

## SENSITIVITY ANALYSIS OF NUMERICAL SCORING OF OPTIONS

### Purpose of the exercise

Assessing if the scoring of the three pre-selected options is balanced and if some reviews in the individual scores or the partition of the scoring by City of Winnipeg and Veolia team member could have changed the ranking of the options.

### Initial technical scores

Scoring as circulated:

| Technical scores |        |
|------------------|--------|
| Option 2         | 660.28 |
| Option 3         | 629.60 |
| Option 4         | 728.60 |

|                                 |     |
|---------------------------------|-----|
| Difference Option 2 vs Option 4 | 9%  |
| Difference Option 3 vs Option 4 | 14% |

**Table 1 : global scores circulated**

### Results if partition between CoW and Veolia

| Technical | City | Veolia | Combined | Original |
|-----------|------|--------|----------|----------|
| Option 2  | 247  | 229    | 476      | 474      |
| Option 3  | 231  | 229    | 460      | 460      |
| Option 4  | 243  | 259    | 501      | 503      |
|           | 102% | 89%    | 95%      | 94%      |
|           | 95%  | 89%    | 92%      | 91%      |
|           | 100% | 100%   | 100%     | 100%     |

  

| Operations | City | Veolia | Combined | Original |
|------------|------|--------|----------|----------|
| Option 2   | 89   | 97     | 186      | 186      |
| Option 3   | 85   | 84     | 169      | 169      |
| Option 4   | 115  | 111    | 226      | 226      |
|            | 77%  | 88%    | 83%      | 83%      |
|            | 74%  | 76%    | 75%      | 75%      |
|            | 100% | 100%   | 100%     | 100%     |

  

| Combined | City | Veolia | Combined | Original |
|----------|------|--------|----------|----------|
| Option 2 | 336  | 326    | 662      | 660      |
| Option 3 | 316  | 313    | 630      | 630      |
| Option 4 | 357  | 370    | 727      | 729      |
|          | 94%  | 88%    | 91%      | 91%      |
|          | 88%  | 85%    | 87%      | 86%      |
|          | 100% | 100%   | 100%     | 100%     |

**Table 2 : results after partition CoW/Veolia**

Globally, it indicates that the global ranking of the options is the same within the City and Veolia and the global scoring (whether combined or original) is reflecting it. The difference between the options is

anyway more significant for technical matters within Veolia's scores and more significant for operation matters within the City's scores.

On inspection of the scoring table there were many places in the table that were either blank or one of the panel member's score was significantly lower than the average of their team's range of scoring. The following sensitivity analysis aims to show if their impact can be significant or not.

**Revision #1**

To balance the scoring, a ratio was used to prorate the weighted score for either the City or Veolia team. For example, if there were 4 City members scoring and 5 Veolia members scoring a particular criterion, a ratio of 4/5<sup>ths</sup> was applied to the Veolia weighted score to provide a balanced result.

| Technical | City | Veolia | Combined | Orginal |
|-----------|------|--------|----------|---------|
| Option 2  | 245  | 192    | 437      | 474     |
| Option 3  | 228  | 193    | 421      | 460     |
| Option 4  | 241  | 216    | 457      | 503     |
|           | 101% | 89%    | 95%      | 94%     |
|           | 95%  | 89%    | 92%      | 91%     |
|           | 100% | 100%   | 100%     | 100%    |

| Operations | City | Veolia | Combined | Orginal |
|------------|------|--------|----------|---------|
| Option 2   | 89   | 97     | 186      | 186     |
| Option 3   | 85   | 84     | 169      | 169     |
| Option 4   | 115  | 111    | 226      | 226     |
|            | 77%  | 88%    | 83%      | 83%     |
|            | 74%  | 76%    | 75%      | 75%     |
|            | 100% | 100%   | 100%     | 100%    |

| Combined | City | Veolia | Combined | Orginal |
|----------|------|--------|----------|---------|
| Option 2 | 333  | 290    | 623      | 660     |
| Option 3 | 313  | 277    | 590      | 630     |
| Option 4 | 356  | 327    | 683      | 729     |
|          | 94%  | 88%    | 91%      | 91%     |
|          | 88%  | 85%    | 86%      | 86%     |
|          | 100% | 100%   | 100%     | 100%    |

**Table 3 : results after revision #1**

The adjustments for blanks in the table and prorating the weighted score have no significant impact on the numerical results.

