Alaska Hydro Corporation

More Creek Hydroelectric Project
Prefeasibility Study

August 2018
E6348

SIGMA ENGINEERING LTD
1444 Alberni Street, 4th Floor, Vancouver, BC, Canada V6G 2Z4
Phone: (604) 688-8271 Fax: (604) 688-1286

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PREFACE

This study has been prepared exclusively for Alaska Hydro Corporation for the purposes of assessing the proposed More Creek hydroelectric project. No third party is entitled to rely on this analysis without the express written permission of Sigma Engineering Ltd and Alaska Hydro Corporation.

This study has been updated from the original June 2015 version. The update has revised the dam type from a roller compacted concrete gravity dam to an arch type dam based on Golder Associates' September 2017 dam prefeasibility study. As well, the dam location has been moved 400m downstream to a location originally studied by BC Hydro. Power generation estimates have not been affected by these design revisions. Project cost estimates and financial models have been updated to reflect additional pricing information and inflation.

1. BACKGROUND

Alaska Hydro Corp. (AHC) is proposing to develop the More Creek hydroelectric project, located approximately 10 km northwest from Bob Quinn Lake in the Skeena region of British Columbia.

The 75 MW project consists of access roads, an intake, a dam, a tunnel and penstock, powerhouse and generating equipment, transmission line and interconnection to the Bob Quinn BC Hydro substation (see Figures 1 and 3.1). The project also includes a diversion of Forrest Kerr Creek into the More Creek watershed.

A low ridge approximately 2.5km wide divides the Forrest Kerr Creek watershed and the South Arm of More Creek. Forrest Kerr Creek is diverted into the More Creek watershed by building a channel across this ridge. Water that initially is lost to the existing Forrest Kerr plant is returned via More Creek and Iskut River back to the plant, with a more regulated flow.

The More Creek project was examined by BC Hydro in the 1980s. BC Hydro conducted a feasibility study of the project, including the Forrest Kerr Diversion. The cost estimate conducted by Sigma for the Forrest Kerr Creek diversion is based on the layout and concept presented in the BC Hydro study. A Prefeasibility Study by Sigma Engineering Ltd. for the project, without including the Forrest Kerr Creek diversion, was completed in June 2015.

Below we describe our methodology and assumptions in developing a model to estimate the projected revenues (hydrology and generation model), and our considerations for developing prefeasibility cost estimates for the project.

2. HYDROLOGY

The hydrology for More Creek is based on flow data from the Water Survey Canada (WSC) streamflow gauge '08CG005 – More Creek near the mouth'. The gauge was located near the proposed intake site and was active from 1972 to 1995 and has a set of 19 complete years of daily flow data available. The drainage area of WSC 08CG005 is 844 km², which is the same as the drainage at the intake of the proposed project. Thus the flow data from the WSC gauge are used without any adjustments as the basis of the hydrology at the site.

The mean monthly and annual flows at the site are shown in Table 1 below:

Table 1. Mean Monthly and Annual More Creek Flows at proposed intake

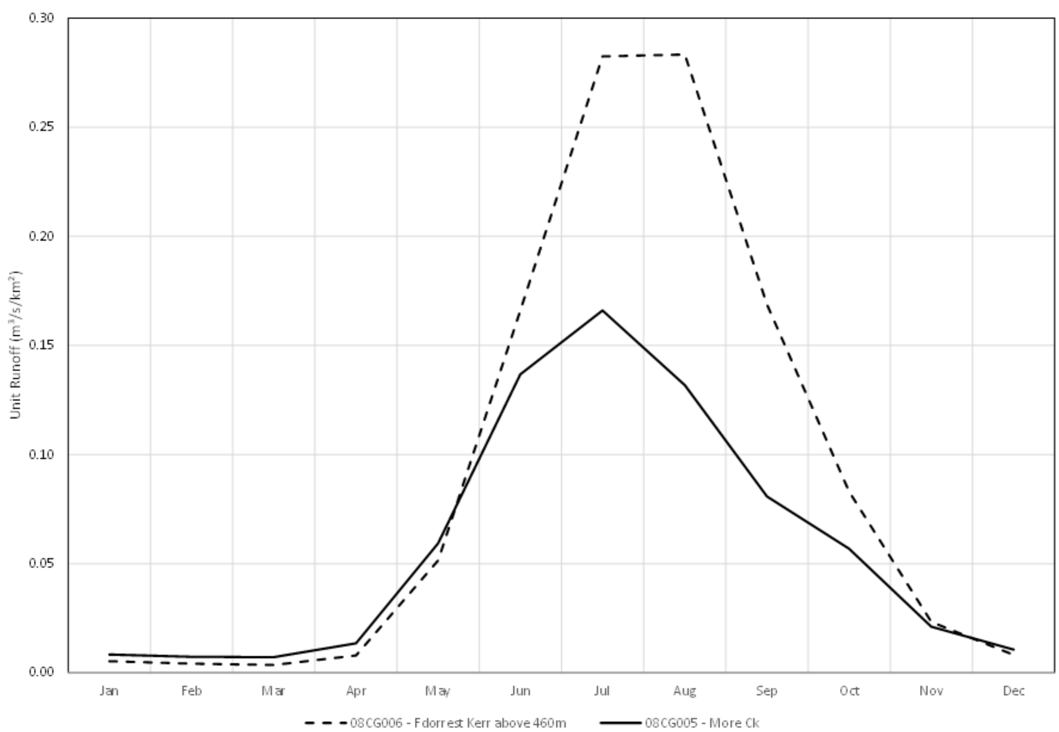
	1974	1975	1977	1978	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Average
Jan	5.3	8.7	8.0	5.8	6.7	12.3	5.8	6.0	4.4	6.0	4.9	8.0	7.6	7.5	7.4	7.2	8.3	6.8	6.6	**7.0**
Feb	4.5	7.5	8.2	5.0	8.2	8.7	4.9	4.9	5.6	4.8	4.0	6.4	5.5	7.2	5.3	6.8	8.3	6.8	4.6	**6.2**
Mar	4.5	6.2	6.3	4.0	5.8	7.5	4.3	4.3	5.3	5.0	7.5	5.4	4.9	6.1	5.5	4.5	12.4	5.9	8.6	**6.0**
Apr	7.5	6.0	14.1	9.1	12.1	8.9	5.3	12.6	9.0	6.0	9.0	10.2	14.6	11.9	14.5	13.4	18.6	17.6	16.2	**11.4**
May	29.6	36.6	43.9	33.0	58.7	67.5	24.5	56.3	49.4	37.1	36.4	38.5	57.0	47.3	59.5	67.5	50.6	102.9	56.3	**50.1**
Jun	64.9	100.6	108.3	110.3	153.7	105.2	129.2	132.7	98.4	99.3	105.5	87.5	110.9	122.8	127.8	134.5	163.2	139.7	98.7	**115.4**
Jul	89.1	172.3	135.3	120.1	138.0	135.3	150.8	119.5	115.7	160.1	162.8	150.3	126.6	144.1	137.1	125.4	196.3	151.2	132.0	**140.1**
Aug	104.3	91.1	150.2	119.6	96.6	114.6	105.0	106.7	130.7	98.2	93.2	88.0	109.4	128.4	140.9	112.5	100.7	105.3	117.6	**111.2**
Sep	87.9	32.7	49.2	45.3	71.3	127.3	68.2	53.3	37.5	59.2	47.2	80.2	68.6	77.5	97.2	76.0	45.3	57.5	113.7	**68.2**
Oct	104.7	17.3	29.7	69.2	98.0	41.4	43.9	26.5	31.3	26.5	74.0	51.0	43.6	41.3	29.5	50.0	27.4	69.5	37.1	**48.0**
Nov	30.7	11.4	10.7	17.3	24.2	30.1	12.2	16.0	9.7	10.1	20.4	24.8	15.9	18.8	16.4	14.3	16.4	20.9	18.3	**17.8**
Dec	12.0	5.3	6.8	7.0	16.1	9.7	7.4	6.0	6.2	4.7	4.9	13.3	9.7	11.7	10.4	11.7	9.8	10.6	7.6	**9.0**
Annual	45.7	41.6	47.9	45.8	57.8	56.0	47.1	45.6	42.3	43.4	47.9	47.3	48.1	52.4	54.6	52.3	55.1	58.3	51.7	**49.5**

