BUILD OWN OPERATE TRANSFER – REAL WORLD COMPARISONS BETWEEN WATHBA 2 WASTEWATER TREATMENT PLANT, UNITED ARAB EMIRATES AND SEAVIEW AND MOA POINT WASTEWATER TREATMENT PLANTS IN WELLINGTON

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ABSTRACT

Build Ow n Operate Transfer (BOOT) type projects are being used as an effective procurement vehicle globally, but are they being finished on time and to a high quality? And what about the costs, BOOT projects are expensive, aren't they?

This paper describes how Public Private Partnerships (PPPs) w ork, compares a BOOT project in the Middle East w ith a Design Build Operate (DBO) project and a Design and Build (D&B) type project, both in New Zealand, details risk allocation and cash flow , and explains w hy the bankers love investing in infrastructure. It also identifies and describes multiple project delivery methods, from traditional services to divestiture.

KEYWORDS

Public Private Partnerships (PPPs), Build Ow n Operate Transfer (BOOT), Design Build Operate (DBO), Design and Build (D&B), Wastew ater Treatment Plant (WWTP)

Figure 1 Wathba 2 WWTP BOOT Project in the early stages of construction (Photo taken from a tower crane)

1 INTRODUCTION

The term ‘Public Private Partnerships’ or ‘PPPs’ normally describes the organisation through which a government service is funded and operated. A PPP is a partnership between the government body and one or more private sector companies and is established by a contract between these entities in which the private party provides an asset (which in turn provides a public service) and assumes considerable financial, technical and operational risk in the project. The Government pays a fee for this service.

Typically, a private sector consortium forms a company called a "Special Purpose Company" (SPC) to design, build, maintain and operate the asset for a significant time frame, say 25 years, after which it will hand it back to the end user in good condition. The SPC is the core of the PPP, which is run like a business, with Government and the private sector companies, having a vested interest.

The SPC makes a significant capital investment normally by borrowing from banks and other investors, on the strength of a contract with government to provide agreed services. The cost of providing the service is eventually paid for by the Government only when the infrastructure is operating (ie is treating waste in the case of a wastewater treatment plant).

The following paper describes different procurement routes and PPPs and compares three (3) wastewater treatment projects: Wathba 2 Wastewater Treatment Plant (WWTP) located in the UAE which is a Build Own Operate Transfer [BOOT] project; Seaview WWTP located in Lower Hutt which is a Design Build Operate [DBO] project; and Moa Point WWTP located in Wellington which is a Design and Build (D&B) project.

The Global trend is moving towards PPP’s as it is thought that increasing private sector involvement, brings with it a quality and innovative end product, built quickly and operated efficiently and effectively, without the massive upfront capital cost, of the traditional procurement model. PPP’s are still less common than traditionally procured projects, particularly in New Zealand, perhaps as they are thought to be more expensive.

Figure 2 Wathba 2 WWTP BOOT Project during commissioning (taken when the first wastewater flow was received at the Wastewater Treatment Plant)

2 PROCUREMENT ROUTES AND PPPS

2.1 INCREASING PRIVATE SECTOR INVOLVEMENT

Conventionally, a government body or organisation (client) would follow a traditional procurement route, whereby they would appoint an engineering consultant to design an infrastructure project and put it out to competitive tender to at least three (3) contractors. The contractors would price the project and give details of the materials, equipment, methods, manpower, program etc. The client would then select the preferred and compliant contractor (nearly always the cheapest) to supply, install, construct and commission the infrastructure with the engineer supervising the construction. The finance is sourced by the client internally, who would operate and maintain the plant for the life of the infrastructure.

This is system is still most widely used, and is a perfectly good way of doing things. Figure 3 (below) shows the progression from the traditional arrangement to project delivery methods with increasing private sector involvement: a management contract, a lease contract, a concession (DBO, BOT, BOOT etc), and complete divestiture.

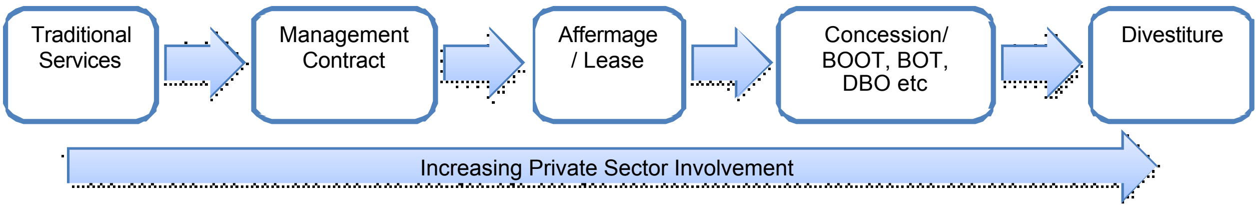

Figure 3 - Increasing Private Sector Involvement

Increasing private sector involvement, is the transfer of risk from the government organisation to the private sector companies for an increasing fee (relative to the risk), and it is thought that it brings with it, a quality and innovative end product, built quickly and operated efficiently and effectively.

2.2 FORMS OF PPP

Table 1 (below) shows the increasing delivery duties carried out and delivery responsibilities taken on (and consequently more involved terms and conditions), during progression from traditional services, to complete divestiture.

Table 1 – Forms of Public Private Partnerships

Ref.	Form of PPP	Delivery Duties	Delivery Responsibilities	Typical Commercial Terms
1	Traditional Services	Supply relevant services	Supply services	Traditional payment terms
2	Management Contract	Supply management services	Supply expertise	Fixed fee plus performance based fee (as an incentive)
3	Lease Contract/ Affermage	Operation services for a fee, but does not invest in capital	Employs staff to operate and maintain an asset	Revenue - O&M cost - lease fee
4	Concession/ BOT/DBO/DBFO	Design, Construct & Operation services, sources capital but	Employ staff to operate & maintain an asset, also	Revenue – operating and maintenance – finance costs –

		does not own infrastructure	finances & manages investment	concession fee
5	BOOT/BOO	Design, Construct & Operation services, invests in capital, owns infrastructure, returns to the employer after 25 years	Employ staff to operate & maintain an asset, also finances & manages investment	As above
6	Divestiture (Sale)	Operation services, Runs operation, invests in capital, owns infrastructure	Employ staff to operate & maintain an asset, also finances & manages investment	Revenue – operating and maintenance – finance costs – license fee

2.3 RISK ALLOCATION

Figure 4 (below) shows the typical allocation of risk between the parties comprising the PPP: the project promoter (End User or government body) and the private entity delivering the project, the SPC. The SPC takes responsibility for feasibility, detailed design through to completion of construction and operation and maintenance, as well as all financing, while the project promoter takes charge of land access and tasks outside the physical site boundary such as service diversions and pipelines up to the boundary interface points.

