

## Capital Regional District Core Area Wastewater Treatment Program

### Discussion Paper – Sustainability Assessment Framework Analysis 036-DP-3

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## 1 Introduction

The Sustainability Analysis Framework (SAF) was prepared to assist the CALWMC in reaching a decision on a preferred option that will lead to a Liquid Waste Management Plan amendment by year's end to build capacity toward sustainable infrastructure.

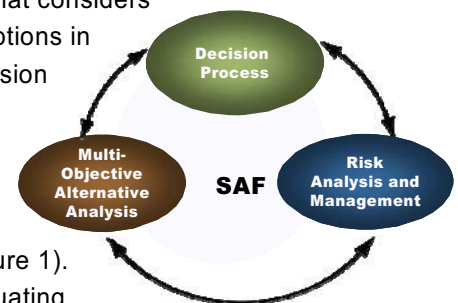
This discussion paper presents the process and results of applying the SAF to three liquid waste options. Of particular emphasis is the incorporation of the community consultation findings and initial understanding of the requirements of the Provincial Government and the Canadian Council of Ministers of the Environment (CCME) into this analysis.

The three options evaluated through the SAF were developed in response to the CALWMC request to review integrated resources recovery options within a distributed wastewater treatment concept.

## 2 Sustainability Assessment Framework Methodology

Key to development of the preferred option is a decision-making framework that guides the CRD through the complex attributes of numerous alternatives to result in the selection of the option to implement.

The SAF is the enhanced triple bottom line (TBL) approach that considers the economic, social and environmental effects of different options in an asset management, or life-cycle cost, context (see Discussion Paper – A Decision-Making Framework for the Wastewater Biosolids Management Program, 031-DP-1). The SAF includes three distinct yet interdependent elements - measuring the achievement of objectives; identification and evaluation of risk; and a decision/policy making process (Figure 1). Through these elements, the SAF provides a method of evaluating options that address multiple objectives. The evaluation provides a base for identifying and mitigating risks and incorporating risk management across all resources. However, it is only a tool to inform policy makers to



**FIGURE 1 - THE SUSTAINABILITY ASSESSMENT FRAMEWORK**

understand the nature of options under consideration and in deliberating a final decision, where local and regional policies must be applied.

## 2.1 Multi-Objective Alternative Analysis

At the heart of SAF is the use of the multi-objective alternative analysis (MOAA) technique. MOAA is a technique to evaluate a number of potential alternative actions. Figure 2 emphasizes the fundamental steps of the MOAA. It begins with the establishment of an objectives hierarchy (Goals, Objectives and Measurements) where the triple bottom line; environmental, social, and economic elements are at the highest level of the hierarchy.

The next key part of the MOAA is formulating performance measures against which the alternatives are assessed for each criteria. The performance measures are used to basically answer the question - how well does the alternative achieve or perform under this criteria? The performance measures could be qualitative or quantitative. A narrative statement is used to explain the performance where qualitative judgements are made.

With the objectives hierarchy and performance measures in place, the next step in the MOAA process is weighting the relative importance of each criterion. Weighting is done to establish the relative value between the Social, Economic and Environmental criteria. Weighting is also done to test the sensitivity of the analysis to changes in the relative importance of social, economic and environmental criteria. In a sensitivity test, the weights are adjusted to “stress” the evaluation to favour one or more of the high level goals to understand how the alternatives, or in the CRD case, the options change one relative to the other.

In the final step alternatives are scored using the performance measures and weightings. All measures and weights are normalized and a weighted average of scores and weights is calculated, resulting in a score for each alternative. Normalizing measures and weights is done to make sure that no one goal such as the economic goal, is weighted greater than another goal due only to the number of criteria being used to evaluate how well an alternative performs in achieving that goal.

