Board Staff Interrogatory #172

Interrogatory

Reference:
Exhibit D2 / Tab 2 / Schedule 11 / Attachment 3 / pp. 17, 56-59
Exhibit D2 / Tab 2 / Schedule 11 / Attachment 3 / p. 15 / Table 5

Preamble:
Bates White found that an average 39% productivity factor would be appropriate for the
D2O Storage Project.

Question(s):

a) Please advise which categories of costs in Table 5 at Exhibit D2 / Tab 2 / Schedule 11 / Attachment 3 / p. 5 are impacted by the assumed productivity factor.

b) Does the term “average productivity factor” denote an average of different cost categories or an average over some period of time, or both?

c) Please produce a sensitivity plot or table which shows the impact of different average productivity factors (between 39% and 66%) on Bates White’s $517.7 million total project cost estimate. Please produce the sensitivity plot at 1% increments, whether individually calculated or interpolated.

d) Based on the sensitivity plot above, please indicate what a 1% increase in productivity factor would equate to in terms of overall project cost impact relative to Bates White’s $517.7 million total project cost estimate (e.g. project cost changes by $x for every 1% increase in productivity factor). If the impact is non-linear, please clarify.

e) Please provide the average productivity factor that OPG uses for DRP Unit refurbishments per U3EE. Does U3EE assume an average 39% productivity factor?

f) Please provide the average productivity factor that OPG uses for developing its operations and maintenance budgets. Do these budgets assume an average 39% productivity factor?

Response

Parts a-d of this response were prepared by Bates White:

a) The assumed average productivity factor was applied to EPC direct costs, which are described in Section VI.A.1 of the Bates White report.

b) To clarify, the term "average productivity factor" denotes neither "an average of different cost categories" nor "an average over some period of time." Rather, it represents the mean of a distribution of eight data points developed by Bates White after reviewing the two "wrench time studies" provided by OPG and briefly discussed in Appendix C, Section C.2, which reads in part, "We combined the findings of [the "wrench time"] studies and computed an average productivity rate…"

c) and d)

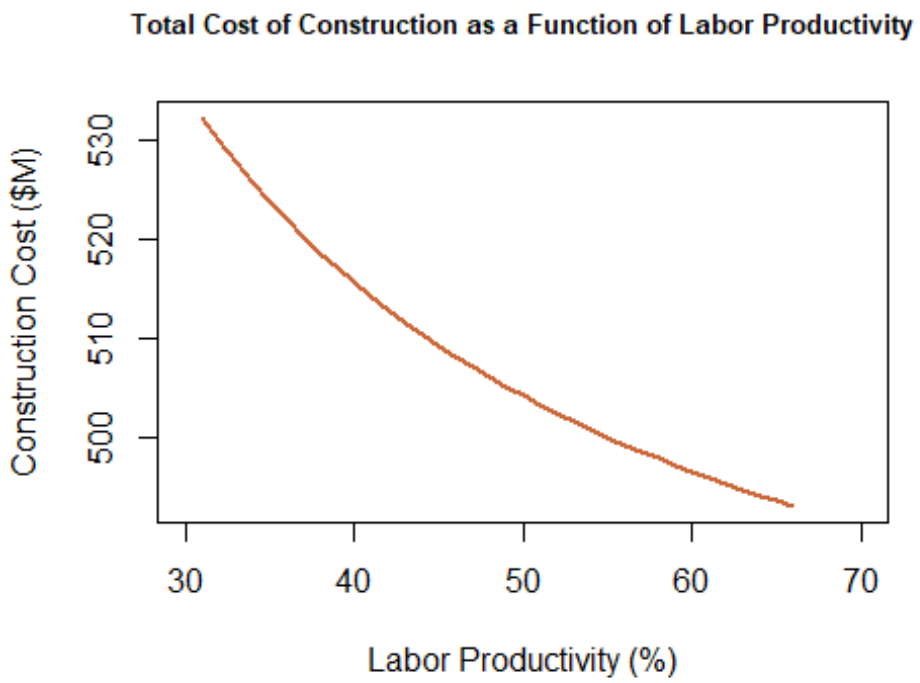
Chart 1 below describes the impact of different average labour productivity rates on the Bates White estimate of the project's total cost. The first column depicts average labour productivity rates ranging from 31% to 66%. The second column depicts the imputed total construction cost associated with each row's productivity rate. The third column indicates the rate of change of the total construction cost with each percentage point increase in labour productivity. For example, an increase in average labour productivity from 39% to 40% would reduce the expected total construction cost by 0.28%, from $517.1 million to $515.6 million.

Chart 1: Impact of Labour Productivity Rates and Total Construction Costs

Productivity (%)	Total Cost ($M)	Rate of Change (%)
31	532.2	0.00
32	529.9	-0.43
33	527.8	-0.41
34	525.7	-0.39
35	523.8	-0.37
36	522.0	-0.35
37	520.3	-0.33
38	518.6	-0.31
39	**517.7**	**-0.30**
40	515.6	-0.28
41	514.2	-0.27
42	512.9	-0.26
43	511.6	-0.25
44	510.4	-0.24
45	509.3	-0.23
46	508.2	-0.22
47	507.1	-0.21
48	506.1	-0.20
49	505.1	-0.19
50	504.2	-0.18
51	503.3	-0.18
52	502.5	-0.17
53	501.6	-0.16
54	500.8	-0.16
55	500.1	-0.15
56	499.3	-0.15
57	498.6	-0.14
58	497.9	-0.14
59	497.2	-0.13
60	496.6	-0.13
61	496.0	-0.13
62	495.4	-0.12
63	494.8	-0.12
64	494.2	-0.11
65	493.7	-0.11
66	493.1	-0.11

Figure 1 below is a graphical representation of Table 1.