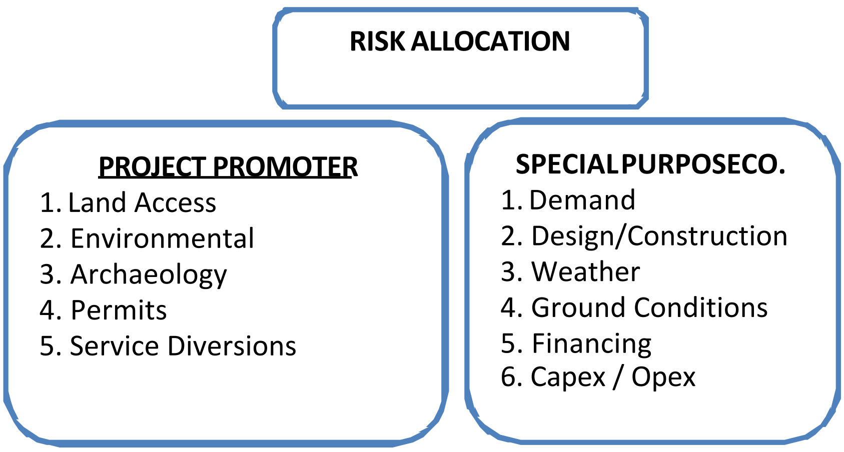

Figure 4 Typical Allocation of Risk between the Project Promoter and Special Purpose Company

2.4 TYPICAL PPP PROJECT STRUCTURE

Figure 5 (below) shows the typical structure of a PPP type project. A SPC is set up, and pays a contractor to build the asset and an Operator to operate it, w hile borrow ing the money from lender(s)/banks(s).

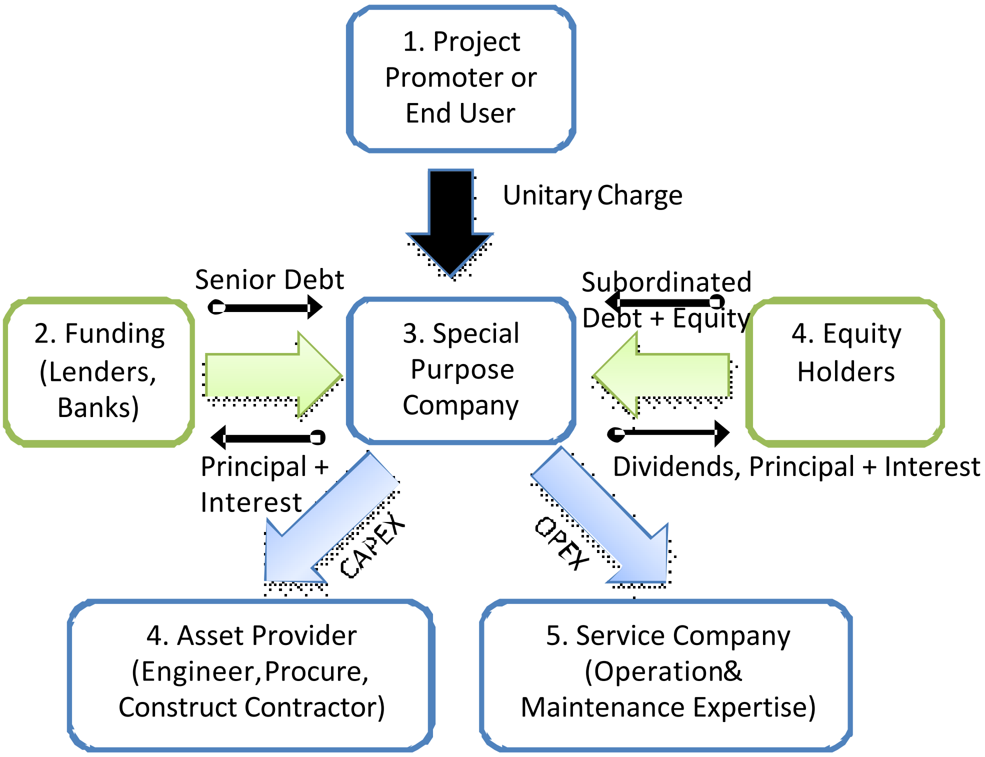

Figure 5 Typical PPP Structure

The SPC is run like a business, and pays the asset providers (Engineer, Procure Construct (EPC) Contractor and Operation and Maintenance (O&M) company, among others) for their services and dividend, principal and interest on its debt, w hile obtaining a fee from the project promoter for w hatever the project provides.

The asset provider (4), a consortium of multi-disciplinary contractors, must w ork closely w ith the service company (5), during the relatively short (typically 3 years) engineering and construction process, to ensure operability, durability and maintenance (preventative [routine], predictive and reactive [breakdow n]) requirements are met.

2.5 TYPICAL PPP CASH FLOW

One of the biggest differentiators betw een the various project delivery methods is the timing and scale of cash flows. The cash flow for the SPC and the EPC Contractor, are described, below :

2.5.1 – SPECIAL PROJECT COMPANY CASH FLOW

Figure 6 (below) shows typical cash flow of a PPP project. During the initial set-up of the SPC and the design and build stage of the project the debt finance is used for capital expenditure, essentially to pay the contractor to build the plant. During this design and construction stage, w hich normally last about four (4) years, the SPC has no income and high outgoings, and subsequently negative cash flow .

Once the facility has been constructed and commissioned to the satisfaction of the engineer, the project promoter w ill pay a service payment as a unit rate for the service provided. This robust revenue stream w ill cover the operational expenditure, finance costs, and shareholder's dividends paid as the services are delivered. The finance costs, which consist of interest plus principal is paid off over the 25 years much like a mortgage.

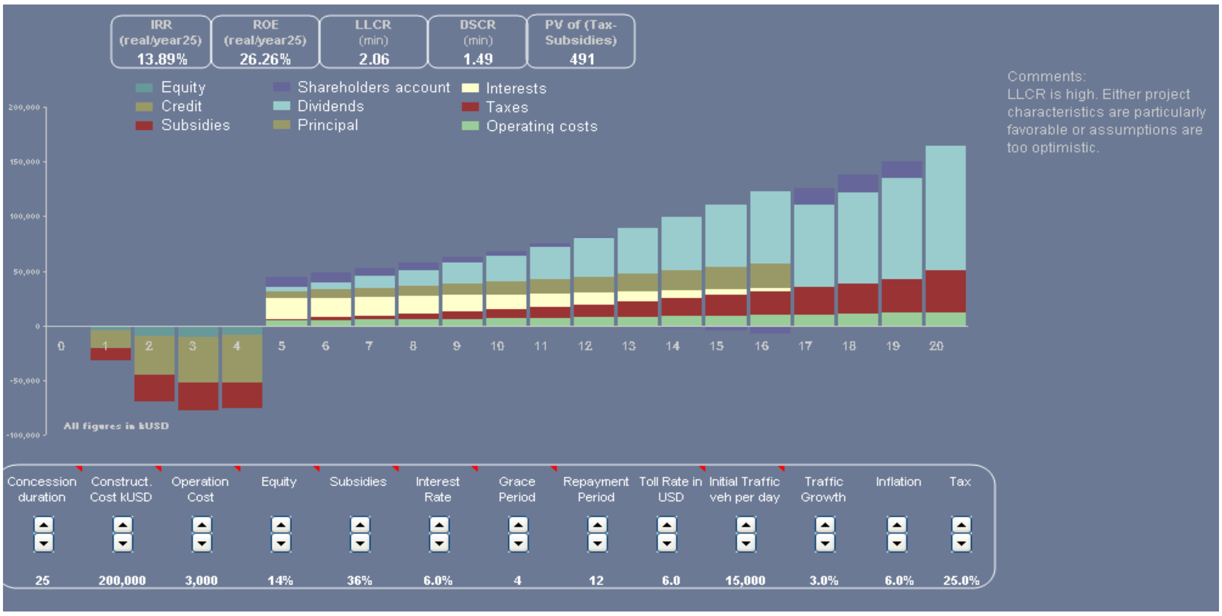

Figure 6 Typical Cash flow of the Project Company over the duration of the project (~ 4+25 years)

2.5.2 – ENGINEER, PROCURE, CONSTRUCT CONTRACTOR’S CASH FLOW

In many PPPs the Contractor’s cash flow is clearly defined at the start of the project, and provided he makes good progress, keeps his progress w ithin the early and late curves as shown in Figure 7 (below), payment w ill be made w ithin a month of making an Interim Payment Application.

