INNOVATIVE PROJECT PROCUREMENT AND DELIVERY FOR THE ROTORUA MEMBRANE BIOREACTOR

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ABSTRACT

Rotorua District Council is currently in the final stages of completing the latest upgrade of its Wastewater Treatment Plant at Te Ngae Road, Rotorua. The upgrade will provide for additional capacity to allow growth for the next 30 years within the existing catchment and for the connection of new communities as part of the Rotorua Lakeside Communities Sewerage Scheme Programme.

The upgrade involves the construction of a Membrane Bio Reactor (MBR plant) which will run in parallel as a sidestream to the existing Biological Nitrogen Removal (BNR) plant. This approach will provide operational flexibility as two nutrient removal plants would be running at the same time.

The upgrade of the existing plant comprises the installation of the membrane filters and supporting equipment such as blowers, screens, aerators, diffusers, pumps and associated controls. Civil works is minimal as it was decided to utilize an existing tank to house the membrane filters. The supply and installation of the above equipment comprises majority of the work.

RDC has decided to procure the different equipment through NZS:4911 contract and have them installed through a standard NZS:3910 contract through a client provided engineering design. This approach enabled RDC to procure the best equipment for the project at a competitive price which would have been difficult to attain in a conventional Design and Build contract. Cost savings on mark up by the contractor to the equipment has been saved as RDC has purchased the major equipment and free issued them to the installation Contractor.

This approach however brings numerous procurement and contractual challenges, such as establishing the delineation of performance responsibility between designer, supplier, and installer and ensuring that they are effectively dealt with in the finalization of the specific contract documents.

This paper will outline the process by which RDC and its advisors went through to ensure:

- That the approach would not expose RDC into unacceptable risks.
- That the above issues are dealt with effectively in developing the procurement strategy and the specific tender documents.
- That the project delivers the set results for RDC ratepayers.

KEYWORDS: Membrane Bio Reactor, Procurement, Project Delivery, Boundary Definition

