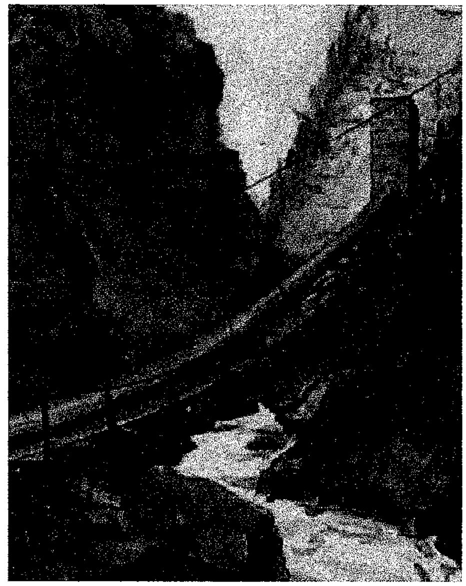
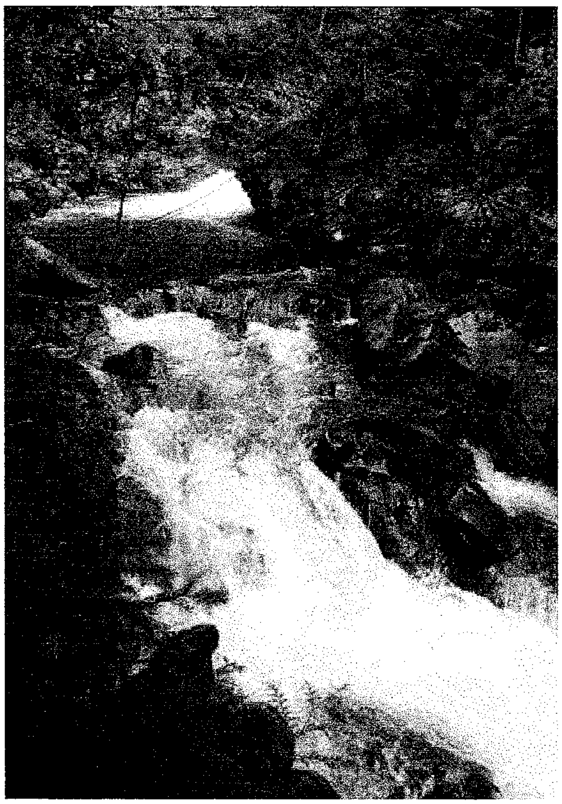
Village of New Denver

Micro Hydro

Feasibility Study

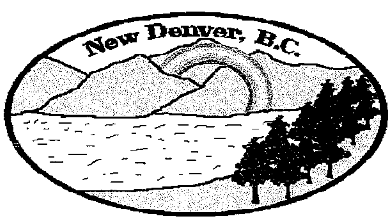




Denver Canyon

Power Project

Final November 2002



Woods Associates Engineering

Geotechnical·Civil·Environmental·Materials

VILLAGE OF NEW DENVER

DENVER CANYON

MICRO HYDRO FEASIBILITY STUDY

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1.0 INTRODUCTION

1.1 Introduction

This report has been prepared at the request of the Council of the Village of New Denver. It is based on the scope of work as set out in our proposal dated December 14, 2001, which was prepared in response to a request for proposals issued by the Village in November 2001. The purpose of the report is to determine the feasibility of establishing a hydro-electric generation plant at Denver Canyon on Carpenter Creek. Although the main focus of the study is on the Denver Canyon site, other sites are briefly discussed for comparison purposes.

The study was prepared as a joint effort of three consultants including Woods Associates Engineering (WAE) as the lead, together with significant input from Scarlett's Electric and Homestead Hydro Systems

A number of factors are considered when determining feasibility, some of which are subjective and depend on the objectives of the project's owner. If a project will cost more to construct and operate than it will generate in revenue or if it will do more environmental damage than can be mitigated then it is obviously not feasible. However, the amount of revenue, over the break-even point, to be considered feasible is ultimately up to the owner. In this case the objectives of the Village of New Denver as they relate to the ultimate project include:

- Primary - To construct a hydro-electric plant for the purpose of generating supplemental income for the Village of New Denver
- Secondary - In order to meet the primary objective, the project must be affordable to construct with the resources available to the Village;
  - It must have a reasonable pay back period and have a sufficient return on investment.

Other project motivation included: contribution to "Green Power" and historical significance for the community.

For the purpose of this study, the system was sized to maximize the efficiency and the marginal return on the funds invested. The plant was increased in size until the efficiency and the corresponding return for each additional dollar spent began to drop off. This is explained in greater detail in the body of the report.

1.2 Background and Historical Significance

Around 1905 C.J. Campbell built a wooden dam across Denver Canyon and piped water to his generating station on the south side of the creek. This produced enough power to run lights in New Denver and Denver Siding. Parts of the concrete flume are still visible. In the 1930's the dam was repaired and a new generator on the north side of the creek was built by Sandy Harris of the Harris Ranch. His Denver Light and Power Company operated until 1955 when a huge storm caused a flood that destroyed the dam.

1.3 Project Description

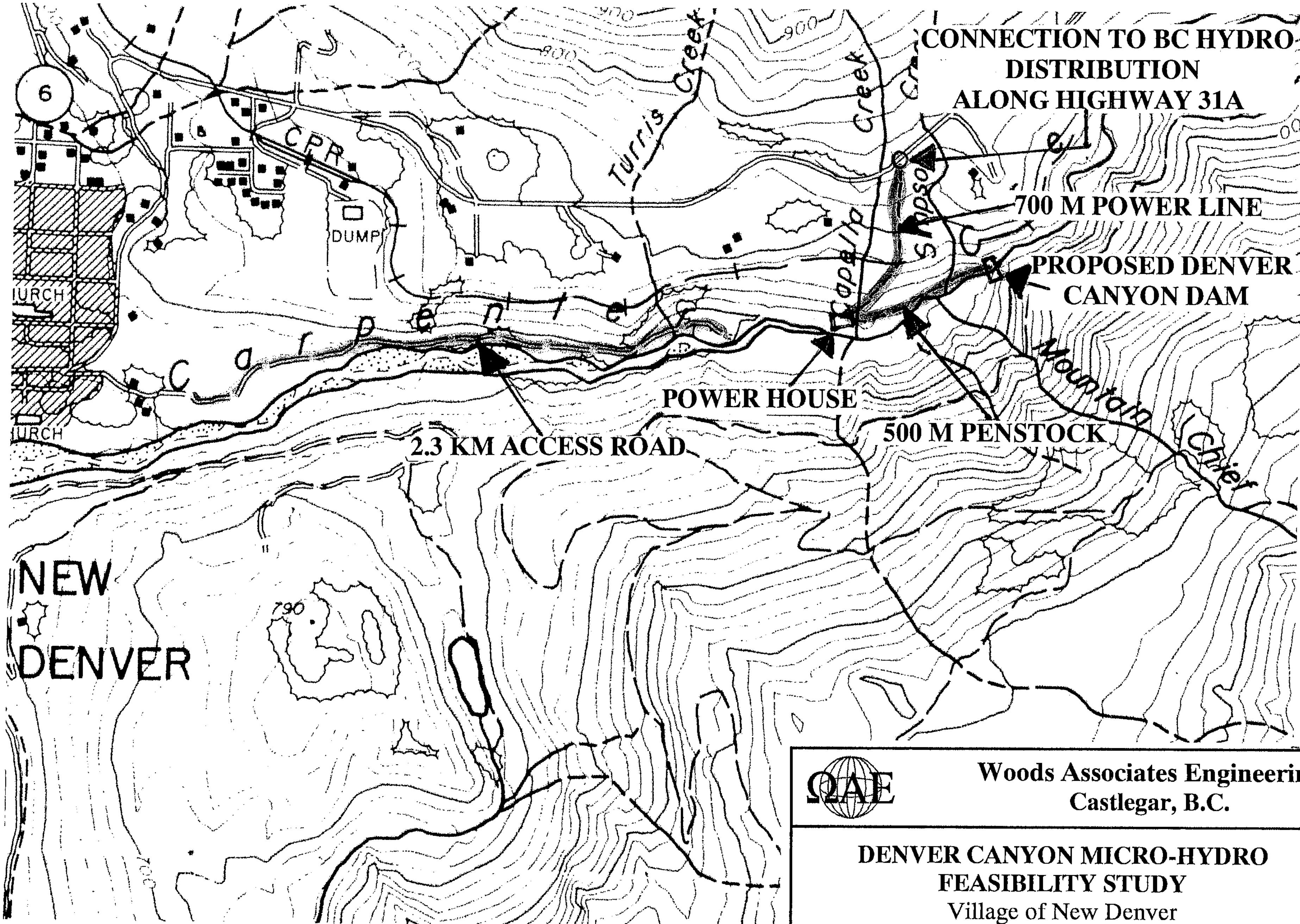
Subsequent sections of this report discuss rational for choosing the size and type of micro hydro plant that we believe is the most feasible while maintaining the objectives of the Village. In short the plant is sized to most efficiently use the mean flow in the creek. The project is located to capture the greatest elevation drop over the shortest distance and involves damming Denver Canyon as was done many years ago. Details of the project components will unfold as we work through the report. Following is a point form outline of the potentially feasible project examined by this study:

- Project Type – run of river (no storage reservoir)
- Diversion – concrete dam across Denver Canyon c/w cleanout gate and screened intake
- Penstock – 520 m (1700 ft.) of 1600 mm (63 in.) diameter steel or high density polyethylene pipe
- Elevation Drop – 33.5 m (110 ft.)
- Powerline – 550 m (1800 ft.)
- Access Road – 2.3 km
- Power House – 70 m^2 (750 sq. ft.) concrete and timber frame building located approximately 500 m downstream of the canyon.
- Turbines – 3 Francis type
- Plant Capacity – 1400 kW
- Design Flow – 6.1 m^3/s
- Total estimated capital cost - $3.0 million

1.4 RETScreen

RETScreen is a Renewable Energy Technologies (RET's) project analysis software made available free of charge by the Federal Government through Natural Resources Canada's CANMET energy diversification research laboratory. It can be used to evaluate the energy production and life cycle costs for various renewable energy technologies

The RETScreen program for micro hydro analysis was used during the preparation of this report for the evaluation of Carpenter Creek. The output from the software is included in Appendix B.



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DENVER CANYON MICRO-HYDRO FEASIBILITY STUDY
Village of New Denver
Location Plan

Scale: 1 cm : 150 m
Drawn by: DS:ak
Date: July 2002

Figure 1

2.0 FLOW IN CARPENTER CREEK

2.1 Analysis of water flow in Carpenter Creek

Water flow analysis for Carpenter Creek is essential to determine the economic feasibility of a hydroelectric power project on the creek. Water flows in West Kootenay creeks are highly variable from season to season and from year to year, over a range as high as 80 to 1. To properly size the penstock and generating equipment (which have a large effect on overall project cost) the water flows to be expected throughout the year must be accurately estimated. Moreover, to determine the economic payback period for the project, the range of variability in flow from year to year should also be determined.

Ideally, daily flow measurements would be available for a prospective hydroelectric creek over a period of decades to permit confident forecasts of future water flows under the full range of dry and wet years. This quantity of data has been collected for a number of creeks in the West Kootenay by Environment Canada's Water Survey Branch; however, Carpenter Creek has not been recorded in that detail.[1] Our solution is to determine which creeks in the Environment Canada database are most comparable to Carpenter Creek and use them as reference creeks. Creeks that are located as close as possible to Carpenter Creek, are in the same size range, and present a similar aspect to the prevailing winds are the best choices. The underlying assumption is that the specific run-off (cubic metres per second per square kilometre of watershed) for the comparison creeks and for Carpenter Creek will be similar.

For this study we chose long term water flow records for Lemon Creek (1973-1995) and for the Slocan River at Slocan City (1945-1968) to compare to Carpenter Creek. We assumed watershed areas of 178 km^2 for Lemon Creek, 1660 km^2 for Slocan River at Slocan City and 209 km^2 for Carpenter Creek above the Denver Canyon intake site. The daily water flow records collected by Environment Canada are collected into monthly averages which can be manipulated in a spreadsheet to create tables of expected power generation which illustrate typical seasonal and annual variations. Tables 2.1 and 2.2 show expected Denver Canyon power production based on data from the Slocan River at Slocan City and Lemon Creek, respectively.

The data from the Slocan River predict a larger flow (and correspondingly larger power production) from Denver Canyon than data from Lemon Creek. This is likely due in part to the different size, elevation and aspect of the two watersheds, and part to the trend of increasing annual precipitation as one moves northward along the Kootenay River, Slocan and Upper Arrow Lake valleys from Castlegar to Revelstoke. Because the Lemon Creek watershed is south of the watershed which feeds the Slocan River at Slocan City, it would be expected to have a lower specific run-off.

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[1] Historical flow data for Carpenter Creek that we were able to find included a limited number of measurements of instantaneous discharge during 1914—one day each in April, May, July, August and November of that year. These data were insufficient to reliably track seasonal variations in flow and shed no light on year-to-year variations. We decided against making instantaneous flow measurements on Carpenter Creek for this study for the same reasons and because a suitable measuring site was not available. There is no well-defined stream channel under the Highway 6 bridge nor a suitable narrowing of the creek elsewhere which could allow soundings and water velocity measurements to be made safely across the creek at measured intervals and depths.

The size of the generator(s) assumed in each table is selected in order to deliver a capacity factor of about 50%. Capacity factor and optimum plant sizing is further explained in Section 9.0. In Table 2.1 the selected generation capacity is 1800 kW, while in Table 2.2 the selected generation capacity is 1200 kW. These figures appear in each table in the high flow months of the year as the upper limit of power production. It is not possible to make a direct comparison of the two tables because the years of Environment Canada data for Slocan River at Slocan City did not overlap with the years of data for Lemon Creek, but data from more than four decades nevertheless gives a good sense of annual variability in water flow. This analysis led to the assumption of a specific run-off value for Carpenter Creek approximately halfway between those for Slocan River at Slocan City and Lemon Creek. We suggest a maximum generation capacity of 1400 kW at Denver Canyon.

