Application of a Sustainability Decision Support Tool in Site Remediation

Robert Noël-de-Tilly, P.Eng.
Golder Associates, Montréal, Québec, Canada
Benoit Bourque, P.Eng.
Golder Associates, Montréal, Québec, Canada

ABSTRACT
Golder Associates has developed a decision support tool to embed sustainable development principles into remediation projects. The tool was initially developed in 2007 for a North American railroad carrier in order to improve contaminated sites management across their operations. Since then, the tool called GoldSET© has been used in Europe, Australia, USA and Canada; in site remediation and waste management. GoldSET© offers a framework to perform a "triple-bottom-line" assessment by giving consideration to technical, economical, environmental and social considerations. The tool offers an executable framework to support pragmatic decision making while taking into account these issues. Recent adaptations of the tool are discussed.

RÉSUMÉ
Golder Associés a développé un outil d'aide à la décision qui permet d'intégrer les principes du développement durable dans les projets de réhabilitation environnementale. L'outil a d'abord été développé en 2007 pour un transporteur ferrovaire nord-américain afin d'améliorer la gestion de leurs sites contaminés. L'outil nommé GoldSET© a depuis été utilisé pour la sélection de scénarios de remédiation et dans le domaine de la gestion des matières résiduelles, en Europe, en Australie, aux États-Unis et au Canada. GoldSET© offre un cadre d'analyse complet pour effectuer des « triples bilans » en intégrant des considérations techniques, économiques, environnementales et sociales. L'outil peut être utilisé de manière à supporter une prise de décision pragmatique en intégrant des considérations de développement durable. Des adaptations récentes de l'outil sont présentées.

1 INTRODUCTION

Golder Associates Ltd ("Golder") has developed a sustainability decision support tool to evaluate the strengths and weaknesses of engineering projects with respect to environmental, social, economical as well as technical dimensions. The tool called GoldSET©[1] (Golder's Sustainability Evaluation Tool) allows for an unbiased comparison of different options on the basis of sustainability principles. As such, it can help identify optimal solutions in a decision-making process based on the principles of sustainable development. This sustainability analysis results in a "triple-bottom-line" assessment, expanding the traditional analytical framework from financial performance to environmental, social and economical performance.

The purpose of a sustainability decision support tool is to offer an analytical framework which simplifies the management of complex sustainability issues involved in projects. This paper will argue that the application of a sustainability decision support tool can be instrumental in managing the business risks associated with large engineering projects. By providing a comprehensive and transparent framework to understand and manage the sustainability issues of a project, a sustainability decision support tool can achieve the following benefits:

- Improve the decision-making process involving complex issues;
- Support proactive stakeholder engagements through a rigorous and transparent evaluation process allowing stakeholders to better understand the alternatives and their respective impacts;
- Ease communication with communities through visual representation of performance with respect to sustainable development and in return facilitate the issuing of social licences for project operations;
- Optimize the comparison of alternatives by providing a framework which allow different options to be compared with a set of key criteria and trade-offs leading to a facilitated decision-making process; and
- Improve corporate image through supporting decisions with a sustainability framework that effectively demonstrates a corporation's willingness to move forward with sustainable development, and can consequently promote a positive corporate image.

Major remediation projects face interconnected and complex technical, economical, social and environmental challenges. In this context, the use of a sustainability decision support tool can achieve important benefits. The following sections will discuss how these benefits can be achieved with a sustainability decision support tool.

2 SUSTAINABLE DEVELOPMENT: IMPLICATIONS

The paradigm called sustainable development stems from the realization that economic development must increasingly be undertaken in ways that respects the integrity of the environment while promoting social equity. The definition of sustainable development calls for a development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). However, translating this concept into reality is a complex challenge that corporations around the world are increasingly facing with their investments.

The development of sustainable projects requires management of conflicting priorities that are challenging to embed into a business model which focuses on the maximization of the return on investments. Costs are to be minimized in a context where the "people" and the "planet" aspects must be carefully managed. The three Ps (Profit, People and Planet) form this "tripled bottom line" that modern corporations are expected to optimize in highly competitive and increasingly scrutinized markets. Indeed, as sustainability issues are becoming more pressing and intricate, the rising scrutiny from civil society organisations, regulators, the media as well as investors renders the issue of sustainable development increasingly unavoidable to the global business community.

Figure 1 : Corporations and public agencies are facing increasing pressure to move forward with sustainability

There is a need to understand the risks and opportunities to the business model arising from the imperatives of sustainable development and how they can be managed. As shown in Figure 1, the increasing pressure from the various stakeholders of an organisation to move forward with sustainability actions is occurring in a context where socio-economic and environmental issues are becoming extremely complex to understand and manage. As a response to this challenge, many resources such as publications from the International Federation of Consulting Engineers (FIDIC, 2004) and performance indicators from the Global Reporting Initiative (GRI, 2006) to name but a few are being proposed to provide a framework for addressing sustainability issues. The practical problem resulting from these resources is that they do not easily apply at the project level to make a difference when a project is being conceived.

