Q. **Reference: Volume II, Exhibit 5 Hatch letter re: Modeling…System Capability**

Page 3 of Exhibit 5: *Hatch letter re: Modeling…System Capability* states…

> "The average annual hydroelectric energy production should be calculated as the average for the years in the study period, not including the warm up years and omitting the last year(s) if it appears that end conditions are affecting the results, as long as at least five years are used for the average".

Please provide the calculation of average annual hydroelectric energy production for the 2013 Test Year together with a detailed explanation justifying the methodology used. (Volume II, Exhibit 5, page 3)

A. The average annual hydroelectric energy production for the 2013 Test year was estimated using Hydro's Vista DSS model following the approach recommended by Hatch in the referenced document. Vista DSS is the next generation of Hatch's SYSSIM model which was used in the previous GRA. Hydro has been using Vista since 1999 for operational purposes and more recently has used it for the GRA.

Key inputs to the Vista model used for the GRA estimate are as follows:

- System characteristics, Hydro – For the hydroelectric system input includes reservoir storage elevation curves, power curves, operating constraints, spillway and outlet rating tables;
- System characteristics, Holyrood – Holyrood is modeled as a purchase contract. Minimum thermal generation estimates based on the operation of Holyrood for voltage regulation and maximum capacity values are input and Vista will use a value between the two limits, as required;
- System characteristics, NUGS - CBPP cogeneration and the two wind farms are modeled as purchase contracts. Purchases from CBPP and the wind farms are

input as fixed values based on expected values. Newfoundland Power and Deer Lake Power's systems are modeled for completeness but the representation of Newfoundland Power's system is as one pseudo plant the size of all Newfoundland Power's plants combined. The Exploits system is modeled to the same level of detail as Hydro's system;

- Run duration – Each Vista simulation was run for twelve annual sequential hydrological records repeated for every year of the historical inflow record;
- Load Forecast – The load forecast for 2013 was input to each of the 12 simulation years. In this way the model ran for 12 essentially identical years to obtain a long-term average. The loads include Newfoundland Power, Hydro Rural customers, Industrial Customers and system losses;
- Start and end reservoir levels – Actual January 1, 2010 reservoirs levels were used as the start conditions. A Vista option to allow the model to select a reasonable end level based on the energy value of the water in storage at the end of the simulation was used;
- Hydrologic scenarios – Daily inflows for each of Hydro's historic data set are input to the model. Sixty-one hydrologic scenarios, starting in 1950 to 2010, were simulated in each Vista run. If the simulation reached the end of the hydrologic period, it would wrap around and use the early years of data. For instance, the 1960 simulation used the years 1960 to 1971 to simulation 2010 to 2021. The 2000 simulation used 2000 to 2010 for 2010 to 2020 and then wrapped around to use 1950 for 2021.
- Time step – the GRA model was run using a monthly time-step. The data was then summarized into annual results for presentation.

Table 1, attached as NP-NLH-115 Attachment 1, shows the output from Vista summarized by year. Each value is itself an average of the results from the 61 hydrologic scenarios modeled. The energy value used for the GRA is the average of

the results from the last 10 years of the 12 year sequence. The first two years were omitted from the average as they were model 'warm-up' years. Small adjustments (i.e., less than 0.5%) were made to the average energy estimated by the model to reflect the energy value of the water lost from storage between the start and end of the simulations.

Table 1
Summarized Vista Output for GRA Analysis

	Hydro Generation, GWh											
Year	Granite	Upper Salmon	BDE	Cat Arm	Hinds Lake	DLP	NP	Paradise River	Star Lake	Buchans	Grand Falls	Bishops Falls
1	238	527	2832	789	313	898	399	36	131	10	428	133
2	248	562	2734	747	336	894	434	38	140	11	461	106
3	245	554	2697	753	332	879	438	39	140	11	472	103
4	241	550	2635	755	330	886	440	40	141	11	476	137
5	245	551	2642	751	336	884	439	40	140	11	472	132
6	241	551	2628	753	337	887	438	40	140	11	473	140
7	242	552	2622	747	337	882	441	40	141	11	476	143
8	240	551	2621	747	341	882	440	40	141	11	475	143
9	240	552	2606	754	338	885	444	40	141	11	475	143
10	243	547	2605	760	340	886	441	40	141	11	476	143
11	239	534	2559	802	339	884	444	41	141	11	478	143
12	240	503	2465	917	405	776	446	40	141	11	469	142
Last 10yr Avg	**242**	**545**	**2608**	**774**	**343**	**873**	**441**	**40**	**141**	**11**	**474**	**137**

	Hydro Generation, GWh					Thermal and Purchases, GWh						Total Load, GWh			
Year	NLH Hydro	Star Lake	Exploits	NUG Hydro	Total Hydro	Cogen	St. Lawrence	Ferme use	HRD	Total Contracts	Total Gen.	DLP	NLH	Total	*Check: Gen - Load*
1	4736	131	570	1297	6734	51	104	84	935	1174	7909	955	6955	7910	*-2*
2	4666	140	577	1329	6712	51	105	86	1037	1279	7990	964	7034	7998	*-7*
3	4620	140	586	1317	6663	51	105	86	1085	1328	7991	957	7036	7993	*-2*
4	4553	141	624	1326	6644	51	105	86	1109	1351	7994	964	7034	7998	*-4*
5	4566	140	614	1323	6644	51	105	86	1109	1351	7995	964	7034	7998	*-3*
6	4551	140	623	1326	6640	51	105	87	1111	1354	7994	964	7034	7998	*-4*
7	4540	141	629	1324	6634	51	105	86	1113	1355	7989	957	7027	7985	*5*
8	4540	141	629	1322	6632	51	105	86	1116	1358	7990	964	7034	7998	*-8*
9	4530	141	629	1330	6631	51	105	86	1117	1359	7990	964	7026	7989	*1*
10	4536	141	629	1327	6634	51	105	86	1121	1363	7997	964	7034	7998	*-1*
11	4514	141	632	1329	6616	51	105	86	1138	1380	7996	957	7036	7993	*3*
12	4570	141	622	1221	6555	51	105	86	1194	1436	7991	964	7034	7998	*-7*
Last 10yr Avg	**4552**	**141**	**622**	**1314**	**6629**	**51**	**105**	**86**	**1121**	**1363**	**7993**	**962**	**7033**	**7995**	***-2***

Major NLH Stations adjusted for storage changes

	Hydro Generation, GWh						
Year	Granite	Upper Salmon	BDE	Cat Arm	Hinds Lake	Paradise River	Total
1	217	430	2472	726	279	36	4160
2	237	524	2595	744	328	38	4467
3	240	534	2612	745	328	39	4499
4	239	542	2605	745	331	40	4503
5	242	544	2618	749	335	40	4528
6	241	547	2611	747	338	40	4524
7	242	551	2629	753	338	40	4554
8	240	550	2616	750	340	40	4536
9	241	555	2624	750	341	40	4551
10	241	553	2618	751	339	40	4544
11	243	556	2641	750	343	41	4573
12	244	560	2650	683	313	40	4491
Last 10yr Avg	**241**	**549**	**2622**	**742**	**335**	**40**	**4530**