IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of Resource Consents and Notices of Requirement for the Central Interceptor main project works under the Auckland Council District Plan (Auckland City Isthmus and Manukau Sections), the Auckland Council Regional Plans: Air, Land and Water; Sediment Control; and Coastal, and the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health

STATEMENT OF EVIDENCE OF CLINTON JAMES CANTRELL ON BEHALF OF WATERCARE SERVICES LIMITED

PROJECT CONCEPT DESIGN / OBJECTIVES

1. INTRODUCTION

1.1 My full name is Clinton James Cantrell. I am the Industry Director for water and wastewater engineering at AECOM New Zealand Ltd.

1.2 I have a Bachelor of Engineering (Civil) and am a registered Professional Engineer in the United States. I have over 25 years of international experience in the management and technical oversight of large wastewater projects and programmes. This includes the planning and concept design of infrastructure to address wastewater system capacity, asset replacement and duplication, and control of wastewater overflows in combined and separate sanitary sewer systems.

1.3 My work experience includes projects completed throughout North America, the United Kingdom, Australia and New Zealand. I have specific experience in the management of projects involving planning and concept design of wastewater tunnels and other options to address wastewater overflows including treatment systems, combined sewer separation, inflow and infiltration reduction, storage tanks and wet weather treatment systems. This includes planning, review, onsite assessments and concept designs of wastewater tunnel systems similar to the Central Interceptor in cities such as Sydney, Chicago, Indianapolis, Cincinnati, Detroit, Cleveland, London, Brighton and Bath.

Involvement in the Central Interceptor Project

1.4 I first became involved with the assessment of Auckland's wastewater system in 1998 when I managed Project Storm 1 for Watercare Services Limited ("**Watercare**"), which involved the development of a complex hydraulic model to assess existing and future capacity issues. After returning to New Zealand in 2007 I became involved with the Central Interceptor Scheme by providing technical advice to Watercare following the completion of the Three Waters Final 2008 Strategic Plan.

1.5 In August 2009 I became the Project Manager for the Principal Engineering Advisor team supporting Watercare's planning, concept design and consent application development for the Central Interceptor Scheme. In this role I have been responsible for the management and technical oversight of the concept design of the Central Interceptor Scheme, including all aspects of options assessment, engineering investigations, risk assessments, and concept design development.

1.6 I am familiar with the various Project sites and have undertaken a number of site visits. This includes visits to locations ultimately chosen for the preferred alignment, as well as multiple options considered for each site. I have also participated in numerous meetings with local communities and various affected parties to discuss specific site issues and concerns.

Code of Conduct

1.7 I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's Updated Practice Note 2011 which took effect on 1 November 2011. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope of evidence

1.8 The purpose of my evidence is to outline the basic operational requirements and functionality of the Central Interceptor Scheme and its key features. I will also outline the benefits resulting from its implementation and explain the options that were considered and rejected during the concept design stage. The background to the Central Interceptor Scheme and its role in the wider Watercare wastewater network has been broadly described by Mr Munro. I will expand on his broad descriptions to provide more detailed discussion on the proposed Central Interceptor Scheme.

1.9 The proposed construction methodology and the use of construction management plans will be covered in the evidence of Mr Cooper. As a result, while I briefly touch on the proposed construction methodology, I do not cover these topics in any detail in my evidence.

1.10 My evidence is structured as follows:

(a) executive summary;

(b) operations and functionality;

(c) a description of the Central Interceptor Scheme and its two components (the main project works (Central Interceptor main tunnel and link sewers)) and CSO Collector Sewers);

(d) consideration of alternative alignment and construction options;

(e) benefits of the Central Interceptor Scheme and those provided by the main project works;

(f) response to submissions;

(g) response to Council Pre-hearing Report; and

(h) conclusions.

2. EXECUTIVE SUMMARY

2.1 The Central Interceptor Scheme consists of a main tunnel which will provide both storage and conveyance, link sewers which will connect to the existing sewer system, and CSO Collector Sewers that will connect to targeted overflow locations. The Scheme is required to meet the key issues facing the Auckland region, namely, the need to duplicate the existing Western Interceptor, provide capacity to accommodate future growth and development, and significantly reduce the volume of untreated wastewater currently discharged directly into urban streams at 122 overflow locations almost every time that it rains.

