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Paper Title **Sustainability Assessment for First Time Wastewater Scheme**

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1.0 ABSTRACT

Point Wells is a small residential settlement located approximately 80km north of Auckland's CBD on a flat headland within the Whangateau Harbour. All wastewater was treated by private septic tanks and soakage field systems. However, these septic tank systems were not functionally and caused both human health and environmental impacts. It was determined by the Rodney District Council to replace the un-sustainable wastewater system with a centralised collection and disposal system. The Rodney District Council, with the assistance of Harrison Grierson Consultants undertook a Sustainability Assessment of possible wastewater servicing schemes for Points Wells.

For Point Wells an EIA Driven Integrated Assessment based on Triple Bottom Line methods was selected. The EIA Driven Integrated Assessment identified a low pressure sewer system as the best wastewater servicing solution for Point Wells. For this assessment methodology to be successful, sustainable objectives and the project boundary conditions needed to be understood to allow the appropriate option to be selected.

2.0 INTRODUCTION

It is an increasing trend in New Zealand to provide centralised wastewater collection schemes for small villages and settlements that rely on onsite wastewater treatment systems (such as septic tanks). Recent examples include Kawakawa Bay (Manukau Water Limited), Mourea (Rodney District Council) on Lake Rotorua, and Taupiri (Waikato District Council) in the Waikato. The driver for the establishment of these schemes is often unacceptable environmental and health impacts from the onsite system's effluent. The poor effluent quality is not only due to poor design and maintenance of the onsite systems but the local geology that is often not suitable for land disposal techniques associated with onsite treatment systems (Rodney District Council, 2005).

The assessment of various wastewater servicing solutions for these areas is often primarily driven by economics and the use of conventional technology. The following paper is an evaluation of a sustainability assessment applied to wastewater servicing for a first time wastewater scheme. Currently, local councils that own and operate water and wastewater schemes in New Zealand are required to consider sustainable development in their activities, however there is no systematic approach for the assessment and selection of appropriate technologies or infrastructure requirements for specific areas (at a local and regional level). In order to provide this systematic approach, the Rodney District Council engaged Harrison Grierson Consultants to undertake a sustainability assessment of various wastewater servicing options for the settlement of Point Wells. The results of this assessment are detailed in Harrison Grierson Consultants' report, Point Wells Wastewater Servicing Strategy, Issues and Options Report (Harrison Grierson Consultants, 2007). This paper presents the results of Harrison Grierson Consultants' assessment.

3.0 BACKGROUND

3.1 Settlement Setting

Point Wells is a small residential settlement located approximately 80km north of Auckland's CBD on a flat headland within the Whangateau Harbour. The settlement is approximately 46 hectares, is primarily residential and had a population of 357 people in the 2001 census. The Rodney District Council has adopted the Point Wells / Omaha Flats Sustainable Development Plan (June, 2006) for the Point Wells area. This plan allows for the intensification and expansion (to approximately 110ha) of the existing residential zone that will increase the population to approximately 1,300 people by 2051.

3.2 Wastewater Issues

No formal centralised wastewater treatment system existed for the Point Wells community. All wastewater was treated onsite mainly through septic tank and soakage field systems. It was determined that the existing systems were not functioning with both adverse environmental effects and a risk to public health (URS, 2005). The key issues associated with the on site wastewater systems in Point Wells were:.

- Excessive infiltration, and overloading or blockages, were leading to system failures. There was evidence of failures occurring with wastewater escaping into local surface drains and the harbour (Rodney District Council, 2005);
- There was no formal site management quality control or pump out system in place for the area. Therefore there was a great deal of uncertainty regarding the standard of maintenance in Point Wells (Rodney District Council, 2005);
- When systems become overloaded, especially in wet weather, odour was generated from disposal systems indicating the effluent was not undergoing significant treatment in the septic tanks (URS, 2005);
- Point Wells is low lying, approximately 5m above sea level, and has a high water table. The local geologically consists of silt with numerous peat deposits overlying a shallow layer of sandstone, between 0.5m and 1.5m deep. These factors prevented the treatment systems' soakage fields from functioning correctly (Rodney District Council, 2005).