Performance scores are a measure of “goal achievement” by an alternative. Using a MOAA, the CALWMC evaluated both financial and non-financial factors in a balanced fashion in-lieu of

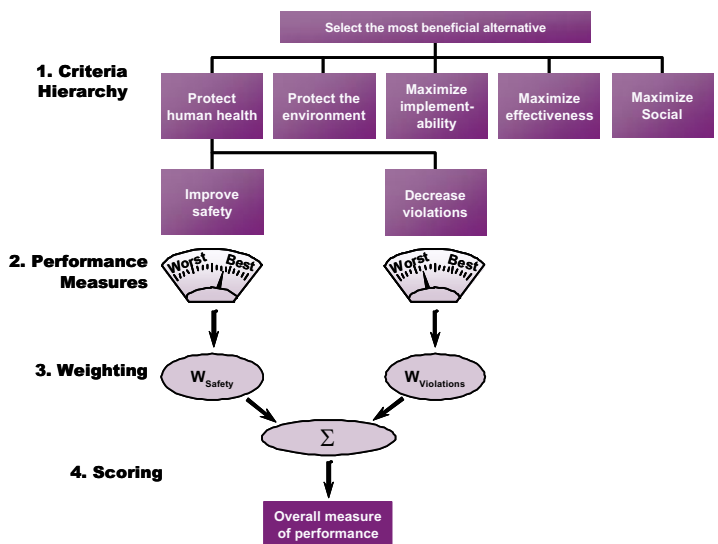


FIGURE 2 - MOAA PROCESS

attempting to reduce all factors to one measure, such as net present value, which is a quantitative financial measure.

## 2.2 Risk Identification and Analysis

Risk can be included in the MOAA, or risk can be dealt with explicitly with risk identification and analysis as a specific, and separate, effort that feeds into the overall SAF. In the analysis done for the CALWMC, risk was embedded in the MOAA criteria set as part of each options analysis. This means that the criteria set considers those risks as part of the performance ratings of the options.

Applying risk within the MOAA ensures that local and regional policy considerations (i.e., “Living Smart” and “Climate Action Plan”) are clearly part of the Liquid Waste Management Plan Amendment.

## 2.3 Decision Process

The decision process is the sequence of meetings and workshops that are used to frame the problem, understand the analysis and make decisions required to develop an implementation plan. For the CRD, this process involved development of options and subjecting each to the SAF, and identifying a communication plan to ensure that check-in points with decision makers and stakeholders is done at appropriate times with appropriate communication.

# 3 SAF Analysis Development

The CALWMC reviewed the development of alternatives and the application of SAF at a number of meetings and workshops.

| CALWMC Meeting Date | Discussion / Action  |
|---------------------|--|
| April 23, 2008      | At this meeting of the CALWMC, the approach to recovering energy and using reclaimed water in a distributed treatment concept was described. The steps to complete an analysis of the opportunities for heat recovery and water reuse throughout the Capital Regional District were outlined. The CALWMC emphasized the importance of completing a triple bottom line assessment of the opportunities. |
| July 23, 2008       | This session presented more detail and a progress report on the integrated resources approach to development of options to recover energy from wastewater and implement water reuse throughout the CRD and the development of a SAF to perform a triple bottom line analysis of the opportunities.   |

| <b>CALWMC Meeting Date</b> | <b>Discussion / Action</b>  |
|----------------------------|---|
| December 17, 2008          | The CALWMC was presented the results of the distributed wastewater management evaluation identifying energy recovery and water reuse opportunity areas (EROA) and options. The TBL analysis of the EROAs was presented to the Committee at this time.   |
| January 28, 2009           | The CALWMC received a presentation introducing SAF structure, objectives hierarchy and rating criteria to be used in evaluating energy and water reuse opportunity options. The emphasis in this meeting was on moving toward a set of three options rather than the 39 EROAs independently.  |
| March 28, 2009             | The CALWMC held a workshop to learn the outcome of the application of SAF to the three distributed wastewater management options and provide feedback on the preliminary results of this assessment.  |
| May 13, 2009               | The CALWMC received a presentation of the SAF including refined criteria, equal weights applied to the Social, Environmental and Economic goals and ratings based on additional input received from the community dialogue sessions.  |
| May 27, 2009               | The CALWMC received a presentation of the SAF demonstrating that when a sensitivity test is conducted in which the weighting is distributed to favour either the Economic goal or alternatively, the Social and Environmental goals, the relative position of the options does not change until the weighting of the Social and Environmental goals together exceeds 88%. At this meeting no further directions were given to adjust scoring. |

## 4 Community Dialogue Application in SAF

A separate memo characterizes the results of community consultation and dialogue conducted by CRD staff. A large portion of the community dialogue comments define principles regarding how citizen and interest groups would like to be involved and what they expect from the implementation of options. The list below captures the principles defined through the community dialogue.