## Revision #2

In addition to revision #1, scoring that was significantly lower or higher than the average of each team was adjusted by replacing the excessively low score with the average of their team. We assume that a significantly higher or lower score is a score which is more than 25% higher or lower than the average of its team. It corresponds roughly to 2 %ile of the scores. Such scores are highlighted in red in the table herebelow :

|          | N° | Criteria  | N. Szoke | D. Celmer | A. Permut | A. Zaleski | A. Fioravanti | D. Lamarre | K. Upendrakumar | D. Gibson | J.Y Bontonou | V. Landragin | K. Smyrski | R. Hahweg | J. Hestad | J. D'Ariès |  |
|----------|----|---|----------|-----------|-----------|------------|---------------|------------|-----------------|-----------|--------------|--------------|------------|-----------|-----------|------------|--|
| Option 2 | 1  | Ability to meet all the license requirements                                      | 10       | 10        | 10        | 10         | 10            | 10         | 10              |           | 10           | 10           |            |           |           |            |  |
| Option 3 |    |   | 10       | 10        | 10        | 10         | 10            | 10         | 10              |           | 10           | 10           |            |           |           |            |  |
| Option 4 |    |   | 10       | 10        | 10        | 10         | 10            | 10         | 10              | 10        |              | 10           | 10         |           |           |            |  |
| Option 2 | 2  | Reliability and risk of failure   | 10       | 10        | 10        | 10         | 8             | 7          | 8               |           |              | 9            | 8          |           |           |            |  |
| Option 3 |    |   | 8        | 8         | 9         | 7.5        | 8             | 6          | 9               |           |              | 10           | 7          |           |           |            |  |
| Option 4 |    |   | 9        | 7         | 7         | 5          | 9             | 8          | 10              |           |              | 9            | 9          |           |           |            |  |
| Option 2 | 3  | Redundancy / Availability of the plant  | 10       | 10        | 10        | 10         | 7             | 8          | 8               |           |              | 10           | 8          |           |           |            |  |
| Option 3 |    |   | 9        | 10        | 10        | 10         | 8             | 9          | 8               |           |              | 10           | 9          |           |           |            |  |
| Option 4 |    |   | 9        | 9         | 8         | 10         | 10            | 10         | 10              |           |              | 10           | 10         |           |           |            |  |
| Option 2 | 4  | Sensitivity of operation and cost to the sew age quality (short term variability) | 10       | 10        | 10        | 10         | 7             | 9          | 10              |           |              | 9            | 7          |           |           |            |  |
| Option 3 |    |   | 10       | 10        | 10        | 10         | 8             | 9          | 9               |           |              | 10           | 7          |           |           |            |  |
| Option 4 |    |   | 10       | 10        | 10        | 10         | 9             | 9          | 8               |           |              | 10           | 10         |           |           |            |  |
| Option 2 | 5  | Ability to operate at low DWF (diurnal)   | 10       | 10        | 10        | 7.5        | 7             | 8          | 8               |           |              | 9            | 9          |           |           |            |  |
| Option 3 |    |   | 9        | 10        | 10        | 7.5        | 8             | 9          | 9               |           |              | 10           | 6          |           |           |            |  |
| Option 4 |    |   | 9        | 10        | 10        | 10         | 10            | 10         | 10              |           |              | 10           | 8          |           |           |            |  |
| Option 2 | 6  | Ability to accomodate WWF   | 10       | 10        | 10        | 10         | 10            | 10         | 10              |           |              | 9            | 10         |           |           |            |  |
| Option 3 |    |   | 10       | 9         | 10        | 7.5        | 10            | 10         | 10              |           |              | 10           | 10         |           |           |            |  |
| Option 4 |    |   | 10       | 8         | 10        | 7.5        | 10            | 10         | 10              |           |              | 10           | 10         |           |           |            |  |
| Option 2 | 7  | Track records in similar climate / confidence in the technology                   | 10       | 10        | 10        | 7          | 10            | 10         | 10              |           |              | 10           | 10         |           |           |            |  |
| Option 3 |    |   | 8        | 9         | 8         | 10         | 8             | 8          | 10              |           |              | 8            | 7          |           |           |            |  |
| Option 4 |    |   | 9        | 10        | 10        | 10         | 10            | 10         | 10              |           |              | 10           | 10         |           |           |            |  |
| Option 2 | 8  | Flexibility regarding denitrification   | 8        | 8         | 8         | 8          | 7             | 8          | 10              |           |              | 8            | 7          |           |           |            |  |
| Option 3 |    |   | 10       | 10        | 10        | 10         | 9             | 9          | 8               |           |              | 10           | 9          |           |           |            |  |