The proposed Forrest Kerr Creek diversion point is approximately 25 km upstream from the confluence of Forrest Kerr Creek with Iskut River. The water available at the diversion is based on flow data from the Water Survey Canada (WSC) streamflow gauge '08CG006 – Forrest Kerr Creek above 460m contour'. The gauge is located about 5 km downstream of the proposed diversion site; it was active from 1972 to 1994 and has 20 complete years of daily flow data available. The drainage area of WSC 08CG006 is 311 km². The drainage area at the proposed diversion site is 275.3 km² (see Figure 2). Flows from WSC-08CG006 were prorated to the diversion site based on drainage areas.

The above calculated daily flows from Forrest Kerr Creek were added to the daily More Creek flows. This study used 18 common years of flow data at WSC gauges 08CG005 and 08CG006.

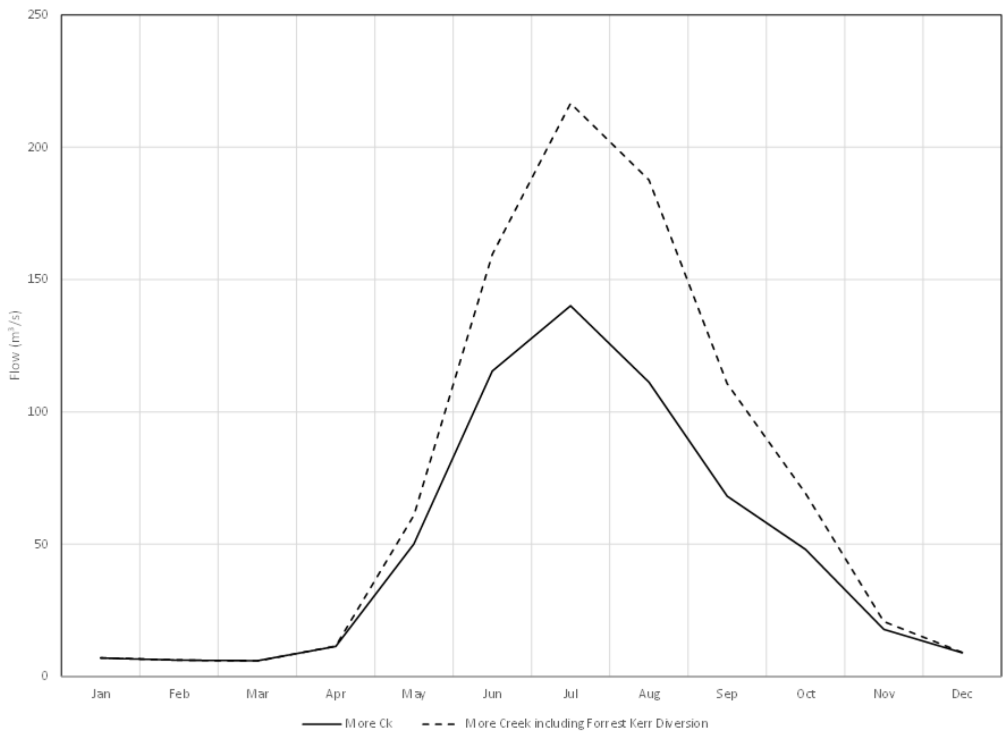
The monthly unit runoff at the two WSC gauges is shown on Figure 4 below:

Figure 4. Unit Runoff



The average monthly flows at the project intake with and without the Forrest Kerr diversion are shown on Figure 5 below:

Figure 5. More Creek Average Monthly Flows



The mean monthly and annual combined More Creek and diverted Forrest Kerr Creek flows at the proposed intake are shown in the table below:

Table 2. Mean Monthly and Annual combined Flows at proposed intake

	1974	1975	1977	1978	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	Average
Jan	5.3	8.7	8.0	5.8	6.7	12.3	5.8	6.0	4.4	6.0	4.9	8.0	7.6	7.5	7.4	7.2	8.3	6.8	7.1
Feb	4.5	7.5	8.2	5.0	8.2	8.7	4.9	4.9	5.6	4.8	4.0	6.4	5.5	7.2	5.3	6.8	8.5	6.8	6.3
Mar	4.5	6.2	6.3	4.0	5.8	7.5	4.3	4.3	5.3	5.0	7.5	5.4	4.9	6.1	5.5	4.5	12.5	5.9	5.9
Apr	8.3	6.0	14.7	9.9	12.3	8.9	5.3	13.2	9.0	6.0	9.0	10.2	14.7	12.3	15.2	13.8	18.9	19.5	11.5
May	36.7	42.0	51.9	41.5	69.0	80.8	27.9	70.2	57.7	41.9	41.8	46.1	69.3	61.5	72.5	82.7	62.4	140.6	60.9
Jun	86.6	130.5	159.3	156.6	205.5	143.3	179.8	191.9	128.2	123.4	138.3	116.1	147.9	178.3	186.0	182.6	216.4	201.2	159.5
Jul	133.5	259.1	181.2	202.1	207.0	250.8	241.5	200.0	174.1	239.4	242.4	228.2	185.6	231.8	222.6	194.4	275.6	229.0	216.6
Aug	176.7	157.8	254.9	208.3	168.7	208.4	177.5	183.0	199.0	166.9	161.8	153.6	180.7	213.8	232.2	192.8	163.6	177.0	187.6
Sep	137.1	50.4	92.6	74.3	124.1	197.0	123.0	91.3	58.5	98.1	84.4	132.5	118.6	137.2	157.0	135.9	74.7	104.8	110.6
Oct	150.3	22.5	38.8	99.1	135.7	57.1	67.4	33.0	39.6	31.4	122.0	77.4	61.1	59.2	38.4	75.0	35.1	101.7	69.2
Nov	35.4	11.8	11.4	22.1	28.0	38.5	13.2	16.5	9.7	10.1	27.9	28.3	17.8	22.3	17.1	15.4	16.7	31.1	20.7
Dec	12.0	5.3	6.8	7.0	16.1	9.7	7.4	6.0	6.2	4.7	4.9	13.4	9.7	12.1	10.5	11.7	9.8	10.7	9.1
Annual	66.4	59.5	70.0	70.2	82.8	85.8	71.9	68.8	58.6	62.0	71.4	69.3	69.1	79.6	81.3	77.4	75.7	86.9	72.6

