**Nelson Regional Sewerage Scheme – A Sustainable Solution?**


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## ABSTRACT


In the mid 1970's two New Zealand territorial local authorities, Nelson City and Tasman District Council jointly set up a regional sewerage authority to provide a centralised wastewater collection, treatment and disposal scheme. The new, at the time award-winning scheme, was opened in 1982 and achieved the community's aims of reducing point discharges to the local estuary, and improving water quality. However since then a new Nelson Regional Sewerage Business Unit (NRSBU) has been formed with a more formal governance structure and a new mandate from its two local authority owners. New initiatives have included addressing economic, environmental and cultural issues, putting in place demand and growth management strategies, and implementing a range of nutrient management and recycling, water re-use, and energy management solutions. Eight years on the NRSBU has achieved a remarkable turnaround in all aspects of its governance, management, service delivery and environmental outcomes of the regional scheme it administers.

But how sustainable has this turnaround been?

This question is considered by using a standardised eight-point decision support tool as an assessment guide. We conclude that the question is complex with no simple answer and demonstrate that the qualitative process of carrying out the self-assessment is in fact more important than the quantitative answer. It is the process itself which provides invaluable insight into the robustness of the decision making on the project, and provides guidance into avenues that should be addressed in future strategic planning and decision making.

The paper also examines the decision making process undertaken, and how a standardised framework of sustainability questions might influence or improve the process, and hence the final decisions.

## 1.0 Introduction

In New Zealand, as elsewhere, society is grappling with the complex issues surrounding the effects of climate change on the environment, and how we should modify our behaviour to protect the future. The New Zealand government is clear that *"achieving sustainable development involves a different way of thinking and working"* and has introduced a number of policies and legislation to speed our acceptance of sustainability principles. These policies have worked, and there is now a widespread acceptance of sustainability into mainstream thinking within New Zealand society and business (Frame, Marquardt 2006).

But how do we know whether we are achieving sustainable development? The whole-of-life assessment criteria embodied in the sustainable philosophy provide a range of complex issues for the practitioner to consider, but to date there is limited background data on which to make an informed decision.

There are many quantitative rating tools being developed around the world, such as the Green Star building rating system, or the BREAM, SPEAR, LEEDS or Carbon Zero assessment systems and a number of countries are rapidly adopting these basic tools for use in their own particular environments and climates. For the civil engineering world of complex projects involving manipulation of the basic "men, money, materials" in the built and natural environment, there does not appear to be quite the same suite of quantitative assessment tools available. In fact a quantitative tool may not be appropriate, as a suitable tool would need to address a range of diverse issues, such as social, cultural, environmental and long-term life cycle issues that are not easily measured or quantified. So what is an appropriate assessment tool that can address the complex issues of measuring sustainability?

## 2.0 An Appropriate Tool

There have been a number of attempts to define the qualitative issues that should be addressed in sustainable development, but these often provide little assistance to an engineering practitioner looking for practical guidance.

One solution has been advanced (Fenner et al 2006) which recommended an eight-point framework that could be used to address the complexity of sustainable development, and to widen the decision-making assessment within engineering horizons. The method suggests a separate set of 10-12 generic questions to establish the sustainable merits of a development against each of eight separate factors covering the complete holistic environment. The factors are shown in Figure 1 and cover a much wider range of issues than have traditionally been addressed by engineers in civil engineering developments.