The planned expansion and intensification of the Point Wells settlement would cause further issues. The Point Wells Sustainable Development Plan wished to maintain the village "feel" of the settlement by having small lot sizes (Rodney District Council, 2006). This would prevent the inefficient use of the highly fertile land around Point Wells as a lifestyle block type development. Further, small lot sizes allowed the Rodney District Council to minimise the roading requirements and ensured that residents would be within walking distance to the small retail area at the centre of the settlement. Therefore large soakage fields required for effective disposal of septic tank effluent would not be possible.

Sea level rise due to climate change was also identified as an issue that would further reduce the already poor performance of the onsite treatment systems. Sea level rise would make the ground water level shallower, shortening the pathway for poorly treated effluent to the surrounding marine environment. Because of these factors, it was not considered sustainable to continue to dispose of wastewater by onsite treatment systems. The effects of these systems were causing an unacceptable public health risk and polluting the surrounding harbour. These adverse effects would be exacerbated by the proposed intensification and expansion of the community.

3.3 Sustainability Assessment

Sustainability assessment is considered one of the principal means for the goal of sustainable development to be achieved. Sustainability assessments focus on the three dimensions of sustainability, namely the social, economic, and environmental spheres. Further, sustainability assessment, unlike other assessment tools, should recognise the issues associated with the interactions between the three spheres; the effect of scale on the assessment and critical threats to the earth’s life supporting cycles. Scale is an important consideration when setting the bounds of a sustainability assessment. These different scales can be micro (site specific), meso (regional) and macro (national or global). The scales can be determined by considering the geographic span of the life cycle of the inputs and outputs (Assefa, 2005).

Once a scale is selected, the approach of the sustainability assessment should be considered. Pope et al. (2004) suggests three different approaches based on the different interpretations of sustainability. Firstly *Environmental Impact Assessment (EIA) Driven Impact Assessment* is a reactive tool that assesses the proposal after it is conceptualised. This tool compares environmental, social, and economic impacts with baseline conditions. This approach is often criticized as it can only determine if a proposal is acceptable based on an assessment of the quantitative and qualitative indicators. Further, EIA Driven Impact Assessment can only applied after a proposal is conceptualised limiting opportunities to modify the proposal to be more sustainable (Pope et al., 2004).

The second approach is *Objective Lead Integrated Assessment* based on objective led strategic environmental assessment (Assefa, 2005). The objective lead assessment attempts to evaluate the extent to which a proposal achieves integrated environmental, social, and economic objectives. Both of these approaches are based on minimising un-sustainability or achieving triple bottom line objectives. EIA Driven Impact Assessment identifies if triple bottom line impacts are acceptable. Alternatively the Objective Lead Integrated Assessment questions whether a proposal contributes positively to triple bottom line goals. Pope (2004) defines these approaches as “direction to target approaches” and avoid defining a condition of sustainability (Pope, 2004).

The third approach is *Assessment for Sustainability*. This approach’s objective is to determine whether a proposal is sustainable (Assefa, 2005). Assessment for Sustainability is extremely complex, requiring an understanding of global cycles and institutional arrangements. Therefore this method is best suited to macro scale projects that take a holistic approach.

For the Point Wells Wastewater Sustainability Assessment, an EIA driven integrated assessment is considered the most appropriate. The objective led integrated assessment required objectives to be set based on baselines requirements. Due to the small scale of the project, the collection of this data was considered to costly and difficult to obtain. The third approach, Assessment for Sustainability was considered to have too broader scope for this specific project which focused on the narrow scope of wastewater servicing needs for a small community.

4.0 ASSESSMENT OBJECTIVES

The sustainability objectives selected for the study are those which minimise resource use, improve efficiency, and minimise discharges to the receiving environment. Weaver et al. (2000) identified elements of the traditional wastewater collection, treatment and disposal systems that are unsustainable. These include high energy and material use and from environmental degradation associated with discharges to the environment (Weaver et al.,2000).