| Option 4 |    |   | 9        | 10        | 10        | 8          | 10            | 10         | 8               |           |              | 10           | 10         |           |           |            |  |
| Option 2 | 9  | Flexibility to upgrade to more stringent requirements (TN&TP, WWF, disinfection)  | 10       | 10        | 10        | 7          | 8             | 10         | 8               |           |              | 8            | 7          |           |           |            |  |
| Option 3 |    |   | 10       | 9         | 10        | 7          | 9             | 8          | 10              |           |              | 9            | 8          |           |           |            |  |
| Option 4 |    |   | 9        | 8         | 8         | 10         | 10            | 10         | 10              |           |              | 10           | 9          |           |           |            |  |
| Option 2 | 10 | Expandability / modularity  | 8        | 8         | 8         | 6          | 7             | 7          | 8               | 8         | 8            | 8            | 7          |           |           |            |  |
| Option 3 |    |   | 9        | 9         | 9         | 6          | 8             | 7          | 9               | 9         | 9            | 8            | 8          |           |           |            |  |
| Option 4 |    |   | 10       | 10        | 10        | 10         | 10            | 10         | 10              | 10        | 10           | 10           | 10         |           |           |            |  |
| Option 2 | 11 | Ease of construction  | 8        | 8         | 8         |            | 7             | 7          | 9               | 9         | 8            | 8.33         |            |           |           |            |  |
| Option 3 |    |   | 6        | 6         | 6         |            | 8             | 7          | 10              | 8         | 7            | 6.67         |            |           |           |            |  |
| Option 4 |    |   | 10       | 10        | 10        |            | 10            | 10         | 10              | 10        | 10           | 9.5          | 10         |           |           |            |  |
| Option 2 | 12 | Environmental impact / sustainability   | 10       | 9         | 10        | 10         | 9             | 10         | 10              | 9         | 8.75         | 9.5          | 8          | 8.50      | 8         | 8.50       |  |
| Option 3 |    |   | 8        | 8         | 8         | 8          | 9             | 9          | 9               | 8         | 8.75         | 8.5          | 7          | 7.50      | 7         | 8          |  |
| Option 4 |    |   | 9        | 7         | 7         | 5          | 8             | 8          | 8               | 7         | 9            | 8            | 7          | 7.50      | 8         | 8.75       |  |
| Option 2 | 13 | Construction duration   | 6.76     | 6.76      | 6.76      | 6.76       | 6.76          | 6.76       | 6.76            | 6.76      | 6.76         | 6.76         | 6.76       |           |           |            |  |
| Option 3 |    |   | 6.47     | 6.47      | 6.47      | 6.47       | 6.47          | 6.47       | 6.47            | 6.47      | 6.47         | 6.47         | 6.47       |           |           |            |  |
| Option 4 |    |   | 10       | 10        | 10        | 10         | 10            | 10         | 10              | 10        | 10           | 10           | 10         |           |           |            |  |
| Option 2 | 14 | Ease of operation   |          |           |           |            |               |            |                 |           |              |              | 8          | 7         | 8         | 7.67       |  |
| Option 3 |    |   |          |           |           |            |               |            |                 |           |              |              | 7          | 7.33      | 7         | 6          |  |
| Option 4 |    |   |          |           |           |            |               |            |                 |           |              |              | 10         | 9.67      | 10        | 8          |  |
| Option 2 | 15 | Ability to recover Phosphorus   | 10       | 10        | 10        | 10         | 9             | 10         | 10              |           |              | 10           |            | 7         | 7         | 7          |  |
| Option 3 |    |   | 9        | 9         | 9         | 10         | 9             | 9          | 10              |           |              | 8            |            | 9         | 9         | 9          |  |
| Option 4 |    |   | 6        | 6         | 6         | 6          | 5             | 6.7        | 5               |           |              | 6            |            | 5         | 4         | 5          |  |
| Option 2 | 16 | Ease of maintenance   |          |           |           |            |               |            |                 |           |              |              | 8          | 5         | 7         | 9          |  |
| Option 3 |    |   |          |           |           |            |               |            |                 |           |              |              | 8          | 5         | 7         | 7          |  |
| Option 4 |    |   |          |           |           |            |               |            |                 |           |              |              | 9          | 10        | 10        | 9          |  |
| Option 2 | 17 | Operator safety   |          |           |           |            |               |            |                 |           |              |              | 9          | 7.60      | 8         | 8.60       |  |
| Option 3 |    |   |          |           |           |            |               |            |                 |           |              |              | 8          | 7.20      | 7         | 8          |  |
| Option 4 |    |   |          |           |           |            |               |            |                 |           |              |              | 9          | 8         | 9         | 8.20       |  |