3. GENERATION AND REVENUE ESTIMATES

A spreadsheet model is used to calculate the monthly and annual generation at the site. The model uses 18 complete years of daily flows as the basis of the calculations.

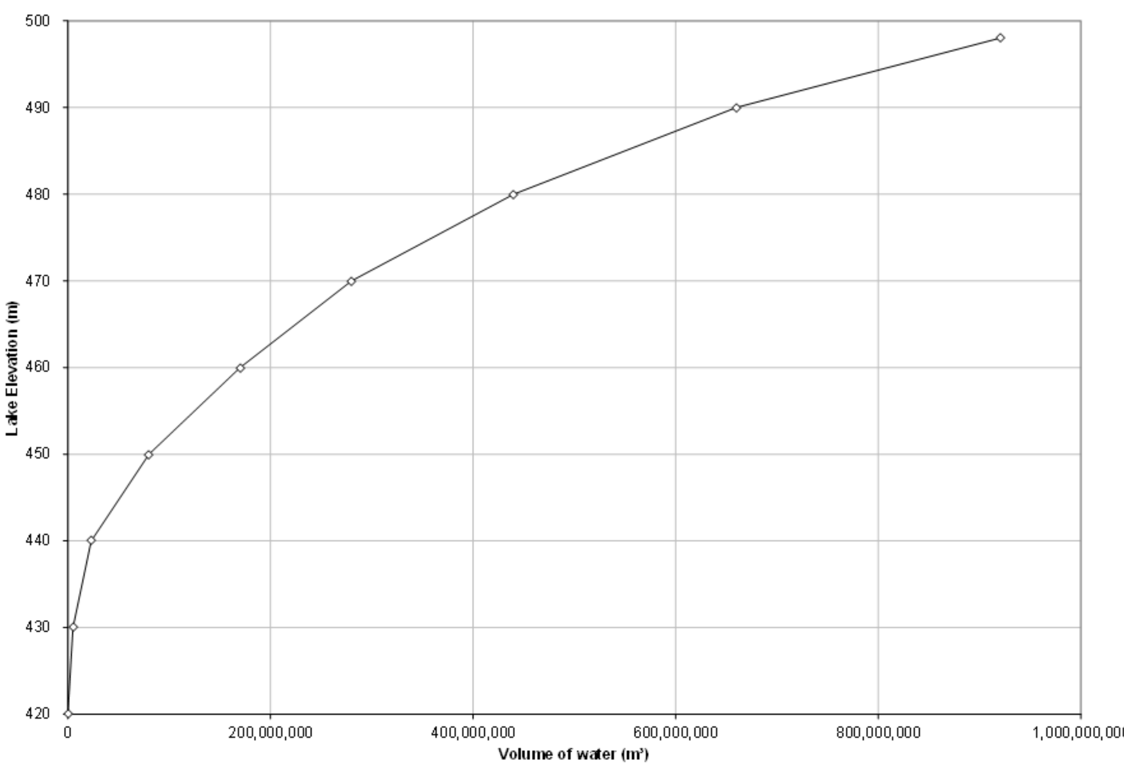
Assumptions

The basic assumptions used in the model are:

Design flow	80	m^3/s
Dam crest elevation	498	m
Minimum lake level	468	m
Mean tailwater level	380	m
Gross head	88 - 118	m
Instream flow release	2.476	m^3/s (5% of mean annual flow)
Minimum turbine flow	20	m^3/s
Installed Capacity	75.2	MW
Generating equipment efficiency	86.45%	
Friction head loss (waterway)	6%	

The following lake storage curve is used (Figure 6). The curve was developed based on available 1:20,000 mapping.

Figure 6. More Creek Reservoir Storage Curve



The 30 m of available storage is equivalent to approximately 90 days of storage at the design flow. The simple operation of the plant would dictate that excess water is stored during the summer months and used in the fall and winter months.

However, this operation assumes that the electricity price is the same throughout the year. Since at this stage, the electricity pricing scheme is not known, the model used the current BC Standing Offer Program (SOP) monthly delivery time adjustments to vary the electricity price through the year.

At the Forrest Kerr Diversion, for the purpose of this analysis, it is assumed that:

- An instream flow release of 3.77 m³/s (15% of the estimated 25.13 m³/s mean annual flow at the point of diversion).
- All flow in excess of 3.77 m³/s is diverted to More Creek.
- In practice, portions of short term peak floods would be spilled down Forrest Kerr Creek, but these are not considered in the analysis.

The model used monthly targets for the design flow to simulate the operation of the plant and maximize the average annual generation and revenue. Our preliminary analysis determined that a monthly target for the design flow of 80m³/s resulted in the maximum generation at the plant.