2.2 The main tunnel and link sewers have been determined to be the only viable option to address the required duplication of the ageing Western Interceptor, and to provide sufficient additional network capacity so that the existing trunk sewers are not overloaded as growth and development continues. Based on current projections, the current capacity of the existing wastewater system will be insufficient to convey the normal daily wastewater flow in dry weather (dry weather flow) within 15 to 20 years. Implementation of the main tunnel and link sewers addresses 18 identified overflow locations, which include the largest in Watercare's system (accounting for approximately 50 - 60 % of the overflow volume). The main tunnel and link sewers also enable a highly cost effective approach to address an additional 104 overflows through the addition of CSO Collector Sewers. The proposed Central Interceptor Scheme provides a means of addressing the effects of these overflows in a highly robust manner which is substantially lower in cost than other options considered.

2.3 The concept of the Central Interceptor Scheme is very similar to many other systems which have been proven to provide the best practical option for addressing similar requirements. This includes Watercare's recently implemented Hobson tunnel project ("**Project Hobson**") and tunnels implemented or under construction in other locations such as Sydney, Chicago, Indianapolis, Cleveland, Boston, Washington DC, London, and Brighton.

2.4 Development of the Notices of Requirement and consent applications represents the culmination of over four years of work by Watercare to assess options and confirm the optimal configuration of the Central

Interceptor Scheme. This work has carefully assessed operational and functionality requirements, which resulted in the development of the proposed Central Interceptor Scheme. The concept design confirms that all key operational and functionality requirements can be addressed resulting in a system that will function properly in all assessed conditions. Proposed construction methods and key Central Interceptor Scheme elements (e.g. shafts, control chambers, ventilation and odour systems, pumping station, etc.) have all been proven to work on other similar projects including the Project Hobson and similar schemes overseas.

2.5 The concept design process included consideration of over 500 possible alignment options which have been considered against numerous technical and non-technical issues such as key connection locations to address the required duplication, capacity and overflow reduction requirements, and ability to minimise effects on local communities. The proposed alignment corridor and key construction sites represent the optimal location for the Central Interceptor Scheme following detailed consideration of these key issues and considerations.

2.6 The benefits of the Central Interceptor Scheme are numerous and include the duplication of the Western Interceptor which provides continued protection of the Manukau Harbour, additional capacity which ensures that growth and development do not result in uncontrolled dry weather overflows along key trunk sewers and significant reduction of the volume of untreated wastewater discharged from 122 overflow locations almost every time it rains. While the Central Interceptor Scheme has not been designed to manage stormwater flooding issues, it does provide an additional benefit in terms of capturing first flush stormwater pollution which currently discharges from the targeted 122 overflow locations. These contaminants can be safely and efficiently treated at the Mangere Wastewater Treatment Plant ("**Mangere WWTP**") so that they do not affect the environment.

2.7 While the actual construction of the Project does result in effects at the surface site locations, the majority of construction will occur deep underground where the effects will be negligible. Furthermore, the concept design allows the Scheme to be operated in a manner that delivers targeted functionality consistently over time, with an asset that has an estimated design life which exceeds 100 years.

2.8 Overflows which are captured by the Central Interceptor Scheme will be safely conveyed and treated at the Mangere WWTP. While the overflows represent a substantial impact on the local streams and harbour they discharge into during storm events, the volumes represent less than 2% of the volume that is currently treated by the Mangere WWTP on an annual average basis. State of the art treatment processes at the Mangere WWTP ensure an adequate level of treatment and continued protection of the Manukau Harbour. The Central Interceptor Scheme has been designed to operate within the current consented flow limits at the Mangere WWTP.

2.9 The concept design of the Central Interceptor Scheme includes controls and provisions to ensure it will operate in a safe and adequate manner under all conditions, including the loss of power or failure of key mechanical equipment.

2.10 The concept design also includes an emergency pressure relief ("**EPR**") structure at the proposed Mangere Pump Station located at the Mangere WWTP. The EPR would only activate due to the failure of the pump station resulting from a power loss or mechanical problems coupled with the main tunnel reaching full capacity, and its activation is designed to ensure that the tunnel would not overflow at other shaft sites along the alignment. Use of an EPR is common practice at any wastewater pump station to ensure that wastewater will not overflow at uncontrolled locations in the event of a pump station failure. With consideration to the redundancies designed into the proposed Mangere Pump Station, dual power feed into the Mangere WWTP, the ability of the main tunnel to store flows for many hours,[1] and Watercare's portable emergency power generator service – the probability of the EPR activating is less than 1 event every 50 years. Furthermore, the effects of the EPR activating can also be actively mitigated by diverting flow away from the main tunnel using a series of automated and manual gates. Closure of these gates would result in overflows occurring at existing overflow points where overflows already occur more frequently.