| <b>Theme</b>                     | <b>Description</b>  | <b>Principle</b>   |
|----------------------------------|---|--|
| Equal Weighting                  | Equal consideration and respect for each component (economic, social, environmental) of the triple bottom line (no weighting) and the need to make a balanced decision. | Key Theme  |
| Adaptable                        | To be adaptive enough to embrace future opportunities.  | Key Theme  |
| Enabling                         | To incorporate resource recovery in a strategic and well thought out way, not necessarily out of a rushed need.   | Key Theme  |
| Phased Implementation or Staging | For the overall project to take a phased approach for a number of widespread reasons.   | Key Theme  |
| Carbon Footprint                 | The need and opportunity to reduce our collective carbon footprint and think progressively and innovatively.  | Environment: Protect and Reduce Long Term Environmental Impact |
| Good Neighbour                   | Ensure the facility(ies) is aesthetically designed and acceptable to fit into neighbourhoods.   | Social: Respect for the Community Character                    |
| Mitigation                       | Limit impact to adjacent homeowners and businesses.   | Social: Respect for the Community Character                    |
| Compliance Assurance             | Stringent monitoring and limit the noise or smell impact from facility(ies).  | Social: Respect for the Community Character                    |
| Efficient and Effective          | The need for the public confidence in knowing their money is being well spent while achieving optimum efficiencies in the treatment process.                            | Economic: Value and Performance                                |
| Resource Utilization             | Maximize opportunities to generate revenues from resource recovery in a responsible fiscal manner.  | Economic: Value and Performance                                |
| Rate Impact                      | Clearly understand the negative financial impacts to residents and communicate them.  | Economic: Accountable and Responsible                          |
| Resource Utilization             | Incorporate multifaceted resource recovery technologies such as heat, energy, water and all in the most effective and efficient manner possible.                        | Environment: Ensure Environmental Best Practices               |
| Carbon Footprint                 | Ensure the carbon footprint of the facility(ies) respects the environmental impacts it creates in its surroundings.   | Environment: Protect and Reduce Long Term Environmental Impact |
| Flexible                         | Build in flexibility to ensure maximizing of future opportunities.  | Environment: Demonstrate "Green" Leadership                    |
| Innovative                       | Integrate innovative and leading edge technologies for treatment and resource recovery.   | Environment: Demonstrate "Green" Leadership                    |

These principles specifically relate to the communities' expectations in applying the SAF. The principles were incorporated directly into the objectives hierarchy either as specific criteria or in the performance measures.

Discussions with the Ministries of Community Development and Environment staff over the past year as well as guidance from Provincial Policy Documents such Climate Action Plan have been incorporated into the MOAA criteria and performance measures.

## 5 SAF Application to Options

### 5.1 Formation of Options

The CALWMC adopted a set of goals for the Secondary treatment program in 2007. These goals form the highest level of the goals and objectives hierarchy in the Sustainability Assessment Framework. The goals are:

- Goal 1 – Environment: Protect Public Health and the Environment
- Goal 2 – Social: Manage Wastewater in a Sustainable Manner
- Goal 3 – Economic: Provide Cost Effective Wastewater Management