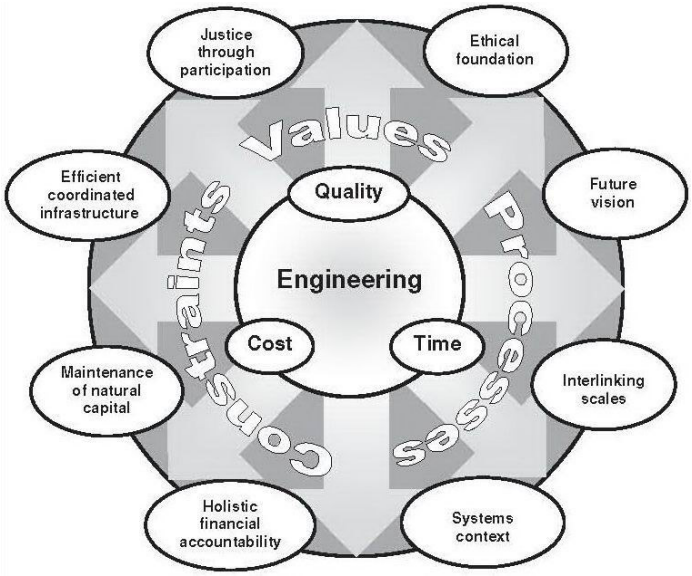


**Figure 1: Eight-point Framework (Fenner et al 2006)**

This paper seeks to evaluate whether this eight-point framework can provide a useful measure of sustainability. It also examines whether a standardised framework of sustainability questions might influence or improve the decision making process, and hence the final decisions in a complex infrastructure project.

## 2.1 Methodology

The particular engineering "project" chosen for evaluation is a regional sewerage scheme in the Nelson/Richmond area at the top of the South Island of New Zealand. The scheme has been upgraded and has "evolved" since it was built 25 years ago, without the benefit in the early stages of a planned sustainable framework to guide ongoing development. In recent years the changes and upgrades have progressed in a more planned and proactive manner than was the case previously. An overview in Section 3 below details the main aspects of the scheme which the authors of this paper have each been heavily involved with for over a decade in a variety of operational, maintenance, management, advisory and consultancy roles.

The generic set of questions (Fenner et al 2006) presents a wide range of philosophical issues that require answers across the full spectrum of social, cultural, environmental, economic and technical aspects of the scheme. Staff members who were involved in the design and management of aspects of the scheme were asked to critically review the questions and provide answers as best they could. The generic questions were used unchanged and were not modified in any way to suit the project.

The team members found that they could not answer the questions with yes/no answers, and included detailed explanations or qualifications in most cases. To assist with the assessment, team members were asked to score each of the answers with a weighting of 1-5, with 1 being poor and 5 being excellent. These weightings were then averaged for each of the eight sets of answers, giving eight scores.

These scores were then plotted on a rose-diagram which provided a simple graphical representation of the assessment of the current sustainability of the sewerage scheme based on the team's combined knowledge.

## 2.2 Results

The assessment process itself provided extremely useful feedback and guidance in a number of ways.

The first and obvious outcome was the numerical results of the assessment, as plotted in Figure 2 below. The symmetrical shape of the diagram suggests that the scheme has been developed over the years with a fairly consistent approach being considered across most sustainable issues. During the evaluation of each question the team members used the full range of weightings from 1-5, highlighting that they considered that some areas of the scheme had been fully addressed and others had been overlooked entirely. At times the team struggled to provide objective weightings when having to judge whether their solutions they had implemented in the past were truly sustainable or merely sound technically correct engineering least-cost options. The assessment methodology averaged the weightings to provide a single score for each of the eight factors which meant that the variations on weightings for the individual questions were "lost" when plotted on the graph. However the information gained from the answers was invaluable for future decision making.