The resulting monthly and annual generation estimates are shown in Table 3 below:

Table 3. Generation estimates (GWh)

	1974	1975	1977	1978	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	Average
Jan	52.7	48.8	8.1	31.1	47.2	48.2	47.0	45.4	23.8	20.9	28.2	47.6	46.2	45.3	45.8	41.6	46.3	32.7	39.3
Feb	46.4	34.1	2.7	1.3	20.8	31.0	16.6	4.0	1.3	1.3	0.0	22.3	10.9	5.4	8.1	1.3	13.7	2.7	12.4
Mar	46.8	1.3	2.7	0.0	1.3	2.7	1.3	1.3	1.3	1.3	2.7	1.3	1.3	1.3	1.3	1.3	5.4	1.3	4.2
Apr	15.9	1.3	5.4	3.4	4.0	2.0	0.7	4.7	3.4	1.3	3.4	4.0	5.4	4.7	5.4	4.7	6.7	7.4	4.7
May	17.5	20.2	25.6	20.2	31.1	31.4	12.1	29.7	28.3	17.6	18.9	21.5	35.1	27.0	31.2	36.7	25.7	36.8	25.9
Jun	36.9	41.7	43.1	43.4	45.5	44.2	43.3	45.2	40.6	42.5	42.4	41.3	41.8	44.8	44.9	43.9	45.4	49.9	43.4
Jul	45.2	52.0	50.5	50.7	54.0	51.9	53.0	53.2	48.6	50.7	51.2	49.9	50.1	53.3	53.4	52.8	55.3	55.4	51.7
Aug	49.9	55.8	55.4	55.7	56.0	56.0	56.0	56.0	54.3	55.7	55.9	55.0	55.0	56.0	56.0	55.9	56.0	56.0	55.4
Sep	52.2	53.7	54.1	54.0	54.2	54.2	54.2	54.0	53.9	54.2	54.1	54.2	54.1	54.2	54.2	54.2	53.9	54.1	54.0
Oct	55.7	53.6	54.8	55.4	55.9	55.4	55.7	54.4	54.4	55.0	55.9	55.5	55.3	55.6	55.2	55.8	54.8	55.7	55.2
Nov	53.4	48.9	50.9	52.9	52.9	52.5	52.0	50.4	50.1	50.8	53.1	51.9	51.8	51.8	51.3	52.2	50.7	53.3	51.7
Dec	52.7	45.8	48.6	51.7	52.1	51.5	50.4	47.9	47.5	48.4	52.0	50.8	50.2	50.4	49.5	50.8	48.7	52.5	50.1
Annual	525.0	457.2	402.0	420.0	475.0	481.0	442.3	446.2	407.5	399.7	417.6	455.5	457.4	449.8	456.2	451.3	462.6	457.8	448.0

If an electricity price of $100/MWh is assumed the same throughout the year, then the average annual revenue would be $44.8 million. Note the lowest and highest annual revenue are $39.9 and $52.5 million respectively, based on the 18 years of modelled flows.

Application of the current BC Hydro monthly delivery adjustment factors, does not result in any noticeable change of the above estimates.

Note that if the electricity price variance through the year is different from that of the current SOP, the monthly target for the turbine flow may differ from the ones shown above. Also, the impact of any monthly variation of electricity prices may vary depending on price change and plant operation.

Impact on Forest Kerr hydro project

The operation of the More Creek hydro project would potentially increase the generation of the existing Forrest Kerr project, located downstream from the More Creek powerhouse. The storage of water during the summer months, when Forrest Kerr would typically be spilling water, and the subsequent release of the stored water over the winter months would increase the Forrest Kerr generation potential.

The operational details of the Forrest Kerr project are not available to us. A high level estimate of the potential additional generation at Forrest Kerr is based on converting the additional daily flow, in excess of the turbine flow (m^3/s) to power (MW) using a factor of 0.80. For example, if the excess daily flow, on a particular day is 70 m^3/s, the additional daily generation at Forrest Kerr id 1.34 GWh (=70 x 0.80 x 24 /1000). The additional average annual generation at the Forrest Kerr project, using the above assumptions, is estimated at about 162 GWh.

4. CONSTRUCTION COST ESTIMATE

A prefeasibility cost estimate for the project has been developed based on the conceptual level design and layout shown in Figures 3.1, 3.2 and 3.3. Any consideration of additional design options or optimizations is outside the scope of this study.

Sigma has attempted to indicate potential areas for future consideration. The geotechnical characteristics in the area of the proposed dam will have a considerable impact on the selected type of dam and the associated cost. The access to the project area is from an existing road and bridges over Iskut River which is shown on online mapping. It appears that the road may be subject to seasonal flooding. For the purposes of this study, it is assumed that the road will be accessible and that technical issues will be addressed in future studies.

Plans of the Forrest Kerr Diversion project access road and earthfill dam are shown on Figures 7 and 8 respectively.

The attached Table 4 shows the prefeasibility construction cost estimate for the project.

Table 4. Prefeasibility Cost Estimate

ACTIVITY	Qty	Unit	Unit Cost $	Total $	SubTotal $	Contingency %	Contingency $	Total $
A Access Roads								
Access Road to Power House	0.5	km	165,000	82,500				
Access Road, Powerhouse to Intake	1	km	600,000	600,000	682,500	20%	136,500	819,000
B Intake Structure								
Clearing, Grubbing, Stripping, Scaling	1	LS	3,000,000	3,000,000				
Archdam Concrete	130,000	m^3	342	44,460,000				
Aggregate Supply	97,500	m^3	50	4,875,000				
Apron Concrete	4,200	m^3	1,500	6,300,000				
Reinforced Concrete	1,800	m^3	1,700	3,060,000				
Trashracks	280	m^2	2,100	588,000				
Spillway Gates	360	m^2	10,500	3,780,000				
Intake gate	36	m^2	10,600	381,600				
Diversion	1	LS	3,700,000	3,700,000				
Control Building	1	LS	100,000	100,000				
Power supply to intake area	1,000	m	265	265,000	70,509,600	20%	14,101,920	84,611,520
C Penstock								
Tunnel (Power Tunnel 500m, Diversion Tunnel 370m)	1	LS	18,100,000	18,100,000	18,100,000	15%	2,715,000	20,815,000
D Powerhouse Structural								
Concrete foundation and terminal anchor block	1	LS	14,850,000	14,850,000				
Building with Crane- supply and install	1	LS	4,750,000	4,750,000	19,600,000	15%	2,940,000	22,540,000
E Powerhouse Generation Equipment								
Turbines, Generators, TIV and Bifurcation	1	LS	31,000,000	31,000,000				
Mechanical Installation	1	LS	1,500,000	1,500,000				
Balance of Plant	1	LS	16,000,000	16,000,000	48,500,000	10%	4,850,000	53,350,000
F Transmission Line								
3 phase 138kV to Bob Quinn	13	km	475,000	6,175,000				
BCH Interconnection Fee	1	LS	8,500,000	8,500,000	14,675,000	20%	2,702,500	17,377,500
G Work Camp								
Work Camp	47,500	Man-Days	212	10,070,000	10,070,000	20%	2,014,000	12,084,000
H Forrest Kerr Diversion Access Roads								
Access Road to Power House	19.0	km	165,000	3,135,000				
Bridges	2	LS	1,200,000	2,400,000	5,535,000	20%	1,107,000	6,642,000
I Forrest Kerr Diversion Structure								
Clearing, Grubbing, Stripping	2.50	ha	100,000	250,000				
Earth Dam Fill	265,000	m^3	40	10,600,000				
Diversion Tunnel	220	m	15,000	3,300,000				
Tunnel Gate	1	LS	450,000	450,000				
Tunnel Plug	1	LS	350,000	350,000				
Cofferdam	1	LS	250,000	250,000	15,200,000	30%	4,560,000	19,760,000
J Forrest Kerr Diversion Channel								
Channel Excavation	100,000	m^3	25	2,500,000	2,500,000	20%	500,000	3,000,000
K Forrest Kerr Work Camp								
Camp	5,500	man-days	212	1,166,000	1,166,000	5%	58,300	1,224,300
TOTAL CONSTRUCTION COSTS					206,538,100		35,685,220	242,223,320
L Insurance and Bonding								
Insurance on Project (1% of construction costs)	1	ls	2,065,381	2,065,381				
Bonding (1% of construction costs)	1	ls	2,065,381	2,065,381	4,130,762	25%	1,032,691	5,163,453
M Interest During Construction								
Interest During Construction (4% of const. cost)	1	ls	8,261,524	8,261,524	8,261,524	10%	826,152	9,087,676
N Project Management								
Project Management (2% of construction costs)	1	ls	4,130,762	4,130,762	4,130,762	10%	413,076	4,543,838
O Engineering								
Consulting (5% of construction costs)	1	ls	10,326,905	10,326,905	10,326,905	10%	1,032,691	11,359,596
P Permitting and Environmental								
Permitting and Studies (1% of construction costs)	1	ls	2,065,381	2,065,381				
Compensation (1% of construction costs)	1	ls	2,065,381	2,065,381	4,130,762	10%	413,076	4,543,838
TOTAL INDIRECT COSTS					30,980,715		3,717,686	34,698,401
TOTAL COST								276,921,721