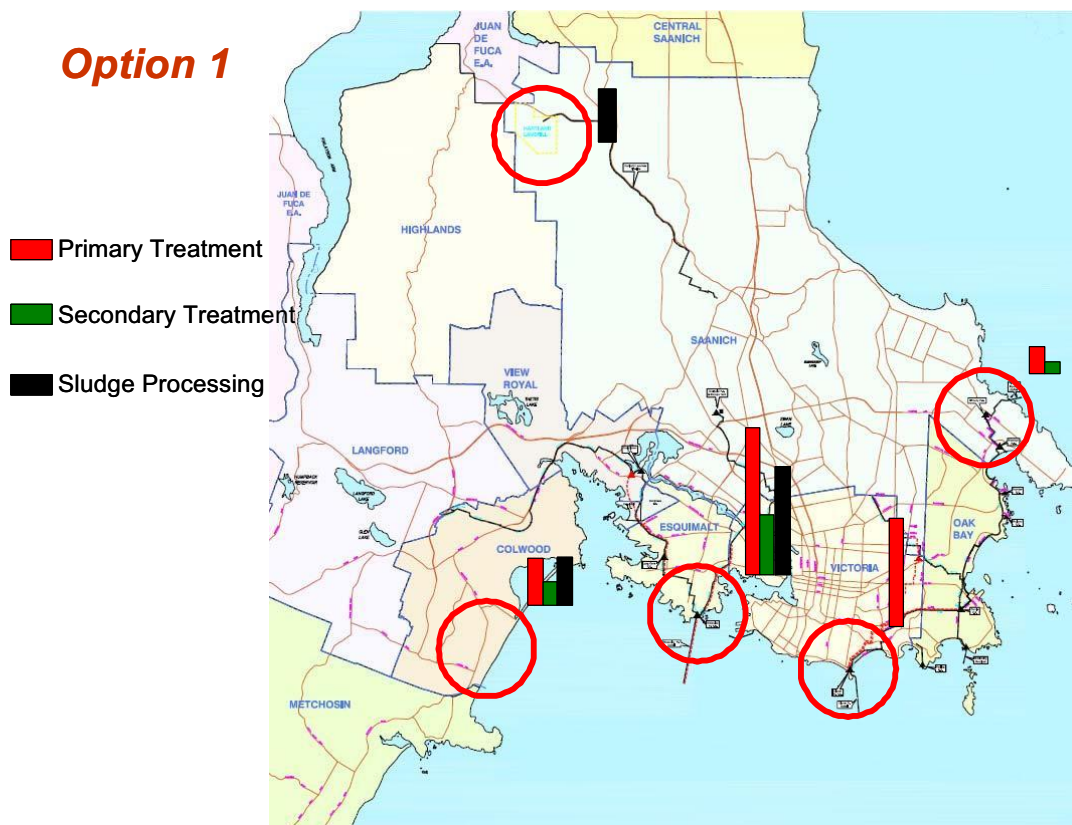
The secondary treatment options, developed in 2008 represent a range of possibilities within which a distributed plant system can be designed to meet these goals. In developing the options, the project team used four guiding principles:

- Fully utilize the energy available within the wastewater system at 2065,
- Develop water reuse in conjunction with energy recovery as an adjunct to energy recovery,
- Enable future privately funded-developed wastewater and water reuse within future urban developments, and
- Match urban development with the energy and water reuse opportunities.

The options are as follows:

**Option 1: Resource Recovery on a Regional Basis – the Fewest Plants (Figure 3)**

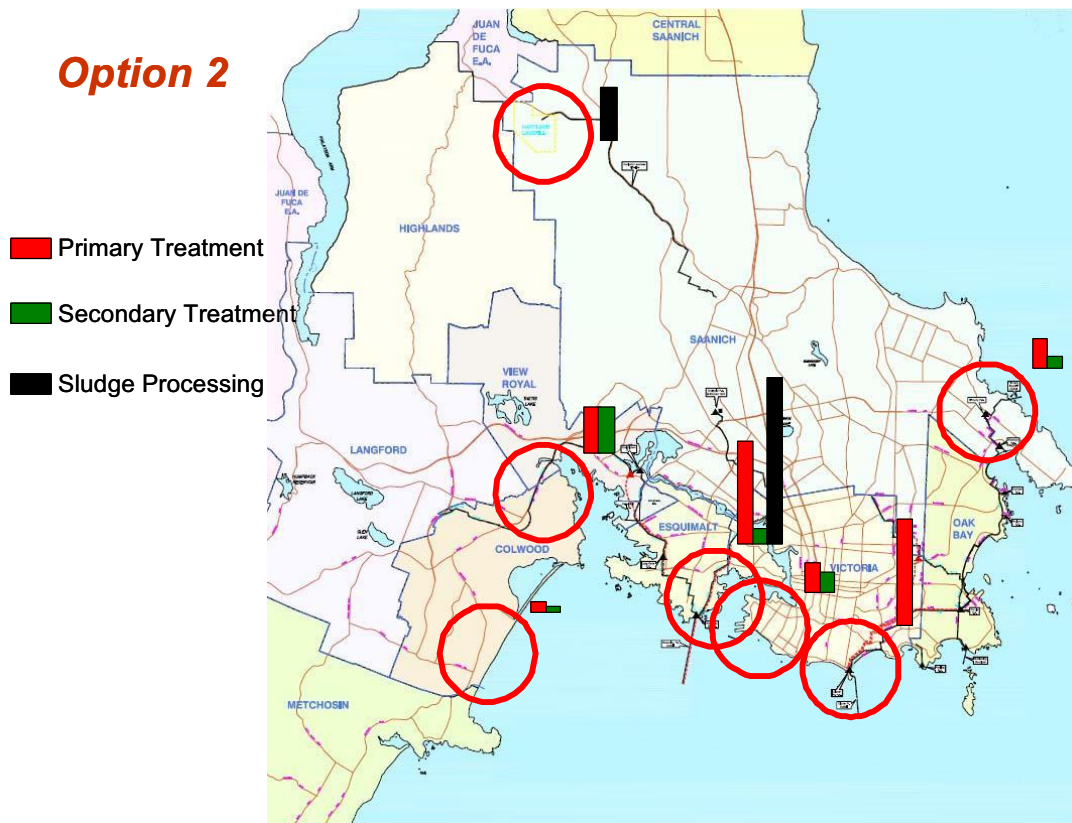
- Three secondary wastewater treatment plants (Saanich East; Macaulay Point / McLoughlin Point; West Shore)
- Heat energy recovery using the effluent from all three plants
- Wet weather flow plant at Clover Point
- Organic energy and phosphorus recovery at the Macaulay Point / McLoughlin Point and the West Shore plants