Milestones and key milestones are stipulated. Failure to meet a milestone is not necessarily an issue, provided there is a valid reason (eg. supplier delay) and the contractor is making good progress elsewhere. How ever, failure to meet a key milestone (such as Start of Design Team Mobilisation, Completion of Mechanical & Electrical (M&E), Control & Instrumentation (C&I) Design, Construction Completion of the Tertiary Treatment Plant and Aeration Tank) is a more serious contractual complication and could potentially stop the project, if strictly implemented.

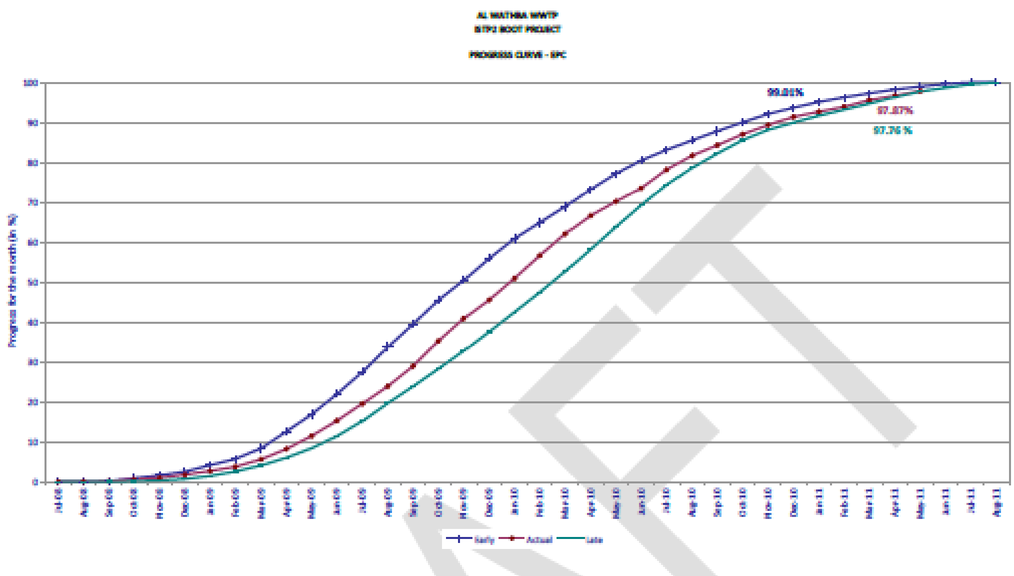

Figure 7 - Wathba Progress 'S' Curve [dated May 2011]

2.5.2.1 - Milestones and key milestones

As an example of how milestones, progress, and payments are inter-linked for a contractor, the Wathba 2 BOOT project has been used as an example:

Example 1 (Payment Milestones)

The Owner’s Engineer was responsible for reviewing a monthly interim payment certificate, for payments to the EPC contractor on the Wathba 2 BOOT project. The total construction value, has been broken down into monthly payments, roughly proportional to the value of works completed and split down 55% Civil, 45% M&E. Payment was generally made for start and completion of certain quite broad tasks, worked out in advance very closely with the detailed construction program, to essentially give a monthly payment of $200,000 to $16 Mil/month, average $6.8 Mil/month. This meant that provided the contractors were making good progress, and staying within the early and late curves on their program, they were paid an predefined figure, which helped with project finances and cash flow.

In addition to this, a maximum draw down was imposed, to prevent the contractor from claiming more, (even if he had completed more), than envisaged. The contractor would typically claim right up to this maximum draw down schedule (within about 2%).

Table 2 (below) shows some examples of milestone payments, which shows how achieving a milestone is linked to payments. Payments were very simple for civil structures and generally made for start of blinding and completion of the structure, ready for water testing. Payment for mechanical and electrical (M&E) works was paid on the first issue of a specification, on a request for price, on placement of a purchase order, ex. Factory and so on, as shown.

Table 2 – Milestone Payments Examples

Month	Payment Description	Amount
	CIVIL PAYMENTS	
5	Civil construction: start blinding of secondary clarifier # 1	$1,600,000
17	Civil completion of structure of buffer tank, ready for water testing	$1,700,000
	MECHANICAL & ELECTRICAL (M&E) PAYMENTS	
3	M&E first issue of technical specifications dewatering centrifuges	$70,000
4	M&E Issue of request for price (RFPs) to suppliers aeration blowers	$250,000
5	M&E purchase order place for dewatering centrifuges (Alfa Laval)	$220,000
15	Ex. factory coarse screens (Inlet)	$940,000
14	Delivery on site dewatering centrifuges	$1,250,000
21	Completion of mechanical installation pre-treatment equipment	$780,000
23	Commissioning: start of pre-commissioning	$1,460,000
30	Commissioning: commissioning completed at 100% and ready for liquid proving period	$125,000

As a rule, the Owner's Engineer would approve a payment milestone as 100% complete or nothing, but were reasonable and items that were practically complete with snags, as show in the example below:

Example 2 (Approval of Payment Milestones):

Month 28: CIVIL Completion of road markings and traffic signs $290,252. The contractor had finished the roads and road markings, but had not fitted all traffic signs. In this example, the contractor had met the intent of the milestone, and this payment milestone was allowed.

Month 28: CIVIL Start of de-mobilisation of construction equipment $345,849. This was rejected as premature, as this was considered the typical movement of equipment on and off site, and was eventually paid when a 'decent' amount of equipment was removed. This was contractually a grey area, and a common sense approach had to be taken.

2.6 BANKERS AND PPPS

As PPPs provide robust, steady and rising revenue streams, particularly for well-known infrastructure projects, such as water and wastewater treatment plants, systems and other utilities, toll roads and urban highways, ports, rail/rapid transit/metro, solid waste and wind, education, prisons and hospitals, it is common to find a willing and competitive lending market. Banks and other investment companies and lenders will generally offer substantial capital at low interest rates.

For example, the SPC for Wathba 2 BOOT, which was backed by Abu Dhabi Sewerage Services Company [ADSSC] (a subsidiary of Abu Dhabi Water and Electricity Authority, ADWEA [essentially backed by the Government]), has borrowed at interest rates somewhere in the region of 4% to 5% per annum. This interest rate even compared well to a private mortgage for a house in Dubai at the time, at 7% to 8% per annum (pa) and even better to a car loan at 10% to 11% pa.

The risk sharing between the promoter and the delivery company and the collaboration between the two establishes confidence with the lenders and encourages good lending terms and conditions and basically a lower interest rate.