Businesses need to be capable of effectively and efficiently evaluating their options with a comprehensive sustainability approach. Such an evaluation process needs to be:

- Easy to understand and communicate;
- Defensible and transparent to the stakeholders;
- Flexible so that both quantitative and qualitative information can be processed;
- Balanced in regards to the sustainability principles;
- Specific to the organisation; and,
- Pragmatic so that it can support sound business decisions.

A comprehensive analytical framework to support sustainability assessments can lead to sound business and engineering decisions; decisions in which principles and corporate policies on sustainable development can be implemented at the project level. This process means that the assessment of the various sustainability issues in a project will be synthesized in order to facilitate the trade-offs leading to optimized decisions. This process will enhance the understanding of the sustainability issues, which will in turn position the project proponents so that they can engage more proactively with their stakeholders, better manage their risks and ultimately improve the overall performance of their project.

3 GOLDSET©: AN EXECUTABLE FRAMEWORK FOR SUSTAINABILITY

Golder has developed a multi-criteria analytical (MCA) framework called GoldSET© to support sustainability assessments. It is used to "operationalise" the principles of sustainable development into engineering projects. This MCA framework was first developed in 2007 to investigate the sustainability elements included in an environmental remediation project. The basis for GoldSET© was to support the evaluation process in order to make sure that the proper recommendations would be made, while including various sustainability principles. To do so, it was designed to address economical, social and environmental impacts, direct and indirect, positive and negative, short and long term. The evaluation process is divided into four main steps, as shown in Figure 2 below:

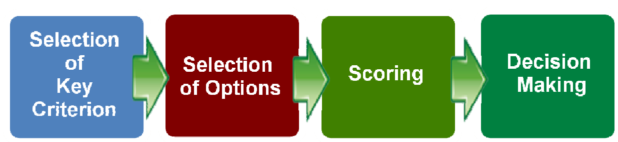

Figure 2 : The Four Steps of the Evaluation Process

During the first step of an evaluation, criteria (sustainable development indicators) tailored to the specificities of the project and the organisation are elaborated based on international and authoritative references, as well as industry specific references, corporate objectives and legal requirements. These criteria are chosen to reflect the critical issues that will determine the overall performance of a project (triple-bottom-line). During the evaluation process, the criteria will be used to evaluate impacts (step 3) which are categorized into various dimensions: economical, social, environmental and technical.

During the second step, various options that could be potentially undertaken for the realization of a specific project are developed. Those are the options that are evaluated with the criteria that have been established in the first step.

The third step is where the sustainability evaluation of the various options under consideration is performed based on a structured system for ranking the options. Tailored scoring and weighting schemes are used to compile a sustainability performance with respect to the various dimensions under consideration for each option. The framework can handle both qualitative and quantitative data. Depending on the size of the project and the level of uncertainty acceptable to the client (versus cost to reduce this uncertainty), the framework can be adapted to the requirements of the project. For instance, project costs and revenues, energy consumption, greenhouse gas emissions, water consumption and wastes can typically be calculated[2] while health and safety, impact on landscape and on cultural heritage of a site may be more difficult to quantify. A key feature of the MCA is that it provides a mean to handle both types of information. The results are presented both numerically and graphically, as shown in Figure 3 below.

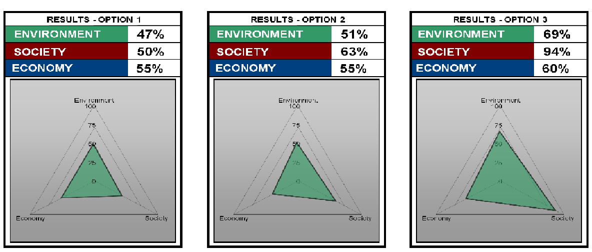

Figure 3 : Results of the SD Evaluation for Two Options

As a fourth and final step, the interpretation leading to a sound decision can be made based on the outputs of the evaluation process. The evaluation process being iterative by nature, further refining can be accomplished if additional information is available or if a new option is proposed. Monte-Carlo modelling and sensitivity analyses can also be performed on the outputs to improve the reliability of the findings. In the end, however, the process will provide a tangible, transparent and optimized evaluation of the options upon which a pragmatic and legitimate decision may be taken. As shown in Figure 3, the end result is a visual compilation of the sustainability performance. This visual presentation demonstrates the elements of each option and allows for effective decisions. The three axis of the triangle present the performance of an option with respect to the three dimensions of sustainable development. Under normal circumstances, the optimized approach will be determined by the bigger, most balanced triangle.

In the end, the choice of the option to undertake will not be dictated by the framework; the decision will remain to the client's prerogative. However, although the biggest triangle is not an absolute criterion for selecting an option, the process will provide an opportunity to understand the sustainability issues and legitimize the choice of an option on that basis. The benefits provided by GoldSET© are not limited to understanding and managing the issues in order to make a decision. The tool can also be used to support the communication process with the various stakeholders. The framework is instrumental in facilitating the communication of key elements because the evaluation process is transparent and the results are presented graphically for each option, allowing effective comparisons.