General Comments

A. Access Roads

Pricing based on recent project built on Vancouver Island.

B. Intake Structure

Reinforced concrete pricing based on pricing for recent projects.

Pricing for mass concrete was based on estimates provided by Golder Associates in their September 2017 report on the More Creek Dam. The Golder report evaluated multiple dam options (earth fill, rock fill, gravity and arch), with an ach type being selected as the most economical.

Pricing for trashracks, intake gate is based on price per square foot from a recent project.

Radial gate pricing based on square foot pricing of smaller gates.

Power supply to intake area assumed typical 25 kV line costs.

C. Tunneling

The 500m long penstock tunnel is 5.5m x 5.5m. The 370m long diversion tunnel is 12m x 12m. Cost for the two tunnels is based on a cost estimate provided to Sigma by CanMine Contracting LP.

D. Powerhouse Structural

Cost estimates are prorated from actual costs for small plants, with an adjustment for economy of scale.

E. Powerhouse Generation Equipment

Cost estimate for generating equipment is based on quote from Andritz Hydro Canada Inc. plus an allowance for $1 million for trifurcation. The turbine quote was for 3 horizontal Francis units with generators. The quoted units allow slow flow ramp down to meet environmental regulations (the units are designed to operate in over speed for prolonged periods).

Balance of plant cost estimate is based on prorated cost of smaller plants discounted by 25% for economy of scale. Balance of plant includes all electrical items not in Turbine-Generator package. Includes controls, switchgear, transformers to 138kV, auxiliary transformers, grounding, plant wiring, etc.

F. Transmission Line

Cost estimate for 3 phase 138 kV line to Bob Quinn is based on unit cost of 69kV line for a recent project, increased for voltage.

An allowance is made for the BCH interconnection price which is very difficult to estimate at this stage.

G. Work Camp

Pricing per man-day is based on quote from full service camp provider. Estimate of number of man-days is based on the total project construction cost.

H. Forrest Kerr Diversion Access Road

Pricing based on recent roads built on Vancouver Island.

I. Forrest Kerr Diversion Structures

Pricing based on an earthfill dam recently constructed in Northern British Columbia.

J. Forrest Kerr Diversion Channel

Pricing based on a recent costs for a penstock right or way with extensive excavation constructed in Northern British Columbia.

K. Forrest Kerr Work Camp

Pricing per man-day is based on quote from full service camp provider. Estimate of number of man-days is based on the total project construction cost.

Limitations

The estimates presented in Table 4 do not include or allow costs for the following:

- Possible fish screens
- Trashrack automatic racking
- A seepage blanket, or grouting, to prevent leakage around the dam
- Plunge pool construction for spillway (may be required depending on site conditions, however the rock foundation is expected to be of good quality)
- Wildlife and First Nations compensation
- Clearing of reservoir. It is assumed to be zero (trees sold for value equal to clearing cost)
- Potential relocation of a Nova Gold (Galore Creek) road that may be flooded. This road may not be needed beyond the More Creek dam location, unless the mine project is restarted.

5. ENVIRONMENTAL AND REGULATORY ISSUES

The BC Hydro layout of the dam and diversion was developed in the 1980s when environmental regulations were less complex and standards lower. BC Hydro's design may present issues with permitting the project in today's regulatory environment.

<u>Flooding- More Creek Reservoir</u>
The More Creek reservoir will flood approximately 2690ha of land as well as the existing More Creek river bed. It is expected that government regulators will want detailed studies regarding the impact of the flooding and reservoir operations.

<u>Diversion and Green Power</u>
Although the diversion may be economic and may have few environmental impacts (based on the alpine environment and the expected absence of fish), the diversion may be precluded from consideration as a green power project. More Creek itself is potentially precluded from being considered a green power project due to the presence of the dam and reservoir. However, the More Creek project (including the Forrest Kerr Diversion) may be considered as green if the overall impact is considered low. The project should be considered clean due to CO_2 offsets. In addition all of the present day standards will need to be followed in the design and construction of the project.

Instream Flow Release

The BC Hydro project concept did not have an instream flow release at the Forrest Kerr Creek earthfill dam. 100% of the Forrest Kerr Creek flow was diverted. The present analysis assumes instream flow release of 3.77 m^3/s (15% of mean annual flow), which exceeds what is often required for a run of river project.

Diversion Flow over Natural Ground

The BC Hydro concept had a portion of the Forrest Kerr Creek diversion flowing over the native natural ground of the ridge. A channel would be eroded down by the flow until coarse materials (boulders) are encountered or the channel slope is reduced. This would incise a channel through the ridge. This erosion would cause sedimentation issues downstream, with the potential to affect any fish populations. The proposed diversion would be constructed and armored appropriately to minimize sedimentation

Bed Load Transport- Forrest Kerr Diversion

The new lake created by the Forrest Kerr Creek diversion would trap sediment, and therefore water flowing from Forrest Kerr Creek into More Creek would lack coarse sediment material (gravel, cobbles). The increased flow in upper More Creek may cause erosion of the upper More Creek creek-bed. Typically eroded creek bed material would be replaced by material moving downstream from higher parts of the watershed, however there would be a lack of bed load as the cleaner creek water would carry less coarse material. Less sediment would be input into the system than removed. This would cause More Creek to be incised lower until equilibrium is reached. The effect is negligible in rocky channels and it will be determined during subsequent project studies to minimize impacts.

