

**Q. Please provide details of the butterfly valve replacement benefit/cost assessment (page F-1, Appendix F, Volume 11).**

A. The benefit/cost assessment of the butterfly valve replacement was completed using a levelized cost approach similar to the analysis used for the entire Rattling Brook Refurbishment Project.

As noted in Appendix F, Volume II, the maximum pressure loss across each valve was measured to be approximately 3 pounds per square inch (psi). The pressure loss across a new butterfly valve is approximately 1 psi. The 2 psi efficiency gain associated with the installation of new butterfly valves to replace the existing main valves at Rattling Brook will result in the production of an additional 0.5 GWh of energy per generating unit.

A cost-benefit analysis incorporating the additional 1 GWh of energy and the capital costs associated with the replacement of the two main valves only, yields an estimated levelized cost over the next 50 years of 3.97 cents per kWh. This is much lower than the cost of replacement energy from Newfoundland and Labrador Hydro's Holyrood thermal generating station. The short-run (fuel-only) cost of incremental energy from the Holyrood thermal generating station is estimated at 7.1 cents per kWh (assuming \$45.00 per barrel), with an associated levelized cost of 8.8 cents per kWh.

The results of the analysis are provided in Attachment A. The capital cost used in the analysis is \$577,180. This is the cost directly associated with the replacement of the two main valves only. The \$729,000 estimate for valve replacement (Table 2, page 11, Rattling Brook Hydro Plant Refurbishment, Volume II) includes, in addition to the cost to replace the two main valves, the cost of a new drain valve, bypass valve and associated equipment. Because the replacement of the drain and bypass valves will not contribute to the additional 1 GWh of energy, the associated cost was not incorporated in the cost/benefit analysis for the main valve replacement.