TABLE - 2.1

Denver Canyon power production (kW) based on data from Slocan River at Slocan City

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Energy (MWh)
1945	361	325	281	359	1785	1800	1800	820	497	398	410	352	6707
1946	315	291	303	660	1800	1800	1800	1188	735	478	388	398	7414
1947	323	325	361	808	1800	1800	n/a	n/a	n/a	766	725	475	n/a
1948	376	296	267	441	1800	1800	1800	1150	825	604	487	378	7463
1949	284	276	291	621	1800	1800	1491	926	548	456	456	514	6909
1950	400	320	320	454	1385	1800	1800	1310	677	577	689	631	7564
1951	611	538	454	696	1800	1800	1800	1368	757	902	669	509	8690
1952	381	376	327	594	1800	1800	1800	1108	599	386	298	262	7104
1953	308	349	310	429	1800	1800	1800	1426	771	645	650	548	7911
1954	439	371	373	468	1800	1800	1800	1800	1310	803	684	698	9013
1955	422	230	284	424	1084	1800	1800	1630	745	648	783	589	7620
1956	490	398	308	825	1800	1800	1800	1183	652	737	577	456	8049
1957	340	289	303	500	1800	1800	1698	926	572	567	485	386	7056
1958	340	340	407	616	1800	1800	1545	691	509	723	594	427	7148
1959	395	349	298	551	1800	1800	1800	1571	1698	1421	1096	691	9834
1960	456	398	369	1069	1800	1800	1800	1198	786	606	626	444	8286
1961	371	403	412	667	1800	1800	1800	946	572	531	504	381	7437
1962	332	349	323	822	1800	1800	1800	1538	812	735	795	616	8557
1963	526	441	456	769	1800	1800	1800	1237	720	529	492	507	8086
1964	420	356	318	427	1618	1800	1800	1800	1154	1181	822	519	8917
1965	468	393	381	672	1800	1800	1800	1247	776	732	706	575	8285

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	(MWh)
1966	461	378	335	842	1800	1800	1800	1232	626	485	504	512	7865
1967	475	449	383	526	1800	1800	1800	1419	706	580	640	483	8074
1968	398	410	555	597	1800	1800	1800	1603	1181	936	701	536	8991

TABLE - 2.2

Denver Canyon power production (kW) based on data from Lemon Creek

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Energy (MWh)
1973	n/a	n/a	n/a	n/a	n/a	1200	1000	339	283	446	414	303	n/a
1974	321	339	337	839	1200	1200	1200	968	443	285	271	242	5582
1975	166	185	207	351	1200	1200	1200	776	685	536	685	656	5728
1976	380	337	276	735	1200	1200	1200	1200	832	457	351	278	6165
1977	207	197	191	547	1200	1200	760	568	656	360	269	221	4653
1978	235	225	378	909	1200	1200	1200	798	764	541	398	287	5939
1979	228	242	276	375	1200	1200	1156	459	335	265	209	251	4523
1980	173	178	217	1200	1200	1200	1004	504	489	346	380	412	5332
1981	407	326	353	943	1200	1200	1200	826	464	570	579	396	6178
1982	235	260	287	389	1200	1200	1200	803	674	676	455	294	5601
1983	221	233	455	740	1200	1200	1200	816	629	382	794	382	6023
1984	346	265	310	658	1200	1200	1200	642	446	366	285	214	5206
1985	183	163	166	658	1200	1200	710	312	441	400	477	269	4511
1986	213	211	378	744	1200	1200	1200	475	335	364	305	225	5000
1987	196	173	323	783	1200	1200	764	403	251	195	195	249	4331
1988	156	145	175	1063	1200	1200	1115	407	305	581	541	305	5251
1989	235	207	223	778	1200	1200	1149	617	561	450	697	459	5676
1990	312	256	299	1200	1200	1200	1200	667	346	360	656	455	5949
1991	274	378	330	905	1200	1200	1200	826	425	267	237	210	5440
1992	184	237	394	1149	1200	1200	968	430	323	360	280	192	5050
1993	178	156	207	459	1200	1200	1200	701	405	323	256	226	4753
1994	209	194	269	1200	1200	1200	1200	398	269	240	207	199	4953
1995	162	203	346	482	1200	1200	1104	613	337	554	708	753	5592

3.0 PREFERRED TYPE OF HYDRO-ELECTRIC SYSTEM

3.1 Selection of small hydroelectric turbines and generators

The choice of turbine for the Denver Canyon hydro site is dictated by the gross head for the project (the difference in elevation of the intake and powerhouse), by the seasonal variation in water flow that the power plant is designed to use, and by the optimum generator size. For a system head of 33 metres and water flow ranging from about 1 to at least 35 m^3/sec, the best turbine options are the Francis turbine and centrifugal pump, both reaction turbines.[2] This is because of their efficiency (up to 88% in the case of the Francis turbine; 70+% in the case of the centrifugal pump) and the fact that at 33 m head they can operate at high enough rpm to permit the generator to be driven directly. Direct drive operation reduces maintenance cost and saves up to 4% of the turbine power, which would otherwise be wasted in belt and pulley losses.

It is desirable to operate all turbines near the peak of their efficiency curves. The centrifugal pump's efficiency curve has a very narrow "plateau" (i.e. the range of water flow values for which efficiency is near its peak), while that of a Francis turbine is much broader. Since the seasonal variation in water flow for Carpenter Creek is larger than the plateau of either a Francis turbine or a centrifugal pump, the system efficiency must be kept high by specifying multiple turbines and generators. The use of multiple turbines permits allows the operation of a single turbine during low winter water flows, and additional turbines as available water flows increase.

Cost, space requirements and complexity require the number of turbines to be kept to a minimum, but against this imperative must be weighed the reduced efficiency that will occur if one or more of the turbines operates at a water flow outside the plateau range. The broader plateau of the Francis turbine efficiency curve allows acceptable system efficiencies over the full design range of water flows with fewer turbines than if centrifugal pumps were used. The cost of a centrifugal pump is lower than that of a Francis turbine with comparable capacity, but this cost saving is offset by the higher efficiency of the Francis turbine.

With the 1400 kW maximum plant capacity of the Denver Canyon project, generators should be sized to minimize cost and provide the benefit of redundancy. The cost of induction and synchronous generators, along with their controls and switchgear, increases rapidly with size. With induction generators in particular, the purchase of reconditioned units can reduce cost, but as their size increases reconditioned units become harder to find. Using multiple generators of a readily-obtained size, driven by multiple turbines—especially if they are all the same size—offers redundancy in the event of component failure or to facilitate routine maintenance. The power plant can continue to produce all or most of the power available from the creek flow during such events, even as one turbine/generator combination is taken out of service.

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[2] Pelton and turgo impulse turbines designed to operate at such a low head and with such a large volume of water would be very expensive to purchase, and because a large diameter Pelton or turgo would be required to handle the water volume, the operating rpm would be low, requiring a gearbox or belt drive. The Kaplan (propellor) reaction turbine is expensive and better suited to gross heads less than 33 metres. The crossflow reaction turbine is prone to metal fatigue and low efficiency.

Taking into account all the above considerations, we determined that three Francis turbines, each directly driving a large induction generator, would be a good solution for the Denver Canyon Project. The final decision would of course be based on a thorough analysis of equipment available on the market, an analysis that was beyond the scope of our study.

4.0 INFRASTRUCTURE ACCESS COSTS.

Following is a summary of the total project costs including infrastructure access costs and costs of the power generating equipment itself. A more detailed break down of the costs is included in the RETScreen analysis included in Appendix B

Initial Costs		
Feasibility study	0.2%	7,000
Development	2.4%	72,000
Engineering	12.3%	375,000
Power Generating Equipment	30.7%	934,745
Infrastructure Access Costs	31.4%	956,613
Financing Costs (5%) & Contingency(25%)	23.1%	703,607
Initial Costs – Total	100.0%	**3,048,965**

5.0 LAND OWNERSHIP:

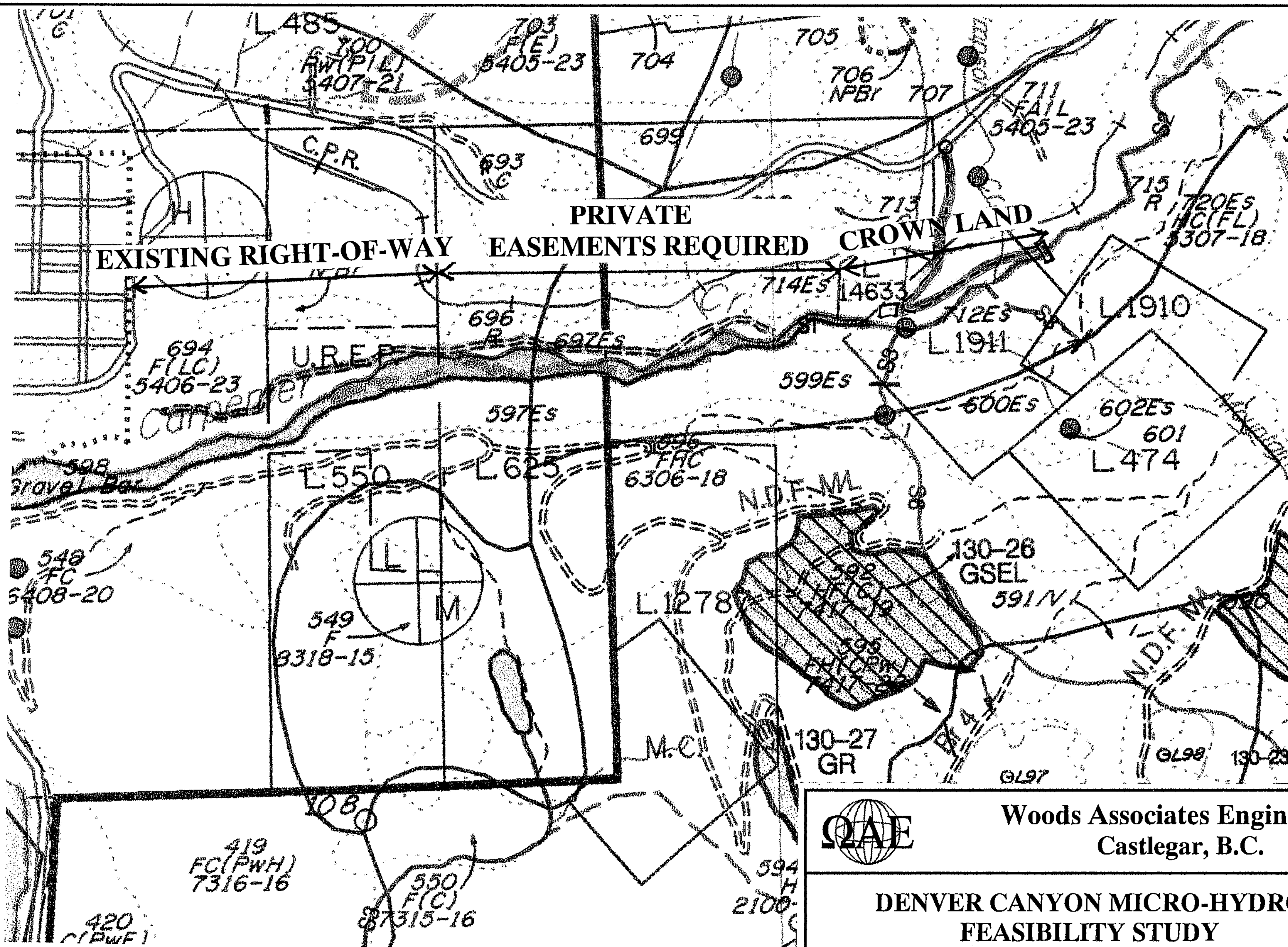
Figure 5.1 shows the location of the proposed plant, the access road and the powerline. Along the length of the project the figure divides the land status into three categories:

1. Land through which existing easements exist (developed and undeveloped)
2. Private land through which no easements exist and would require negotiation
3. Crown Land

The dam and intake structure along with the penstock, powerhouse and powerline have all been located on crown land. The dam and the majority of the powerline would be located on unsurveyed crown land, while the powerhouse would be located on DL 1911 owned by the Crown. A number of options for obtaining tenure of crown land exist. They include lease, license of occupation, temporary permit, and out right purchase. The Crown Land Tenure/Purchase Application Process as downloaded from the Land & Water BC web site is contained in Appendix C

The upper end of the access road and middle portion of the project appears to pass across private property over which no easements are registered.

The portion of the access road nearest to town would come off the end of 6th Avenue onto what was until recently undeveloped road right of way. Recent subdivision activity in the area has seen some of the roadway developed.



Woods Associates Engineering
Castlegar, B.C.

DENVER CANYON MICRO-HYDRO FEASIBILITY STUDY

Village of New Denver

Easement Requirements

Scale: 1 cm : 150 m
Drawn by: DS:ak
Date: July 2002

Figure 5.1

6.0 ENVIRONMENTAL ISSUES:

To identify potential environmental impacts that a hydro project at Denver Canyon might create, we asked Summit Environmental Services to inspect the Denver Canyon site and produce a preliminary assessment. A report of this work, performed by Brent Phillips, M.Sc., R.P. Bio., is attached as Appendix A.

A number of potential environmental impacts were identified, all of which demand further study if the Denver Canyon hydro project is determined to be technically and economically viable. These potential impacts included various impacts associated with construction, reduction in fish habitat in Carpenter Creek between the dam and the powerhouse, flow ramping effects, water temperature effects, fish habitat alterations due to backwatering behind the dam and infrastructure impacts on fish habitat and riparian vegetation.

Mr. Phillips' preliminary assessment indicated that several of these potential impacts are unlikely to be significant, or may readily be reduced by use of best engineering and construction practices. The relatively high water levels which pertained during the preliminary assessment made it more difficult to determine the type (species and size of fish) and quality of habitat in the affected section of Carpenter Creek. In-stream inventory work may be required to determine fish species and populations in the affected section. Mitigation initiatives, which might replace any affected habitat, have not yet been considered or discussed with regulatory authorities. The determination of required minimum fish flows, if any, may depend on the type and quality of fish habitat in the affected section. These factors, combined with the limited time and resources available for Mr. Phillips' preliminary assessment, mean that its primary value is to identify and describe the main potential environmental impacts which will require further study if the project proceeds.

Upon completion of the project one of the greatest environmental impacts will be the potential dewatering of about 500 m of the creek. To make the project feasible as much of the creek as possible needs to be diverted through the penstock during low winter flows. The impact on the project feasibility resulting from leaving the required residual flow in the creek is outlined in the financial analysis. It shows that the impact can be significant and that any options for allowing less than the typical 10-20% residual warrant further investigation.

7.0 LICENCING:

7.1

A search of the Ministry of Sustainable Resource Management's database reveals that two water licenses currently exist on Carpenter Creek. They are as follows:

Licence No	WR Map Point Code	Purpose	Quantity	Licensee	Priority Date	Issue Date
C048512	5450b x3 (pd26954)	Land Improve	0	Village of New Denver	01/28/1976	Prior to 1976
C113484	5452 gg (pd26968)	Power-General	4.8 CS	Silversmith Power Corp.	04/05/1897	07/17/1998

It appears from the above table that there are no existing licences that will obstruct the Village from obtaining a licence to divert water at Denver Canyon. The Village of New Denver is the Licensee for the first licence and the Silversmith Power Corp. has its diversion point well upstream of Denver Canyon. To divert water at Denver Canyon for the purpose of General Power Generation as outlined in this study a Water License in the amount of 6.6 cu. m/s would be required. The fees shown in the table below for a power plant less than 5MW would apply

Table 7.1 Licence Fees

Purpose (PUC Code)	Description	(One Time) Application Fee		Annual Rental Fee	
07C **Power - General**	Where water is used to produce power for general use. "General" means • a power use where the capacity and energy generated is from a power development or developments owned by a public utility regulated by the British Columbia Utilities Commission under Part 3 of the ***Utilities Commission Act,*** • a power use where the capacity and energy generated from a power development or developments exceeds that necessary to supply the licensee's capacity and energy requirements as defined by the commercial use category, or • any power use which is not residential or commercial.	- power plant < 5MW - 5 MW to < 20 MW - equal to or > 20 MW	$2 000.00 $5 000.00 $10 000.00	- construction capacity, for each kilowatt (indexed) - authorized capacity, other than construction capacity, for each kilowatt (indexed) - output, for each megawatt-hour a year, up to a total of 250 000 megawatt-hours from all power developments operated by the same licensee (indexed) - output for each additional megawatt-hour a year (indexed) - minimum annual rental, for each licence	$0.345 $3.453 $2.417 $4.835 $200.00

8.0 FLOOD PLAIN:

The Regional District of Central Kootenay (RDCK) has a Flood Plain Bylaw 1000. This bylaw stipulates a 30 m setback for construction near Carpenter Creek. The diversion dam, the powerhouse, and some portions of the penstock will necessarily be constructed closer than the 30 m allowance. To do so, an engineering report must be submitted to the RDCK along with the building permit application requesting a variance. The report will demonstrate how the structures to be installed will be constructed to withstand flooding in the event of high water. The RDCK may also require some additional wording or covenants saving them harmless in the event that the plant is damaged by flooding.