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1 The concept design report confirms that in the year 2025 the tunnel can store dry weather flows for 60 - 68 hours, and in the year 2062 it can store flows for 40 - 45 hours.

3. OPERATIONS AND FUNCTIONALITY

Overview of the operation of the Central Interceptor Scheme

3.1 The overall concept of the Central Interceptor Scheme has been explained in the evidence of Mr Munro. Mr Munro has also explained the two aspects of the Central Interceptor Scheme, one of which, the main project works, is the project currently being presented ("**Project**"), and the other being the works associated with the CSO Collector Sewers.

3.2 The basic configuration of the overall Central Interceptor Scheme (main tunnel, link sewers and CSO Collector Sewers) is required to:

(a) provide asset security by duplicating the lower section of the ageing Western Interceptor which is at risk of failure, significantly reducing the major wastewater overflows into the Meola Creek catchment;

(b) provide additional sewer network capacity for growth and development; and

(c) reduce over 100 existing wastewater overflows from the combined sewer system into urban streams and the Waitemata Harbour.

3.3 These are the key drivers for the Central Interceptor Scheme, and have been described in some detail by Mr Munro. The Project delivers the first two drivers. In terms of the third driver, the Project significantly reduces the overflow volumes at 18 existing wastewater overflows (a further 104 existing wastewater overflows will be reduced by the CSO Collector Sewers, a separate project that is dependent on the main tunnel).

3.4 In general, the operation of the main tunnel can be considered under two scenarios: dry weather flow conveyance, and wet weather storage and conveyance. For the hearing I will present an animation to further explain the main tunnel's functionality for these various conditions.

Dry weather flow conveyance

3.5 Under normal dry weather conditions, the Central Interceptor Scheme operates to provide conveyance for wastewater intercepted at each of the network connection points. Under these conditions wastewater from the existing network is dropped into the main tunnel at the connection points and then conveyed via the main tunnel to the Mangere WWTP. At the Mangere WWTP, the new pump station pumps the wastewater out of the main tunnel and into the plant. The main tunnel would operate on this basis for the majority of the time, and while it represents a new inflow point to the plant compared to the current network arrangement, under dry weather conditions it does not alter the amount of wastewater arriving at the plant. The wastewater diverted to the main tunnel would have otherwise flowed to the Mangere WWTP via either the Orakei Main Sewer and Eastern Interceptor, or via the Western Interceptor.

Wet weather storage and conveyance

3.6 The main tunnel has been sized to provide capacity for storage of some 200,000 m^3 of wastewater. This required storage volume considers overflows targeted by the Project, as well as additional overflows which will be targeted by the future CSO Collector Sewers and a possible future extension of the main tunnel. Under dry weather conditions very little of the main tunnel's overall storage capacity is used. However, under wet weather conditions, when stormwater enters the wastewater system (particularly from the old combined networks), the main tunnel is used to capture and store the diluted wastewater that would then otherwise overflow to the environment.

3.7 As a result of implementing the Project, overflows from 18 targeted locations will be diverted into the main tunnel for conveyance and storage. Implementation of the CSO Collector Sewers will divert an additional 104 overflows into the main tunnel. The Central Interceptor Scheme will reduce the volumes of these overflows by approximately 80 % during an average year of rain, and this level of reduction will continue as growth occurs up to the maximum probable development limits.

3.8 In addition to capturing the pollution associated with the wastewater components of the overflows, the Central Interceptor Scheme will also capture "first flush" contaminants from the urban stormwater runoff which currently discharges out of the 122 overflow locations. The Scheme is not designed to convey large portions of stormwater which occur during flooding conditions, but the contaminants associated with the smaller volumes of initial runoff (such as oils and heavy metals) can be quite significant and can impact the environment on both a short and long-term basis. **Figure 1** below provides an example of first flush stormwater contamination which occurs from typical urban runoff areas including roads, parking lots and commercial/industrial facilities. This contaminated runoff should ideally be captured for treatment before it is released into the environment.