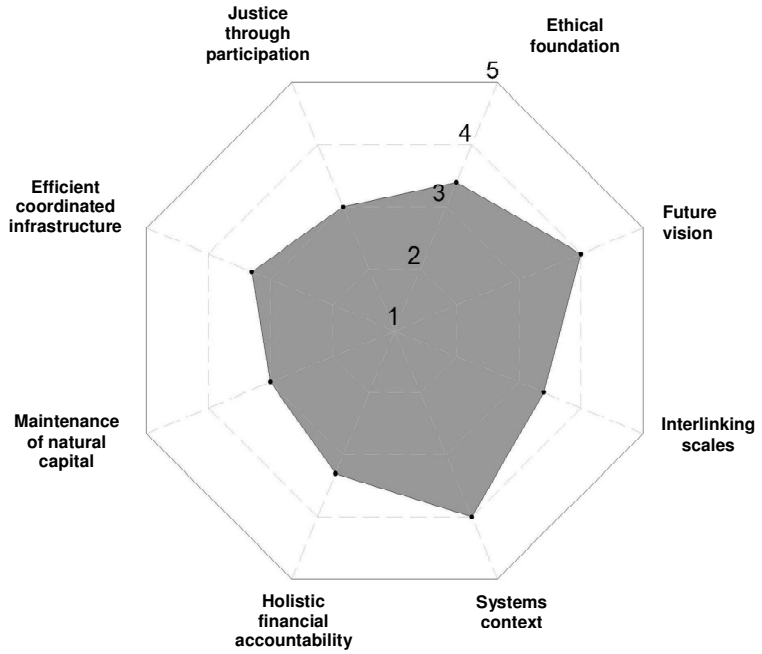


**Figure 2: Results of assessment using eight-point framework**

The second main outcome was that initially the team found the generic questions difficult to answer as in some cases at first sight they did not appear to be directly applicable to the scheme. As the team grappled with the answers, they began to realise that the struggle to find the answer was in itself the value of the assessment, rather than the final answer or the subsequent numerical weighting that was assigned to the answer. Rather, the benefits lay in the critical analysis process itself which forced them to review why they had made decisions in the past, and the subsequent identification of the areas where future decisions could be made to improve the sustainability of the scheme.

A third conclusion was (perhaps self-evidently) that if the wider set of principles had been considered and incorporated within the planning process, then more sustainable outcomes were likely to have been produced. With the benefit of hindsight, the team realised that opportunities for achieving more sustainable solutions had been missed. However the earlier reports considering the principles of fairness and equity (Ollivier, Chamberlain 1999) and sound technical engineering investigations (Railton, Clarke 1997, 1998) helped provide the foundation for the overall high standard of sustainability that was achieved in the assessment.

A fourth observation was that the Resource Management Act (RMA) has introduced a legislative requirement to consider a much wider range of environmental, social, economic and cultural values than might have been addressed without the act. The RMA provides a structure that when used in the spirit of the law promotes holistic thinking that can produce a sustainable result.

A fifth observation was the realisation that the team had provided input into most of the sustainable factors addressed by the eight-point framework. However the team acknowledged that for smaller projects the engineering team would be unlikely to have any influence on many of the factors considered by the framework

## 3.0 Nelson Regional Sewerage Delivery

### 3.1 Decision making

The following section briefly describes the changes that have occurred in the Nelson regional sewerage scheme over the last 10 years. The details are included to provide an overview of the range of issues that have been addressed, and to indicate the comprehensive nature of change within the scheme. When we consider the decision-making process we see that most of the decisions over the last decade have been influenced by reports that addressed principles of governance, fairness, equity and risk and which resulted in the creation of a new governance structure, the NRSBU. These principles had some similarity to but did not include all of the currently accepted principles of sustainability that are addressed in the eight-point framework being assessed in this paper.

### 3.2 Background

The Nelson/Tasman region is situated at the top of the South Island, New Zealand, and is renowned for its fine weather, high sunshine hours, golden beaches, fruit orchards and seafood harvest from Tasman Bay, so local residents show concern for preserving the environment. Nelson City and Richmond township in Tasman District are built around the edges of a tidal estuary and in the past had numerous point-source discharges of wastewater. In the mid 1970's, the two local authorities joined together to create the Nelson Regional Sewerage Authority (NRSA) to jointly manage wastewater collection, treatment and disposal.

The five main contributors to the scheme were assessed as being the residents from the two urban areas, Nelson City and Richmond, plus three main industries, a meat processing freezing works, fruit processing plant, and a timber processing facility. In 1983 a new scheme was constructed and is presented in Figure 3 below. It consisted of a concrete rising main which pumped wastewater to a treatment plant built on Bells Island in the middle of the estuary. The treatment plant was designed as an aerobic lagoon followed by three facultative and two maturation ponds. Treated effluent is discharged on outgoing tides through a short and shallow outfall into the main estuarine channel.