Table 4 : identification of irrelevant scores

| Technical | City | Veolia | Combined | Original |
|-----------|------|--------|----------|----------|
| Option 2  | 245  | 192    | 436      | 474      |
| Option 3  | 230  | 192    | 421      | 460      |
| Option 4  | 242  | 216    | 458      | 503      |

|  |      |      |      |      |
|--|------|------|------|------|
|  | 101% | 89%  | 95%  | 94%  |
|  | 95%  | 89%  | 92%  | 91%  |
|  | 100% | 100% | 100% | 100% |

| Operations | City | Veolia | Combined | Original |
|------------|------|--------|----------|----------|
| Option 2   | 89   | 97     | 186      | 186      |
| Option 3   | 85   | 84     | 169      | 169      |
| Option 4   | 115  | 111    | 226      | 226      |

|  |      |      |      |      |
|--|------|------|------|------|
|  | 77%  | 88%  | 83%  | 83%  |
|  | 74%  | 76%  | 75%  | 75%  |
|  | 100% | 100% | 100% | 100% |

| Combined | City | Veolia | Combined | Original |
|----------|------|--------|----------|----------|
| Option 2 | 333  | 289    | 622      | 660      |
| Option 3 | 315  | 276    | 591      | 630      |
| Option 4 | 356  | 327    | 683      | 729      |

|  |      |      |      |      |
|--|------|------|------|------|
|  | 94%  | 88%  | 91%  | 91%  |
|  | 88%  | 84%  | 86%  | 86%  |
|  | 100% | 100% | 100% | 100% |

**Table 5 : results after revision #2**

The global combined scores would remain the same in proportion and the only minor modification would be with respect to the technical scoring. Anyway this wouldn't be significant.

Anyway, as discussion meetings have been made with all the scorers and the first draft of scores in order to share experiences and thoughts, we assume that the scorers who attended these meetings scored in full consciousness and therefore that their scores shouldn't be changed.

**Revision #3**

In addition to revisions #1 and 2, an equal weight 4.65% (= total weight /number of criterion) was applied to each criterion that was not weighted as zero.

| Technical | City | Veolia | Combined | Original |
|-----------|------|--------|----------|----------|
| Option 2  | 277  | 228    | 505      | 474      |
| Option 3  | 267  | 230    | 497      | 460      |
| Option 4  | 275  | 253    | 528      | 503      |

101%      90%      96%      94%  
 97%      91%      94%      91%  
 100%      100%      100%      100%

| Operations | City | Veolia | Combined | Original |
|------------|------|--------|----------|----------|
| Option 2   | 59   | 64     | 122      | 186      |
| Option 3   | 56   | 55     | 111      | 169      |
| Option 4   | 73   | 71     | 145      | 226      |

80%      89%      85%      83%  
 76%      77%      77%      75%  
 100%      100%      100%      100%

| Combined | City | Veolia | Combined | Original |
|----------|------|--------|----------|----------|
| Option 2 | 336  | 292    | 628      | 660      |
| Option 3 | 323  | 285    | 608      | 630      |
| Option 4 | 348  | 324    | 672      | 729      |

96%      90%      93%      91%  
 93%      88%      90%      86%  
 100%      100%      100%      100%

**Table 6 : results after revision #3**

One more time, the ranking wouldn't be affected significantly.

The same way, if all the criteria were to be weighted equally (**revision #4**), the results would be the same as shown below.

| Technical | City | Veolia | Combined | Orginal |
|-----------|------|--------|----------|---------|
| Option 2  | 291  | 236    | 527      | 474     |
| Option 3  | 282  | 238    | 520      | 460     |
| Option 4  | 289  | 259    | 548      | 503     |

|  |      |      |      |      |
|--|------|------|------|------|
|  | 101% | 91%  | 96%  | 94%  |
|  | 98%  | 92%  | 95%  | 91%  |
|  | 100% | 100% | 100% | 100% |

| Operations | City | Veolia | Combined | Orginal |
|------------|------|--------|----------|---------|
| Option 2   | 52   | 56     | 108      | 186     |
| Option 3   | 49   | 49     | 98       | 169     |
| Option 4   | 65   | 63     | 128      | 226     |

|  |      |      |      |      |
|--|------|------|------|------|
|  | 80%  | 89%  | 85%  | 83%  |
|  | 76%  | 77%  | 77%  | 75%  |
|  | 100% | 100% | 100% | 100% |

| Combined | City | Veolia | Combined | Orginal |
|----------|------|--------|----------|---------|
| Option 2 | 343  | 292    | 635      | 660     |
| Option 3 | 331  | 286    | 618      | 630     |
| Option 4 | 354  | 322    | 676      | 729     |

|  |      |      |      |      |
|--|------|------|------|------|
|  | 97%  | 91%  | 94%  | 91%  |
|  | 94%  | 89%  | 91%  | 86%  |
|  | 100% | 100% | 100% | 100% |

**Table 7 : results after revision #4**

In conclusion, the sensibility analysis shows that the scores always lead to the same following ranking :

1. Option 4
2. Option 2
3. Option 3

It is important to point out the fact that this ranking would be the same with :

- the sole scores of the CoW staff,
- the sole scores of Veolia staff
- the combined scores of CoW and Veolia and
- the score of CoW and Veolia as the Program Team.