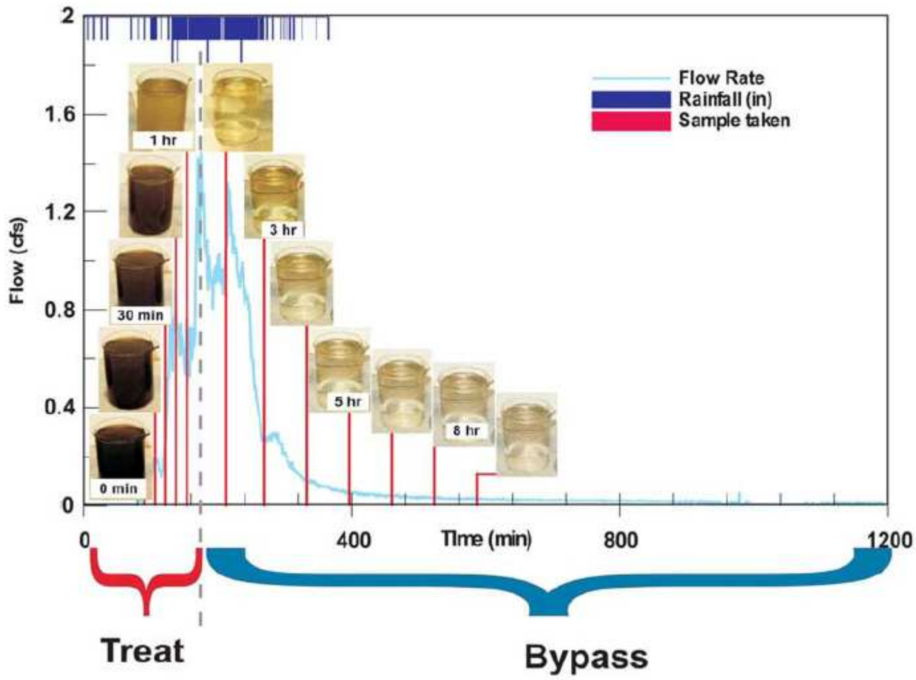

Figure 1: Stormwater First Flush Contaminant Characterisation

3.9 As a rain storm event occurs the main tunnel will gradually start to fill as the overflows are diverted into it and the proposed Mangere Pump Station limits flows into the Mangere WWTP to ensure flows remain within the consented limits. Depending on the duration and intensity of the storm, the remaining storage capacity reduces until the main tunnel becomes full. Hydraulic modelling predicts that the main tunnel will fill to its maximum storage capacity approximately 6 to 8 times per average year of rain. As the main tunnel approaches full capacity, automated inlet control gates at 9 of the sites will close and excess inflows will overflow to the environment via new (at 2 locations adjacent to existing overflows), upgraded (at 3 locations), replaced (at 2 locations) and existing (at 2 locations not adjacent to the sites) engineered overflow structures. As the storm event finishes, the wastewater levels in the main tunnel will slowly drop as the Mangere WWTP processes the stored wastewater. The net result is that total volumes and frequencies of overflows targeted by the Central Interceptor, which is discussed in more detail in Section 4.8 below, will be substantially reduced.

Interaction between tunnel and plant

3.10 The interaction between the main tunnel and the Mangere WWTP has been a key design consideration, as performance of the plant is directly affected by the amount and rate of wastewater arriving for treatment. This interaction will be managed by the Mangere Pump Station, which will control the delivery of flow from the main tunnel into the Mangere WWTP.

3.11 The treatment plant resource consents set performance requirements for the quality and average daily and annual quantities of treated wastewater discharged to the Manukau Harbour. As explained above, during dry weather all wastewater conveyed by the main tunnel would have otherwise been conveyed to Mangere WWTP, either via the Orakei Main Sewer and Eastern Interceptor or the Western Interceptor. During wet weather conditions, the storage provided in the main tunnel allows for management of peak flows into Mangere WWTP and the proposed Mangere Pump Station has been designed so that the rate of pumping is controlled, therefore the ability of the Mangere WWTP to operate within current consent limits is not affected.