2.7 PUBLIC SECTOR AND PPPS

Ultimately, the Government Body, makes the decision to go into partnership with the private sector, for the following reasons:

1. Leverage of debt finance to do more projects and therefore speed up infrastructure development
2. Transfer risk to the Private Sector and gain private sector delivery efficiencies
3. Integration of the design, build, operation service leads to innovation
4. Whole life cost and fiscal benefit of an "off-balance sheet" accounting of the capital costs (CAPEX)
5. The PPP approach, which incorporates performance criteria (strict KPIs) and quality and durability requirements (such as hand back standards) leads to a focus on service delivery, which ultimately benefits customers.

3 WATHBA BOOT, SEAVIEW BOT AND MOA POINT DBO

This section summarises three (3) wastewater treatment projects delivered successfully, using three (3) different delivery methods.

3.1 WATHBA BOOT

3.1.1 WATHBA WWTP

The Al Wathba 2 Sewage Treatment Plant is construction on a huge scale. This plant was built from scratch, at a green field (desert) location, designed to will treat 300,000 m^3/d of wastewater, adjacent to Al Wathba 1 a similar WWTP of the same capacity. Remotely located 1 hour's drive South West of Abu Dhabi Island, between Al Wathba prison and Al Dhafra Air Base, this plant will cater for Abu Dhabi's expansions plans, specifically the Abu Dhabi Island and environs (Mustaffa, Khalifa City A&B, Mohammed Bin Zayed City etc) and the planned Abu Dhabi Central District. The existing plant (Mafraq WWTW) was treating around 500,000 m^3/d, almost double its design capacity.

The preliminary design started late 2008, with construction starting in earnest by May 2009, from when the sand dunes were converted to a completed, running, working plant, treating ~ 200,000 m^3/d of wastewater to a high standard, the power was on, and the SCADA working (albeit with a few snags) and operating in Automatic mode by December 2011.

3.1.2 WATHBA BOOT PROJECT STRUCTURE

Figure 8 (below) is a photo of the signboard at the entrance to the site, showing the key stakeholders involved in the construction of this brand new wastewater facility.

Abu Dhabi Sewerage Services Company (ADSSC), as the project promoter [or End User or Employer] appointed a Special Project Company (SPC), in this case (Al Wathba Veolia Besix Wastewater Company) responsible for delivery of this project. The SPC, part owned by ADSSC, the water company Veolia Water and the major contractor, Besix, was bound by the terms of a unique contract (named the Sewage Treatment Agreement, or STA).

Figure 8 The Project Signboard at the entrance to Wathba 2 WWTP Construction site, clearly showing the end user (ADSSC), the Special Purpose Company (Al Wathba Veolia Besix Wastewater Co.), their [Owner's] Engineer (Halcrow), and the main Civil and M&E Contractors (Besix/Six Construct and OTV Sanotec)

The Engineers Cardno and Halcrow acted on behalf of ADSSC and the SPC respectively. The former, Cardno, acted as technical, legal and financial advisors. The latter, Halcrow acted as the Owner's Engineer, responsible for protecting the interests and contractual position of the Project Company during the design, construction and commissioning.

The project sponsors and main shareholders, ADWEA, Veolia Water and Besix were bound by a shareholders agreement with the Project Company. The eleven (11) long term lenders were bound to the SPC by a common term agreement, and the three (3) short term lenders were bound by an equity bridge facility.

The Engineer Procure Construct (EPC) Contractor and the operator had strong established links with the companies that formed the SPC, to form an intertwined project structure. The EPC, was a consortium between the civil contractors Besix/Sixco and the mechanical and electrical contractors OTV and Sanotec, with the overall designer Veolia Water. The main Sub-Contractors, form part of the project structure but have no equity in the project company (such as Thermo {MEP}, SGS {Mechanical} and CAE {Electrical}) and Main Sub-Consultants (such as Benaim {Structural}).

The Operator, Vebes [a joint venture type arrangement between Veolia Water and Besix] will operate and maintain the facility for twenty five (25) years.

Figure 9 (below) shows the project structure of the Wathba 2 BOOT project.

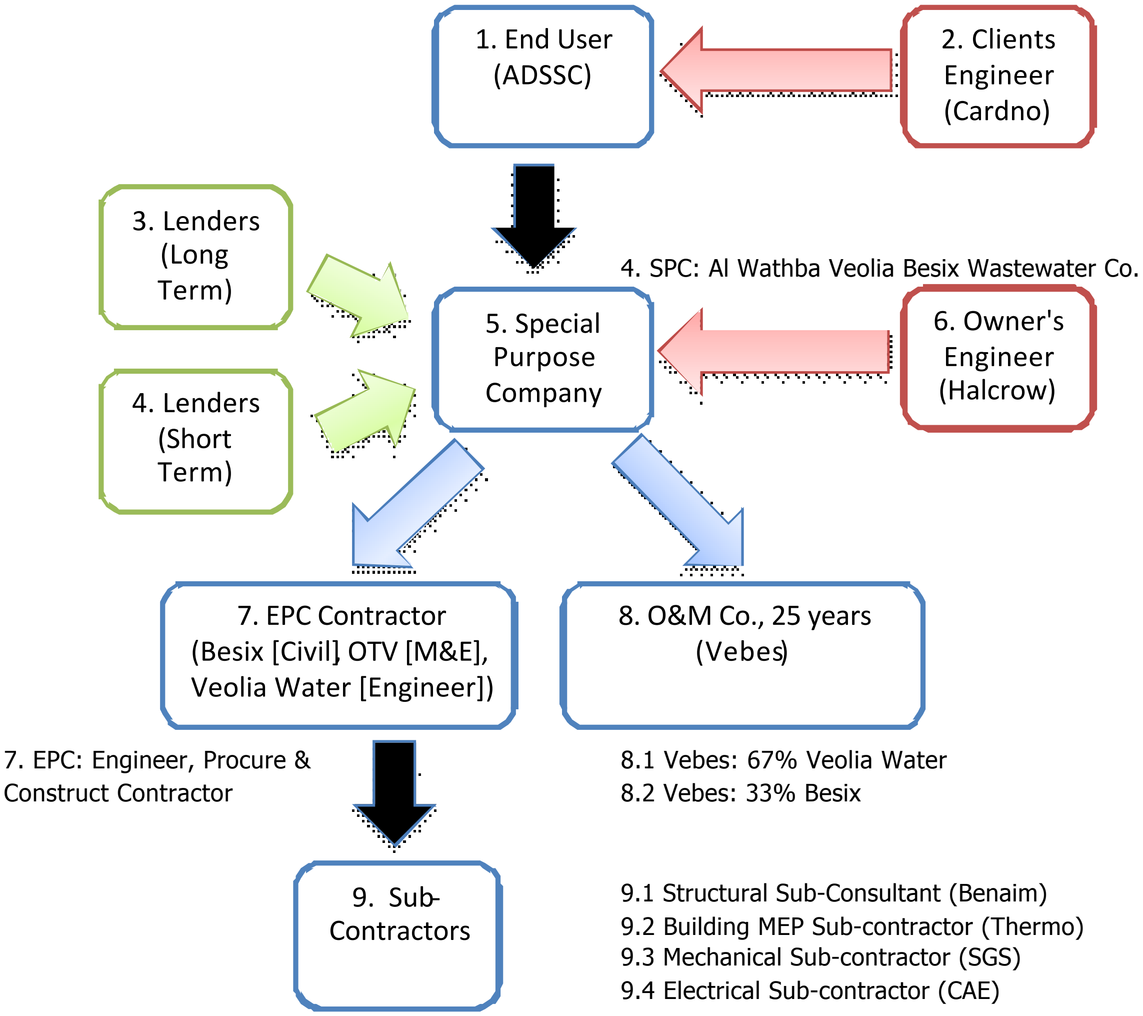

Figure 9 Wathba 2 WWTP BOOT Project Structure

3.1.3 WATHBA BOOT DESIGN AND CONSTRUCTION

The conventional design approach, consisting of preliminary and primary treatment, an activated sludge biological process followed by filtration and disinfection with chlorine with full biosolids processing, is a similar process design to Mafraq WWTP , which is proven in the Middle East and has been operating for over 25 years (Phase 1 circa 1984) and therefore offers a high quality effluent with a low risk of failure.