1.0 INTRODUCTION

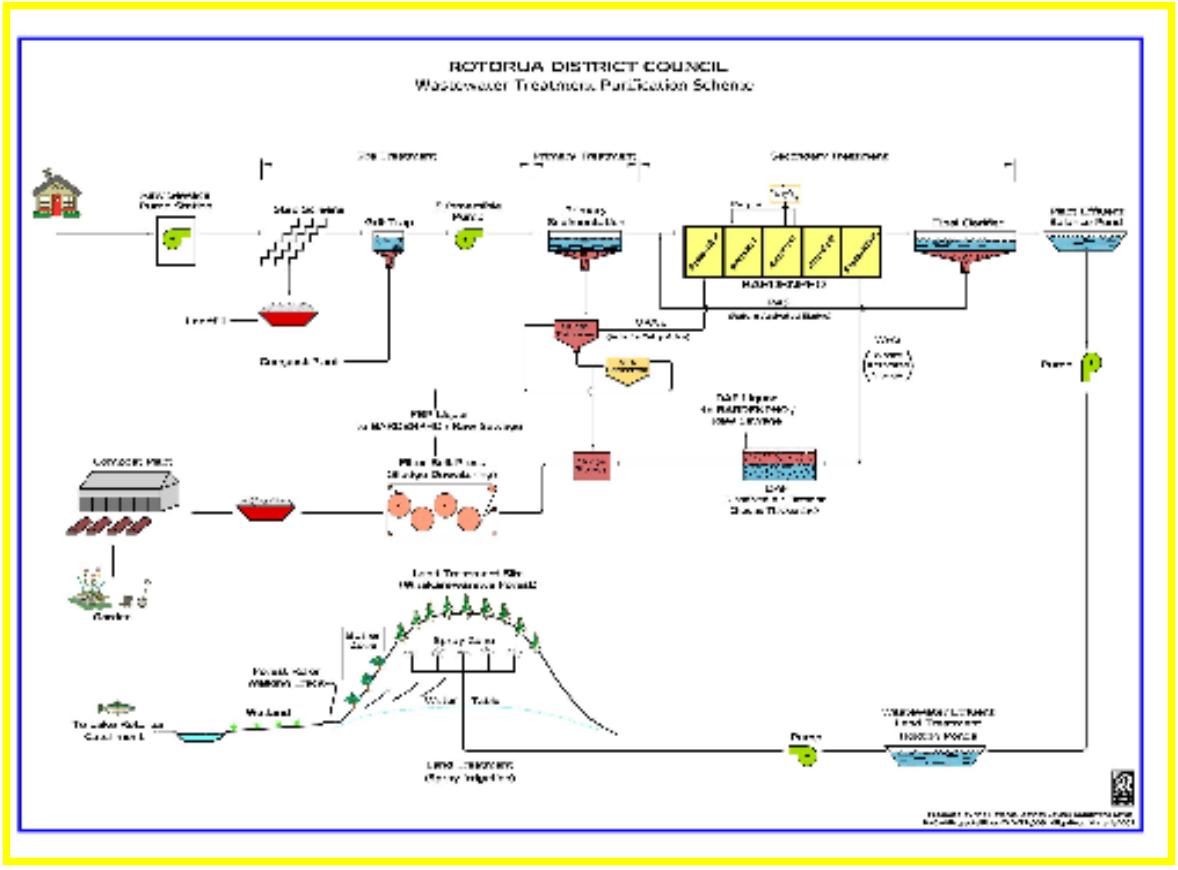
1.1 THE EXISTING ROTORUA WASTEWATER TREATMENT PLANT

The existing Rotorua Wastewater Treatment Plant is located at Te Ngae Road, Rotorua and is currently treating an average wastewater flow of about 20 megalitres per day. The plant was originally established in the late 1970's and has gone through a series of upgrades to its current form.

The current plant includes a Biological Nutrient removal Plant (BNR) utilizing the modified Bardenpho process. The BNR plant was initially constructed in the late 1980's and extended in 2005. During the 2005 upgrade, a methanol dosing facility was installed to provide additional carbon source into the system to enhance denitrification and improve the nitrogen removal capacity of the plant.

In front of the BNR plant is an Inlet Screen and Primary Sedimentation tanks which were part of the original treatment plant. After the BNR plant are two Secondary Clarifiers which provides for the final polishing of the treated effluent before being discharged to the final effluent pond for storage. The final effluent is eventually pumped to the Whakarewarewa Forest Land Treatment System. A Process Schematic of the existing plant is shown as Figure1.

Figure 1 – Process Schematic of the Existing Plant



1.2 THE CURRENT UPGRADE OF THE ROTORUA WASTEWATER TREATMENT PLANT

1.2.1 Upgrade Drivers

The current upgrade of the Rotorua Wastewater Treatment Plant is required because of the following reasons.

a) The need to increase the plant's capacity to allow for connection of other catchments into the system and growth within the existing catchment.

b) To improve the current nutrient removal performance of the existing plant

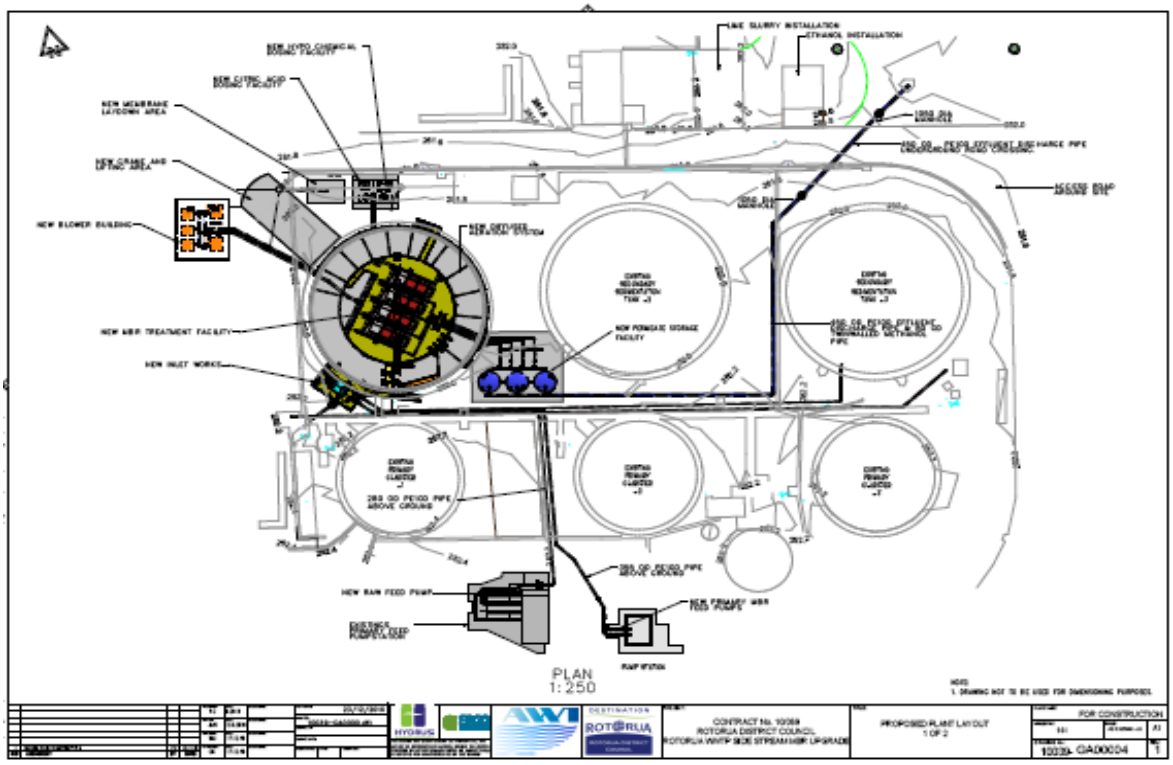
c) To enable operational flexibility and redundancy especially during times when one of the secondary clarifiers servicing the BNR plant are taken off line for periodic maintenance and repair.