3.12 While the overflows which have been targeted by the Central Interceptor Scheme discharge a significant amount of flow and pollution on any given event, they represent a very small portion of the flow and pollution treated at the Mangere WWTP on an annual basis. The Mangere WWTP presently treats approximately 120 to 130 million m^3 of wastewater and stormwater each year. Presently it is estimated that the volume of discharge from the 122 targeted overflows is approximately 2.17 million m^3 per year, which is less than 2 % of the volume presently treated at the Mangere WWTP. Projections of volumes out to the year 2062 confirm that the overflows will remain at less than 2% of the total treated volume. Additional analysis of pollutant loads, including pollution associated with stormwater runoff (e.g. heavy metals), shows that the additional amounts from captured overflows to be treated by the Mangere WWTP is less than 1 % of what is currently treated. This is because pollution associated with the overflows targeted by the Central Interceptor Scheme are much more dilute than higher strength wastewater in the existing trunk sewers which feed into the Mangere WWTP.

3.13 The existing Mangere WWTP provides a high degree of effective treatment which ensures the plant can operate within consented effluent quality limits. Watercare is currently in the process of designing a new enhanced biological treatment system, and is planning on implementing a state of the art wet weather treatment system which will operate in parallel to the biological system during large storm events. These systems will ensure that the Mangere WWTP can safely and efficiently treat all flows and associated pollution received in both dry and wet weather conditions, including flows received by the Central Interceptor Scheme.

4. BENEFITS

4.1 The benefits of the Central Interceptor Scheme as a whole, and the Project specifically, have been discussed in detail in the evidence of Mr Munro.

4.2 In summary, the Central Interceptor Scheme presents an integrated and cost effective solution for the network, addressing asset duplication, capacity and overflow mitigation needs, and providing a framework for the ongoing operation of the network for the next 50 years and beyond.

4.3 Once completed, the Central Interceptor Scheme will provide the following key benefits:

(a) Asset security through the duplication of the lower section of the ageing Western Interceptor, which will protect the Manukau Harbour from impacts associated with a potential failure of this asset.

(b) The provision of capacity in the wastewater network for future growth and development on the Auckland Isthmus for the next 50 years and beyond.

(c) Significant reduction of the major wastewater overflows and associated pollution, including first flush stormwater pollution, which impact urban streams and the Waitemata Harbour almost every time it rains.

(d) Opportunity to further reduce existing wastewater overflows from the combined sewer system into urban streams and the Waitemata Harbour, by enabling the CSO Collector Sewers and the proposed Waterfront Interceptor (which has been discussed in the evidence of Mr Munro).

(e) Positive effects on public health and the environment through the effective operation of the wastewater network generally.

4.4 It is important to note that the Project is required as the best practicable option to achieve the benefits described in items (a) and (b) above alone. Implementation of the Project also enables the benefit of cost-effective reduction of overflows, but would still be required to address (a) and (b) regardless of overflows.

4.5 The Project will duplicate the lower section of the Western Interceptor which is deteriorating due to corrosion caused by hydrogen sulphide gas levels in this pipeline. In particular, the lower section of the Western Interceptor through the Hillsborough Tunnel and the Manukau Siphon is showing serious signs of deterioration and is estimated to have between 15 to 25 years of life left before it needs to be replaced. As this part of the Western Interceptor continues to deteriorate, the risk of failure increases. The Siphon is also vulnerable to damage as it was laid on the bottom of the Manukau Harbour in an open channel.

4.6 As the Central Interceptor duplicates the Western Interceptor, it will eliminate the current risks in the event that the Western Interceptor fails and will provide Watercare with asset security for this critical infrastructure. When the Central Interceptor is commissioned, Watercare will inspect the Western Interceptor to determine its condition and the feasibility/cost effectiveness of rehabilitating it. Based on this, Watercare will then decide what the future use of the Western Interceptor will be, if any. If the condition of the Western Interceptor is poor and would require rehabilitation which is deemed cost-prohibitive, it is unlikely that it would be retained in service because of the potential risks to the Manukau Harbour in the event of failure and it would likely be filled with cement grout or similar. However, such decision can only be made once the main tunnel has been commissioned and inspections have been completed.