9.0 QUANTITY OF POTENTIAL ELECTRICITY GENERATION

9.1 System Efficiency and Plant Capacity Factor

The total potential electricity generation for a small hydro plant is only limited by amount of water flow that can be diverted from the stream. However it is not economically feasible to install a plant large enough to harness the entire spring runoff because so much of its generating capacity would be unproductive during the low winter flows. Thus in determining the optimum size of generators in a small hydro plant, two factors are considered:

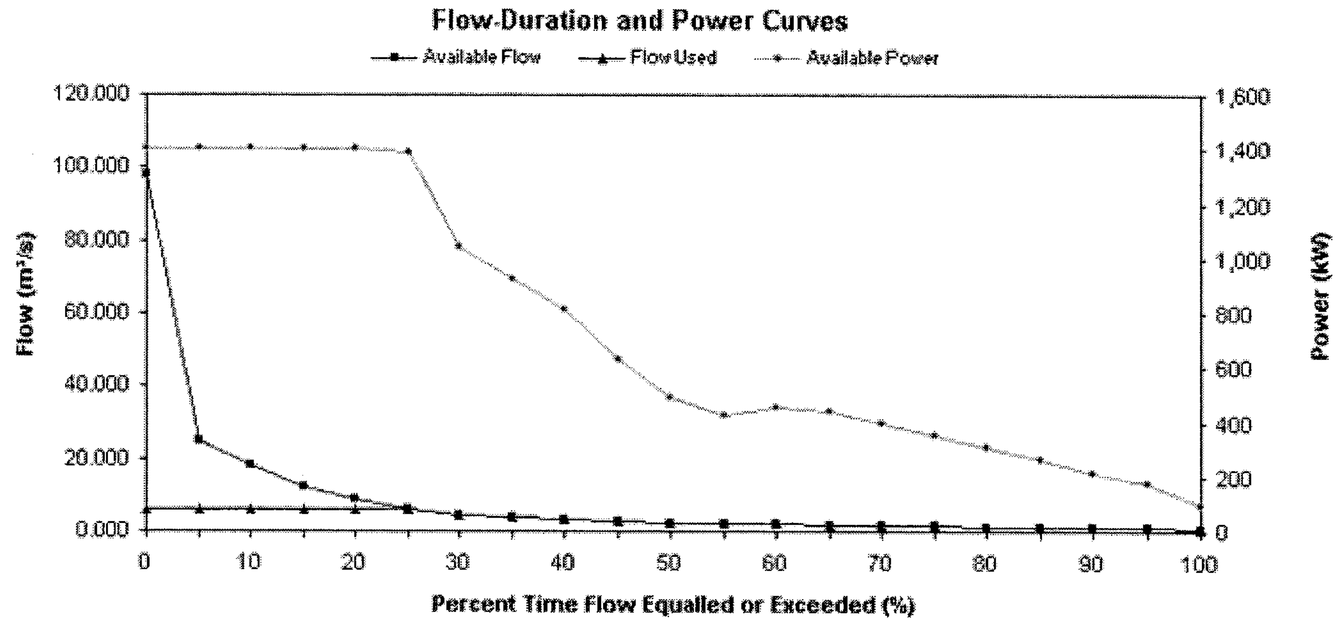
1. The efficiency of the system
2. Marginal return on investment as the system increases in size

Section 2 discussed using a 50% capacity factor to choose an optimum hydro plant size. The actual energy output of a small hydro plant over the year compared to the energy it would produce if operated at maximum capacity all year long is expressed as the annual capacity factor. The annual capacity factor is expressed as a percentage and is used as a measure of economic efficiency. Typical values in energy industry practice range from 40% to 95%.

The annual capacity factor is thus a measure of the available flow at the site and how efficiently it is harnessed. Provided that there are no technical or environmental restrictions on the maximum output of a small hydro plant, the optimum size of the plant will depend primarily on the availability of water (illustrated by the flow-duration curve). At some point, due to the shorter durations of larger flows, the cost of increasing generation capacity cannot be justified by the resulting increase in energy production. Typically, for a run-of-river small hydro plant, this point is close to the mean flow at the site.

For example in our previous discussion we have estimated the mean flow in Carpenter Creek to be about 5.5 m/s. If we choose a design flow rate for this project near this mean (6.1 m^3/s was used) then a corresponding maximum plant capacity of about 1400 kW can be calculated based on the head available at the site. The following table shows that for about 25% of the time the maximum capacity of the plant will be exceeded by the flow in the creek. For the rest of the year the creek flow will be less than plant capacity. However, the total average output over the year works out to be about 50% of what it would be if the plant ran at full output for 12 months.

A larger plant could harness more of the large spring run off but would operate at less than peak capacity for more of the year. Conversely a smaller plant would run at its peak output more often but would fail to capture the available flows in the spring. The balancing act of choosing the optimum plant size is fine tuned during the financial analysis. In that analysis we are able to determine that as the plant size exceeds about 1265 kW for Denver Canyon the return on investment begins to fall off.



The total energy delivered by a 1400 kW plant at Denver Canyon based on the above flow-duration is about 6200 MWh. At $0.05 per kWh this translates into annual income of about $310,000.

10.0 ECONOMIC VIABILITY OF THE PROJECT

10.1 Introduction

From our investigation, it does not appear that there are any major technical barriers to this project. Thus, we expect that the feasibility of the project will be based on the economic viability. This viability in turn is based on a number of variables. In this section we will attempt to highlight the variables that the feasibility of the project is particularly sensitive to, as well as those that require some judgment, estimation or prediction of the future. A number of the variables are beyond the control of the Village and therefore present some risk. Others are better defined. In the final analysis one must look at the return on investment and decide if the yield is worth the risk.

A more detailed break down of the numbers used in the financial summary is included in the RETScreen print out in Appendix B. Below is a list of some of the variables used in the analysis followed by discussion of how the variables affect the outcome.

Input Variables

- Price of Power Produced
- Power Cost Escalation Rate (how will the price change over the life of the project)
- Inflation
- Debt Ratio (how much initial cash contribution or down payment)
- Debt Interest Rate
- Debt Term
- Initial Total Cost
- Life of the Project

Output Variables

- IRR (internal rate of return)
- Simple Pay Back
- Years to Positive Cumulative and Annual Cash Flows
- NPV (net present value)
- Annual Life Cycle Savings
- Profitability Index – PI

10.2 Discussion and Variable Definitions

Most of the input variables are self-explanatory while the definition and significance of some of the output variables are not so obvious.

Price of Power –BC Hydro is currently paying in the neighbourhood of $0.05 per kilowatt-hour for firm power from green energy producers. Each contract is negotiated individually and thus there are some variations. From time to time BC Hydro will request proposals. We understand that last fall they offered $.049 plus ½ Vancouver's inflation rate increase per year. This summer an RFP was sent to industrial producers and we understand that this fall another green energy proposal request will be made. For the purpose of this report we used $0.05 for the majority of our analysis. However the outcome is quit sensitive to what is used for this variable, and a half-cent variation can make a 4 to 5 year difference in the time to positive cash flow. That said, it is a variable that can be fairly well defined through negotiations with BC Hydro prior to committing to a project.

Power Cost Escalation Rate – This is the rate at which the price for power increases each year. This can vary as noted above to as low as ½ the inflation rate to as high as 3%. We chose 2.5% for our analysis. The outcome of the analysis is very sensitive to this variable, which is difficult to predict. However, as with the price of power it is also part of the contract negotiated with BC Hydro so the producer will know the number before committing.

IRR (Internal Rate of Return) - represents the interest yield provided by the project over its life. In other words, what will be the return on your investment? It is calculated by finding the discount rate that causes the net present value of the project to be equal to zero. The Village can compare the internal rate of return of the project to its required rate of return (often, the cost of capital).

If the internal rate of return of the project is equal to or greater than the required rate of return of the village, then the project could be considered acceptable assuming equal or less risk. If it is less than the required rate of return, the project is typically rejected.

Simple Pay Back – this represents the length of time that it takes for an investment project to recoup its own initial cost, out of the cash receipts it generates. It does not include the cost of borrowing and therefore not a real indicator of profitability but rather a measure of time when comparing one project to another.

Years to Positive Cumulative Cash Flow – this is essentially the number of years it takes to pay back the initial cash put up to start the project. We have assumed that 80% of the project will be financed. Thus, a cash contribution of about $610,000 is required from the Village during implementation of the project. If we are optimistic with our input variables this number is about 8 years but can range up 15 years for more pessimistic numbers.

Years to Positive Annual Cash Flow – this is the time it take before the project no longer needs to be subsidized and can pay for its own O&M and debt payments. This is an important number for the Village since it quickly shows whether the project will be an annual burden or whether it can stand on its own. A long life project such as micro hydro may not look attractive on the surface if it has many years to positive cumulative cash flow. But as long as the annual cash flow is positive during that time, then the debt is being repaid without input from the Village and could therefore be a good long-term investment. (Similar to a rental home where the rent more than covers the mortgage.)

NPV (Net Present Value) - the present value of all cash inflows is compared to the present value of all cash outflows associated with the project. The difference between the present value of these cash flows determines whether or not the project is generally an acceptable investment. Positive NPV values are an indicator of a potentially feasible project. In using the net present value method, it is necessary to choose a rate for discounting cash flows to present value; 8% was used in this study. In simple terms, the NPV is the amount of money the Village would have to invest today at 8% to achieve the same result as undertaking the project

Annual Life Cycle Savings/Income – this number is the levelized nominal yearly income having exactly the same life and net present value as the project. The annual life cycle savings are calculated using the net present value, the discount rate and the project life.

Profitability Index –PI - this is calculated as the ratio of the net present value (NPV) to the project equity. Ratios greater than one (1.0) are indicative of profitable projects.

10.3 Financial Analysis

In the following tables a number of the output variables are compared with changes to the price of power and the power cost escalation rate. The other input variables were held constant during the calculation as shown

Table 10.1 Price of Power vs Profitability

Energy cost escalation rate	2.5%
Inflation	2.5%
Discount rate	8.0%
Project life	50yr

Price of Power	Years to Positive Cash Flow Cum./Annual	Cash at 25 Years (end of debt)	Cash at 50 Years (end of life)	NPV Net Present Value	IRR (%)
.040	18.2 / 3	399,000	10,300,000	240,000	9.3
.045	11.6 / 1	1,480,000	13,400,000	770,000	12.5
.05	7.9 / 1	2,550,000	16,500,000	1,300,000	16.2
.055	5.9 / 1	3,600,000	19,600,000	1,800,000	20.3
.06	4.6 / 1	4,700,000	22,700,000	2,400,000	24.9

Table 10.2 - Power Cost Escalation vs Profitability

Initial Price of Power	$.05
Inflation	2.5%
Discount rate	8.0%
Project life	50 yr

Power cost escalation	Years to Positive Cash Flow Cum./Annual	Cash at 25 Years (end of debt) ($)	Cash at 50 Years (end of life) ($)	NPV Net Present Value ($)	IRR (%)
1 %	11 / 1	550,000	5,700,000	270,000	10.5
1.5 %	9.6 / 1	1,170,000	8,800,000	580,000	12.6
2 %	8.6 / 1	1,800,000	12,300,000	920,000	14.5
2.5 %	7.9 / 1	2,550,000	16,500,000	1,300,000	16.2
3.0 %	7.4 / 1	3,300,000	21,500,000	1,740,000	17.7

Section 2.0, Flow in Carpenter Creek, discusses the available flow and corresponding power production available from Carpenter Creek. The above tables assume that all but about 1% of the mean flow can be diverted from Carpenter Creek during low winter flows. In fact this may be optimistic based on the discussion in Section 6.0, Environmental Issues, which suggests that 10% to 20% of the mean flow may have to remain in the creek as residual flow. This has a significant impact given that normal low winter flow is often less than this minimum residual flow and thus would effectively shut down the plant. To demonstrate this impact the results from the tables above for the $.05 power price with 2.5% escalation rate are repeated below for various residual flow rates:

Table 10.3 - Various Residual Flow Rates vs profitability

Initial Price of Power	$0.05
Power Cost Escalation Rate	2.5%
Inflation	2.5%
Discount rate	8.0%
Project life	50 yr

Residual Flow (% of mean)	Years to Positive Cash Flow Cum./Annual	Cash at 25 Years (end of debt) ($)	Cash at 50 Years (end of life) ($)	NPV Net Present Value ($)	IRR (%)
1 %	7.9 / 1	2,550,000	16,500,000	1,300,000	16.2
10%	14.6 / 1	910,000	11,800,000	490,000	10.7
20%	27.5 / 10	(630,000)	7,400,000	(270,000)	6.6

10.4 – Other Technical Issues Affecting Economic Viability

BC Hydro has indicated that before additional power can be generated in the New Denver 12 kV distribution system a significant upgrade is required to the New Denver 60/12 kV Substation. An email from BC Hydro is included in Appendix E which indicates the total cost budget level cost for the upgrade will be in the order of $1,226,000. They also indicate additional costs of about $110,000 to upgrade feeder capacity.

If the full cost of this upgrade is to be borne by the Village or any other proponent of a new small hydro system then the project immediately becomes unfeasible. Thus some attempt must be made to find creative ways to avoid this cost through negotiations with BC Hydro or other funding agencies. As a further step to investigating the requirements of these upgrades and associated costs it is recommended that an independent consultant be retained to review BC Hydro's recommendations.

These upgrade costs have not been included in the financial analysis since it is assumed that the project would only proceed if these costs can be avoided.

11.0 OTHER SITES

WILSON CREEK FALLS

- Located 12 km North of Roseberry just inside the Goat Range Park boundary
- Over 200 km2 drainage area
- 208 feet vertical at Water Falls

  very short Penstock or Tunnel
- Requires 12 km of powerline to reach 3 phase distribution at Roseberry
- At 15x Seaton Creek

  Max output = 3.75 MW

  Annual production = 15,000,000 kWh/yr at $0.05/kWh = $750,000/yr
- Fish issues

DENNIS CREEK above the Golf Course Intake

- Located 1 km East of Roseberry
- 17 km2 drainage area above the intake
- 800 feet vertical with 6000 feet Penstock
- Requires 1 km of powerline to reach 3 phase distribution at Roseberry
- At 5x Seaton Creek

  Max output = 1.25 MW

  Annual production = 5,000,000 KWH/yr at $.05/KWH = $250,000/yr
- Fish issues

HICKS CREEK

- Located 4.5 km North of Roseberry
- 12 km2 drainage area above the intake
- 1000 feet vertical with 6000 feet Penstock
- Requires 4.5 km of powerline to reach 3 phase distribution at Roseberry
- At 4.5x Seaton Creek

  Max output = 1.125 MW

  Annual production + 4,500,000 KWH/yr at $.05/KWH = $225,000/yr
- Fish issues

SHANNON CREEK

- Located at the North West end of Slocan Lake
- 32.9 km2 drainage area
- 1700 feet vertical with 11,500 feet (3.5 km) Penstock
- Requires 3 km of powerline and 8 km of powerline upgrade to reach 3 phase distribution at Roseberry
- At 18x Seaton Creek

  Max output = 4.5 MW

  Annual production = 18,000,000 kWh/yr at $0.05/kWh = $900,000/yr
- Joint powerline possible with Wragge Creek
- Fish issues

WRAGGE CREEK

- Located at the North West end of Slocan Lake
- 23.7 km2 drainage area
- 900 feet vertical with 7400 feet (2.25 km) Penstock
- Requires 3.5 km of powerline and 8 km of powerline upgrade to reach 3 phase distribution at Roseberry
- At 8x Seaton Creek

  Max output = 2 MW

  Annual production = 8,000,000 KWH/yr at $.05/KWH = $400,000/yr
- Joint powerline possible with Shannon Creek
- Fish issues

APPENDIX A

Summit Environmental Consultants

Screening Environmental Assessment

SUMMIT
ENVIRONMENTAL CONSULTANTS LTD.