1.2.1 Components of the Current Upgrade

The current $8 million upgrade involves the installation of a Membrane Bio Reactor (MBR) plant and other ancillary equipment within an existing unused sedimentation tank that was part of the original plant configuration. Retrofitting the MBR plant into the existing structure significantly reduced the cost of the project. After the completion of the MBR Plant, the Rotorua Wastewater Treatment Plant would then have two nitrogen removing plants operating in parallel.

The Membrane Bio Reactor (MBR) plant treats wastewater in a series of anaerobic/ anoxic/ aerobic treatment zones similar to a conventional activated sludge plant before entering the membrane tank for solids liquid separation. MBR plant operates similarly to a conventional activated sludge process except that micro porous membranes are used for solid/liquid separation instead of a clarifier. Because of its inherent characteristics MBR plant could treat relatively large volumes of wastewater over small footprints. This technology was chosen because of the limited available space within the Rotorua Wastewater Treatment Plant site. Figure 2 Shows the Layout Plan of the current Plant upgrade.

Figure: 2 –Layout Plan of the Current Upgrade



The heart of the current upgrade is the installation of the membrane filters. The plant upgrade was therefore centred on the provision of equipment to support the membrane filters achieve their performance requirements. The current plant upgrade includes the following:

a) Refurbishment of the existing unused sedimentation tank including the installation of internal walls for the membrane filter trains.

b) Coating of the internal walls of the refurbished tank to prevent chipping of the concrete wall which could damage the membrane filter.

c) Four membrane filter trains including all supporting structures.

d) Inlet screen to ensure that suspended solids within the influent to the membrane process is within the levels required.

e) All pumps required which includes Return Activated Sludge pumps, Permeate pumps, Back Pulse pumps and Dosing pumps.

f) Blower to provide the air requirements of both the activated sludge process and the membranes.

g) Mixers and diffusers required for both the activated sludge process and the membranes.

h) Mechanical and process pipework.

i) Electrical upgrades as required.

j) Chemical dosing and permeate tanks.

k) Instrumentation and Control to integrate the new system into the overall instrumentation and control of the existing plant.

2.0 DEVELOPMENT OF PROCUREMENT STRATEGY

2.1 GENERAL

The Procurement Strategy for this particular project established the best option for Rotorua District Council (RDC) in securing contract/s for the whole project.

The following flow chart (Figure 3) illustrates the process that RDC went through in establishing the procurement strategy for the project. The individual process components are discussed in detail on the following sections.