The Sewage Treatment Agreement (STA), by which the main stakeholders in the project were bound, went in to considerable detail, and as it was a fixed price contract, detailed all major mechanical items and process plant. Therefore, any change to the contract became a variation, substitution or modification, and the contractor was obligated to show to the engineer’s satisfaction, that the equipment proposed was equal or better, than originally offered.

For example, the Electro-Chlorination system was changed from the manufacturer ElectroChlor to Cumberland Natchlor 68 (due to better experience in the middle east), and the Sludge Turning Machines were changed from the manufacturer Wendelwolfe to Ceritec Ceridry (as they were a bigger company that could handle a bigger order of some 20 units more easily).

The change of manufacturer for the sludge turning machines, from Wendelwolfe to Ceratec Ceradry, for faster and presumed to be better, but therefore heavier machines, emphasized the importance of a thorough design. The supporting walls weren’t designed to support these heavier machines, which were much heavier on one-side. We were forced to allow for this knock on effect, by retrofitting every other supporting wall and strengthening it, but that meant that the machines were opposite to the one next to it, which caused problems with electrics and instrumentation later on.

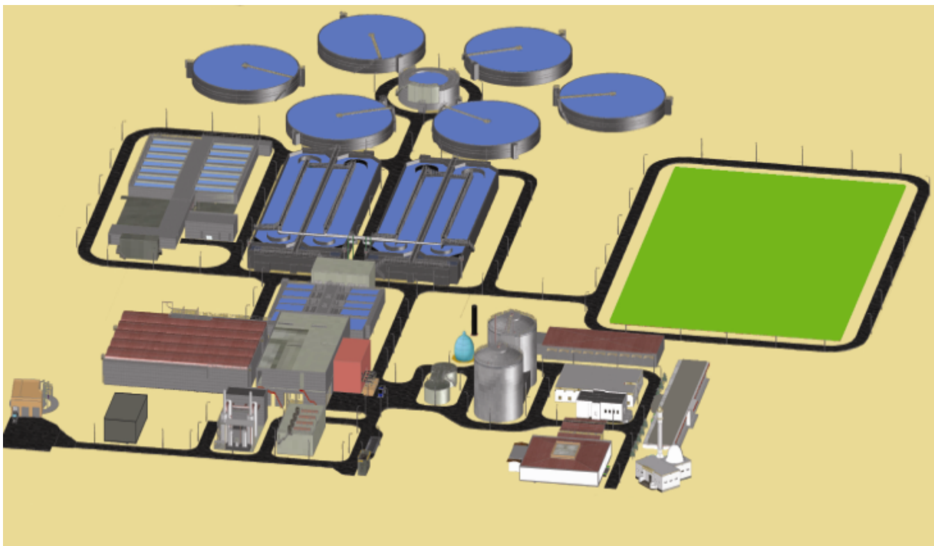

Figure 10 Wathba 2 WWTP 3D Rendered Design (for Illustration Purposes)

Veolia proprietary designs were used, such as MULTIFLOW lamellar type primary settlers, low load AZENIT selector and aeration tank, and CLARIFLO peripheral feed and discharge, with suction sludge draw off, secondary clarifiers.

3.1.3 WATHBA BOOT PROCUREMENT & CONSTRUCTION

The STA stated hand back standards. This meant that after the operation period of twenty five (25) years, the Civil/Structural infrastructure, mechanical equipment and electrical assets, were required to have forty (40) years, twenty (20) years and ten (10) years [respectively] of life left in them. This clause led to all mechanical equipment and electrical items being sourced from 'well known' European and American companies, which were thought to be more reliable and robust, such as ITT Flygt and Goulds, Siemens and Alfa Laval etc.

To ensure valuable items were built to specification prior to the long shipment, to prevent against failure of, or a poor quality product arriving on site (which in turn would have a serious impact on the program), major items of mechanical equipment were inspected and tested by the engineer in the factory prior to shipment. These inspections are known as factory acceptance tests (FATs).

All equipment was inspected on delivery and in almost all cases there were no signs of damage during transit. However, in one incident a Siemens turbo compressor motor (a large, very valuable and precise piece of equipment) was dropped during unloading. After thoroughly inspection of the compressor motor and the internal parts, the manufacturer issued a service report stating: "the compressor has been checked and approved for normal commissioning and operation without any remarks against the normal guarantee conditions." Most equipment was installed on arrival, and any equipment that could not be installed immediately, was stored on-site in an appropriate environment.

Figure 11 Wathba 2 WWTP Construction

There were situations where an employer instigated variation was issued, such as in one case where the protective coating of epoxy was considered insufficient for the protection of concrete in certain areas. The concrete comprising upstream processes subject to corrosive and abrasive raw sewage, had to be designed for an asset life of sixty five (65) years (40 years asset life after 25 year operation) and GRP was used in lieu of epoxy.

In most cases, GRP was installed, at the wet/dry cyclic zones, which is known as the most vulnerable area. Although, certain process such as the biological process, containing well a aerated liquid, an epoxy coating was thought to be adequate. Figure 11 (above), biological aeration tanks, epoxy coated, during construction (mechanical installation).

Constructability is obviously important, and the jig saw type arrangement of filter floors, were fabricated and organized like a factory. The concrete was poured at night due to high temperatures during the day, and even mixed with ice (to get the concrete mix < 28 Deg.C), and cured with wet hessian, sack type material or a curing chemical.

3.1.4 WATHBA BOOT TESTING, COMMISSIONING & OPERATION

The Wathba 2 Plant was configured to provide for operational redundancy of critical equipment so that a failure of a critical item does not result in a failure to satisfy the effluent specifications. Figure 12 (below), shows one (1) of four (4) aeration tanks in operation.