#17A - 100 KALAMALKA LAKE RD.
VERNON, BC V1T 7M3
TEL 250 545-3672 FAX 250 545-3654
www.summit-environmental.com

July 22, 2002

Reference: **201-01.01**

Mr. Dan Sahlstrom, P.Eng.
Woods Associates Engineering
2248 Columbia Avenue
Castlegar, B.C.
V1N 2X1

Dear Mr. Sahlstrom:

Re: Screening Environmental Assessment of Proposed Power Production Facilities on Carpenter and Silverton Creeks.

In July 2002 Woods Associates Engineering contracted Summit Environmental Consultants to conduct a brief screening environmental assessment of proposed electricity generating facilities on Carpenter and Silverton Creeks. On July 16 I conducted a field inspection of potential sites along with Mr. Jeff Ankenman and Ms. Sue McMurtrie, local (Slocan Valley) designers of small hydro facilities. In addition, I have reviewed readily available reports and maps. My understanding of the proposed facilities is based on written descriptions of the facilities prepared by Mr. Ankenman and a regional hydrological analysis by Mr. Don Scarlett, P.Eng. This letter forms our environmental screening assessment report.

Carpenter and Silverton Creeks are major tributaries to Slocan Lake that flow through the towns of New Denver and Silverton, respectively. The towns are built on the fans of the two creeks and thus were prone to flooding prior to dyking of the lower reaches of the creeks (across the fans). Both towns once generated their own electricity using water power from the creeks and would like to do so again, if technically and environmentally feasible.

Carpenter Creek

Project Description

In the early 1900s a hydro power generation facility was constructed on Carpenter Creek. A wooden dam was constructed in Denver Canyon, which is about 3.4 km from the mouth of Carpenter Creek on the main channel. Water was passed from the dam to power generating stations (2) via a concrete channel and wooden stave pipe. One of the generating stations was about 550 m downstream of the dam, on the right bank of the channel. The generating station was operational until the 1950s when it was destroyed by a flood. All that remains at the site of the generating station is the concrete foundation (J. Ankenman, pers. comm.).

The proposed hydro power generating facility on Carpenter Creek would consist of a concrete dam in Denver Canyon, approximately 550 m of penstock along the right (north) bank of Carpenter Creek, a powerhouse near the historic facility, and about 700 m of power transmission line to the BC Hydro line along Highway 31A. The dam would probably be about 3 – 5 m tall and backwater 50 – 100 m of channel. There are falls that cannot be passed by fish in Denver Canyon downstream of the proposed dam site. The penstock would generally be within 5 – 30 m of the creek. However, it would generally follow the existing road, except at the canyon where a new road would be blasted into the rock. The facility would likely be designed to operate using up to 5.6 m^3/s of water diverted from the creek through the penstock, then diverted back to the creek adjacent to the powerhouse.

Environmental Setting

Carpenter Creek is known to contain kokanee salmon (spawners (Fall) from Slocan Lake) and rainbow trout (residents, and spawners (Spring) from Slocan Lake) (FISS, 2002). There are two major tributaries of Carpenter Creek upstream of Denver Canyon, Kane Creek and Seaton Creek. Both of which contain resident rainbow trout. Seaton Creek also contains brook trout. In addition, it is likely that there are bull trout present (residents, and spawners (Fall) from Slocan Lake) in Carpenter Creek. There is a 5 to 10 m high falls near the bottom of Denver Canyon that is a complete barrier to upstream fish migration (Photo 3).

Based on flow duration curves for Carpenter Creek generated by the RETscreen computer program (extrapolated from Lemon Creek and Slocan River by Mr. Don Scarlett, P.Eng.) the mean daily discharge of Carpenter Creek occassionally drops as low as between 0.71 m^3/s and 0.86 m^3/s and as high as between 43.74 m^3/s and 88.15 m^3/s. The mean annual discharge is approximately 5.6 m^3/s.

All of the area potentially impacted by the proposed project lies within the Interior Cedar-Hemlock biogeoclimatic zone. Based on observations of vegetation during the site visit the area is typical of the moist/wet subzones. Observed vegetation included:

- rose species (*Rosa sp.*);
- alder species (*Alnus sp.*);
- western redcedar (*Thuja plicata*);
- western hemlock (*Tsuga heterophylla*);
- Douglas fir (*Pseudotsuga menziesii*);
- thimbleberry (*Rubus parviflorus*);
- red-osier dogwood (*Cornus stolonifera*); and
- willow species (*Salix sp.*).

Potential Environmental Impacts

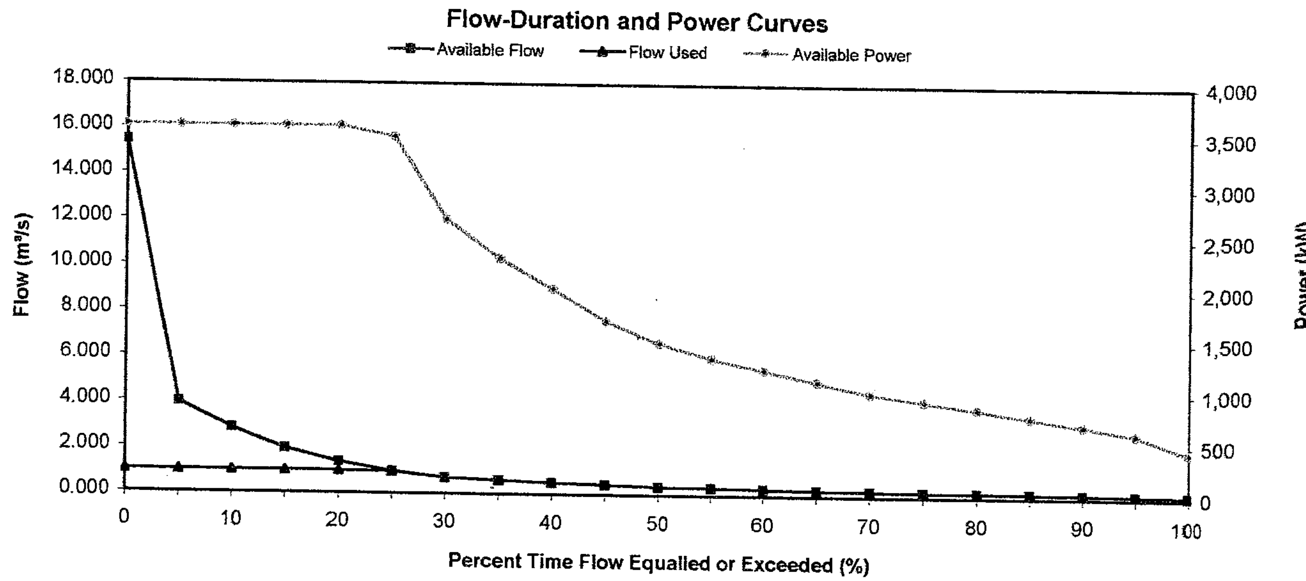
This section will focus primarily on the potential impacts of the infrastructure and operation of the proposed hydro power facility. During construction there will be potential impacts from

RETScreen® Energy Model - Small Hydro Project

Site Conditions		Estimate	Notes/Range
Project name		Shannon Creek	
Project location		Northwest end of Slocan Lake	
Gross head	m	520.0	
Maximum tailwater effect	m	0.00	
Residual flow	m³/s	0.00 0%	Complete Hydrology & Load sheet
Firm flow	m³/s	0.12	

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Design flow	m³/s	1.000	
Turbine type	-	Pelton	Complete Equipment Data sheet
Number of turbines	turbine	2	
Turbine peak efficiency	%	86.1%	
Turbine efficiency at design flow	%	84.6%	
Maximum hydraulic losses	%	7%	2% to 7%
Generator efficiency	%	93%	93% to 97%
Transformer losses	%	2%	1% to 2%
Parasitic electricity losses	%	2%	1% to 3%
Annual downtime losses	%	4%	2% to 7%

Annual Energy Production		Estimate	Notes/Range
Small hydro plant capacity	kW	3,583	
	MW	3.583	
Small hydro plant firm capacity	kW	**444**	
Available flow adjustment factor	-	1.00	
Small hydro plant capacity factor	%	52%	40% to 95%
Renewable energy delivered	MWh	**16,225**	
	GJ	58411	



Complete Cost Analysis sheet

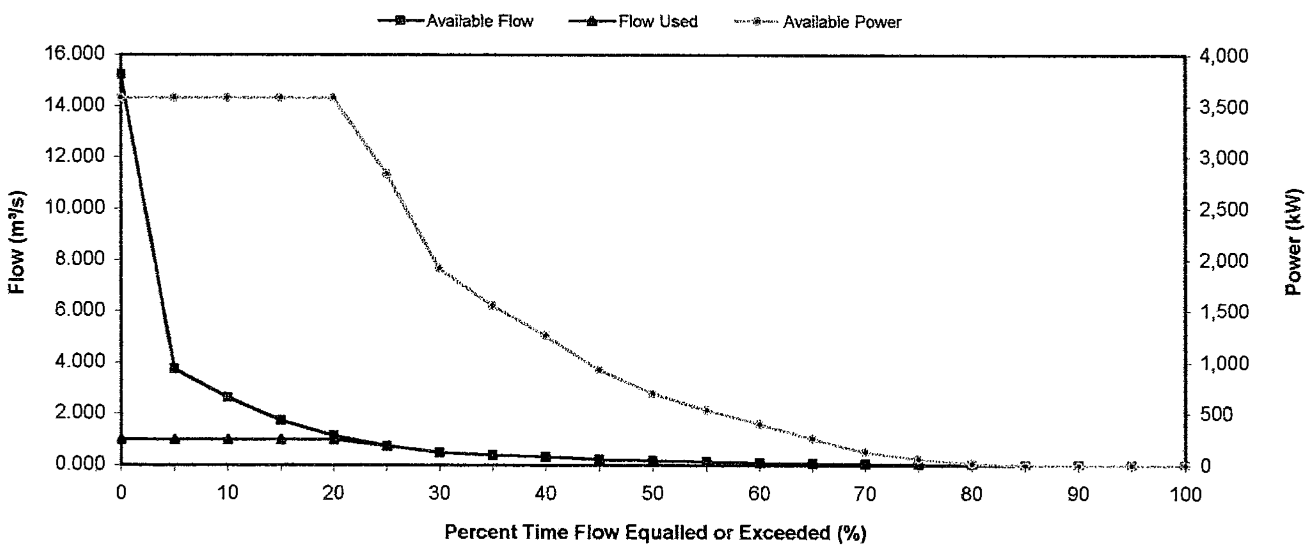
RETScreen® Energy Model - Small Hydro Project

Site Conditions		Estimate	Notes/Range
Project name		Shannon Creek	
Project location		Northwest end of Slocan Lake	
Gross head	m	520.0	
Maximum tailwater effect	m	0.00	
Residual flow	m^3/s	0.20	20% Complete Hydrology & Load sheet
Firm flow	m^3/s	0.00	

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Design flow	m^3/s	1.000	
Turbine type	-	Pelton	Complete Equipment Data sheet
Number of turbines	turbine	2	
Turbine peak efficiency	%	86.1%	
Turbine efficiency at design flow	%	84.6%	
Maximum hydraulic losses	%	7%	2% to 7%
Generator efficiency	%	93%	93% to 97%
Transformer losses	%	2%	1% to 2%
Parasitic electricity losses	%	2%	1% to 3%
Annual downtime losses	%	4%	2% to 7%

Annual Energy Production		Estimate	Notes/Range
Small hydro plant capacity	kW	3,583	
	MW	3.583	
Small hydro plant firm capacity	kW	**0**	
Available flow adjustment factor	-	1.00	
Small hydro plant capacity factor	%	36%	40% to 95%
Renewable energy delivered	MWh	**11,304**	
	GJ	40696	

Flow-Duration and Power Curves



Complete Cost Analysis sheet

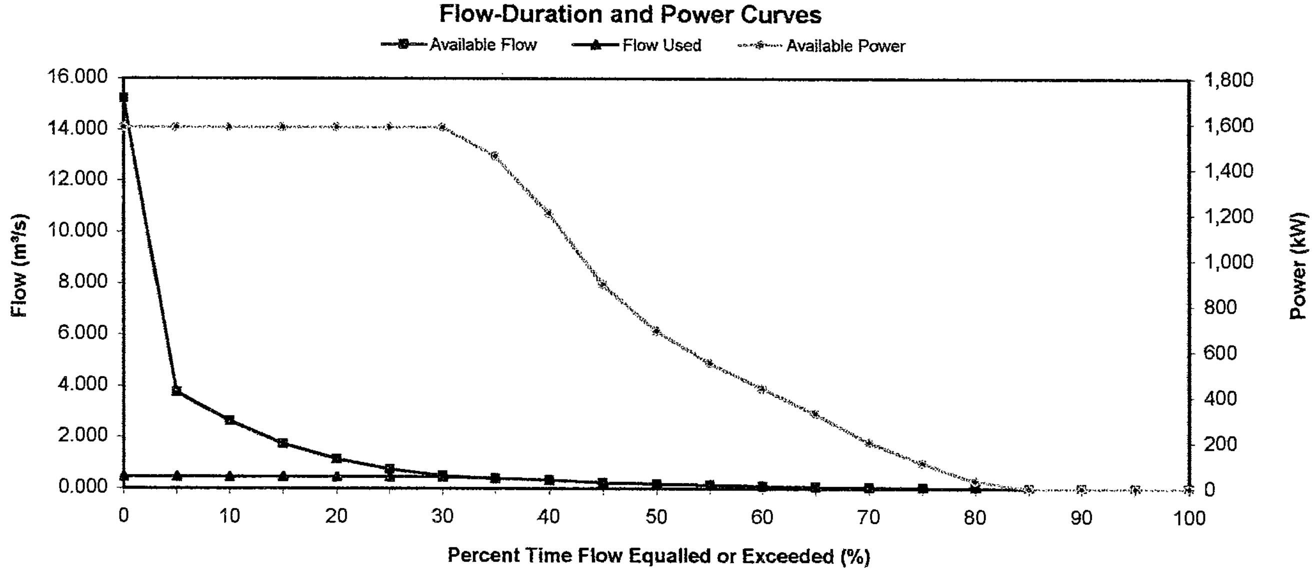
RETScreen® Energy Model - Small Hydro Project

Site Conditions		Estimate	Notes/Range
Project name		Shannon Creek	
Project location		Northwest end of Slocan Lake	
Gross head	m	520.0	
Maximum tailwater effect	m	0.00	
Residual flow	m³/s	0.20 20%	*Complete Hydrology & Load sheet*
Firm flow	m³/s	0.00	

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Design flow	m³/s	0.450	
Turbine type	-	Pelton	*Complete Equipment Data sheet*
Number of turbines	turbine	2	
Turbine peak efficiency	%	84.7%	
Turbine efficiency at design flow	%	83.2%	
Maximum hydraulic losses	%	7%	2% to 7%
Generator efficiency	%	93%	93% to 97%
Transformer losses	%	2%	1% to 2%
Parasitic electricity losses	%	2%	1% to 3%
Annual downtime losses	%	4%	2% to 7%

Annual Energy Production		Estimate	Notes/Range
Small hydro plant capacity	kW	1,587	
	MW	1.587	
Small hydro plant firm capacity	kW	**0**	
Available flow adjustment factor	-	1.00	
Small hydro plant capacity factor	%	49%	40% to 95%
Renewable energy delivered	MWh	**6,844**	
	GJ	24639	