Bed Load Transport- More Creek Project

The new reservoir created by the More Creek project will also trap sediment. This could have impacts to the creek bed composition downstream of the dam, with a reduction in gravels as the coarser sediments are trapped in the project reservoir. However the section of More Creek downstream of the proposed dam is quite rocky and it soon joins the Iskut River which itself has a high sediment load in the freshet period.

Impact on downstream facilities

The impact of the More Creek project on the existing downstream Forrest Kerr hydroelectric project, should be further assessed, although overall there appear to be benefits to them given:

(a) The likely reduction of the sediment load at Forrest Kerr project
(b) The decrease in freshet flows and the increase in winter flows
(c) The energy output at the Forrest Kerr project should increase based on the fact that the freshet flows typically exceed plant capacity and there is spare generating capacity during the winter time when natural flows are at their lowest.

It is anticipated that construction will be staged from the More Creek camp site to minimize diversion footprint.

Attached are text and figures from BC Hydro's "*Stikine Iskut Development, Iskut Canyon and More Creek Projects – Preliminary Design Study Phase 1 Interim Report*" (1984) and an earlier 1980 report (title unknown) regarding potential hydro projects in the area.

6. FINANCIAL ANALYSIS

The financial analysis of the project is based on a 40-year period. Sigma used a spreadsheet financial analysis model that has been developed and used for hydroelectric projects in BC. The analysis takes into account the estimated construction costs and escalating annual operating costs (O&M, administration, property/liability insurance, water rent, property and school taxes).

The analysis does not include any land acquisition and permitting costs, royalty payments or wheeling fees. The analysis indicates the expected net present value (NPV) and internal rate of return (IRR) for the project (see Appendix A).

Assumptions

- The annual gross generation from Table 3 is used.
- The construction cost from the previous sections is used.
- The capital cost of the project includes cost estimates for Project Management, Engineering and Finance costs, expressed as a percentage of the construction cost. The estimates are based on typical costs for hydroelectric project in BC. The capital cost also includes an inflation adjustment from 2018 to 2020.
- The annual operating costs include the following, all adjusted annually for inflation:
  - Administration and Operation and Maintenance Cost as 1% of the Capital Cost
  - Insurance cost. Based on typical industry rates, which need to be confirmed by insurance professionals.
  - Water Rent based on 2018 rates.
  - Property and School Taxes. Typical BC rates are used which will need to be confirmed at a later stage.
- The analysis assumes 20% equity, 25 year amortization, an effective interest rate of 5.5% and an electricity price of $100/MWh.

APPENDIX A

Financial Analysis

Last Revised 21-Aug-18
Spreadsheet by: Sigma

ALASKA HYDRO CORPORATION - MORE CREEK HYDRO PROJECT
PRELIMINARY FINANCIAL ANALYSIS FOR POWER SALES

BASIC PARAMETERS

Table 1

POWER PRODUCTION DETAILS

Gross Head 118m, Design Flow 80 m³/s
Base Case IFR 5% of MAF (2.476m³/s)

Hydro Power Plant Rated Capa	**75,255**	kW
Max Power Supplied to BCH	75,255	kW
Power Plant Load Factor	65.3%	
Avg Annual Generation	49,171	kW
Net Annual Power Sales	**430.741**	GWh/yr
Gross Generation	*448.000*	*GWh/yr*
Daily vs Real time adjustment	*0.0%*	
Station Service	*200*	*kW*
Transformer/powerline losses	*2.5%*	
Outages (sched., unsch.)	*1.0%*	

CAPITAL COST

Access Roads	6,217,500	
Intake structure	88,209,600	
Tunneling	**18,100,000**	
Powerhouse	19,600,000	
Generation Equipment	**48,500,000**	
Transmission Line/Interconn.	14,675,000	
Work Camp	11,236,000	
Contingencies	39,402,906	245,941,006
Project Management	4,130,762	
Engineering, Consultants	10,326,905	
Finance Costs (incl IDC)	12,392,286	
Land and Permitting	4,130,762	276,921,721 (sub-total)
Inflation (2 yrs at 2.3%)	12,884,891	
	============	
Total Capital Cost in 2018 $:	$289,806,612	
Cost per Installed kW	3,851	

LONG TERM PROJECT VALUE

Hydro Plant Design Life	40	Years
Depreciation Rate	2.5%	per Year
Annual Book Depreciation	$7,245,165	

ANNUAL OPERATING COSTS

Admin., O&M as a Percent of Capital Cost		
Daily Admin., Operation & Maintenance	incl	
Annual Overhaul & Equip. Repair	1.00%	
First Year Total O & M Cost (incl. admin)	$2,898,066	
O & M Inflation Rate	2.3%	
Insurance		
Property Value for Insurance Purposes		
100% of Capital Cost	$289,806,612	
Property Insurance	1.50	$/1000
General Liability	$10,000,000	
Liability Insurance	6.00	$/1000
First Year Insurance	$494,710	
Insurance Inflation Rate	2.3%	
Water Rent		
Water Tax on Engy Produced (<160GWh)	1.367	$/MWh
Water Tax on Engy Produced (>160GWh)	6.374	$/MWh
Water Tax on Installed Capacity	4.555	$/kW
First Year Water Rent	$2,287,209	
Water Rent Inflation Rate	2.3%	
(based on 2018 Rental Rates)		
Property and School Taxes		
Assessed Property Value		
45% of Capital Cost less Equip (est.)	$100,442,975	
School Tax (est.)	13.600	$/1000
Municipal & Property Tax (est.)	11.054	$/1000
First Year Tax Assessment	$2,476,291	
Tax Inflation Rate	2.3%	

Internal Rate of Return	33.61%
Before Tax Cashflow Net Present Value @ 10%	153,924,728
Debt Service Coverage in Year 1	2.07

FINANCING DETAILS

Total Capital Cost	289,806,612	
Equity Input	20.0%	
Equity Amount	57,961,322	
Finance Amount	231,845,289	
Amortization Period	25	Years
Reference Interest Rate	3.50%	Prime Rate
Interest Rate over Refer.	2.00%	
Effective Interest Rate	5.50%	
Annual Payment	$17,283,916	