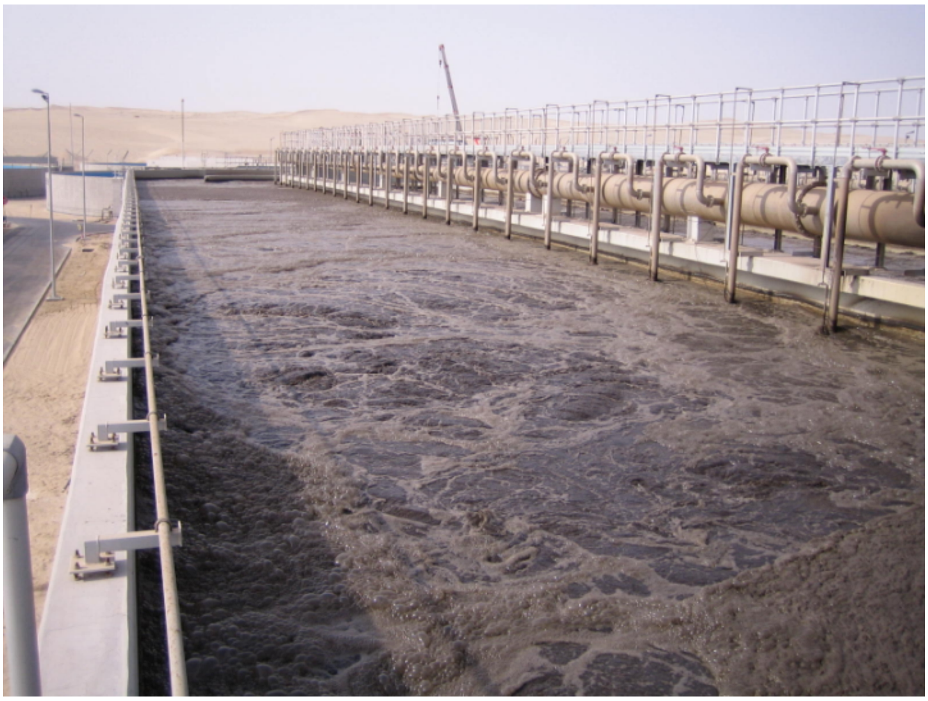

Figure 12 Wathba 2 WWTP Operation

A strict testing regime was implemented during the commissioning, to ensure the plant was fit for purpose. This included equipment validation, administering a snag list, hydrostatic tests (tanks/pipes) and ensuring emergency facilities such as the bypass line was operational. Obvious criteria, such as sufficient wastewater influent and compliant effluent and sludge had to be adhered to, as well as administrative requirements, such as evidence of an approved plant proving period plan, and safety requirements such as a working firefighting system and safety showers with eye baths.

3.1.4 WATHBA BOOT KPIs

The following key performance indicators (KPIs) with contractual limits had to be met, so as the Wathba 2 Plant was designed, manufactured and configured in such a way that it will maximize the ability to treat influent to produce high quality effluent and sludge, quietly and without smell, with minimum power and chemical costs:

- Effluent Quality: The required effluent quality is quite high, < 10 mg/L BOD & SS and full nitrification < 2 mg/L ammonia; based on 24 hour composite samples. The effluent shall also be clear (turbidity < 2 NTU) and be disinfected (< 100 CFU/100mL [E.Coli] & free chlorine residual > 1 mg/L).

- Sludge Quality: The sludge guarantee (at contract capacity) are: average dry solids content of sludge cake: ≥ 85%DS; reduction in volatile organic matter ≥ 38%DS

- Odour: The agreed levels for hydrogen sulfide (H_2S) and odour units (OU) are defined as 3 ppbv, and 99.5% compliance level with 2.5 OU, at the site perimeter when the Wathba 2 plant is in operation.

- Noise: Noise insulation is provided, such as acoustic covers and the like to ensure noise levels do not exceed 85 dB(A) at a distance of one meter from the noise source at an ambient noise of 45 dB(A), as well as noise levels generated from the Wathba 2 Plant shall not exceed 45 dB(A) at the site perimeter.

- Power Consumption: The engineering is to provide a safe working environment, which complies with all statutory regulations and standards for a plant, which is to operate 24 hours per day, 365 days per year. A dual 24V DC Uninterrupted Power Supply (UPS) System with 12 hour back-up shall power each of the new PLCs and SCADA system and Emergency Generators for the process plant. Electricity Consumption at Contract Capacity < 194,400 kWh/d

- Chemicals Consumption: Chemicals for Wastewater Treatment: NaCl (99.7% purity) for brine preparation for electro-chlorination 3.75 kg/produced kg Cl_2 (NaCl at Contract Capacity 22,500 kg/d). Chemicals for Sludge Treatment: Polymer for primary Sludge thickening/ excess biological Sludge thickening/ Polymer for Sludge dewatering 5/7/9 kg/ton DS. Chemicals for Deodorisation. Caustic, NaOH (solution at 30%) 0.88 ml/ m^3 air (or < 7.0 m^3/d @ Contract Capacity), Hypo, NaOCl (solution at 8 g/l of chlorine concentration) from electro-chlorination 124 ml/ m^3 air, Acid, H_2SO_4 0.028 ml/ m^3 air (or < 0.14 m^3/d @ Contract Capacity)

3.1.5 WATHBA BOOT HEALTH, SAFETY AND ENVIRONMENT

During the construction and operational periods, all relevant laws, rules and regulations in respect of health, safety and environmental matters must be complied with. This project had very few injuries and no serious injuries, due to the very strict health and safety regulations that were enforced on-site. The main risks, like most sites, were falls from height (either items falling on you, or you falling off) and traffic, and these topics were controlled well. Obviously things like heat stroke and dehydration, and during commissioning electrocution, high levels of poisonous H_2S and general sickness from wastewater, were the main focus.

Regular training sessions, workshops and tool boxes were carried out, and an interesting card system was used. The Contractors HSE team, had a card system similar to football, where if you were seen doing anything unsafe or potentially unsafe, you were given a yellow card (& had your photo taken), Recidivist offenders, and engineers who received two (2) yellow's in an short time frame, were given a red. You would then have a compulsory H&S refresher, normally on your weekend and generally be 'hassled' by management. This worked very well, and no-one was above the attention of the HSE team, including the project company personnel or even the end user/client.

The project company implemented an Environmental Management System on site; and showed a real commitment to safeguarding the environment with monitoring of the EPC contractor and its activities, and for these reasons had no environmental non-compliance.

3.2 SEAVIEW DBO

Figure 13 (below) shows the project structure of the Seaview DBO project (Seaview in Petone, Wellington), which has a similar arrangement to the Wathba 2 BOOT (detailed in section 3.1, above), but without the complex lender/financing layer. The Lower Hutt City Council (in collaboration with Upper Hutt City Council) appointed the Special Project Company, Hutt Valley Wastewater Services (HVWS), a joint venture between New Zealand Water Services and OMI-Beca, and their design build subcontractor Seaview Projects Ltd, a joint venture between Bovis Lend Lease and CH2M Beca.

The Engineers MWH and BECA, acted on behalf of Lower Hutt City Council and as the designers within the SPC, respectively. The former, MWH, acted as technical advisors and the later, BECA acted as the engineers (as CH2M BECA) and technical and O&M specialists (as CH2M BECA & OMI).

The SPC for this design, construction and operation project also included the main Contractor, Lend Lease and the operator, Australian Wastewater Services. Fletchers Construction held no equity position as a subcontractor.