Flow-Duration and Power Curves



Complete Cost Analysis sheet

erosion, de-watering, spills of blast chemicals, concrete, and machine fuel/oil, and vegetation removal. However, these impacts can be mitigated using known technologies and best management practices. Any vegetation removed from along the penstock route during construction would be replaced with suitable native species. The main potential impacts from the infrastructure and operation of the facility are:

1. *Reduction in fish habitat from reduced instream flows*: If the facility is designed to use between 5.6 and 6.6 m^3/s of water, it could accommodate all of the flow in the creek through most of the year. This would result in the de-watering of about 500 m of river channel (at least 7,500 m^2 of wetted channel area) that is probably used by spawning and rearing rainbow and bull trout, and possibly spawning kokanee salmon (Photos 1 and 2). A commonly required minimum flow release into fish-bearing channels downstream of flow diversions (between the dam and powerhouse) is about 20% of the mean annual discharge (Ptolemy 2000), which is estimated to be about 1.10 m^3/s. Thus, the minimum fisheries flows could be all of the natural flow in low flow months.
2. *Flow ramping effects*: Since this will be a run-of-river facility with no water storage there will not be flow ramping issues, except when the generator goes on/off-line for maintenance or due to a malfunction.
3. *Increased water temperature*: If a significant volume of water is being diverted during the summer and early-fall there could be an increase in water temperature in Carpenter Creek that would the detrimental to spawning and rearing fish. However, additional study will be required to identify whether this could be an issue since creeks with a large groundwater influence may decrease in temperature when surface water is diverted. Since the canyon has an east-west orientation and has near-vertical walls (about 40 m high) there are likely to be minimal water warming effects in the headpond.
4. *Instream fish habitat alterations from creek backwatering*: The dam could backwater 50 – 100 m of stream channel in Denver Canyon (Photos 4 and 5). This section of canyon likely provides marginal fish habitat since the channel is narrow and confined (deep, fast flows), appears to have a gradient of about 10% and a bed comprised of bedrock. There is no fish access from downstream due to an impassable falls.
5. *Loss of instream fish habitat and riparian vegetation from the infrastructure footprint*: There will be a permanent loss of potentially vegetated area from the placement of impermeable surfaces (intake, powerhouse foundation, and spillway) within the riparian area of Carpenter Creek. Mitigation of these impacts may include removing the foundation of the historic powerhouse and revegetation of that area.

There is abundant area downstream, along the dyked section of channel, that could be revegetated to mitigate some of the environmental impacts from the project.

Silverton Creek

Project Description

The proposed hydro power generating facility on Silverton Creek would consist of a low head (1 - 2 m) concrete dam several kilometers upstream of Silverton. The dam would probably backwater 25 – 50 m of channel. Water would be piped downstream 3 – 5 km to a powerhouse along the bank of the creek (Photo 7). The penstock would likely follow the existing forestry road that follows the creek, as would the power transmission line to the town of Silverton. The facility would likely be designed to operate using up to 3.6 m^3/s.

Environmental Setting
Silverton Creek is known to contain bull trout, cutthroat trout, rainbow trout, and kokanee salmon (FISS 2002). Maurier Lake in the headwaters of the creek has been stocked with rainbow trout. The water intake is likely to be located downstream of the confluence of Silverton and Maurier Creeks (Photo 8), both of which contain bull and rainbow trout above this point. There are no barriers to fish passage between the mouth of Silverton Creek and the confluence with Maurier Creek. Within the bottom seven kilometers of Silverton Creek channel gradients are generally less than 8% (Photo 6).

Based on flow duration curves for Silverton Creek generated by the RETscreen computer program (extrapolated from Lemon Creek and Slocan River by Mr. Don Scarlett, P.Eng.) the mean daily discharge of Carpenter Creek occassionally drops as low as between 0.38 m^3/s and 0.47 m^3/s and as high as between 23.65 m^3/s and 47.66 m^3/s. The mean annual discharge is approximately 5.6 m^3/s.

All of the area potentially impacted by the proposed project lies within the Interior Cedar-Hemlock biogeoclimatic zone. Based on observations of vegetation during the site visit the area is typical of the moist/wet subzones. Observed vegetation included:

- devil's club (*Oplopanax horridus*);
- western hemlock (*Tsuga heterophylla*);
- western redcedar (*Thuja plicata*); and
- red-osier dogwood (*Cornus stolonifera*).

Potential Environmental Impacts
This section will focus primarily on the potential impacts of the infrastructure and operation of the proposed hydro power facility. During construction there will be potential impacts from erosion, de-watering, spills of blast chemicals, concrete, and machine fuel/oil, and vegetation removal. However, these impacts can be mitigated using known technologies and best management practices. Any vegetation removed from along the penstock route during construction would be replaced with suitable native species. The main potential impacts from the infrastructure and operation of the facility are:

1. *Reduced instream flows*: If the facility is designed to use up to 3.6 m^3/s of water, it could take all of the flow in the creek through most of the year. This would result in the de-watering of a few kilometers of river channel that is used by spawning and rearing trout, and possibly spawning kokanee salmon. A commonly required minimum flow release into fish-bearing channels downstream of flow diversions (between the dam and powerhouse) is about 20% of

the mean annual discharge (Ptolemy 2000), which is estimated to be about 0.60 m^3/s. The minimum fisheries flows could be all of the natural flow in low flow months.

2. *Flow ramping effects*: Since this will be a run-of-river facility with no water storage there will not be flow ramping issues, except when the generator goes on/off-line for maintenance or due to a malfunction.
3. *Increased water temperature*: If a significant volume of water is being diverted during the summer and early-fall there could be an increase in water temperature that would the detrimental to bull trout, which are particularly sensitive to increased water temperatures. However, additional study will be required to identify whether this could be an issue since creeks with a large groundwater influence may decrease in temperature when surface water is diverted.
4. *Reduced fish access*: If a 1 – 2 m tall dam is constructed it is likely that upstream fish access will be adversely affected, especially for juvenile fish, even if fish passage facilities are included in the design. Additional field assessments would be necessary to determine the likely magnitude of impacts if fish passage is restricted. It is unlikely that a complete blockage to fish passage would be acceptable.
5. *Instream fish habitat and riparian vegetation alterations from creek backwatering*: The dam could backwater 25 – 50 m of stream channel (Photo 8). Most of the stream channel in areas considered for the intake has a gradient of about 6 % and a bankfull depth of approximately 1.5 m (estimated visually). In order to accommodate the added channel depth from backwatering the banks would likely have to be raised by two or more meters (dyked). There would not be a direct loss of fish habitat from backwatering (change to deep pool cover and rearing habitat), but raising the channel banks would result in a loss of riparian vegetation, including mature coniferous trees. Mitigation of impacts from backwatering should focus on improving riparian vegetation along portions of the channel that currently have little vegetation. The impacts from backwatering at the water intake will likely be significant but mitigable.
6. *Loss of instream fish habitat and riparian vegetation from the dam and powerhouse footprint*: There will be a permanent loss of potentially vegetated area from the placement of impermeable surfaces (intake, powerhouse foundation, and spillway) within the riparian area of Silverton Creek. The extent of vegetation loss will depend on the location of the intake, powerhouse and spillway. There are several points along the creek that could be used for these purposes and currently have little or no vegetation. There are also numerous sections of channel will largely intact riparian vegetation that would be much more adversely affected by vegetation removal. In general, the location of the infrastructure could be selected such that there will be minimal impacts on riparian vegetation. However, the dam will eliminate fish habitat by covering spawning substrate and rearing habitat. Mitigation of these impacts will likely focus on improving fish habitat elsewhere along the creek, especially towards the mouth or at one or more of the decaying bridges spanning the creek.

In summary, there will likely be significant environmental impacts to aquatic and riparian resource values on both Silverton and Carpenter Creeks from the development of hydro power generation facilities. It appears likely that most of these impacts will be mitigable. However, there may be significant costs from mitigation works (habitat restoration, riparian planting) and from reduced power generation potential (i.e. approximately 20% of mean annual discharge must be released from the dam at all times). The potential temperature impacts of flow diversion are unknown, but they may pose a significant problem to hydro development if temperatures increase sufficiently to adversely impact fisheries resources.

If these projects proceed to a detailed design stage, the potential environmental impacts should be assessed and quantified in more detail based on the detailed designs. We look forward to your comments on this draft report. Please contact me if you have any comments or questions.

Yours truly,

Summit Environmental Consultants Ltd.

Brent Phillips, M.Sc., R.P.Bio.
Senior Biologist

Enclosures: Photographs

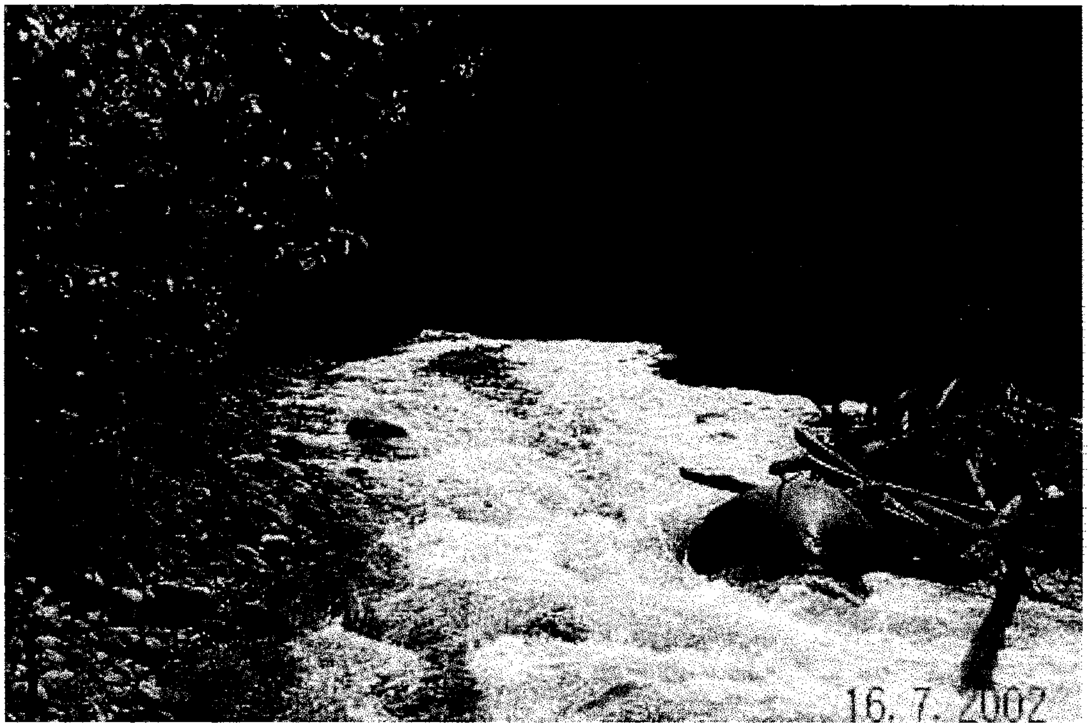


Photo 1: Carpenter Creek near the proposed powerhouse.

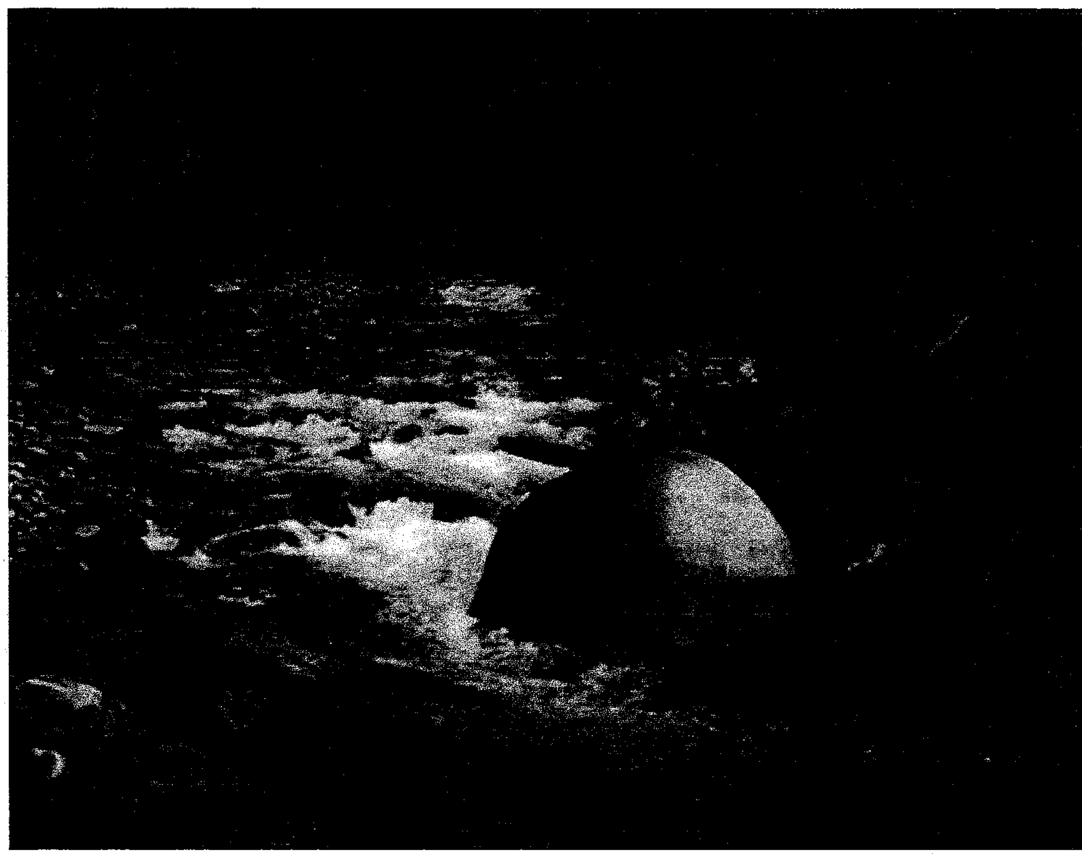


Photo 2: Carpenter Creek at the same location as in Photo 1 in November 2001.

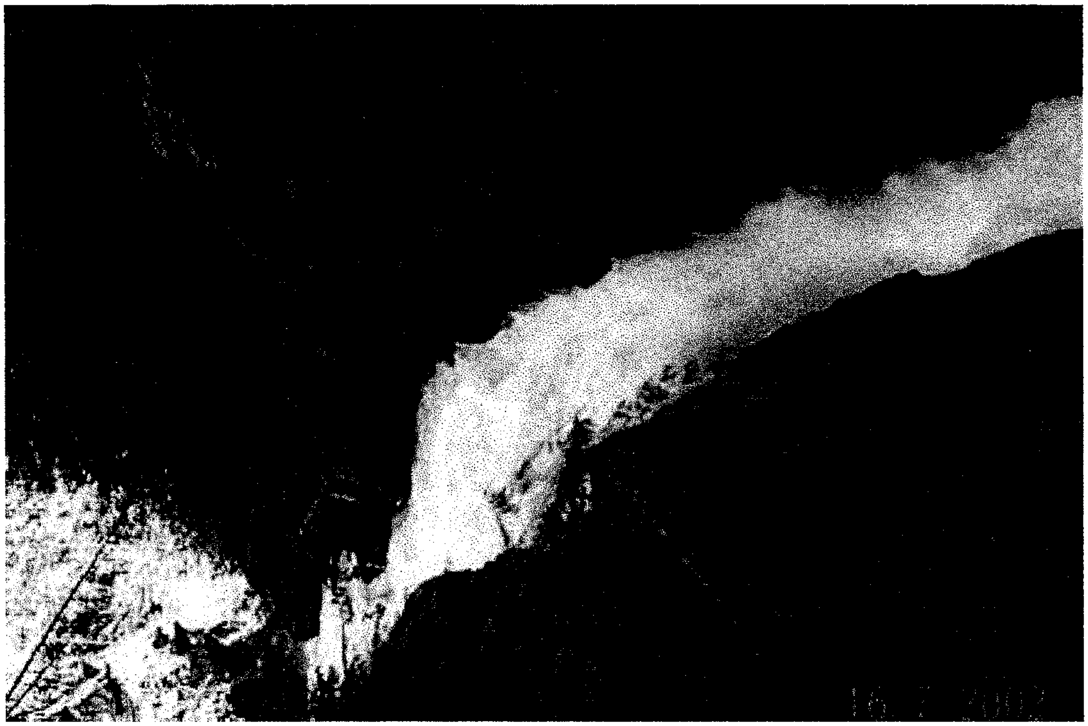


Photo 3: Falls (5-10 m high) near the bottom of Denver Canyon, Carpenter Creek.