REVENUE DETAILS

Energy Payment

	CPI (BC)	Price (cents/kWh)
2018	100.0	10.00

CPI rate	2.30%
Delivery Time adjustment	1.019

2018 EPA signing (effective date)

Last Revised 21-Aug-18

Spreadsheet by: Sigma

ALASKA HYDRO CORPORATION - MORE CREEK HYDRO PROJECT
PRELIMINARY FINANCIAL ANALYSIS FOR POWER SALES

OPERATING COSTS AND REVENUE

Table 2

		OPERATING COSTS									REVENUE			
Proj Year	Calendar Year Beginning Jan 1	Operation and Maintenance A	Insurance B	Water Rent C	Regional Taxes D	E	Plant Operating Cost $ F	Plant Operating Cost cents/kWh G	H	Annual Operating Cost $ I	Average Annual Generation kW J	Annual Generation MWh K	Revenue cents/kWh L	Revenue $ M
1	2021	2,898,066	494,710	2,287,209	2,476,291		8,156,276	1.89		8,156,276	49,171	430,741	10.19	43,896,803
2	2022	2,964,722	506,088	2,339,815	2,533,246		8,343,870	1.94		8,343,870	49,171	430,741	10.31	44,401,617
3	2023	3,032,910	517,728	2,393,630	2,591,510		8,535,779	1.98		8,535,779	49,171	430,741	10.43	44,918,040
4	2024	3,102,667	529,636	2,448,684	2,651,115		8,732,102	2.03		8,732,102	49,171	430,741	10.55	45,446,342
5	2025	3,174,029	541,818	2,505,004	2,712,091		8,932,941	2.07		8,932,941	49,171	430,741	10.68	45,986,795
6	2026	3,247,031	554,279	2,562,619	2,774,469		9,138,398	2.12		9,138,398	49,171	430,741	10.80	46,539,678
7	2027	3,321,713	567,028	2,621,559	2,838,282		9,348,581	2.17		9,348,581	49,171	430,741	10.94	47,105,277
8	2028	3,398,112	580,070	2,681,855	2,903,562		9,563,599	2.22		9,563,599	49,171	430,741	11.07	47,683,885
9	2029	3,476,269	593,411	2,743,538	2,970,344		9,783,561	2.27		9,783,561	49,171	430,741	11.21	48,275,801
10	2030	3,556,223	607,060	2,806,639	3,038,662		10,008,583	2.32		10,008,583	49,171	430,741	11.35	48,881,332
11	2031	3,638,016	621,022	2,871,192	3,108,551		10,238,781	2.38		10,238,781	49,171	430,741	11.49	49,500,789
12	2032	3,721,691	635,305	2,937,229	3,180,048		10,474,273	2.43		10,474,273	49,171	430,741	11.64	50,134,494
13	2033	3,807,289	649,917	3,004,785	3,253,189		10,715,181	2.49		10,715,181	49,171	430,741	11.79	50,782,774
14	2034	3,894,857	664,866	3,073,895	3,328,012		10,961,630	2.54		10,961,630	49,171	430,741	11.94	51,445,965
15	2035	3,984,439	680,157	3,144,595	3,404,557		11,213,748	2.60		11,213,748	49,171	430,741	12.10	52,124,409
16	2036	4,076,081	695,801	3,216,921	3,482,861		11,471,664	2.66		11,471,664	49,171	430,741	12.26	52,818,457
17	2037	4,169,831	711,805	3,290,910	3,562,967		11,735,512	2.72		11,735,512	49,171	430,741	12.43	53,528,468
18	2038	4,265,737	728,176	3,366,601	3,644,915		12,005,429	2.79		12,005,429	49,171	430,741	12.60	54,254,810
19	2039	4,363,849	744,924	3,444,032	3,728,748		12,281,554	2.85		12,281,554	49,171	430,741	12.77	54,997,857
20	2040	4,464,217	762,057	3,523,245	3,814,510		12,564,030	2.92		12,564,030	49,171	430,741	12.94	55,757,994
21	2041	4,566,894	779,585	3,604,280	3,902,243		12,853,002	2.98		12,853,002	49,171	430,741	13.13	56,535,615
22	2042	4,671,933	797,515	3,687,178	3,991,995		13,148,621	3.05		13,148,621	49,171	430,741	13.31	57,331,121
23	2043	4,779,387	815,858	3,771,983	4,083,811		13,451,040	3.12		13,451,040	49,171	430,741	13.50	58,144,923
24	2044	4,889,313	834,623	3,858,739	4,177,738		13,760,414	3.19		13,760,414	49,171	430,741	13.69	58,977,443
25	2045	5,001,767	853,819	3,947,490	4,273,826		14,076,903	3.27		14,076,903	49,171	430,741	13.89	59,829,111
26	2046	5,116,808	873,457	4,038,282	4,372,124		14,400,672	3.34		14,400,672	49,171	430,741	14.09	60,700,368
27	2047	5,234,495	893,546	4,131,163	4,472,683		14,731,887	3.42		14,731,887	49,171	430,741	14.30	61,591,663
28	2048	5,354,888	914,098	4,226,180	4,575,555		15,070,721	3.50		15,070,721	49,171	430,741	14.51	62,503,458
29	2049	5,478,051	935,122	4,323,382	4,680,793		15,417,347	3.58		15,417,347	49,171	430,741	14.73	63,436,224
30	2050	5,604,046	956,630	4,422,819	4,788,451		15,771,946	3.66		15,771,946	49,171	430,741	14.95	64,390,444
31	2051	5,732,939	978,632	4,524,544	4,898,585		16,134,701	3.75		16,134,701	49,171	430,741	15.18	65,366,611
32	2052	5,864,796	1,001,141	4,628,609	5,011,253		16,505,799	3.83		16,505,799	49,171	430,741	15.41	66,365,230
33	2053	5,999,687	1,024,167	4,735,067	5,126,512		16,885,432	3.92		16,885,432	49,171	430,741	15.64	67,386,817
34	2054	6,137,679	1,047,723	4,843,973	5,244,421		17,273,797	4.01		17,273,797	49,171	430,741	15.89	68,431,901
35	2055	6,278,846	1,071,821	4,955,385	5,365,043		17,671,095	4.10		17,671,095	49,171	430,741	16.14	69,501,021
36	2056	6,423,260	1,096,473	5,069,359	5,488,439		18,077,530	4.20		18,077,530	49,171	430,741	16.39	70,594,731
37	2057	6,570,994	1,121,692	5,185,954	5,614,673		18,493,313	4.29		18,493,313	49,171	430,741	16.65	71,713,597
38	2058	6,722,127	1,147,490	5,305,231	5,743,811		18,918,659	4.39		18,918,659	49,171	430,741	16.91	72,858,196
39	2059	6,876,736	1,173,883	5,427,251	5,875,918		19,353,788	4.49		19,353,788	49,171	430,741	17.19	74,029,122
40	2060	7,034,901	1,200,882	5,552,078	6,011,065		19,798,926	4.60		19,798,926	49,171	430,741	17.46	75,226,978
TOTALS		186,897,297	31,904,016	147,502,902	159,696,871	0	526,001,086	2.37		526,001,086	49,171	430,741	11.47	2,293,396,163