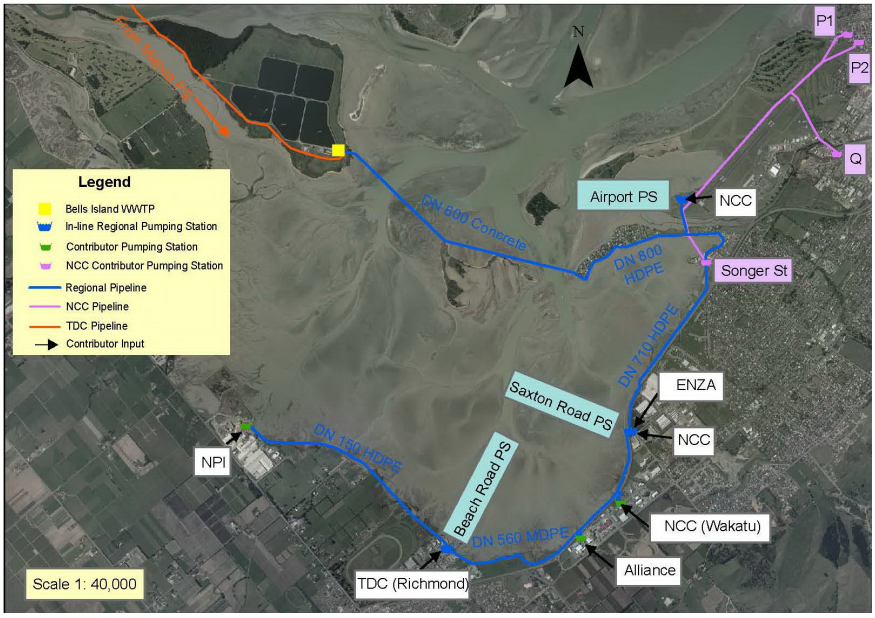


**Figure 3: Plan View of Scheme**

## 3.3 Impetus for Change

In 1997, one year after a major capacity upgrade, the Bells Island treatment plant had again reached capacity. It was apparent that although the original scheme had been technically innovative, the contracts with each of the main contributors in effect promoted "open-pipe" behaviour where the contributors could, within reason, discharge whatever they wanted to the collection system leaving the regional authority to treat and dispose of the wastewater, and take the risk of any non-compliance.

Duffill Watts & Tse Ltd (DWT) were asked to investigate and report on the options to upgrade the STP, and presented two technical reports to the NRSA in November 1997 (Railton, Clarke 2007) and August 1998 (Railton, Ollivier 1998) which identified a range of upgrade options, but noted there was a risk in proceeding with the upgrades as there were anomalies in the trade waste charging methods and that the ownership of the scheme was poorly understood. As a result the two local authorities faced unacceptable financial risks if they proceeded with the upgrade.

DWT were commissioned to carry out a further review of the scheme. The resulting report (Ollivier, Chamberlain 1999) recommended a range of broad principles that needed to be addressed in the future, including defining the roles of the owners and users, the form of the trade waste contract, and a new cost and risk allocation and pricing model.

## 3.4 Governance

The two local authority owners initiated a governance review of the NRSA following an Audit New Zealand (Audit NZ 1998) report and the report on ownership issues. As a result, a new entity, the Nelson Regional Sewerage Business Unit (NRSBU) was set up in 2000 with a new structure to manage the regional sewerage scheme. The NRSBU is an autonomous entity with its own board, consisting of two elected councillors from each of the two local authorities, plus an independent chair. Financial and administration services are provided under contract from the NCC, and the NCC Manager, Infrastructural Assets is contracted to act concurrently as Business Unit Manager of the scheme. These changes in the governance structure set the basis for improved and sustainable management of the scheme.

Since its establishment in 2000, the Board has developed a greater understanding of the operation of the scheme in its entirety, as well as the need for incorporating a long term strategic focus in its decision making processes. The current Board has continued this development, placing emphasis on achieving best-practice environmental, sustainable, social and cultural outcomes for the scheme. Recent Board initiatives have included having an external peer review of the scheme, briefings on international trends in waste management, treatment and disposal methods, adopting guiding sustainable principles to assist decision making, and encouraging ongoing professional development for key staff. In addition the Board has also sought external advice and training to improve its own standards of governance.