4.7 The capacity of the existing network is insufficient to cater for predicted population growth. Based on current projections, the capacity of the Orakei Main Sewer (which provides service to most of the combined sewer area including Auckland's CBD and the western isthmus - around 25 % of the total area served by the Mangere WWTP) will be insufficient to convey the normal daily wastewater flow in dry weather (dry weather flow) within 10 to 15 years. Without additional interceptor capacity, future population growth could result in dry weather overflows of undiluted wastewater into the environment on a daily basis. Additional capacity is required to minimise the risk of this occurring. The Central Interceptor will provide the required network capacity for growth and development on the Auckland Isthmus for the next 50 years and beyond. This will support regional strategies to intensify urban development within the urban limits.

4.8 The Central Interceptor will achieve significant overflow reduction at 18 targeted locations. The Central Interceptor will address Watercare's largest overflows, which are located on the transmission network in the Meola Creek catchment. These 18 overflows include the two largest in the combined sewer system (Lyon Avenue and Haverstock Road), and represent approximately 50 to 60 % of the volume associated with all overflows targeted by the Central Interceptor Scheme. The majority of these 18 overflows, by volume, discharge into the Meola Catchment, but also impact the Motions and Whau Catchments. Reducing the overflows will have a dramatic positive effect in these locations.

4.9 The overflow reductions achieved by the Project will provide the following environmental benefits:

(a) **Public health** - The significant reduction in wastewater overflows will reduce potentially harmful pathogens reaching the Meola Creek and Meola Creek estuary and associated coastal waters. I note that the Auckland Regional Public Health Service ("**ARPHS**") has lodged a submission in strong support of the Project because of the "clear public health benefits" of the Central Interceptor.

(b) **Ecological values** - The significant reduction in network overflow discharges will result in a range of ecological benefits in Meola Creek and Meola Creek estuary. These will include reduced nutrient and organic loads, improvements in water quality, and reduction in the likelihood of conditions that cause ecological stress and adverse ecological change.

(c) **Amenity values** - Watercare's two largest network overflows discharge to the head of Meola Creek, adjacent to Mount Albert Grammar School and the Roy Clements Treeway boardwalk. Other significant overflows occur further downstream. These overflows adversely affect the amenity values of these public areas, reducing aesthetic and recreational values. The Central Interceptor will significantly reduce the level of overflow to the Meola Creek, and will enhance amenity values.

(d) **Cultural values** - Watercare recognises the importance of land and water resources to mana whenua. The Central Interceptor will result in a significant reduction in the volume and frequency of network overflows and will significantly reduce the volume of wastewater contaminants reaching Meola Creek and the associated degradation of this waterway.

4.10 The Project also enables the construction of the CSO Collector Sewers, which target another 104 overflow locations. This generates public health, ecological, and amenity benefits for Whau, Oakley, and Motions Creeks.

4.11 Once completed, the wider Central Interceptor Scheme (being the Project and the CSO Collector Sewers) will reduce overflows from a total of 122 locations in the catchment, which currently discharge in the order of 2,200,000 m^3 of diluted wastewater on an average annual basis. Based on population and land development projections for 2062, modelling indicates that during average annual rainfall conditions the Central Interceptor Scheme can reduce overflows by 80%, and possibly more during less than average years of rain. This level of overflow reduction is a significant benefit of the Scheme. It is consistent with international standards for combined sewer overflow control including those used in Europe and North America and is directly in line with international best practice performance targets established in the United States and United Kingdom for sewer systems which are similar to Auckland's.

4.12 It also ensures that growth and development can continue unabated without resulting in increased overflow amounts, including the risk of overflows occurring during dry weather conditions.

4.13 The Project will be integral to the ongoing operation of the wastewater network on the Auckland Isthmus over the next 50 years and beyond. The wastewater network enables the communities of Auckland to provide for their ongoing health and wellbeing, and for continued economic growth and development across Auckland.

4.14 Internationally the use of a deep tunnel storage and conveyance system to address issues similar, in both scale and nature, to those faced in Auckland is considered best practice. The drivers of asset duplication, conveyance and reduction of wastewater overflows bring the proposed solution of the Central Interceptor Scheme to the fore as the only practical option. In many cases overseas, with sewer systems similar to Auckland's, the driver of reducing overflows alone has resulted in implementation of tunnel conveyance and storage systems as the preferred option.

4.15 An example of this is the Deep Rock Tunnel that is currently being constructed in Indianapolis, Indiana. Indianapolis and Auckland are similar in population and size, and both have a combined sewer system which is similar in scale and area. The Deep Rock Tunnel has been designed at 12 km in length with a diameter of 5 metres, almost the same dimensions as the Central Interceptor main tunnel. The Deep Rock Tunnel also has very similar construction site configurations in terms of shaft arrangements, and control systems, and a pumping station which will connect directly to their wastewater treatment plant.