4 CASE STUDIES

Golder was retained to adapt its sustainability screening tool to assist in remedial project planning for two distinct organisations:

- Major railway company; and,
- Canadian governmental agency.

Railway Company

For the railway company, the tool was developed in order to enhance viability of operations, provide transparency and support proactive stakeholder engagement. The tool allowed integrating sustainability concepts into the decision-making process.

Sustainability indicators were selected based on the needs and characteristics of the client's projects, corporate sustainability objectives, and international guidelines, such as the Global Reporting Initiative (GRI, 2006), the International Federation of Consulting Engineers Project Sustainability Management Guidelines (FIDIC, 2004), the Office for Rail Regulation in the UK (ORR, 2006a and 2006b) and the Railway Association of Canada (RAC, 2002). With these indicators, the tool was developed in order to help managers decide on the most sustainable remedial option through the evaluation of environmental, social, and economic impacts. A module for estimating energy consumption and greenhouse gas emissions was also developed in this case.

The sustainability screening tool was to be pilot tested for the evaluation of remedial options for a plume of diesel-like product located in fractured bedrock under an operational rail yard in Ontario. At the onset of sustainability assessment, the site underwent monthly product extraction from interceptor sumps to aid in the recovery of free phase hydrocarbon product. Other remedial options under consideration included an interceptor trench with pumping for product recovery, a multi-phase extraction system, a well-based hydraulic barrier with pumping for product recovery, and injection of oxygenated water for plume containment and in situ

[2] Various methodologies, such as a life-cycle (LCA) approach can be used with the tool.

bioremediation. The main concerns involved environmental liability with respect to potential plume migration outside of property limits or under existing infrastructure as well as potential impacts on groundwater receptors.

The aim of the pilot test was to demonstrate the effectiveness of the adapted Golder Sustainability Evaluation Tool for Site Remediation (GolderSET©-SR) in identifying the most sustainable remedial option through the evaluation of environmental, social, and economic impacts. GolderSET©-SR contains indicators relevant to site remediation inspired by international standards and practical experience. The screening tool was customized to address client operations and concerns based on the consultation of corporate and industry resources. GolderSET©-SR enables decision-makers to evaluate short and long-term overall impacts of potential projects in a simple, systematic way.

The pilot test identified two remedial options with positive anticipated impacts on environmental, social, and economic issues, namely multi-phase extraction and injection of oxygenated water. The most sustainable options featured some technical uncertainty related to their anticipated effectiveness under site conditions. Recommendations were presented for additional site assessment and testing to reduce uncertainty related to technical performance. Monitoring of key environmental, social, and economic indicators could ensure a sustainable performance in the long term.

Canadien Governmental Agency

For the Canadian governmental agency, sustainability indicators were selected based on the needs and characteristics of the federal contaminated sites, governmental sustainability strategies, international guidelines and scientific references. With these indicators, the Federal Sustainability Evaluation Tool was developed in order to help managers decide on the most sustainable remedial options through the evaluation of environmental, social, and economic impacts.

The tool includes both qualitative and quantitative indicators. The quantitative indicators can be entered directly into the tool or can be estimated from simplified life-cycle analysis (LCA) modules built specifically for remediation technologies. The technologies currently included are excavation and soil disposition, multi-phase extraction systems, in-situ bioremediation, chemical oxidation as well as pump and treat systems.

The simplified LCA modules were developed to allow for a first-order quantitative comparison of the life-cycle environmental impacts of different remediation technologies applicable to a contaminated site when screening for a remediation technology. The simplified LCA modules were developed consistent with the current International Standards ISO 14040:2006 and ISO 14044:2006. The impact categories currently included in the simplified LCA modules are greenhouse-gas emissions, energy use, water use and waste.

System boundaries for the remediation technologies included in this project were established through consultation of remediation specialists in order to depict all the processes involved in a remediation project and consistent with the diagrams provided by the study entitled Life Cycle Framework for Contaminated Site Remediation Options commissioned by the Ontario Ministry of Environment and Energy (*Diamond et al., 1998*). An example of the process diagram is depicted in Figure 4.

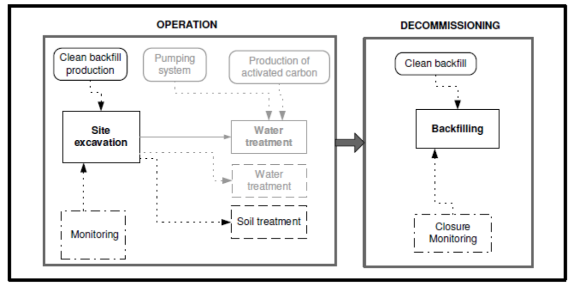

Figure 4 : Process Diagram for Soil Excavation and Disposition

The output from the Federal Sustainability Evaluation Tool will be presented by a ternary representation where the most sustainable option is represented by the largest, most balanced triangle with respect to the three axes of the graph (the environmental, social and economic performance of the options under consideration).

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