## 3.5 Management

The newly restructured NRSBU instigated a more rigorous approach to financial management and reporting than had previously been delivered. This resulted in preparation of two key documents for the Board to guide its activities - the Asset Management Plan and the annual Business Plan.

### 3.6 Ownership Issues

The DWT report on ownership (Ollivier, Chamberlain 1999) recommended a clear separation of the roles and responsibilities of the owners (two local authorities, NCC and TDC) and the customers (NCC, TDC and three major industries). Of particular importance was the recognition of the two separate local authority roles of owner and customer, and that as owners they attracted ultimate financial and operational risk of the scheme. Once these roles were clarified, it became far easier to identify the separate responsibilities and risks of each, and to instigate appropriate strategies and solutions to move forward.

### 3.7 Customer Contracts/Pricing Model

A new Customer Contract and Cost Allocation and Pricing Model (CAPM) were developed based on the key principles identified in the earlier reporting. The CAPM clearly identified risks, set out criteria for sampling and monitoring, charged costs fairly and appropriately, and provided clear demand management signals.

The CAPM was finally signed off in August 2007, almost 10 years after the original ownership issues were raised.

### 3.8 Demand Management

One of the outcomes of the negotiation for the CAPM (Schruer et al 2008) has been the significant reduction in discharge loads and flows to the scheme that were achieved even before the CAPM was agreed and signed. Both councils increased their efforts and expenditure to reduce inflows to the scheme through control of infiltration, proactive maintenance and storage strategies. There has been a marked decrease in average daily flow to the treatment plant, and in addition, the councils have agreed to use a common Trade Waste Bylaw and take a more proactive role in managing and monitoring trade waste flows.

The industrial customers although not major water users reduced peak flow discharges with on-site storage strategies, and implemented a high degree of waste minimisation practices on each of their sites. The industrial customers have also started communicating with each other and are managing their discharges to reduce the risks of exceeding the combined allocated treatment quota. This “risk club” behaviour was foreshadowed in the early DWT reports which recommended a tradable rights mechanism be set up.

### 3.9 Customer Relationship

Another main outcome of the negotiations for the CAPM is the improved relationships and understanding between all parties. This is reflected in the improved strategic planning and decision making process of the Board, as well as the day-to-day operations of the plant. The negotiating process itself has helped all involved improve their knowledge of the operations and processes within the scheme, on a technical, financial and management basis.

This has led to a better understanding of the various roles and influences each party has in contributing to the smooth running of the scheme, which has led to the improvements already achieved. The customers have taken responsibility for their own discharges to the scheme, and now have a greater understanding of the effects of their discharge in both the short term and the longer term treatment capacity they need to purchase.

### 3.10 Plant Operation and Maintenance

The Bells Island treatment plant was originally operated by NCC staff who also managed a broad range of maintenance and operations of other Council assets. It became apparent that, as the scheme and the treatment plant became increasingly more complex, an alternative service delivery methodology was needed. NRSBU chose to outsource the complete management of day-to-day maintenance and operation of the plant, as well as the upgrade works, and to transfer the associated performance risk. The arrangement is working well, with the plant operating satisfactorily within all its consent conditions, in a difficult operating environment.

### 3.11 Technical Initiatives

A brief summary of the technical upgrades carried out at the plant is given below:

a) Pond Management Strategy - the pond system is energy efficient and sustainable, but was susceptible to shock loading and the effects of parasitic attack on the pond algae. A strict monitoring programme and strong management protocols were developed, and these have provided a solution that delivers a consistent and reliable treatment process.

b) Process upgrades - the original design of the plant had a number of mis-matched components which led to poor separation of pollutant loads. A new aeration basin (Railton, Clarke 1998) and clarifier were constructed which has improved solids recovery and quality (which assists the ATAD process), improved total treatment capacity of the plant, and reduced nitrogen and phosphorous levels in the discharges to the ponds.

c) ATAD Operation - the ATAD facilities have been upgraded with modifications to the dewatering equipment to handle the improved sludge feed and the internal aeration system to provide enhanced high-quality biosolids.