Therefore the objectives for selecting the best servicing option for Point Wells were:

- Minimise impacts on the environment;
- Minimise impacts on public health;
- Minimise the total cost of the system to what the council and the community could afford; and
- Align the wastewater servicing with the overall objectives of the Point Wells Sustainable Development Plan (RDC, 2006).

5.0 BOUNDARY CONDITIONS

The Point Wells Wastewater Sustainability Assessment was limited to the selection of the most sustainable wastewater servicing technology for the settlement. The assessment included consideration for servicing the existing and expanded settlement as proposed by the Sustainable Development Plan (Rodney District Council, 2006). The pattern of development recommended by the Sustainable Development Plan (Rodney District Council, 2006) was assumed to provide the best social, environmental, and economic outcomes for the settlement and the wider community. Furthermore, the North East Rodney District Wastewater Strategy (Rodney District Council, 2005) required that wastewater be collected in a centralised network and conveyed to the Omaha Wastewater Treatment Plant for treatment and disposal. This decision was based on the high effluent quality and excess capacity available at the Ohama Treatment Plant. The treatment plant is located approximately 3.8km south of Point Wells. Other important boundary conditions for the study are summarised below.

- The Rodney District Council had a total budget for the project of $3,600,000 (Rodney District Council, 2006). Any solution that exceeded this budget would not be feasible.

- Only available technologies that would be possible for the Rodney District Council to implement were assessed.
- Environmental impacts were limited to the immediate discharge environment, the Whangateau Harbour.
- Environmental impacts from material suppliers were not considered.
- Water supply for the settlement is by rainwater collection from roofs. There is no intension to provide a water supply scheme to the settlement.

6.0 METHODOLOGY

6.1 Identification of Schemes

Four options to collect and transfer wastewater from Point Wells to the Omaha Wastewater Treatment Plant were identified;

- A low pressure sewer system - This servicing option would consist of individual grinder pumps and chambers at each property pumping into a pressure sewer network. The wastewater collected in the network is then conveyed to the Ohama Wastewater Treatment Plant. The physical infrastructure required for this option includes 5.4km of pressure sewers, 221 grinder pump units to service the existing community and 298 units for the future intensification and expansion of Point Wells;

- Vacuum sewer system - This servicing option would consist of one vacuum pits per two properties, discharging to a vacuum sewerage network. The wastewater is collected at a centrally located vacuum pump station where the wastewater would be pumped to the Omaha Treatment Plant. The vacuum system would consist of 6.2km of vacuum sewers, 2.1km rising main to the Omaha treatment plant, 111 vacuum pits to service the existing community, and 144 units for the future intensification and expansion of Point Wells;

- Low infiltration gravity system - The low infiltration option would consist of polyethylene (PE) pipe so that sewers can be curved to minimise the number of points were access is required. The system also uses plastic access chambers instead of concrete manholes. Wastewater would be collected by a network of gravity sewers and pumping stations to a central pumping station where the wastewater would be pumped to the Omaha WWTP. This option would consist of 4.9km of sewers, 120 access chambers, 3.3km of rising mains, and 5 pumping stations;

- Conventional gravity system - The conventional gravity network is based on the Rodney District City Council engineering standards. To achieve this, the option proposed would consist of PVC or vitrified clay (VC) sewers and reinforced concrete manholes. A network of gravity sewers and pumping stations would collect wastewater to a central pumping station where the wastewater would be pumped to the Omaha WWTP. Based on a conceptual investigation of the site, the local network would consist of 4.9km of sewers, 120 manholes, 3.3km of rising mains, and 5 pumping stations.

6.2 Assessment

The four options considered in this study were evaluated in terms of an EIA driven impact approach using a Triple Bottom Line (TBL) assessment using the objectives and boundary conditions described in the previous sections. For the cost estimates a net present value (NPV) analysis of all costs related to the construction and maintenance of the entire system was considered. This includes both the public and private components of the wastewater systems. This ensured that there were no price distortions. The NPV analysis considered development from 2008 to 2051 and assumed a discount rate of 8%.

The TBL assessment considers the social, environmental, and economic effects of each option and have been scored based on their relative effects. The scoring system and weighting for each element of the TBL Assessment is summarised below.