**FIGURE 3 - OPTION 1**

**Option 2: Resource Recovery based on a Combined Regional – Local Basis (Figure 4)**

- Five secondary wastewater treatment plants (Saanich East; Macaulay Point / McLoughlin Point; James Bay; plus two plants on the West Shore)
- Heat energy recovery using the effluent from all five plants
- Modification of sewerage area boundaries
- Wet weather flow plant at Clover Point
- Organic energy and phosphorus recovery at the Macaulay Point / McLoughlin Point plant

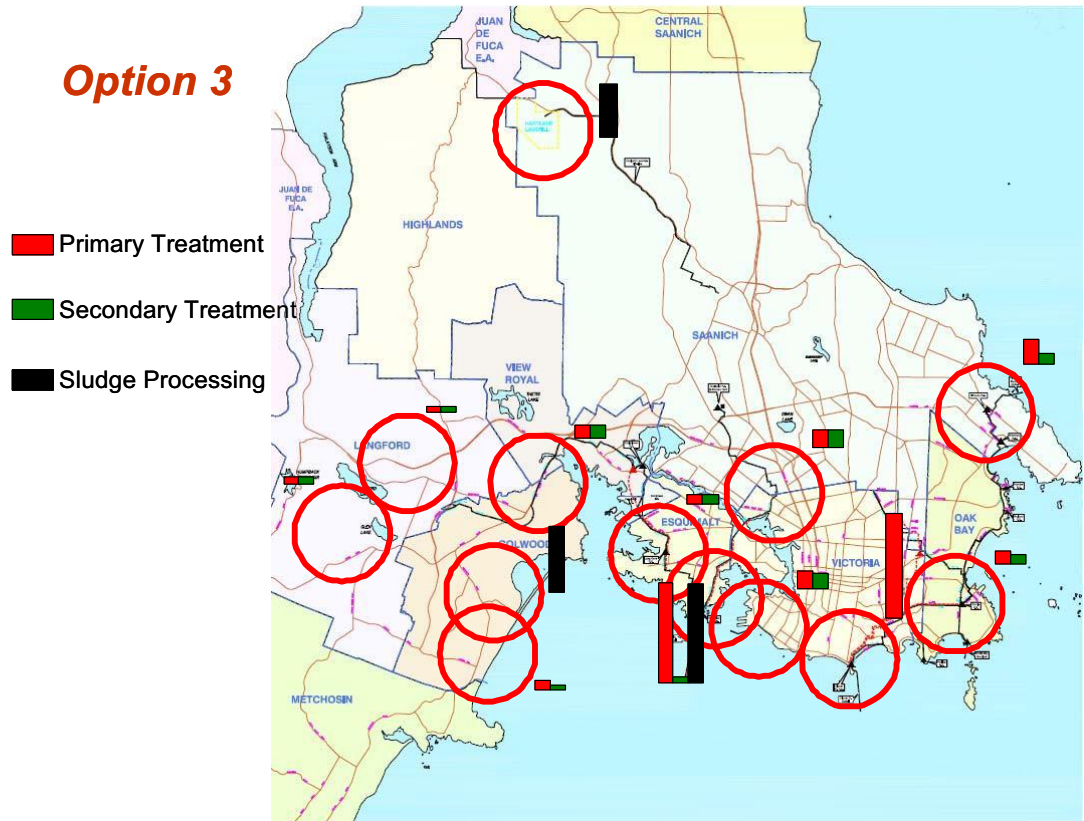


**FIGURE 4 - OPTION 2**



**Option 3: Resource Recovery on a Local Scale – the Largest Number of Plants (Figure 5)**

- Ten secondary wastewater treatment plants
- Aggressive water recycling at individual buildings
- Heat energy recovery using the effluent from all ten plants
- Wet weather flow plant at Clover Point
- Organic energy and phosphorus recovery at the Macaulay Point / McLoughlin Point plant and at an Organic Waste Processing Centre located in the West Shore Options SAF Evaluation



**FIGURE 5 - OPTION 3**

The SAF evaluation of the three options incorporated the SAF evaluation of the 39 energy recovery opportunity areas. The fundamental difference is the addition of costs, revenue, and net present value to assess economic performance.

Once the three options were developed, the SAF was used to complete a comparison of how well the options perform against a objectives hierarch for each of the goals developed by the CALWMC. The criteria flow from the three secondary treatment goals and have been refined through community consultation. The tables below (Figures 6, 7, and 8) summarize the criteria for each goal.

**FIGURE 6 - ENVIRONMENT ELEMENT AND CRITERIA**

| <b>Environment - Protect Public Health and the Environment</b> |   |  |
|--|---|--|
| <b>E1</b>  | <b>E2</b>   | <b>E3</b>  |
| Compliance assurance in meeting regulatory targets             | Minimize the impact of the facilities footprint with respect to environmental impacts to surroundings | Maximize use of strategic, flexible, and multi-faceted resource recovery |