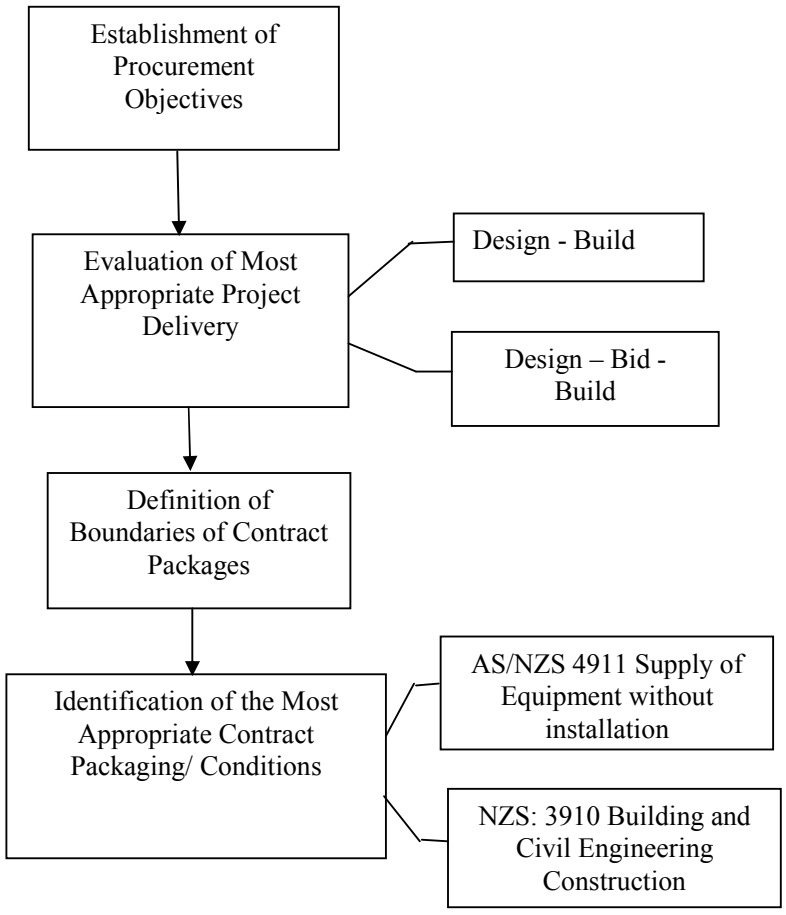


Figure 3 –Procurement Strategy Development Flowchart

2.2 ESTABLISHMENT OF PROCUREMENT OBJECTIVES

The project involves minimal civil and structural works. Majority of the work involves the installation of major equipment that would complete the whole process upgrade. Based on this, several project objectives were established to guide RDC in determining the most appropriate project delivery method for the upgrade. The procurement objectives are as follows:

a) The ability to procure specific equipment considering a good balance between quality and price.

b) The ability to utilize equipment that has provided good performance to RDC. This does not pertain to the performance of the equipment alone but the provision of after sales local support by the supplier.

c) Reduce lead times for long lead items. This was essential to deliver the project on time.

d) Procurement would provide best value for money considering lifetime cost and contract packaging.

e) Risk is allocated to entity that would best manage it.

f) Responsibility for quality and performance allocated to entity most qualified and able to control it.

g) Performance guarantees and continued after sales support guarantees are clearly defined and provided for in the contract.

h) Contracts to utilize "Industry Standard" forms such as:

NZS 3910:2003	Conditions of Contract for Building and Civil Engineering Construction.
AS/NZS 4911:2003	General Conditions of Contract for Supply of Equipment without Installation.

2.3 EVALUATION OF THE MOST APPROPRIATE PROJECT DELIVERY METHOD

For this particular project, two project delivery methods were considered:

a) Design and Build (DB)

This is a project delivery method whereby the design and construction services are contracted to a single entity known as the Design-Build Contractor.

The Contractor takes full responsibility for the outcome of the project and all associated risks.

b) Design – Bid – Build (DBB)

This is a project delivery method in which the Project Owner contracts with separate entities for each of the design and construction of a project.

Responsibilities for project outcome are divided between the Designer and the Builder. All associated project risks are allocated appropriately to both Designer and Builder but the Project Owner takes significant risks if a dispute arises between the Designer and the Builders.

An evaluation was undertaken to determine the most appropriate project delivery method for the current plant upgrade. The evaluation undertaken involved a broad analysis of how each project delivery method would satisfy the set procurement objectives.

The following table (Table 1) sets out the qualitative comparison/ evaluation of each project delivery method in terms of their ability to satisfy the set procurement objectives.