Table 1: Impact Scoring for Indicators

Impact	Score
Major positive	5
Minor positive	2
Nil / neutral	0
Minor negative	-2
Major negative	-5

The scores are also weighted for long and short-term effects. Long term effects receive a weighting of 3, while short term impacts are given a weighting of 1. The indicators selected for the assessment were chosen to reflect a balance of short and long term indicators reflecting environmental, social and economic issues.

For quantitative indicators the impact scoring was determined by comparison of effects. A selection of these qualitative indicators included material use, energy use, risk of overflow, length of construction, and earthwork volumes. Once the data for the indicators were collected , they were compared for each option and the impact scoring allocated based on the relative effect of each option.

The qualitative indicators were determine collaboratively with Harrison Grierson, the Rodney District Council, and representatives from the community. These indicators included impacts of private land, amenity, visual effects and public health risks.

The results of the assessment are summarised below including the final scoring for each of the four options.

Table 2: Summary of Triple Bottom Line Assessment For Point Wells Wastewater Servicing Options				
	Score			
Option	**Low Pressure Sewer**	**Vacuum**	**Low infiltration**	**Conventional**
Long-term Social Considerations	1.3	1.3	0.5	0.5
Short-term Social Considerations	-1	-1	-2.5	-2.5
Long-term Economic Considerations	0	0.75	-1.25	-2.25
Short-term Economic Considerations	5	2	0	-2
Long-term Environmental Considerations	2.3	2.3	1	0
Short-term Environmental Considerations	0	-1	-3	-3
Capital Cost	**$2.8M**	**$3.3M**	**$3.6M**	**$3.9M**
NPV Cost	**$4.2M**	**$3.6M**	**$4.7M**	**$5.0M**
Total Non Weighted	**7.6**	**4.3**	**-5.3**	**-9.3**
Total Weighted	**14.8**	**13.0**	**-4.8**	**-12.8**

6.3 Results

The low infiltration and conventional gravity system options exceeded the Rodney District Council's available budget. Furthermore these two options resulted in the greater negative social and environmental impact due to disruption during construction, high infiltration and higher overflow risk. Therefore these two options were excluded from further consideration. In terms of the TBL assessment, the low pressure and vacuum sewer system options have very close results. The relative advantages and disadvantages of low pressure and vacuum systems are compared in the following table.

Table 3: Comparative Advantages of Vacuum and Low Pressure Sewer Systems for the Point Wells Structure Plan Area		
Feature	**Vacuum Sewer System**	**Low Pressure Sewer System**
Pipe sizes	110NB and greater	40NB and greater.
Pipe gradients	To specific grades required by the vacuum system	Grade variable to suit contours. Suitable for economic installation by directional drilling.
Trench depths	Pipes are able to be laid in shallow trenches without the need for additional pump stations	Pipes can be laid in shallow trenches without the need for additional community pump stations.

Table 3: Comparative Advantages of Vacuum and Low Pressure Sewer Systems for the Point Wells Structure Plan Area

Feature	Vacuum Sewer System	Low Pressure Sewer System
Number of pump Stations required	One to serve the entire catchment.	One to serve each property (308 for the ultimate development)
Inflow and infiltration	Minimal due to sealed pipe system.	Minimal due to sealed pipe system.
Maintenance costs	Very low sewer maintenance cost. Medium cost to maintain vacuum pump station.	Moderate cost associated with maintenance of many small individual grinder pumps. Run to failure technology.
Operational costs	Low cost - one vacuum pump station.	Moderate with one grinder pump system per property.
Septicity of wastewater at Treatment Plant	Wastewater will be relatively fresh due to low residence time in vacuum pipes and the presence of air.	Wastewater will be possibly septic due to high residence time in pressure pipe network.
Leak occurs in communal pipeline	Loss of vacuum and alarm is raised for leak to be repaired. No ex-filtration occurs.	Contamination of groundwater table by sewage ex-filtrating from a pressure pipe until leakage is detected.
Extended power outage	One mobile generator at the vacuum pumping stations can maintain the entire collection system.	Very difficult for the system to operate. However the individual pumping chambers will provide significant storage.