**FIGURE 7 - SOCIAL ELEMENT AND CRITERIA**

| <b>Social - Manage Wastewater in a Sustainable Manner</b>                                  |  |  |
|--|--|--|
| <b>S1</b>  | <b>S2</b>  | <b>S3</b>  |
| Ensure facilities are and acceptable to fit into neighbourhoods (aesthetics, noise, odour) | Maximize adaptation and flexibility to current and future technology opportunities | Maximize opportunity to reduce the carbon footprint progressively and innovatively |

**FIGURE 8 - ECONOMIC ELEMENT AND CRITERIA**

| <b>Economic - Provide Cost Effective Wastewater Management</b> |   |   |
|--|---|---|
| <b>F1</b>  | <b>F2</b>   | <b>F3</b>                               |
| Minimize lifecycle costs                                       | Maximize phasing or staging potential to reduce rate impact | Maximize revenue from resource recovery |

The performance measures for each of these criteria were set within a 1 to 5 numeric scale – 1 is the worst condition or “lowest performance”, and 5 represents the best condition/performance. This 1 to 5 scale is defined for each criterion.<sup>1</sup> Ratings of how well each option performs against the objective hierarchy was initially conducted by the consultant team and reviewed in meetings with CALWMC.

The weighting of the three fundamental criteria (social, economic, and environmental) was originally unequal in weight. They were unequal to reflect an emphasis on sustainable life-cycle cost. As a result the economic goal was equal in weight to the combination of social and environmental goals. The community dialogues clearly indicated that this added weight for the economic goal is not a preference. Indeed, the principle that arose from the community dialogue sessions was that all

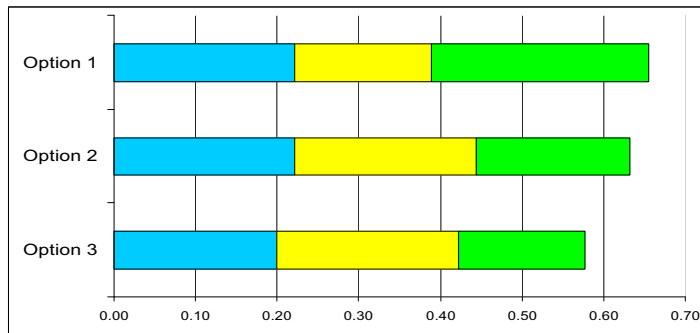
<sup>1</sup> The SAF analysis was completed in an excel workbook file provided to CRD with this discussion paper.

three goals should be of equal weight. The weight of the goal should then be equally distributed among the criteria that refine the goal.