Photo 4: Potentially backwatered portion of Denver Canyon, Carpenter Creek.

Photo 5: Potentially backwatered portion of Denver Canyon in November 2001.

Photo 6: Silverton Creek between the proposed water intake and powerhouse.

APPENDIX B

RETSCREEN

Carpenter Creek

- Energy Model
- Hydro & Load
  Based on Lemon Creek with
  Slocan River Specific Run off
- Equipment Data
- Cost Analysis
- Financial Summary

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Canada

RETScreen® International is a standardised and integrated renewable energy project analysis software. This tool provides a common platform for both decision-support and capacity-building purposes. RETScreen can be used worldwide to evaluate the energy production, life-cycle costs and greenhouse gas emissions reduction for various renewable energy technologies (RETs). RETScreen is made available free-of-charge by the Government of Canada through Natural Resources Canada's CANMET Energy Diversification Research Laboratory (CEDRL). The user is encouraged to properly register at the RETScreen website so that CEDRL can report on the global use of RETScreen.

Small Hydro Project Model

TO START (click here)
- Brief Description & Model Flow Chart
- Cell Colour Coding

RETScreen Features (click to access info)
- Online Manual
- Product Data
- Weather Data
- Cost Data
- Currency Options

Model Worksheets (click to access sheets)
- Energy Model
- Hydrology & Load
- Equipment Data
- Cost Analysis
- Greenhouse Gas Analysis
- Financial Summary
- Blank Worksheets (3)

RETScreen® International
Renewable Energy Project Analysis Software

RETScreen is available free-of-charge at
http://retscreen.gc.ca

Internet Options
- RETScreen Website
- Training Information
- Registration
- Contact CEDRL

Contributors
- 85 + Technology Experts
- Collaborating Organisations

UNEP

NASA

Version 2000 - Release 2

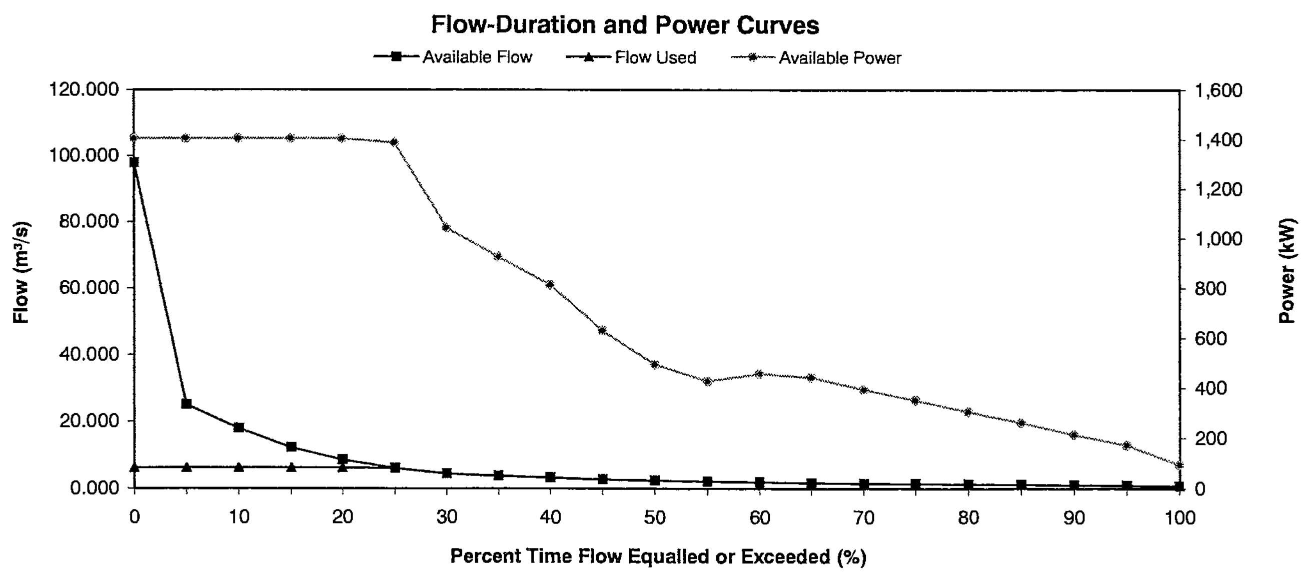
NRCan/CEDRL

RETScreen® Energy Model - Small Hydro Project

Site Conditions		Estimate	Notes/Range
Project name		Denver Canyon	
Project location		BC	
Gross head	m	33.0	
Maximum tailwater effect	m	0.00	
Residual flow	m³/s	0.05	***Complete Hydrology & Load sheet***
Firm flow	m³/s	0.97	

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Design flow	m³/s	6.200	
Turbine type	-	Francis	***Complete Equipment Data sheet***
Number of turbines	turbine	3	
Turbine peak efficiency	%	88.5%	
Turbine efficiency at design flow	%	84.2%	
Maximum hydraulic losses	%	7%	2% to 7%
Generator efficiency	%	93%	93% to 97%
Transformer losses	%	2%	1% to 2%
Parasitic electricity losses	%	2%	1% to 3%
Annual downtime losses	%	4%	2% to 7%

Annual Energy Production		Estimate	Notes/Range
Small hydro plant capacity	kW	1,404	
	MW	1.404	
Small hydro plant firm capacity	kW	**171**	
Available flow adjustment factor	-	1.00	
Small hydro plant capacity factor	%	50%	40% to 95%
Renewable energy delivered	MWh	**6,183**	
	GJ	22259	



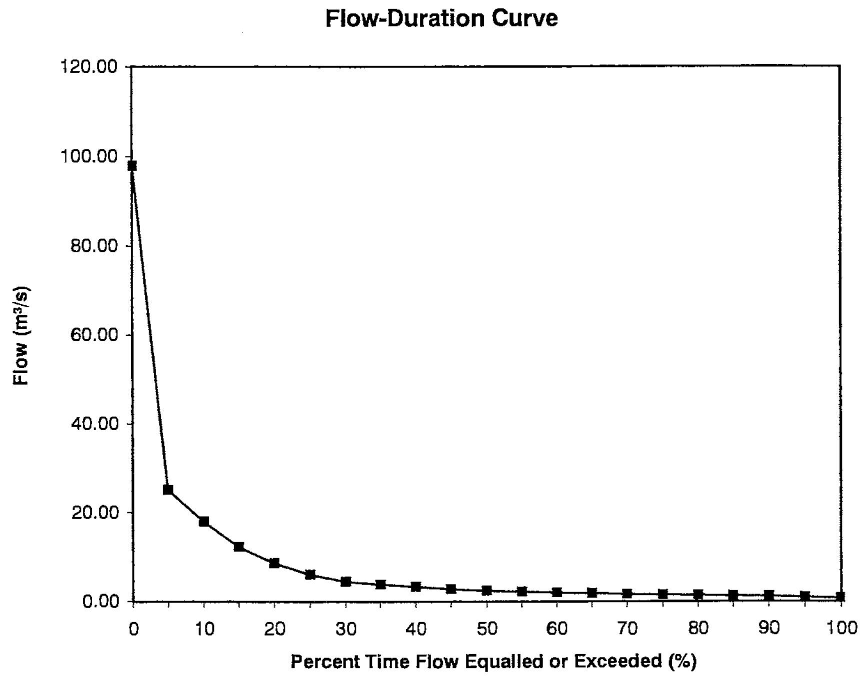
Complete Cost Analysis sheet

RETScreen® Hydrology Analysis and Load Calculation - Small Hydro Project

Hydrology Analysis		Estimate	Notes/Range
Project type		Run-of-river	
Hydrology method		Specific run-off	
Hydrology Parameters			
Drainage area above site	km^2	209	
Specific run-off	$m^3/s/km^2$	0.029	***See Map***
Mean flow	m^3/s	6.1	
Residual flow	m^3/s	0.05	
FDC type / Proxy gauge #	-	CC6 / 08NJ160	***See Weather Database***
Percent time firm flow available	%	98%	90% to 100%
Firm flow	m^3/s	0.97	

Flow-Duration Curve Data

Time (%)	Flow data Normalized (m^3/s)	Actual (m^3/s)
0%	16.16	97.95
5%	4.14	25.09
10%	2.97	18.00
15%	2.03	12.30
20%	1.42	8.61
25%	1.00	6.06
30%	0.74	4.49
35%	0.63	3.82
40%	0.55	3.33
45%	0.46	2.79
50%	0.40	2.42
55%	0.36	2.18
60%	0.33	2.00
65%	0.30	1.82
70%	0.27	1.64
75%	0.25	1.52
80%	0.23	1.39
85%	0.21	1.27
90%	0.19	1.15
95%	0.17	1.03
100%	0.13	0.79



Load Characteristics	Estimate	Notes/Range
Grid type	Central-grid	
		Return to Energy Model sheet

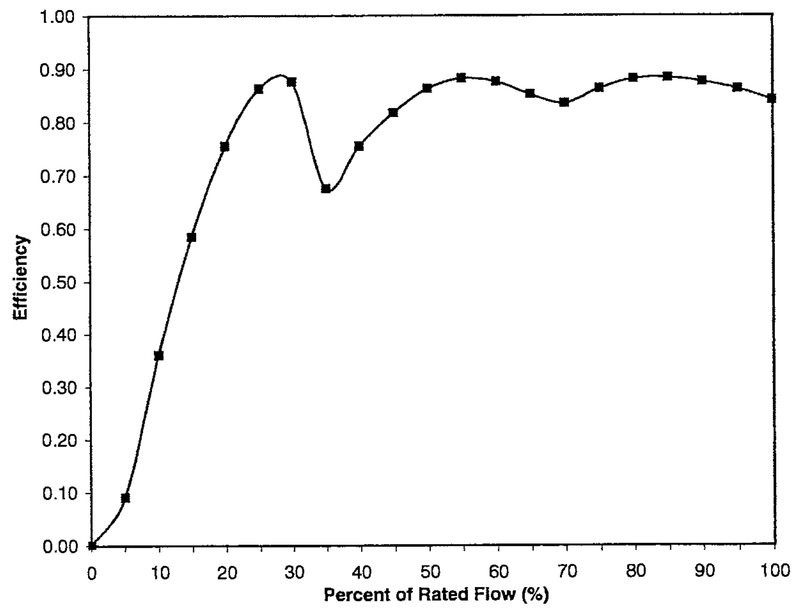
RETScreen® Equipment Data - Small Hydro Project

Small Hydro Turbine Characteristics		Estimate	Notes/Range
Gross head	m	33.0	
Design flow	m³/s	6.20	
Turbine type	-	Francis	***See Product Database***
Turbine efficiency curve data source	-	Standard	
Number of turbines	turbine	3	
Small hydro turbine manufacturer		ABC Ltd.	
Small hydro turbine model		model XYZ	
Turbine manufacture/design coefficient	-	4.5	2.8 to 6.1; Default = 4.5
Efficiency adjustment	%	0%	
Turbine peak efficiency	%	88.5%	
Flow at peak efficiency	m³/s	5.1	
Turbine efficiency at design flow	%	84.2%	

Turbine Efficiency Curve Data

Flow (%)	Turbine efficiency	Turbines running #	Combined turbine efficiency
0%	0.00	0	0.00
5%	0.00	1	0.09
10%	0.00	1	0.36
15%	0.09	1	0.58
20%	0.19	1	0.76
25%	0.28	1	0.86
30%	0.36	1	0.88
35%	0.44	2	0.68
40%	0.52	2	0.76
45%	0.58	2	0.82
50%	0.65	2	0.86
55%	0.70	2	0.88
60%	0.76	2	0.88
65%	0.80	2	0.85
70%	0.84	3	0.84
75%	0.86	3	0.86
80%	0.88	3	0.88
85%	0.88	3	0.88
90%	0.88	3	0.88
95%	0.86	3	0.86
100%	0.84	3	0.84

Efficiency Curve - 3 Turbine(s)