Table 1 – Qualitative Comparism of Project Delivery Options

Procurement Objectives	Ability to Satisfy Procurement Objectives	
	Design – Bid-Build	**Design - Build**
(1) Equipment procurement considers good balance between quality and price	Good Equipment supply could be easily excluded from build contract. Equipment specification taken from Client design.	Limited Equipment supply would be difficult to exclude from build contract
(2) Ability to utilize RDC preferred equipment	Good Could be achieved by specifying specific brand and model and purchased by Project Owner as free issued equipment.	Good Could be achieved by specifying specific brand
(3) Reduce lead times for long lead items	Good Separate supply of equipment contract could be awarded ahead of install contract	Limited Allowance needs to be included within the contract period duration for equipment with long lead times.
(4) Best value for money considering lifetime cost and contract packaging	Good Whole of life cost evaluation of specific equipment is incorporated. Purchase of equipment directly from supplier/ manufacturer eliminates contractors mark up on price	Limited Whole of life cost evaluation of specific equipment could be incorporated. Build contractor will include mark up on equipment price
(5) Risk is allocated to entity that would best manage it	Good Equipment suppliers take all risk related to the delivery of equipment. RDC takes risk regarding storage and upkeep of delivered equipment. Installer takes risk of equipment mishandling	Good Build contractor takes all risk. Risk premium is included within the price
(6) Responsibility for Quality and Performance allocated to entity most qualified and able to control it	Good Equipment supplier takes responsibility for performance of equipment. Installer takes responsibility for functional performance of system	Good Build Contractor takes full responsibility. Price premium is included for rectification of non-performance by equipment suppliers
(7) Performance warranties and continued after sales/ installation support	Good Equipment supplier is directly under contract with RDC for performance and long term after sales support warranties	Limited Performance warranties may only extend up to Contract maintenance period. No direct contract relationship with equipment supplier

Based on the above and for the magnitude of the project, it was established that the most appropriate project delivery method for this upgrade was Design – Bid and Build with all the major equipment procured by the owner separately and free issued to an installation contractor.

2.4 DEFINITION OF BOUNDARIES OF CONTRACT PACKAGES

2.4.1 The Need to Define Contract Boundaries for Several Supplies of Equipment Contracts and the Installation Contract.

The membrane system is the heart of the MBR process and each membrane system consists of specialised proprietary equipment that is only available from the sole manufacturer of the system. There are however generic equipment required for other sub processes that would directly affect the performance of the membrane.

Considering that the membrane supplier was required to provide performance guarantees for their system it was therefore essential to identify the boundaries for the membrane supply contract. The definition of the boundaries identified the equipment considered to be crucial to the performance of the membrane. These equipment were then included as part of the membrane supply contract. This approach minimised the possibility of the membrane performance guarantee being voided by non performance issues of equipment that could reasonably be interpreted to be caused by issues outside the scope of the supply or control of the membrane supplier.

The other equipment that were identified as not critical towards the performance of the membrane were excluded from the membrane supply contract and considered as potential separate supply of equipment contract packages.

2.4.2 Result of Supply/ Installation Contract Boundary Definition and Corresponding Contract Procurement Method and Conditions

Applying the key considerations described above, the supply boundaries of the membrane supply contract and other equipment boundaries were established. Figure 4 shows a pictorial representation of the supply boundaries. Table 2 shows the result of the Supply/Installation Contract boundary definition and the resulting contract procurement method and conditions. The resulting contract packages included 3 supply of equipment, an installation contract and a system integration contract.