Figure 1: Total Construction Costs as a Function of Labour Productivity Rates



The cost-productivity function in Figure 1 is slightly nonlinear. That nonlinearity is a consequence of incorporating the annual inflation of wages and associated compensation costs (e.g., health and life insurance costs) over the six years of construction.

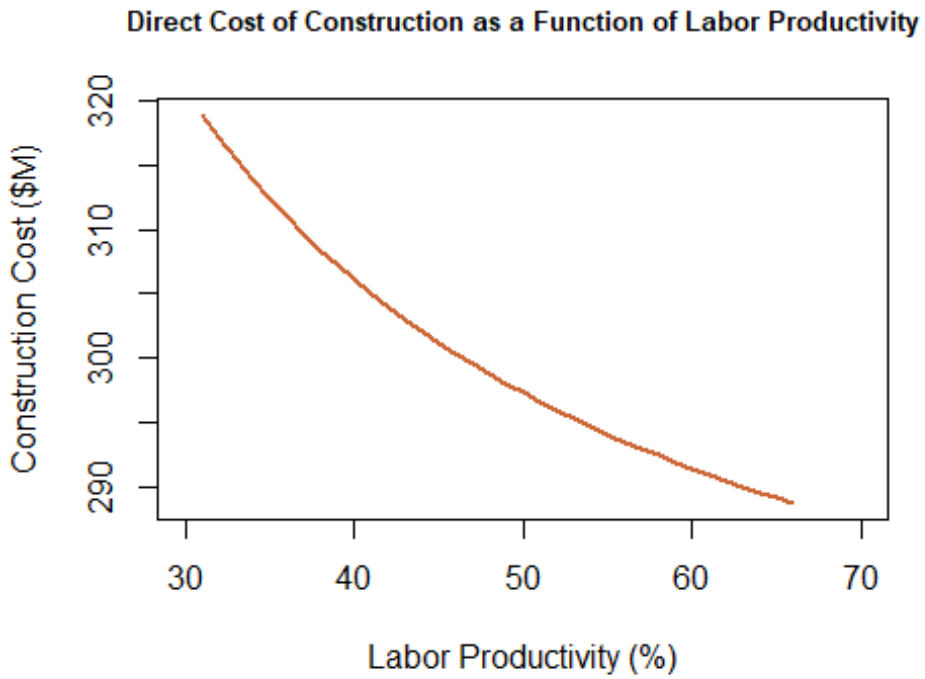
We note that labour productivity affects only direct construction cost, not other elements in the total project cost. Chart 2 depicts a sensitivity table of labour productivity rates on the Bates White estimate of direct construction cost.

Chart 2: Impact of Labour Productivity Rates and Direct Construction Costs

Productivity (%)	Direct Cost ($M)	Rate of Change (%)
31	318.9	0.00
32	317.1	-0.56
33	315.5	-0.53
34	313.9	-0.50
35	312.4	-0.47
36	311.0	-0.45
37	309.7	-0.43
38	308.4	-0.41
39	**307.7**	**-0.39**
40	306.1	-0.37
41	305.0	-0.35
42	304.0	-0.34
43	303.0	-0.32
44	302.1	-0.31
45	301.2	-0.29
46	300.4	-0.28
47	299.5	-0.27
48	298.8	-0.26
49	298.0	-0.25
50	297.3	-0.24
51	296.6	-0.23
52	295.9	-0.22
53	295.3	-0.22
54	294.7	-0.21
55	294.1	-0.20
56	293.5	-0.19
57	293.0	-0.19
58	292.4	-0.18
59	291.9	-0.18
60	291.4	-0.17
61	290.9	-0.17
62	290.5	-0.16
63	290.0	-0.16
64	289.6	-0.15
65	289.2	-0.15
66	288.7	-0.14

Figure 2 below is a graphical representation of Table 2.

Figure 2. Direct Costs of Construction as a Function of Labour Productivity Rates



Bates White selected a 39% productivity rate because it represented the mean value of the range of productivity rates presented in the “wrench time” studies referenced on p. 58 of the Bates White report (discussed further in the response to Ex. L-D2-02-Energy Probe-043). The lower bound of that range of productivity rates was 31%, and the upper bound was 66%.

The RSMeans cost data embed a labour productivity rate of 66%. The RSMeans data are collected primarily from routine commercial construction projects, such as office buildings, schools, and medical facilities. A variety of considerations, contractually required breaks and site security at the D2O project, made it more appropriate to use a labour productivity factor of 39%.

Bates White notes that, in light of these considerations, productivity rates significantly above the 39% used in the report are unlikely and become increasingly implausible as they approach 66%.

e) OPG did not apply a productivity factor in developing the U3EE. In 2018, a baseline analysis looking at a subset of projects within the DRP concluded that a productivity factor of 34% was applicable to the project. Actual productivity achieved on the DRP (including radiological and conventional work) was 49.1% in 2018, 48% in 2019, 51% in 2020 and 52% in 2021 LTD.

f) OPG does not apply a productivity factor in developing its operations and maintenance budgets because the nature of the work is predictable based on the more than two decades of operational experience running Darlington.