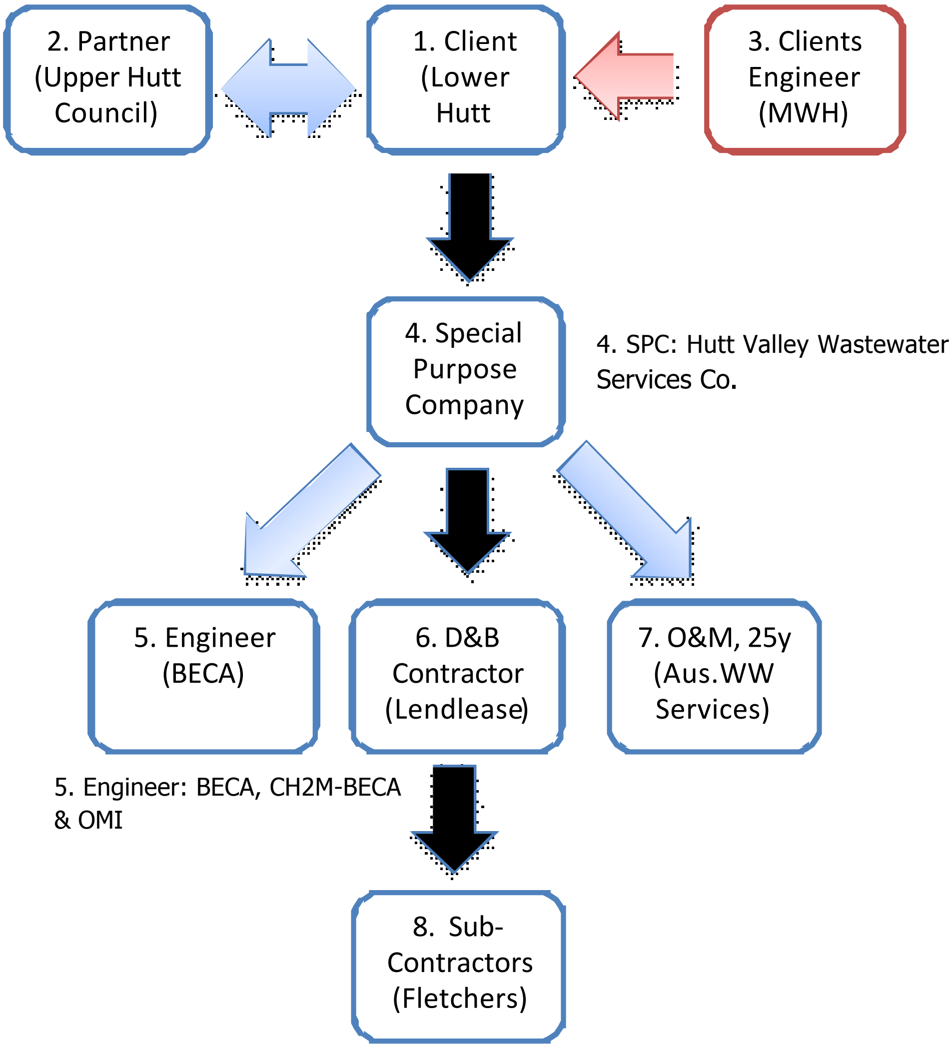

Figure 13 Sea View WWTP BOT Project Structure

The location of the brown field site, an industrial area in Lower Hutt, provided a near flat site and allowed for the design of a conventional activated sludge system, a secondary treatment plant supplemented by ultraviolet disinfection of treated effluent, sludge beneficiation and comprehensive odour control together with new pump stations and a sewage pipeline.

This Design, Build and Operate project, shown in Figure 14 (below) was funded through private sector means, the details of which are commercially confidential. The contract was managed with a standard FIDIC contract, with strict key performance indicators (KPIs), penalties and hand back requirements, as the plant will be transferred back to council control at the end of the 18 year O&M period.

Figure 14 Overhead Photo of Seaview WWTP, Lower Hutt, Wellington, New Zealand. The Biological Process with the four (4) Secondary Clarifiers, are clearly identifiable on the left of the photo.

Unusually a 'Black Box' Consent was applied for and granted under New Zealand's Resource Management Act (RMA), and gave details of the effluent quality and flows to be discharged into Wellington Harbour, but did not go into any detail on how it would achieve this.

3.3 MOA POINT D&B

Of the three (3) case studies mentioned, the Moa Point Design and Build Project have the least private sector involvement, as shown in Figure 15 (below).

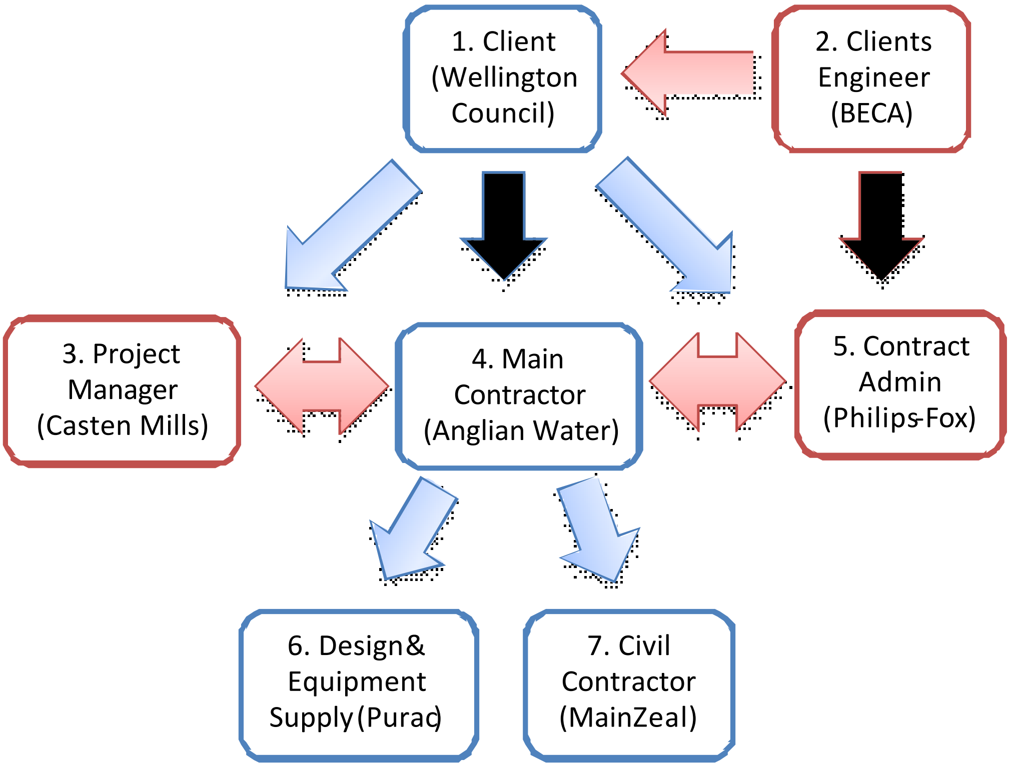

Figure 15 Moa Point WWTP DBO Project Structure

Wellington City Council, through an international tendering process, selected Anglian Water as the main contractor, for this design and build project. Wellington City Council also chose BECA as their technical advisors, who reported back to them through the contract administrators, Philips Fox Law yers, with Casten Mills as their project managers.

Anglian Water subcontracted Main Zeal as the civil structural contractor and PURAC as the process designer and equipment supplier. It should be noted that Wellington City Council in collaboration w ith BECA, processed the consents and ensured compliance w ith the Resource Management Act.

The Moa Point WWTP w as designed and constructed in the late 90's (1998-1999) to treat 0.8 – 0.9m^3/s of w astewater from Wellington City. This w astew ater treatment plant w as built in quite a sensitive area, close to houses and the airport (see Figure 17, below) with strict controls to architecture, odour and noise, as w ell as treated effluent. This perhaps, w as the main driver for the selection of the compact Kaldnes® Moving Bed Bioreactor (MBBR) biological process, with ultraviolet disinfection prior to discharge into Cook Strait.