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ALASKA HYDRO CORPORATION - MORE CREEK HYDRO PROJECT
PRELIMINARY FINANCIAL ANALYSIS FOR POWER SALES

CASH FLOW

Table 3

Proj Year	Calendar Year Beginning Jan 1	Interest A	Capital Repayment B	Capital Balance C	Project Book Value D	Annual Operating Cost $ E	Total Annual Cost $ F	Total Annual Cost cents/kWh G	Total Annual Revenue $ H	Before Tax Cash Flow I	Annual Income J
				231,845,289						-57,961,322	0
1	2021	12,751,491	4,532,425	227,312,864	289,806,612	8,156,276	25,440,192	5.91	43,896,803	18,456,611	15,743,871
2	2022	12,502,208	4,781,709	222,531,155	282,561,446	8,343,870	25,627,787	5.95	44,401,617	18,773,830	16,310,373
3	2023	12,239,214	5,044,703	217,486,452	275,316,281	8,535,779	25,819,696	5.99	44,918,040	19,098,345	16,897,882
4	2024	11,961,755	5,322,161	212,164,291	268,071,116	8,732,102	26,016,019	6.04	45,446,342	19,430,324	17,507,320
5	2025	11,669,036	5,614,880	206,549,411	260,825,951	8,932,941	26,216,857	6.09	45,986,795	19,769,938	18,139,653
6	2026	11,360,218	5,923,699	200,625,712	253,580,785	9,138,398	26,422,315	6.13	46,539,678	20,117,363	18,795,897
7	2027	11,034,414	6,249,502	194,376,210	246,335,620	9,348,581	26,632,498	6.18	47,105,277	20,472,780	19,477,116
8	2028	10,690,692	6,593,225	187,782,985	239,090,455	9,563,599	26,847,515	6.23	47,683,885	20,836,370	20,184,430
9	2029	10,328,064	6,955,852	180,827,133	231,845,289	9,783,561	27,067,478	6.28	48,275,801	21,208,324	20,919,010
10	2030	9,945,492	7,338,424	173,488,709	224,600,124	10,008,583	27,292,500	6.34	48,881,332	21,588,832	21,682,091
11	2031	9,541,879	7,742,037	165,746,672	217,354,959	10,238,781	27,522,697	6.39	49,500,789	21,978,092	22,474,964
12	2032	9,116,067	8,167,849	157,578,822	210,109,794	10,474,273	27,758,189	6.44	50,134,494	22,376,305	23,298,989
13	2033	8,666,835	8,617,081	148,961,741	202,864,628	10,715,181	27,999,097	6.50	50,782,774	22,783,677	24,155,592
14	2034	8,192,896	9,091,021	139,870,721	195,619,463	10,961,630	28,245,547	6.56	51,445,965	23,200,418	25,046,273
15	2035	7,692,890	9,591,027	130,279,694	188,374,298	11,213,748	28,497,664	6.62	52,124,409	23,626,745	25,972,606
16	2036	7,165,383	10,118,533	120,161,161	181,129,132	11,471,664	28,755,580	6.68	52,818,457	24,062,877	26,936,244
17	2037	6,608,864	10,675,052	109,486,108	173,883,967	11,735,512	29,019,428	6.74	53,528,468	24,509,040	27,938,927
18	2038	6,021,736	11,262,180	98,223,928	166,638,802	12,005,429	29,289,345	6.80	54,254,810	24,965,464	28,982,479
19	2039	5,402,316	11,881,600	86,342,328	159,393,636	12,281,554	29,565,470	6.86	54,997,857	25,432,387	30,068,822
20	2040	4,748,828	12,535,088	73,807,239	152,148,471	12,564,030	29,847,946	6.93	55,757,994	25,910,049	31,199,971
21	2041	4,059,398	13,224,518	60,582,721	144,903,306	12,853,002	30,136,919	7.00	56,535,615	26,398,696	32,378,049
22	2042	3,332,050	13,951,867	46,630,855	137,658,141	13,148,621	30,432,538	7.07	57,331,121	26,898,583	33,605,285
23	2043	2,564,697	14,719,219	31,911,635	130,412,975	13,451,040	30,734,956	7.14	58,144,923	27,409,968	34,884,022
24	2044	1,755,140	15,528,776	16,382,859	123,167,810	13,760,414	31,044,330	7.21	58,977,443	27,933,114	36,216,725
25	2045	901,057	16,382,859	0	115,922,645	14,076,903	31,360,819	7.28	59,829,111	28,468,292	37,605,986
26	2046	0	0	0	108,677,479	14,400,672	14,400,672	3.34	60,700,368	46,299,696	39,054,531
27	2047	0	0	0	101,432,314	14,731,887	14,731,887	3.42	61,591,663	46,859,776	39,614,610
28	2048	0	0	0	94,187,149	15,070,721	15,070,721	3.50	62,503,458	47,432,737	40,187,572
29	2049	0	0	0	86,941,984	15,417,347	15,417,347	3.58	63,436,224	48,018,877	40,773,712
30	2050	0	0	0	79,696,818	15,771,946	15,771,946	3.66	64,390,444	48,618,498	41,373,333
31	2051	0	0	0	72,451,653	16,134,701	16,134,701	3.75	65,366,611	49,231,910	41,986,745
32	2052	0	0	0	65,206,488	16,505,799	16,505,799	3.83	66,365,230	49,859,431	42,614,266
33	2053	0	0	0	57,961,322	16,885,432	16,885,432	3.92	67,386,817	50,501,385	43,256,219
34	2054	0	0	0	50,716,157	17,273,797	17,273,797	4.01	68,431,901	51,158,103	43,912,938
35	2055	0	0	0	43,470,992	17,671,095	17,671,095	4.10	69,501,021	51,829,926	44,584,761
36	2056	0	0	0	36,225,826	18,077,530	18,077,530	4.20	70,594,731	52,517,201	45,272,036
37	2057	0	0	0	28,980,661	18,493,313	18,493,313	4.29	71,713,597	53,220,284	45,975,119
38	2058	0	0	0	21,735,496	18,918,659	18,918,659	4.39	72,858,196	53,939,537	46,694,372
39	2059	0	0	0	14,490,331	19,353,788	19,353,788	4.49	74,029,122	54,675,333	47,430,168
40	2060	0	0	0	7,245,165	19,798,926	19,798,926	4.60	86,094,726	66,295,801	59,050,635
TOTALS		200,252,618	231,845,289			526,001,086	958,098,994	6.38	2,304,263,910	1,346,164,916	1,288,203,594
								Net Present Value @ 10%		153,924,728	201,544,139
								Internal Rate of Return		33.61%	#DIV/0!

Note: Sale for 1.5 x book value assumed in Year 40