Return to Energy Model sheet

RETScreen® Cost Analysis - Small Hydro Project

Costing method: Detailed | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost			Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study									
Site investigation	p-d	2	CAD	300	CAD	600	0.02%	-	-
Hydrologic assessment	p-d	2	CAD	300	CAD	600	0.02%	-	-
Environmental assessment	p-d	1	CAD	300	CAD	300	0.01%	-	-
Preliminary design	p-d	4	CAD	300	CAD	1,200	0.04%	-	-
Detailed cost estimate	p-d	2	CAD	300	CAD	600	0.02%	-	-
Report preparation	p-d	4	CAD	500	CAD	2,000	0.07%	-	-
Project management	p-d	1	CAD	500	CAD	500	0.02%	-	-
Travel and accommodation	p-trip	10	CAD	100	CAD	1,000	0.03%	-	-
Other	Cost	1	CAD	200	CAD	200	0.01%	-	-
Credit - Feasibility study	Credit	0	CAD	-	CAD	-	0.00%	-	-
Subtotal:					CAD	7,000	0.23%		
Development									
PPA negotiation	p-d	10	CAD	300	CAD	3,000	0.10%	-	-
Permits and approvals	p-d	10	CAD	300	CAD	3,000	0.10%	-	-
Land rights	site	1	CAD	25,000	CAD	25,000	0.82%	-	-
Land survey	p-d	0	CAD	500	CAD	-	0.00%	-	-
Project financing	p-d	2	CAD	500	CAD	1,000	0.03%	-	-
Legal and accounting	p-d	5	CAD	500	CAD	2,500	0.08%	-	-
Project management	p-yr	0.5	CAD	75,000	CAD	37,500	1.23%	-	-
Travel and accommodation	p-trip	0	CAD	2,500	CAD	-	0.00%	-	-
Other	Cost	0	CAD	-	CAD	-	0.00%	-	-
Credit - Development	Credit	0	CAD	-	CAD	-	0.00%	-	-
Subtotal:					CAD	72,000	2.36%		
Engineering									
Design and tender documents	p-yr	1.0	CAD	187,500	CAD	187,500	6.15%	-	-
Contracting	p-d	0	CAD	-	CAD	-	0.00%	-	-
Construction supervision	p-yr	1.0	CAD	187,500	CAD	187,500	6.15%	-	-
Other	Cost	0	CAD	-	CAD	-	0.00%	-	-
Credit - Engineering	Credit	0	CAD	-	CAD	-	0.00%	-	-
Subtotal:					CAD	375,000	12.30%		
Renewable Energy (RE) Equipment									
Turbines/generators, controls	kW	1,404	CAD	600	CAD	842,113	27.62%	-	-
Equipment installation	%	10%	CAD	842,113	CAD	84,211	2.76%	-	-
Transportation	%	1%	CAD	842,113	CAD	8,421	0.28%	-	-
Other	Cost	0	CAD	-	CAD	-	0.00%	-	-
Credit - RE equipment	Credit	0	CAD	-	CAD	-	0.00%	-	-
Subtotal:					CAD	934,745	30.66%		
Balance of Plant									
Access road	km	2.3	CAD	20,000	CAD	46,000	1.51%	-	-
Clearing	ha	0.3	CAD	20,000	CAD	5,000	0.16%	-	-
Earth excavation	m³	300.0	CAD	10	CAD	3,000	0.10%	-	-
Rock excavation	m³	450.0	CAD	30	CAD	13,500	0.44%	-	-
Concrete dam	m³	120	CAD	1,000	CAD	120,000	3.94%	-	-
Timber crib dam	m³	0	CAD	-	CAD	-	0.00%	-	-
Earthfill dam	m³	0	CAD	-	CAD	-	0.00%	-	-
Dewatering	%	10%	CAD	120,000	CAD	12,000	0.39%	-	-
Spillway	m³	1	CAD	50,000	CAD	50,000	1.64%	-	-
Canal	m³	0	CAD	-	CAD	-	0.00%	-	-
Intake	m³	1	CAD	50,000	CAD	50,000	1.64%	-	-
Tunnel	m³	0	CAD	-	CAD	-	0.00%	-	-
Pipeline/penstock	kg	200,000	CAD	3	CAD	500,000	16.40%	-	-
Powerhouse civil	m³	1	CAD	50,000	CAD	50,000	1.64%	-	-
Fishway	m lift	0.0	CAD	-	CAD	-	0.00%	-	-
Transmission line and substation	km	0.7	CAD	50,000	CAD	35,000	1.15%	-	-
Transportation	%	3%	CAD	884,500	CAD	22,113	0.73%	-	-
Transformers&Connection	Cost	1	CAD	50,000	CAD	50,000	1.64%	-	-
Credit - Balance of plant	Credit	0	CAD	-	CAD	-	0.00%	-	-
Subtotal:					CAD	956,613	31.37%		
Miscellaneous									
Special equipment	project	0	CAD	-	CAD	-	0.00%	-	-
Contractor's overhead	%	0%	CAD	956,613	CAD	-	0.00%	-	-
Training	p-d	0	CAD	700	CAD	-	0.00%	-	-
Interest during construction	%	5.0%	CAD	2,345,358	CAD	117,268	3.85%	-	-
Contingencies	%	25%	CAD	2,345,358	CAD	586,339	19.23%	-	-
Credit - Miscellaneous	Credit	0	CAD	-	CAD	-	0.00%	-	-
Subtotal:					CAD	703,607	23.08%		
Initial Costs - Total					CAD	3,048,965	100%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost			Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M									
Land lease	project	1	CAD	500	CAD	500	0.6%	-	-
Property taxes	%	0.4%	CAD	3,048,965	CAD	12,196	14.2%	-	-
Water rental	kW	1,404	CAD	12	CAD	16,842	19.7%	-	-
Insurance premiums	%	0.40%	CAD	3,048,965	CAD	12,196	14.2%	-	-
Transmission line maintenance	%	5.0%	CAD	35,000	CAD	1,750	2.0%	-	-
Spare parts	%	0.25%	CAD	3,048,965	CAD	7,622	8.9%	-	-
O&M labour	p-yr	0.66	CAD	35,000	CAD	23,100	27.0%	-	-
Travel and accommodation	p-trip	0	CAD	-	CAD	-	0.0%	-	-
General and administrative	%	5%	CAD	74,206	CAD	3,710	4.3%	-	-
Other	Cost	0	CAD	-	CAD	-	0.0%	-	-
Contingencies	%	10%	CAD	77,917	CAD	7,792	9.1%	-	-
Annual Costs - Total					CAD	85,708	100%		

Periodic Costs (Credits)		Period	Unit Cost			Amount	Interval Range	Unit Cost Range
Turbine overhaul	Cost	20 yr	CAD	200,000	CAD	200,000	-	-
					CAD	-	-	-
					CAD	-	-	-
End of project life	Credit	-	CAD	-	CAD	-		Go to GHG Analysis sheet

RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Denver Canyon			
Project location		BC			
Renewable energy delivered	MWh	6,183	GHG analysis sheet used?	yes/no	Yes
Excess RE available	MWh	-	Net GHG emission reduction	t_{CO2}/yr	2,793
Firm RE capacity	kW	171	Net GHG emission reduction - 50 yrs	t_{CO2}	139,671
Grid type		Central-grid			

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0500	Debt ratio	%	80.0%
RE production credit	CAD/kWh	-	Debt interest rate	%	5.0%
			Debt term	yr	25
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Avoided cost of capacity	CAD/kW-y	-			
Energy cost escalation rate	%	2.5%			
Inflation	%	2.5%			
Discount rate	%	8.0%			
Project life	yr	50			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	0.2%	CAD	7,000	O&M	CAD	85,708
Development	2.4%	CAD	72,000			
Engineering	12.3%	CAD	375,000	Debt payments - 25 yrs	CAD	173,065
RE equipment	30.7%	CAD	934,745	**Annual Costs - Total**	**CAD**	**258,774**
Balance of plant	31.4%	CAD	956,613			
Miscellaneous	23.1%	CAD	703,607	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**3,048,965**	Energy savings/income	CAD	309,155
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-			
				Annual Savings - Total	**CAD**	**309,155**
Periodic Costs (Credits)						
Turbine overhaul		CAD	200,000	Schedule yr # 20,40		
		CAD	-			
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate RE production cost?	yes/no	No
Pre-tax IRR and ROI	%	16.2%	Calculate GHG reduction cost?	yes/no	No
After-tax IRR and ROI	%	16.2%			
Simple Payback	yr	13.6	Project equity	CAD	609,793
Year-to-positive cash flow	yr	7.9	Project debt	CAD	2,439,172
Net Present Value - NPV	CAD	1,306,798	Debt payments	CAD/yr	173,065
Annual Life Cycle Savings	CAD	106,821	Debt service coverage	-	1.32
Profitability Index - PI	-	2.14			

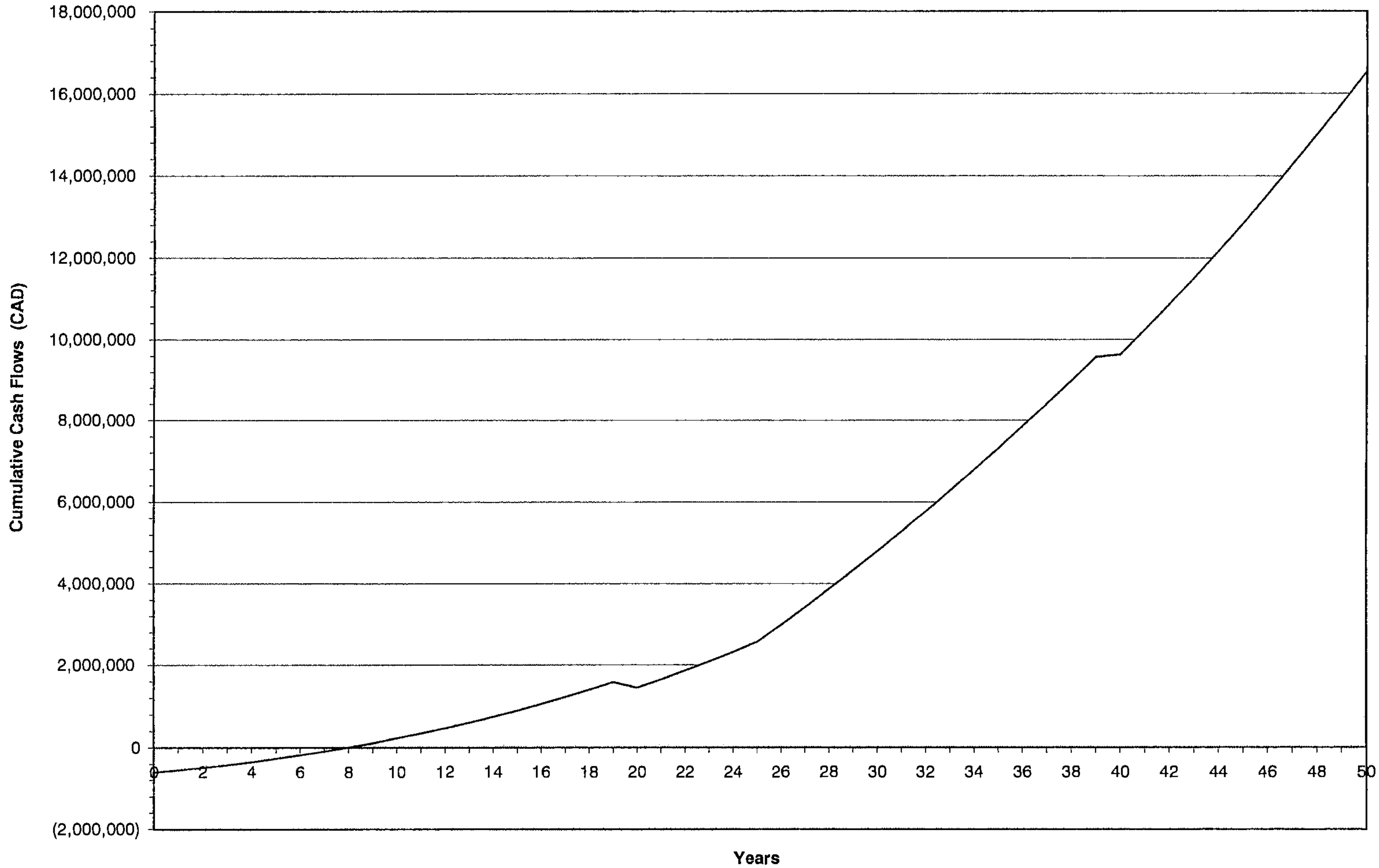
Yearly Cash Flows

Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(609,793)	(609,793)	(609,793)
1	55,967	55,967	(553,826)
2	61,693	61,693	(492,133)
3	67,562	67,562	(424,571)
4	73,577	73,577	(350,994)
5	79,744	79,744	(271,250)
6	86,064	86,064	(185,186)
7	92,542	92,542	(92,644)
8	99,182	99,182	6,538
9	105,988	105,988	112,526
10	112,965	112,965	225,491
11	120,115	120,115	345,606
12	127,445	127,445	473,051
13	134,958	134,958	608,009
14	142,658	142,658	750,667
15	150,551	150,551	901,219
16	158,642	158,642	1,059,861
17	166,935	166,935	1,226,795
18	175,435	175,435	1,402,230
19	184,147	184,147	1,586,377
20	(134,646)	(134,646)	1,451,731
21	202,231	202,231	1,653,962
22	211,613	211,613	1,865,575
23	221,230	221,230	2,086,805
24	231,088	231,088	2,317,893
25	241,191	241,191	2,559,084
26	424,613	424,613	2,983,697
27	435,228	435,228	3,418,926
28	446,109	446,109	3,865,035
29	457,262	457,262	4,322,297
30	468,693	468,693	4,790,990
31	480,411	480,411	5,271,401
32	492,421	492,421	5,763,822
33	504,732	504,732	6,268,554
34	517,350	517,350	6,785,903
35	530,284	530,284	7,316,187
36	543,541	543,541	7,859,728
37	557,129	557,129	8,416,857
38	571,057	571,057	8,987,914
39	585,334	585,334	9,573,248
40	62,954	62,954	9,636,203
41	614,966	614,966	10,251,169
42	630,341	630,341	10,881,510
43	646,099	646,099	11,527,609
44	662,252	662,252	12,189,860
45	678,808	678,808	12,868,668
46	695,778	695,778	13,564,446
47	713,173	713,173	14,277,619
48	731,002	731,002	15,008,621
49	749,277	749,277	15,757,898
50	768,009	768,009	16,525,906

Cumulative Cash Flows Graph

Small Hydro Project Cumulative Cash Flows
Denver Canyon, BC

Year-to-positive cash flow 7.9 yr | IRR and ROI 16.2 % | Net Present Value CAD 1,306,798



APPENDIX C

Crown Land Applications

Land and Water British Columbia Inc.

A corporation of the government of British Columbia

He

June 17, 2002

Search

Tenure / Purchase

Crown Land Application Process

Each application for a Crown land tenure goes through four stages.
In this section, each of those stages is outlined in detail.

Note that requirements vary for different types of tenures. For specific information, contact any of Land and Water British Columbia Inc.'s offices.

For more details, click on your choice from the following menu:

Stage 1: Preparing a Crown Land Application

- Eligibility & application package
- Two or more applicants
- Site plan tips
- Site Management Plan
- Crown Land advertising requirements

Stage 2: Initial Review of a Crown Land Application

Stage 3: Evaluating the Crown Land Application

- Advertising
- Land Status
- Referrals
- Aboriginal Interest Assessment
- Environmental Impacts
- Sustainable Land Use
- Field Inspection

Stage 4: Decision on the Crown Land Application

- Revising a proposal
- Offer of Tenure

Stage 1: Preparing a Crown Land Application

Application procedures vary according to the proposed use of the Crown land and the type of tenure. Start by getting the appropriate application package for your proposed use from one of Land and Water British Columbia Inc.'s regional offices.
For contact information, click here.

For additional information on Land and Water British Columbia Inc.'s programs for specific land use categories, click here.

Application Eligibility

Before preparing an application, make sure you:

- meet the general requirements and any specific eligibility requirements for the proposed tenure ; and
- will not have more than 520 hectares of Crown land under application at one time.

In descending order of complexity, the greatest amount of information and assessment is required for:

- a lease;
- applications for sensitive areas, for large areas of Crown land or for uses which have greater impact on lands and/or communities;
- a license; and
- a temporary permit.

Joint Applications

When an application is made by two or more people, make sure each applicant's full name is listed and each name is followed by either "joint tenancy" or by "tenancy in common" to indicate the type of tenancy.

- Joint tenancy: If a joint tenant dies, his or her interest in the land passes automatically to the remaining joint tenant(s).
- Tenancy-in-common: If a tenant-in-common dies, his or her interest in the land can be willed to heirs and does not automatically pass to the remaining joint tenant(s).

Most application packages should include:

- a completed Application for Crown Land;
- a cheque for the non-refundable application fee, payable to the Land and Water British Columbia Inc.;
- an accurate general location map;
- a site plan (see tips below) of the area (1:5000 or 1:1000) showing the proposed operating area, access roads, watercourses, district lots and major landmarks as reference points, and an accurate metes and bounds description tied to an identifiable start point;
- a zoning map or letter from local government confirming zoning; and
- a completed Economic Impacts Questionnaire;
- a general requirements checklist - new application to guide Lower Mainland Clients in the process.

Site plan tips

- When describing a parcel of land, the description and boundaries must encompass and completely enclose the land, starting and finishing at the same point.
- Grid paper makes it easier to draw your plan or sketch map of the application area. Be sure to give measurements and show an approximate scale on your plan.
- For applications that encompass large areas of Crown land (i.e. some uses under the Commercial Recreation Program, or large linear utilities under Telecommunications) a smaller scale overview map may be sufficient at the initial stages of the application
- Questions? You can always contact Land and Water British Columbia Inc. staff for help.

Application packages may also require:

- a staking notice form or, when Crown land is partially unsurveyed, the land must be staked using Land and Water British Columbia Inc.'s Form 1 as well as the usual application form;
- a Certificate of Incorporation;
- a copy of the State of Title of the requested property;
- a copy of survey plans and charges described in the Title indicated above;
- photos showing the nature of the Crown land; and
- a draft management plan (see details below);
- Crown Land advertising requirements and proof of advertising.