Figure 16 Overhead Shot of Moa Point WWTP, Wellington, clearly showing the close proximity of the airport (runway) and houses.

This project w as run based on a unique contract w ith strict key performance indicators (KPIs), penalties and hand over requirements.

3.4 SPECIFICATIONS AND COSTS

Table 3 (below) attempts to compare a number of parameters to the three (3) projects. The financing costs of Wathba 2 at US$239 Million (broken dow n into US$41M during the construction phase of about 3 years and US$198M during the 25 year operating period, are about double the construction costs over tw enty five (25) years. This compares w ell to a typical residential mortgage in New Zealand (say $400,000 @ 5% to 7% equivalent to $750,000 over 25 years).

Table 3 – Specification and Costs Comparison

Ref.	Description	Wathba 2 WWTP BOOT	Seaview WWTP DBO, Lower Hutt	Moa Point WWTP D&B, Wellington
1	Design Flow (m3/d)	300,000 m^3/d	54,500 m^3/d	68,000 m^3/d
2	Population Equivalent (PE)	1,000,000	144,000	136,000
3	Effluent Quality, BOD/SS/NH_3 (mg/L)	10/ 10/ 2	10/ 20/ 30	20/ 30/ -
4	Power Consumption (kWh/d)	194,400 kWh/day	-	-
5	Year of Construction	2008-2011	1999-2002	1998-1999
6	Construction Cost (US$)	US$.210.8 Million	US$.35.2 Million	Commercially Confidential
7	Financing Cost (US$)	US$.239 Million (over 3+25 years)	Commercially Confidential	Commercially Confidential
8	Service Payment	$0.30 to $0.50/$m^3$ of wastewater	Commercially Confidential	Commercially Confidential

The end user, ADSSC only pays for w astew ater treated, as per figure 17 (below), the inlet flow meter on w hich the payment is based. This monthly service payment is quite complex but is essentially made up of a capital costs payment (A), fixed O&M payment (B), negative payment for out of spec effluent and sludge and adjustment for electricity (C) and a variable O&M payment. This service payment figure (A+B-C+D) amounts to $0.30 to $0.50 / m^3 of wastewater treated, w hich w ith a plant that can potentially treat 300,000 m^3/d, could be equivalent to $45M/year, and over $1 Billion in 25 years.

Figure 17 Inlet FM (prior to installation) had to be more accurate than usual for operating a wastewater plant, as the data from which was used as the basis for the monthly service payments.

4 CONCLUSIONS

The similarities in design between Wathba 2 and Seaview WWTP can be put down to their location, ie cheap land, well away from population centers, as compared to Moa Point where a compact MBBR type plant has been selected, as it is in a sensitive area, close to Wellington Airport and private houses. However, the chosen process has no relationship to the delivery method chosen.

Wathba 2 and Moa Point projects both have a unique contract, prepared to cater for their particular requirements (probably at some expense), while the Seaview project was based on the international conditions of contract, FIDIC. There are too many unknown variables to conclude the reasons for this, but it can be assumed that the extra expense of preparing a unique contract was justified by the specific and particular requirements of the client, while still fostering a harmonious client/contractor relationship, particularly in view of the long contract period.

Increasing private sector involvement, moves from Moa Point D&B, through Seaview DBO to Wathba 2 BOOT, whereby Moa Point D&B was conventionally funded, and Seaview DBO and Wathba 2 BOOT were privately funded, with the Wathba BOOT the most financial and contractually complex.

Table 4 (below) compares these three (3) projects.

<u>Table 4 - Comparison of Projects</u>

Ref.	Description	Wathba 2 WWTP BOOT	Seaview WWTP DBO, Lower Hutt	Moa Point WWTP D&B, Wellington
1	Design	Standard ASP (Copy) with Veolia Process Plant	Standard ASP	Compact MBBR
2	Location	Remote. Green Field	Industrial Area, Brown Field	Central Built Up Area, Sensitive
3	Project Funding	Complex Lender Financial	Private Sector Fund	Conventional Funding (Publically

		Arrangement		funded)
4	Project Company	Yes	Yes	No
5	Unique Contract	Yes (Sewage Treatment Agreement)	No (FIDIC [Orange Book])	Yes
6	Strict KPIs, Penalties & Hand back Standards	Yes	Yes	Yes
7	Variations	Yes (numerous)	Yes	Yes
8	Tough Consents/Permissions Requirement	Yes	Yes (Black Box)	Yes
9	Construction Program	2.5 years	2 – 3 years	2 – 3 years
10	O&M Duration	25 years	18 years	N/A

The key conclusions to be made, from comparing these three (3) plants, are that:

- All three procurement methods (D&B, DBO & BOOT) have proven to be successful. They were constructed on-time, to the required quality and budget (within a reasonable tolerance). They are now efficiently processing wastewater to meet the necessary standards (again within a reasonable tolerance) and are being (and will continue to be) maintained properly.
- Multiple variable factors influence the procurement method that is chosen. Some of these factors include: financial feasibility, project size, lenders, contract requirements and construction timeframe
- The project structure will vary depending on the delivery method. This selected procurement method impacts risk allocation and long term costs/fiscal benefit/cash flow.

5 ACKNOWLEDGEMENTS

[1] Nick Walmsley, BSc CEng MIChemE FIPENZ CPEng IPER, Technical Director - Water Technology, GHD, formally Technical Director at BECA.

6 REFERENCES

[2] WEF Manual of Practice No. 8, 1992, Design of municipal Wastewater Treatment Plants (Vol. 1 & 2). Water Environment Federation

[3] Website: World Bank Tool kit (http://web.worldbank.org)

[4] Websites: http://www.wellington.govt.nz, http://www.gw.govt.nz, http://www.beca.com.

7 NOMENCLATURE

- **ADSSC/ADWEA** = Abu Dhabi Sewerage Services Company, a subsidiary of Abu Dhabi Water and Electricity Authority
- **BOOT** = Build, Own, Operate, Transfer Type Project

- **BOO** = Build, Own, Operate Type Project
- **BOT** = Build, Operate, Transfer Type Project
- **Concession** = A (public service) concession, is when a private company enters into an agreement with the government body to have the exclusive right to operate, maintain and carry out investment in, a public utility for a given number of years.
- **D&B** = Design and Build type project (sometimes called D&C, Design and Construct)
- **DBFO** : Design, Build, Finance, Operate
- **Divestiture** = selling of infrastructure/assets
- **EPC** = Engineer, Procure Construct (Contractor)
- **HSE or H&S** = Health, Safety & the Environment, or Health & Safety
- **H_2S** = Hydrogen Sulphide
- **Lease Contract or Affermage** = A lease or affermage gives a company the right to operate and maintain a public utility, but investment remains the responsibility of the public.
- **Management Contract** = Under a management contract the operator will collect the revenue only on behalf of the government and will in turn be paid an agreed fee.
- **M&E,C&I** = Mechanical and Electrical, Control and Instrumentation
- **MBBR** = Moving Bed Bio-Reactor (a biological process for treating wastewater)
- **O&M** = Operation and Maintenance
- **PPP** = Public Private Partnership
- **SPC** = Special Purpose Company, also called the Project Company
- **WWTP** = Wastewater Treatment Plant