Figure 4 Pictorial Representations of Supply Boundaries

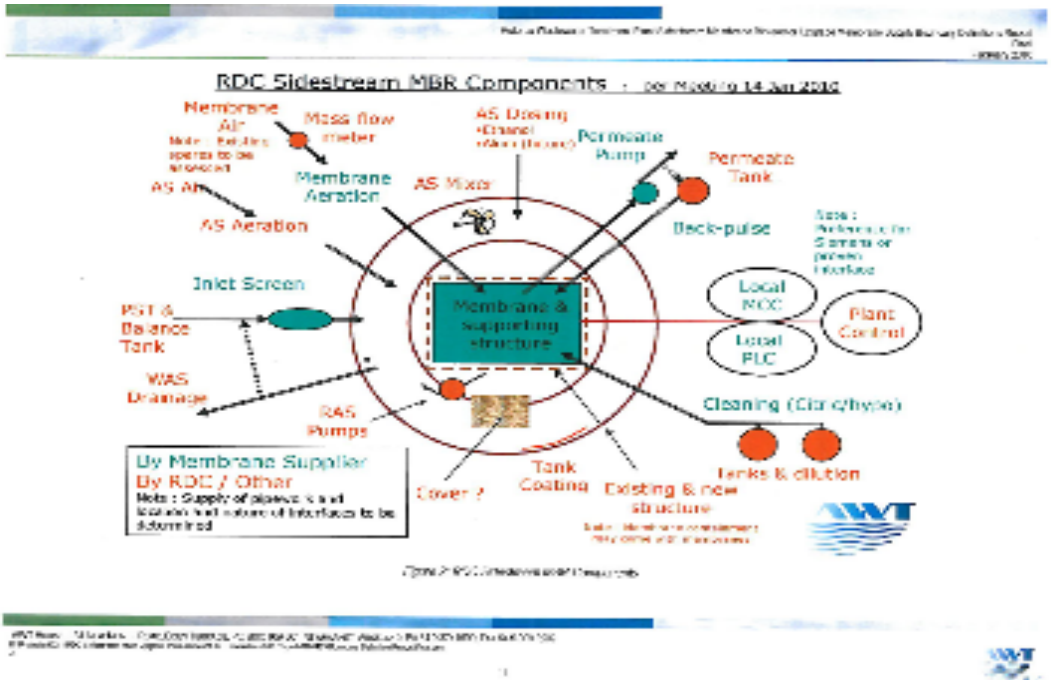


Table 2. – Result of Installation Contract Boundary Definition and Corresponding Contract Procurement Method and Conditions

Item	Procurement Method	Contract Condition	Comments
A) <u>Membrane Supply Contract</u> – Membranes and supporting structure – Permeate pump, Back Pulse Pump – Dose Pumps – Inlet Screen – Membrane aeration diffusers/ manifold – Pipework as part of the package	Selected tender using Price Quality Method (PQM) of Tender Evaluation. Whole of life cost considered	AS/NZS: 4911:2003	Except for the inlet screen, all of the equipments associated are part of the membrane proprietary package. The inlet screen was included because influent suspended solids quality is critical to the performance of the membrane. Including this as part of the membrane supply contract puts the inlet screen performance as responsibility of the membrane equipment supplier. Procurement method satisfied all procurement objectives.
<u>B) Other Major Equipment Not Critical to the Performance of the Membrane</u> – Return Activated Sludge Pumps/ Mixers	Negotiated	AS/NZS: 4911:2003	Pumps and mixers used are RDC preferred brand. .Price negotiation was based on current supply. Procurement method satisfied all procurement objectives
– Waste Activated Sludge Pumps	Negotiated	AS/NZS: 4911:2003	Pump used is RDC preferred brand. Procurement method satisfied all procurement objectives
– Air Supply to activated Sludge and Membrane Aeration (Blowers) and Diffusers	Public Tender PQM Tender Evaluation	AS/NZS: 4911:2003	Procurement method satisfied all procurement objectives
C) **<u>Installation Work and Minor Equipment Supply</u>** – Repair and coating of existing clarifier tank – Membrane containment structure – Minor process/ instrumentation	Public Tender PQM Tender Evaluation	NZS 3910:2003	This was considered as the installation contract. All equipment purchased in A & B above was free issued to the installation contractor. Procurement method satisfied all procurement objectives

equipment – New Blower Room – Installation of all equipment (A,B and C) and instrumentation – All Mechanical Pipeworks – Electrical upgrades, MCC – Safe access (stairways, walkways, hand railing etc. – Storage tanks for permeate and Clean in Place chemicals – Water supply and washdown facilities			
D) **<u>Other Works/ Minor Equipment</u>** Integration of membrane suppliers proprietary control system and other mechanical, electrical, instrumentation and process control equipment into the main plant control system	Negotiated	Standard RDC Short Form Commercial Agreement	This work was undertaken by the Contractor that installed and maintains the whole plant control and instrumentation system. This approach ensured that system integration was seamless. Procurement method satisfied all procurement objectives.

3.0 CONCLUSIONS

The procurement of the equipment and works required for the current upgrade of the Rotorua Wastewater Treatment Plant was undertaken after careful consideration of the options available to (RDC).

A structured evaluation process was undertaken to establish the most appropriate project delivery and procurement option for the upgrade. The process included the following:

- Establishment of Procurement objectives;
- Evaluation of the most appropriate project delivery method;
- Definition of boundaries of contract packages;
- Identification of the most appropriate contract packaging and conditions.

The evaluation showed that the most appropriate project delivery method for this plant upgrade is Design – Bid and Build (DBB) with the major equipment procured by RDC and free issued to an installation contractor.

The resulting contract packages included 3 Supply of Equipment Contracts (AS/NZS: 4911:2003), an Installation Contract (NZS:3910:2003) and a System Integration Contract (Standard RDC Short Form Commercial Agreement).

The above approach required more contract administration and coordination work by the RDC Project Management Team. It is however considered that the extra effort is worthwhile as it enabled RDC to satisfy all the established procurement objectives for the project.