Management Plan

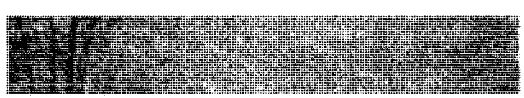
A critical component of many tenure applications, a written management plan details what activities will take place on the Crown land and how, when, and where they will occur.

A management plan should include information, *when relevant*, on the following:

- the company's or applicant's business history;
- a prospectus;
- the operation, activities, level of use, and anticipated number of clients;
- any planned buildings and their location;
- the estimated completion date for the development;
- impacts of the proposed use on the land, resources and other users or interest groups;
- measures to eliminate or minimize any conflicts with other users,
- protection of environmental integrity; and
- means to ensure public access.

In order to obtain management plan information, the applicant may have to finance expert studies such as economic feasibility or environmental impact studies.

A management plan will change in response to feedback by some or all of the following:



- Land and Water British Columbia Inc.;
- other agencies;
- stakeholder groups;
- the public; and
- First Nations.

The final approved management plan will become part of the legal tenure document. It will be the basis by which Land and Water British Columbia Inc. will monitor and enforce specific performance requirements during the tenure.

Land and Water British Columbia Inc. regional staff is available to answer questions as you prepare the application materials. Click here for a contact list.

The completed application package is submitted to the appropriate Land and Water British Columbia Inc. regional office or Business Unit for consideration.

Continue to Stage Two: Initial Review of a Crown Land Application

Return to Stage One: Preparing a Crown Land Application

Return to the starting menu.

Updated February 27

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APPENDIX D

Ownership Titles

Date: 02/07/18 TITLE SEARCH PRINT - NELSON Time: 15:56:49
Requestor: (PA97458) WARD BAY CONSULTING LTD. Page: 001
TITLE - KN16052

NELSON LAND TITLE OFFICE TITLE NO: KN16052
FROM TITLE NO: XH17815

APPLICATION FOR REGISTRATION RECEIVED ON: 24 FEBRUARY, 1999
ENTERED: 01 MARCH, 1999

REGISTERED OWNER IN FEE SIMPLE:
)WNER • BELL POLE COMPANY, INC.NO. A46708
1710 SHUSWAP AVE
PO BOX 339
LUMBY, BC
V0E 2G0

TAXATION AUTHORITY:
NELSON TRAIL ASSESSMENT AREA

DESCRIPTION OF LAND:
PARCEL IDENTIFIER: 009-360-883
OT # • LOT 2 DISTRICT LOT 550 KOOTENAY DISTRICT PLAN 17712

LEGAL NOTATIONS: NONE

CHARGES, LIENS AND INTERESTS:
NATURE OF CHARGE
CHARGE NUMBER DATE TIME

RESTRICTIVE COVENANT
W27086 1987-12-22 08:16
REGISTERED OWNER OF CHARGE:
R/W • HER MAJESTY THE QUEEN IN THE RIGHT OF THE PROVINCE OF BRITISH COLUMBIA AS REPRESENTED BY THE MINISTRY OF TRANSPORTATION AND HIGHWAYS
W27086
REMARKS: SECTION 215 LTA

"CAUTION - CHARGES MAY NOT APPEAR IN ORDER OF PRIORITY. SEE SECTION 28, L.T.A."

DUPLICATE INDEFEASIBLE TITLE: NONE OUTSTANDING

TRANSFERS: NONE

PENDING APPLICATIONS: NONE

*** CURRENT INFORMATION ONLY - NO CANCELLED INFORMATION SHOWN ***

Land Title System

Search Results

For: [PA97458] [WOODS, BRYAN (P) (LDBC)]
Jul 18, 2002
As Of: 02/07/18 16:26:52
04:26:53 PM

Check for Prints

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Print Only Current Title Info. | Print Current & Cancelled Title Info.

Folio: NEW DENVER

Search by Title Displaying Current Information

Title Displayed

```
NELSON           LAND TITLE OFFICE        TITLE NO: W17526
DECLARED VALUE    N/A                FROM TITLE NO: T7559

APPLICATION FOR REGISTRATION RECEIVED ON:  01 SEPTEMBER, 1987
                                  ENTERED:  03 SEPTEMBER, 1987

REGISTERED OWNER IN FEE SIMPLE:
   KENNETH ROBERT JOHN BUTLER, CONTRACTOR
   DONNA MARGARET BUTLER, NURSE
   BOX 313
   NEW DENVER, BC



   V0G 1S0
   JOINT TENANTS

TAXATION AUTHORITY:
  NELSON TRAIL ASSESSMENT AREA

DESCRIPTION OF LAND:
  PARCEL IDENTIFIER: 008-289-409
  PARCEL A (SEE 203295I) DISTRICT LOT 6519 KOOTENAY DISTRICT EXCEPT PARTS
  INCLUDED IN PLANS 9155 AND 15962

LEGAL NOTATIONS: NONE


CHARGES, LIENS AND INTERESTS:
 NATURE OF CHARGE
  CHARGE NUMBER   DATE    TIME

 RIGHT OF WAY
  D12414       1970-11-27  11:52
   REGISTERED OWNER OF CHARGE:
    VILLAGE OF NEW DENVER
         D12414
   REMARKS: INTER ALIA

 RESTRICTIVE COVENANT
  T7557        1984-03-29  09:19
```

OWNER.

LOT #.

```
   REGISTERED OWNER OF CHARGE:
    HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA
    AS REPRESENTED BY THE MINISTRY OF TRANSPORTATION AND HIGHWAYS
         T7557
   REMARKS: SECTION 215 LTA
            INTER ALIA

 MORTGAGE
  KL160545    1997-04-18  11:26
   REGISTERED OWNER OF CHARGE:
    KOOTENAY SAVINGS CREDIT UNION
         KL160545
```

"CAUTION - CHARGES MAY NOT APPEAR IN ORDER OF PRIORITY. SEE SECTION 28, L.T.A."

DUPLICATE INDEFEASIBLE TITLE: NONE OUTSTANDING

TRANSFERS: NONE

PENDING APPLICATIONS: NONE

*** CURRENT INFORMATION ONLY - NO CANCELLED INFORMATION SHOWN ***

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APPENDIX E

BC Hydro Upgrade

Requirements for

New Denver Substation

Hotmail® homesteadhydro@hotmail.com

Inbox | Previous Page

From : "Fulton, Richard" <Richard.Fulton@BCHydro.bc.ca>
To : '"homesteadhydro@hotmail.com"' <homesteadhydro@hotmail.com>
CC : "Steer, Anthony" <Anthony.Steer@BCHydro.bc.ca>
Subject : Generation in the New Denver 12 kV Distribution System
Date : Tue, 11 Jun 2002 17:00:12 -0700
Attachments : newdenversubstationdiagram.pdf (73k)

Dear Mr. Ankenman:
This is in reply to your letter dated 14 May 2002.

1.0 NEW DENVER 60/12 kV SUBSTATION

New Denver (NDR) substation is supplied by a single 69 kV transmission line from Monashee (MON) substation, which also supplies Nakusp substation. NDR substation has 69/12 kV transformer T1 (5.0 MVA 55 deg C rise), a 300 A 12 kV voltage regulator and feeder position 12F52 with a circuit recloser. NDR substation also has 69/12 kV transformer T2 (4.0 MVA 55 deg C rise), a 300 A 12 kV voltage regulator and feeder position 12F51 with a circuit recloser. The 12 kV bus is split. Attached is the NDR Operating Diagram:

<<new denver substation diagram>>

BC Hydro P&C Planning (system protection planning) requires protection upgrades to prevent islanding where generation can island a substation bus, substation transformer or transmission line. Islanding is where generation carries some BCH customer load, temporarily or sustained, after part of the BCH system plus IPP generation separates from the main BCH system. Islanding of customer load is judged not a hazard to customer loads or BCH equipment when annual min load is at least 2 X max coincident generation. This translates to NDR substation as follows:

NDR Transformer T1 and Feeder 12F52:
Annual min load is estimated at 800 kVA. Thus, aggregate generation > 400 kVA in feeder 12F52 will attract the P&C modifications in Table 1 below.
The existing IPP generation is estimated at:
(a) Homestead Hydro = 200 KW at 0.90 pf = 222 kVA,
(b) Silversmith P&L = 150 kW at 0.90 pf = 167 kVA
Total existing IPP annual maximum generation = 389 kVA. Thus, there is very little margin for added generation without attracting the P&C modifications in Table 1 below.

NDR Transformer T2 and Feeder 12F51:
Annual min load is estimated at 500 kVA. Thus, aggregate generation > 250 kVA in feeder 12F51 will attract the P&C modifications in Table 1 below.

Our estimates of feeder annual min load could be verified/revised by installing load recorders on each of the two feeder positions for say 7-10 days during the summer. We would have to know IPP hourly generation to add that offset to the feeder 12F52 load survey results.

Table 1:
1) add a new control building to house the new protection panels and expand perimeter fencing to allow space for new breakers ... $210k,
2) replace a 69 kV disconnect and 12 kV feeder recloser with circuit breakers. The existing 12 kV feeder reclosers are not rated to trip for out-of-step conditions. A 69 kV CB is required to provide station transformer and bus protection. Add new VT's on the 69 kV bus (for line protection) and 12 kV bus (for feeder torque control and feeder auto-reclosing) ... $336k,
3) provide 69 kV line protection, transformer differential protection and feeder protection ... $400k,
4) add a transfer trip between MON and NDR for MON T3, T4 or T5 protection. This transfer trip can also be used for 69 kV line protection so NDR line protection will consist of transfer trip received for primary protection and distance and ground relaying for standby protection. Transfer trip equipment at MON and NDR .... $70k. Add communication media for the transfer trip at a rough guess of $210k. BCH Telecom will have to look into Telus lines in the vicinity since there is no existing communication media into NDR substation.

Total budget-level cost for above = $1,226,000.

2.0 FEEDER 12F51, 52 CAPACITY

The nominal current rating for three-phase feeders is 300 A. The NDR feeders operate at 12.5 kV, giving a nominal feeder capacity of 6.5 MVA.

Feeder 12F51 NDR (crosses Silverton Creek at Silverton) has a 1.6 km section of #2 ACSR conductor with a current rating of 150 A. The steady-state capacity is 3.2 MVA assuming balanced phases. The current rating of the feeder could be raised to 270 A (5.8 MVA capacity) by reconductoring this section of #2 ACSR with 336 kCM ASC conductor at a cost of about $80k.

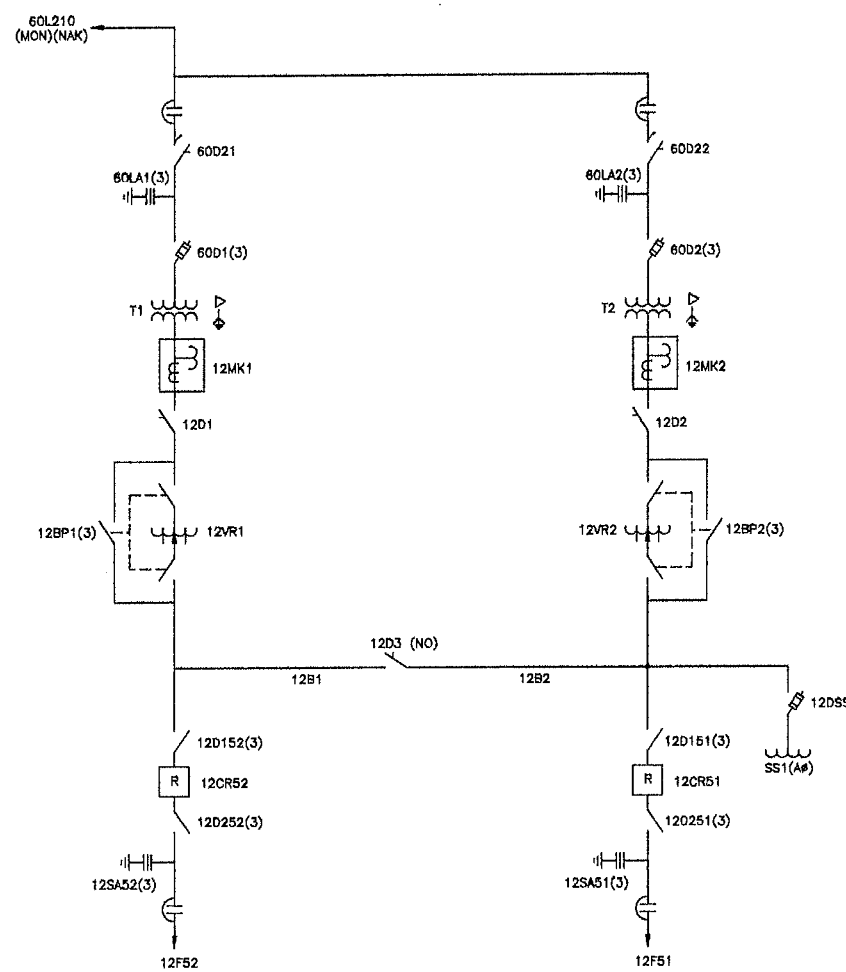
Feeder 12F52 NDR (nearest access to Carpenter Creek sites) has a 0.6 km section of #2 ACSR conductor with a current rating of 150 A. The steady-state capacity is 3.2 MVA assuming balanced phases. The current rating of the feeder could be raised to 300 A (6.5 MVA capacity) by reconductoring this section of #2 ACSR with 336 kCM ASC conductor at a cost of about $30k.

The preceding addresses feeder primary conductor capacity. There may be additional costs for feeder protection requirements in the field. These costs can be estimated once generator location and characteristics are known.

Please call or write if you have added questions.
Regards.....
Rich

Richard Fulton e-mail: richard.fulton@bchydro.com
Distribution Engineering & Planning, Edmonds E-07, Burnaby, BC
Tel: (604)-528-3227 Fax: (604)-528-1662
Intranet http://edmapp02/td/dep

NDR



RATINGS OF EQUIPMENT

TRANSFORMERS

T1 – FERRANTI, 3ø, 3.75/5MVA, ONS/ONP, 55°C, 64KVΔ ±2x2.5%–25.2/12.6KVY⏚, DETC.

T2 – RELIANCE, 3ø, 3/4MVA, ONS/ONP, 55°C, 61.425KVΔ ±2x2.5%–12.47/7.2KVY⏚, DETC.

SS1 – GE, PERMALEX, 7200/120–240 V, 15 kVA, 1ø.

RECLOSERS

12CR51 – McGRAW EDISON, CLM TYPE RE, 400 A.
12CR52 – McGRAW EDISON, CLM TYPE RE, 560 A.

REGULATORS

12VR1,2 – FERR. PACKARD, 300 A, 650 kVA, 12 kV ±10% IN 21 TAPS

FUSES:

60D1,60D2 – 30E, SLOWBLOW, TCC 119–1
12DSS1 – 2H

NO.	DATE	REVISION	PLT. ALT.	BY	CH.	CH.	APP.
7	2001JUL08	CHANGED 12D1,12D2,12D3 ADDED DEAD END JUMPERS.		JBL			JRC
6	2000JUL03	UPDATED		JBL			JRC
5	88-09-07	T1 REPLACED, MINOR REVISIONS	DCR	JL			
4	87-08-05	CHG'D DISC. 54 TO 51	DCR	BM			
3	86-03-27	T2 FUSES CHANGED	DCR	JL			
2	80-10-06	CONN. CORRECTED	DGK	ES			
1	78-11-21	REDRAWN, 12VR2 ADDED	JCH	HD			

BC hydro

NEW DENVER

(NDR)

SUBSTATION OPERATING ONE LINE

NDR