**Benefit/Cost Assessment of  
Butterfly Valve Replacement**

## Present Worth Analysis

Weighted Average Incremental Cost of Capital 7.15%

Present Worth Year 2007

| Generation                   | Generation                    | Capital<br>Revenue<br>Requirement | Operating<br>Costs | Operating<br>Benefits | Net<br>Benefit | Present<br>Worth<br>Benefit | Cumulative<br>Present<br>Worth<br>Benefit | Rev Rqmt<br>(¢/kWhr) | Levelized Rev Rqmt<br>(¢/kWhr) |
|------------------------------|-------------------------------|-----------------------------------|--------------------|-----------------------|----------------|-----------------------------|-------------------------------------------|----------------------|--------------------------------|
| Hydro<br>49.26 yrs<br>8% CCA | Hydro<br>49.26 yrs<br>30% CCA |                                   |                    |                       |                |                             |                                           |                      |                                |
| YEAR                         |                               |                                   |                    |                       |                |                             |                                           |                      |                                |
| 2007                         | 0                             | 577,180                           | 21,724             | 0                     | 0              | -21,724                     | -20,274                                   | -20,274              | 2.172                          |
| 2008                         | 0                             | 0                                 | -13,535            | 0                     | 0              | 13,535                      | 11,789                                    | -8,485               | 3.967                          |
| 2009                         | 0                             | 0                                 | 10,440             | 0                     | 0              | -10,440                     | -8,486                                    | -16,971              | 3.967                          |
| 2010                         | 0                             | 0                                 | 26,925             | 0                     | 0              | -26,925                     | -20,426                                   | -37,397              | 3.967                          |
| 2011                         | 0                             | 0                                 | 38,167             | 0                     | 0              | -38,167                     | -27,023                                   | -64,420              | 3.967                          |
| 2012                         | 0                             | 0                                 | 45,739             | 0                     | 0              | -45,739                     | -30,223                                   | -94,643              | 3.967                          |
| 2013                         | 0                             | 0                                 | 50,742             | 0                     | 0              | -50,742                     | -31,291                                   | -125,934             | 3.967                          |
| 2014                         | 0                             | 0                                 | 53,947             | 0                     | 0              | -53,947                     | -31,048                                   | -156,981             | 3.967                          |
| 2015                         | 0                             | 0                                 | 55,893             | 0                     | 0              | -55,893                     | -30,021                                   | -187,002             | 3.967                          |
| 2016                         | 0                             | 0                                 | 56,957             | 0                     | 0              | -56,957                     | -28,551                                   | -215,554             | 3.967                          |
| 2017                         | 0                             | 0                                 | 57,405             | 0                     | 0              | -57,405                     | -26,856                                   | -242,409             | 3.967                          |
| 2018                         | 0                             | 0                                 | 57,421             | 0                     | 0              | -57,421                     | -25,071                                   | -267,480             | 3.967                          |
| 2019                         | 0                             | 0                                 | 57,135             | 0                     | 0              | -57,135                     | -23,281                                   | -290,761             | 3.967                          |
| 2020                         | 0                             | 0                                 | 56,637             | 0                     | 0              | -56,637                     | -21,538                                   | -312,300             | 3.967                          |
| 2021                         | 0                             | 0                                 | 55,991             | 0                     | 0              | -55,991                     | -19,872                                   | -332,171             | 3.967                          |
| 2022                         | 0                             | 0                                 | 55,242             | 0                     | 0              | -55,242                     | -18,298                                   | -350,469             | 3.967                          |
| 2023                         | 0                             | 0                                 | 54,420             | 0                     | 0              | -54,420                     | -16,822                                   | -367,291             | 3.967                          |
| 2024                         | 0                             | 0                                 | 53,547             | 0                     | 0              | -53,547                     | -15,448                                   | -382,740             | 3.967                          |
| 2025                         | 0                             | 0                                 | 52,639             | 0                     | 0              | -52,639                     | -14,173                                   | -396,912             | 3.967                          |
| 2026                         | 0                             | 0                                 | 51,705             | 0                     | 0              | -51,705                     | -12,992                                   | -409,905             | 3.967                          |
| 2027                         | 0                             | 0                                 | 50,754             | 0                     | 0              | -50,754                     | -11,903                                   | -421,807             | 3.967                          |
| 2028                         | 0                             | 0                                 | 49,791             | 0                     | 0              | -49,791                     | -10,898                                   | -432,705             | 3.967                          |
| 2029                         | 0                             | 0                                 | 48,820             | 0                     | 0              | -48,820                     | -9,972                                    | -442,677             | 3.967                          |
| 2030                         | 0                             | 0                                 | 47,843             | 0                     | 0              | -47,843                     | -9,120                                    | -451,797             | 3.967                          |
| 2031                         | 0                             | 0                                 | 46,861             | 0                     | 0              | -46,861                     | -8,337                                    | -460,134             | 3.967                          |
| 2032                         | 0                             | 0                                 | 45,876             | 0                     | 0              | -45,876                     | -7,617                                    | -467,751             | 3.967                          |
| 2033                         | 0                             | 0                                 | 44,890             | 0                     | 0              | -44,890                     | -6,956                                    | -474,707             | 3.967                          |
| 2034                         | 0                             | 0                                 | 43,902             | 0                     | 0              | -43,902                     | -6,349                                    | -481,056             | 3.967                          |
| 2035                         | 0                             | 0                                 | 42,913             | 0                     | 0              | -42,913                     | -5,792                                    | -486,847             | 3.967                          |
| 2036                         | 0                             | 0                                 | 41,923             | 0                     | 0              | -41,923                     | -5,281                                    | -492,128             | 3.967                          |
| 2037                         | 0                             | 0                                 | 40,933             | 0                     | 0              | -40,933                     | -4,812                                    | -496,940             | 3.967                          |
| 2038                         | 0                             | 0                                 | 39,942             | 0                     | 0              | -39,942                     | -4,382                                    | -501,322             | 3.967                          |
| 2039                         | 0                             | 0                                 | 38,951             | 0                     | 0              | -38,951                     | -3,988                                    | -505,310             | 3.967                          |
| 2040                         | 0                             | 0                                 | 37,960             | 0                     | 0              | -37,960                     | -3,627                                    | -508,938             | 3.967                          |
| 2041                         | 0                             | 0                                 | 36,969             | 0                     | 0              | -36,969                     | -3,297                                    | -512,235             | 3.967                          |
| 2042                         | 0                             | 0                                 | 35,978             | 0                     | 0              | -35,978                     | -2,994                                    | -515,229             | 3.967                          |
| 2043                         | 0                             | 0                                 | 34,986             | 0                     | 0              | -34,986                     | -2,718                                    | -517,947             | 3.967                          |
| 2044                         | 0                             | 0                                 | 33,995             | 0                     | 0              | -33,995                     | -2,464                                    | -520,411             | 3.967                          |
| 2045                         | 0                             | 0                                 | 33,004             | 0                     | 0              | -33,004                     | -2,233                                    | -522,644             | 3.967                          |
| 2046                         | 0                             | 0                                 | 32,012             | 0                     | 0              | -32,012                     | -2,021                                    | -524,665             | 3.967                          |
| 2047                         | 0                             | 0                                 | 31,021             | 0                     | 0              | -31,021                     | -1,828                                    | -526,493             | 3.967                          |
| 2048                         | 0                             | 0                                 | 30,030             | 0                     | 0              | -30,030                     | -1,652                                    | -528,145             | 3.967                          |
| 2049                         | 0                             | 0                                 | 29,038             | 0                     | 0              | -29,038                     | -1,490                                    | -529,635             | 3.967                          |
| 2050                         | 0                             | 0                                 | 28,047             | 0                     | 0              | -28,047                     | -1,343                                    | -530,979             | 3.967                          |
| 2051                         | 0                             | 0                                 | 27,055             | 0                     | 0              | -27,055                     | -1,210                                    | -532,188             | 3.967                          |
| 2052                         | 0                             | 0                                 | 26,064             | 0                     | 0              | -26,064                     | -1,087                                    | -533,276             | 3.967                          |
| 2053                         | 0                             | 0                                 | 25,073             | 0                     | 0              | -25,073                     | -976                                      | -534,252             | 3.967                          |
| 2054                         | 0                             | 0                                 | 24,081             | 0                     | 0              | -24,081                     | -875                                      | -535,127             | 3.967                          |
| 2055                         | 0                             | 0                                 | 23,090             | 0                     | 0              | -23,090                     | -783                                      | -535,910             | 3.967                          |
| 2056                         | 0                             | 0                                 | 22,098             | 0                     | 0              | -22,098                     | -699                                      | -536,609             | 3.967                          |
| 2057                         | 0                             | 0                                 | 21,107             | 0                     | 0              | -21,107                     | -623                                      | -537,233             | 3.967                          |
| 2058                         | 0                             | 0                                 | 20,116             | 0                     | 0              | -20,116                     | -555                                      | -537,787             | 3.967                          |
| 2059                         | 0                             | 0                                 | 19,124             | 0                     | 0              | -19,124                     | -492                                      | -538,280             | 3.967                          |
| 2060                         | 0                             | 0                                 | 18,133             | 0                     | 0              | -18,133                     | -435                                      | -538,715             | 3.967                          |
| 2061                         | 0                             | 0                                 | 17,141             | 0                     | 0              | -17,141                     | -384                                      | -539,099             | 3.967                          |

