the minimum necessary to make large wind turbines viable. However, smaller wind turbines, some of which can be mounted to the roofs of housings, do not require such strong winds to be effective. These micro-turbines might prove useful for locations such as downtown Squamish where large windmills would be unsightly.

Based on the feedback provided at a community meeting on wind energy, the majority of Squamish residents seem to be in support of the development of local wind energy resources. Residents major concerns focused on environmentally sensitive development and the visibility of the towers. The majority of residents felt that wind turbines should be less visible or not visible at all.



Comparison of the power used by one pulp mill to that of a house.

C.4.6 Differentiated Land Uses

Given the fact that the majority of Squamish's residential development consists of single-family detached homes, residential energy consumption in Squamish will be greater than in other communities with a greater percentage of multi-family housing types. Large, energy intensive primary industries – such as the pulp and paper mill – mean that Squamish's energy demands will be higher than in communities with more tertiary employment sectors.

C.4.7 Future Implications

BC's electrical generating infrastructure is currently at capacity and the demand for energy is growing. In the next 15 years Squamish will be in a key position to benefit from the activity of Independent Power Producers and the development of local green energy resources.

Squamish hopes to increase its employment base by attracting more industry and businesses including a wind turbine manufacturing plant. Squamish is also projected to see increased population growth as people in Greater Vancouver and Whistler must go further out in the search for affordable housing. All this growth will put increased demand on energy resources. Squamish can position itself to meet its own energy needs locally as well as provide additional energy supply for the province. This may be accomplished by adopting policies and guidelines that encourage and promote energy-efficient forms of development and by developing its renewable energy resources in a sustainable manner.

In terms of design, an energy-efficient approach will mean making a conscious decision to build more attached or semi-attached forms of housing such as townhouses, rowhouses, and condominium/apartment buildings. It will also mean exploring district heating and co-generation energy options for commercial and industrial areas. For example, Squamish's heavy industries provide opportunities for one operation's waste energy to be captured by the system to provide heating for another commercial building.

© Photo National Renewable Energy Laboratory

Furry Creek Run of River Project

Wind Turbine Farm

Run of River Bypass & Gate Chmbr