The results are a summation of the weighted performance ratings. Figure 9 below summarizes the results. The values scores are presented for each of the triple bottom line elements. The total value scores are the summation of the three triple bottom line elements. The higher the score – the better the option performance. The image immediately below the table presents the same information graphically.<sup>2</sup> Another way to look at this information is with a value to cost comparison. Figure 10 demonstrates the summation of the environment and social scores in relation to the net present value cost of the options.

**FIGURE 9 - EQUAL WEIGHT RESULTS**

|          | Environment | Social | Economic | Total Value Score |
|----------|-------------|--------|----------|-------------------|
| Option 1 | 0.22        | 0.17   | 0.27     | 0.65              |
| Option 2 | 0.22        | 0.22   | 0.19     | 0.63              |
| Option 3 | 0.20        | 0.22   | 0.16     | 0.58              |



**FIGURE 10 - VALUE SCORE TO NPV RATIO, EQUAL WEIGHTS**

|          | Environment | Social | NPV              |
|----------|-------------|--------|------------------|
| Option 1 | 0.22        | 0.17   | \$ 1,174,000,000 |
| Option 2 | 0.22        | 0.22   | \$ 1,538,000,000 |
| Option 3 | 0.20        | 0.22   | \$ 1,666,000,000 |

| Environmental plus Sustainability Value Score | Value Score/NPV Ratio* |
|---|------------------------|
| 0.39  | 0.33                   |
| 0.44  | 0.29                   |
| 0.42  | 0.25                   |

*\*Environmental and Sustainable Value received per net present value dollar*

<sup>2</sup> The entire SAF analysis was completed in an excel workbook file provided to CRD with this discussion paper.

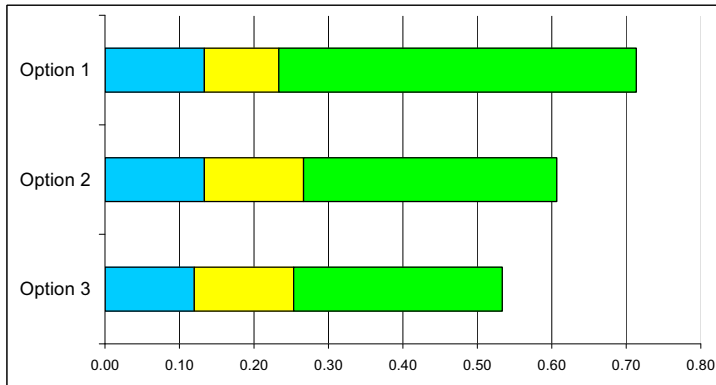
## 5.2 Sensitivity Analysis

A sensitivity analysis of the weights can test how much influence the weights have on the relative ranking of the options' overall performance. Each goal (social, economic and environment) is "stressed" in this analysis by assigning unequal weights.

The first "stressed" weighting scenario is placing more weight on the economic element: 20% environment, 20% social, and 60% economic. The results are presented in Figures 11 and 12.

**FIGURE 11 - SENSITIVITY SCENARIO 1 RESULTS**

|          | Environment | Social | Economic | Total Value Score |
|----------|-------------|--------|----------|-------------------|
| Option 1 | 0.13        | 0.10   | 0.48     | 0.71              |
| Option 2 | 0.13        | 0.13   | 0.34     | 0.61              |
| Option 3 | 0.12        | 0.13   | 0.28     | 0.53              |