d) Co-generation - a wider review (Clarke 2007) of the ATAD facility recommended that when the existing tanks reach the end of their economic life, they should be replaced by anaerobic digesters with a power generation unit feeding back into the plant. This system will reduce the solid content needing disposal by around 40%, and will supply approximately 60% of the plant's energy needs.

e) Biosolids - currently the biosolids are pumped to a distribution facility in an adjacent council-owned pine forest. The biosolids have enhanced growth of the pines, and has improved the economic return to Council from the harvest.

f) Effluent Reuse - treated effluent is currently used for internal wash-water to reduce potable water consumption, and irrigation of the adjacent farm. Increasing effluent reuse is considered to be a key objective for NRSBU, and therefore other opportunities are being considered at present, including the possibility of irrigating two adjacent golf-courses

g) Regional - septage facility - A centralised collection point has been set up on the treatment plant site where septage can be discharged, monitored and then fed into the treatment plant in a controlled manner. This improved procedure has reduced the incidence of illegal discharges, and has allowed the discharge of septage to be controlled using the nationally recognised Waste Track System.

### 3.12 Long-Term Strategies

NRSBU is currently undertaking a long-term strategic review of the scheme in its entirety as part of the resource consent planning process under the framework of the New Zealand Resource Management Act. The process is looking at options over an 80 year time horizon, and will involve a major consultation exercise with the iwi, wider community, institutional organisations and other interested groups. The strategy (Leonard et al 2008) will also consider regional demographics and climate change issues.

### 3.13 Long Term Relationships

Management of major infrastructural assets benefits from a sound knowledge and understanding of the asset, which can often only be obtained from ongoing familiarity with the asset. NRSBU has maintained this familiarity with the form of its operations and maintenance contract for the scheme, which has retained the core team of plant operators, and locked in the plant designers.

Where necessary, consultancy work has been tendered out on a case-by-base basis, to ensure transparency with spending of public funds. While NRSBU has not entered into a formal alliancing arrangement, management has recognised the need for continuity and has maintained the same consultants for the bulk of the strategic planning and investigation work. This, and the few changes in the customer representatives, means that the core team from the NRSBU management, consultants, customers and operators has been relatively constant for over a decade which has assisted the level of achievements to date.

### 3.14 Community Involvement

The NRSBU obtains community input through the Long Term Council Community Plans (LTCCP), and asset management plans prepared by its two local authority owners and from the Council's elected representatives on the Board. Specific community input is obtained as part of any major upgrade to the scheme either during the consent process as part of the mandatory consultation and hearing procedures or prior to this during the planning and investigation phases. In New Zealand, the Resource Management Act legislation requires specific attention to "social, economic, environmental and cultural effects of our decisions". The cultural effects requirement acknowledges the special status of the Maori people under the Treaty of Waitangi signed in 1840. In the Nelson region, six separate iwi are currently acknowledged as tangata whenua, and NCC has signed a formal Memorandum of Understanding (Whakatinana nga Whainga, 2007) with them "to provide opportunities to further the involvement of Maori in decision-making processes of the Nelson City Council".

## 4.0 Conclusion

Sustainability in large complex civil engineering projects is a simple and easy-to-use concept, but is not so easy to measure or achieve in practice. Increasingly world-wide a range of tools is being created, adopted and refined to try and provide a measure of sustainability. For complex infrastructural projects, a measure has been proposed (Fenner et al 2006) which asks generic questions based on an eight-point framework of holistic values. This framework has been used in this paper to measure the sustainability of the key initiatives that have already been implemented, or are currently being planned for the Nelson regional sewerage scheme.

The assessment is too complex to provide either a simple yes/no answer, so the results have been presented in a diagrammatic format, and we conclude that yes the scheme has achieved a high-standard of sustainability with the developments over the last decade. However the scorecard shows that "we could do better".

Of more importance however than the answer, is asking the questions and the ensuing debate over how to answer the questions. This debate raises awareness over gaps in the existing analysis or performance, and provides insight into how changes or modifications could be made and integrated into future planning strategies.

We conclude that the eight-point framework is a useful tool, both for short term decision making and for strategic planning and guiding sustainable decision making.

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