The low pressure sewer system's discounted lifetime cost is $635,000.00 more than the vacuum system. However, the principal reason for the more expensive low pressure system obtaining a higher TBL score than the vacuum option is due to the following factors.

- The disruption and disturbance caused during the installation of a low pressure system will be significantly less than a vacuum system. The small diameter pipes used by the low pressure system allowed the network to be installed economically by directional drilling (trenchless). This would be a favourable method for construction in terms of both social, and environmental impacts. The "saw tooth" configuration of the vacuum mains mean it is necessary to use open trenching when installing the network.

- The initial capital cost (2008) of the low pressure system was less than the vacuum system. For the vacuum system a centralised vacuum pumping station is required which constitutes 30% of the initial cost. The low pressure system network will grow at the same pace as development occurs in Point Wells, therefore the financial risk of the initial investment in the infrastructure is minimised.

- The Rodney District Council have identified several areas where low pressure sewer technology will be very favourable. These areas include Matakana, Kumeu, Muriwai and parts of Orewa, Warkworth and Helensville. It was thought that by standardising on a single technology, low pressure systems, the council would benefit from economies of scales.

7.0 DISCUSSION

The results of the Point Wells assessment showed that the conventional and low infiltration gravity solutions did not meet the economic boundary condition set for the project. Therefore these options were not considered further. The low pressure sewer system was selected as it achieved the best results by being the closest aligned to the sustainability objectives. These objectives included minimising energy and material use; providing the lowest risk of overflow, and minimising the total volume of wastewater produced. The EIA driven impact assessment process is criticised for not identifying the most sustainable option (Pope, 2004). However for the Point Wells project which had defined boundary conditions and objectives, a solution that is the least unsustainable was identified from the potential options.

An alternative method that could have been applied to the Point Wells Sustainability Assessment is the objective led integrated assessment. This method interprets sustainability as a series of TBL goals to be achieved. The basis of this method is to achieve a ‘win-win-win’ outcome by ensuring that the preferred proposal meets the desired social, environmental, and economic objectives (Pope, 2004). The primary assumption of the assessment methodology is that the objectives improve the probability of a more sustainable outcome. However, if objectives are not framed with sustainability in mind, this may not be achieved by the assessment. This method would require additional baseline information to quantify the sustainability objectives for Point Wells, which was not available for the assessment. This method is suitable for micro scale projects where the impacts are likely to be minimal on a national, or global perspective. Where significant effects are likely, a more rigorous approach such a assessment for sustainability may be more suitable.

8.0 PROJECT IMPLEMENTATION

On 28 June 2008 the low pressure sewer system in Point Wells was commissioned by the Rodney District Council. The total cost of public portion of the network was $1.2 million, allowing Rodney District Council to use the remaining budget ($2.4 million) on other urgent works throughout the district.

The construction of the network required 7.3km of pipeline to be installed. This was achieved in four months by directional drilling (trenchless) resulting in small earthworks volumes and minimal disruption to the community.

The local community have embraced the new system with over half the population committing to decommission their onsite treatment and disposal systems and connect to the new network before construction was completed. Following completion of the network there has been a steady increase in the number of connections to the network. Once a large proportion of the community is connected to the network the associated environmental and health benefits will become more apparent.

9.0 CONCLUSIONS

The treatment and disposal of wastewater by means of onsite septic tanks and disposal fields was not sustainable in Point Wells. The un-sustainability of this system was not only due to poor maintenance but because the geology of the area did not allow safe disposal of effluent by soakage. The growth proposed in the settlement would have lead to increased environmental degradation and health risks.

The EIA Driven Integrated Assessment identified a low pressure sewer system as the best wastewater servicing solutions for Point Wells. For this assessment methodology to work, sustainable objectives and the boundary conditions needed to be understood to allow the appropriate option to be selected. The Object Led Integrated Assessment methodology would have been a more rigorous tool as it allows proposals that do not meet measured sustainability objectives to be rejected as not contributing to an improvement in sustainability. The low pressure systems has been proven to be an extremely successful project through significant saving of public funds and high levels of support for the system by the community.

10.0 REFERENCES

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