**FIGURE 12 - VALUE SCORES TO NPV RATIO, SENSITIVITY SCENARIO 1**

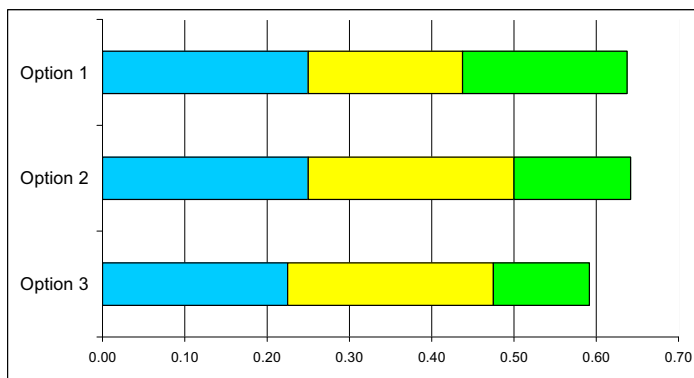
|          | Environment | Social | NPV              | Environmental plus Sustainability Value Score | Value Score/NPV Ratio* |
|----------|-------------|--------|------------------|---|------------------------|
| Option 1 | 0.13        | 0.10   | \$ 1,174,000,000 | 0.23  | 0.20                   |
| Option 2 | 0.13        | 0.13   | \$ 1,538,000,000 | 0.27  | 0.17                   |
| Option 3 | 0.12        | 0.13   | \$ 1,666,000,000 | 0.25  | 0.15                   |

\*Environmental and Sustainable Value received per net present value dollar

The second “stressed” weighting scenario is placing more weight on the environment and social elements: 37.5% environment, 37.5% social, and 25% economic. The results are presented in Figures 13 and 14.

**FIGURE 13 - SENSITIVITY SCENARIO 2 RESULTS**

|          | Environment | Social | Economic | Total Value Score |
|----------|-------------|--------|----------|-------------------|
| Option 1 | 0.25        | 0.19   | 0.20     | 0.64              |
| Option 2 | 0.25        | 0.25   | 0.14     | 0.64              |
| Option 3 | 0.23        | 0.25   | 0.12     | 0.59              |



**FIGURE 14 - VALUE SCORES TO NPV RATIO, SENSITIVITY SCENARIO 2**

|          | Environment | Social | NPV              | Environmental plus Sustainability Value Score | Value Score/NPV Ratio* |
|----------|-------------|--------|------------------|---|------------------------|
| Option 1 | 0.25        | 0.19   | \$ 1,174,000,000 | 0.44  | 0.37                   |
| Option 2 | 0.25        | 0.25   | \$ 1,538,000,000 | 0.50  | 0.33                   |
| Option 3 | 0.23        | 0.25   | \$ 1,666,000,000 | 0.48  | 0.29                   |

\*Environmental and Sustainable Value received per net present value dollar

The second stress test indicates that option one and two are equal in how well each does in achieving the social, environmental and economic goals. However, even under this weighting, the value score to NPV ratio indicates that, Option 1 continues to provide the environmental and social benefits at a lower cost. In other words, for every unit of environmental and social benefit achieved, Option 1 does so at a lower cost per unit.

Clearly, Option 2 presents significant social and environmental benefits but the cost per unit to obtain those benefits continues to exceed the cost per unit for the social and environmental benefits achieved in Option 1.

## 6 Conclusions

The Sustainability Assessment Framework is a means to inform the decision body of the tradeoffs among the fundamental economic, social, and environment goals. It provides a guide to the relative performance of the options. It also illustrates the difficulty measuring the performance of the options for both quantitative and qualitative criteria. For both qualitative and quantitative measures, there are significant judgements to be made in scoring the options. Ultimately, it provides a framework for analysis and a process for informing decisions makers of their choices and allows for policy considerations to be incorporated into the selection of a preferred option.

Other conclusions include:

- The community principles emphasize an equal balance between economic sustainability and desire to achieve social and environmental sustainability. This analysis points to Option 1 as the option that most adequately achieves that balance.
- The SAF analysis also demonstrates that Option 2 produces significant environmental benefits and that further consideration should be given to defining ways to capture the resource recovery benefits of Option 2.

Overall, Option 1 and refinements of Option 1 to capture the social and environmental benefits of Option 2 will help the CRD achieve sustainable goals well beyond a single goal of achieving compliance with secondary treatment at the lowest possible cost. Enhancement of Option 1 will contribute to a design that ensures that today's expectations of sustainable infrastructure and integrated resources management become tomorrow's standards.