## Present Worth Analysis

Weighted Average Incremental Cost of Capital 7.15%

Present Worth Year 2007

|      | <u>Generation</u>            | <u>Generation</u>             | <u>Capital</u><br><u>Revenue</u><br><u>Requirement</u> | <u>Operating</u><br><u>Costs</u> | <u>Operating</u><br><u>Benefits</u> | <u>Net</u><br><u>Benefit</u> | <u>Present</u><br><u>Worth</u><br><u>Benefit</u> | <u>Cumulative</u><br><u>Present</u><br><u>Worth</u><br><u>Benefit</u> | <u>Rev Rqmt</u><br>(¢/kWhr) | <u>Levelized Rev Rqmt</u><br>(¢/kWhr) |
|------|------------------------------|-------------------------------|--------------------------------------------------------|----------------------------------|-------------------------------------|------------------------------|--------------------------------------------------|-----------------------------------------------------------------------|-----------------------------|---------------------------------------|
|      | Hydro<br>49.26 yrs<br>8% CCA | Hydro<br>49.26 yrs<br>30% CCA |                                                        |                                  |                                     |                              |                                                  |                                                                       |                             |                                       |
| YEAR |                              |                               |                                                        |                                  |                                     |                              |                                                  |                                                                       |                             |                                       |
| 2062 | 0                            | 0                             | 16,150                                                 | 0                                | 0                                   | -16,150                      | -338                                             | -539,437                                                              | 1.615                       | 3.967                                 |
| 2063 | 0                            | 0                             | 15,159                                                 | 0                                | 0                                   | -15,159                      | -296                                             | -539,733                                                              | 1.516                       | 3.967                                 |
| 2064 | 0                            | 0                             | 14,167                                                 | 0                                | 0                                   | -14,167                      | -258                                             | -539,991                                                              | 1.417                       | 3.967                                 |
| 2065 | 0                            | 0                             | 13,176                                                 | 0                                | 0                                   | -13,176                      | -224                                             | -540,215                                                              | 1.318                       | 3.967                                 |
| 2066 | 0                            | 0                             | 12,184                                                 | 0                                | 0                                   | -12,184                      | -193                                             | -540,408                                                              | 1.218                       | 3.967                                 |
| 2067 | 0                            | 0                             | 11,193                                                 | 0                                | 0                                   | -11,193                      | -166                                             | -540,574                                                              | 1.119                       | 3.967                                 |
| 2068 | 0                            | 0                             | 10,202                                                 | 0                                | 0                                   | -10,202                      | -141                                             | -540,715                                                              | 1.020                       | 3.967                                 |
| 2069 | 0                            | 0                             | 9,210                                                  | 0                                | 0                                   | -9,210                       | -119                                             | -540,834                                                              | 0.921                       | 3.967                                 |
| 2070 | 0                            | 0                             | -37,436                                                | 0                                | 0                                   | 37,436                       | 451                                              | -540,383                                                              | -3.744                      | 3.967                                 |
| 2071 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2072 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2073 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2074 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2075 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2076 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2077 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2078 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2079 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2080 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2081 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2082 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2083 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2084 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2085 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2086 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |
| 2087 | 0                            | 0                             | 0                                                      | 0                                | 0                                   | 0                            | 0                                                | -540,383                                                              | 0.000                       | 3.967                                 |