4.16 Other examples can be found in the cities of Sydney, Chicago, Cleveland, Milwaukee, Seattle, Portland, Columbus, Washington DC, Boston, London and Brighton. In each case the concept of a tunnel was confirmed as the most cost effective option to address problems very similar in scale and nature to Auckland's.

5. PROJECT DESCRIPTION

Overview of the Project

5.1 The Project involves the construction, commissioning, operation and maintenance of a bulk wastewater interceptor and associated activities. **Figure 1.1**, set out on page 4 of the Hearing Drawing Set, provides an overview of the key features of the Project. During the hearing I will illustrate the Project's key features using a Google Earth animated map view. In summary, the Project incorporates:

(a) A new sewer tunnel between Western Springs and the Mangere WWTP approximately 13 km in length and between about 22 to 110 m (current design) below the ground surface (shown as the purple line on **Figure 1.1**).

(b) Three link sewer tunnels and a smaller trenched link sewer pipe connecting the main tunnel and existing sewers (shown as black lines on **Figure 1.1**):

(i) Link Sewer 1 between Motions Road and the main tunnel at Western Springs: a tunnel approximately 1 km long and up to about 18 to 28 m deep;

(ii) Link Sewer 2 between Rawalpindi Reserve and the main tunnel at Mount Albert War Memorial Reserve: a tunnel approximately 1 km length, and up to about 22 to 43 m deep;

(iii) Link Sewer 3 between existing Pump Station 25 (Miranda Reserve) and the main tunnel at May Road: a tunnel approximately 3 km long, and up to about 23 to 85 m deep; and

(iv) Link Sewer 4, connecting the local network from Witla Court to the main tunnel at Kiwi Esplanade: a pipeline approximately 0.6 km long, about 400 mm diameter, and buried up to about 3 m deep.

(c) Connections from the main tunnel and link sewers to the existing sewer network.

(d) Associated structures at the connection points, including access shafts, drop shafts, flow control structures, grit traps, air vents and air treatment facilities ("**ATFs**").

(e) Replacement/upgrading of overflow discharge structures in nearby watercourses at seven sites.

(f) A new pump station at the Mangere WWTP to pump wastewater from the main tunnel to the plant.

(g) Other associated works at and in the vicinity of the Mangere WWTP, including an air treatment facility, a rising main to connect to the plant and an EPR structure to enable the safe discharge of flows in the extreme scenario that pump station failure occurs and main tunnel storage capacity is exceeded.

5.2 The Project has been developed to a concept design stage. As the Project moves through the detailed design process and as the construction methodology is confirmed, it is likely that some details will change. All figures and dimensions provided are therefore approximate and will be confirmed during the detailed design process. While the layouts and dimensions provided in the Central Interceptor Main Project Works Assessment of Effects of the Environment submitted to the Council on August 2012 ("**AEE**"), and drawings are approximate, the concept designs represent an appropriate basis for assessing the potential effects arising from construction, operation and maintenance of the Project.

5.3 I will now describe the Project in more detail including the design concept, tunnel horizontal alignment, tunnel depth, tunnel size and shape, the tunnel liner, link sewers, and functional requirements (such as access shafts and air flow management) - referring to schematics where necessary. The evidence of Mr Cooper will address the proposed construction methodologies in more detail.

Tunnel Horizontal Alignment

5.4 As is discussed in Section 6 below, the concept design process involved a detailed assessment and comparison of hundreds of tunnel horizontal alignment options with careful consideration of key constraints to identify the preferred scheme shown on **Figure 1** and **1.1** on pages 4 and 5 of the Hearing Drawing Set.

5.5 To allow for future design optimisations and flexibility, the final horizontal location of the main tunnel and link sewer tunnels is to be within a corridor 40 m wide.

5.6 In summary, the alignment for the main tunnel is from Western Springs in the north, at depth under the suburbs of Mount Albert and Mount Roskill, under the Manukau Harbour and under Mangere Bridge and Ambury Park to the Mangere WWTP.

5.7 Features of the alignment of the main tunnel and link sewer tunnels are summarised in Figures 5-2 and 5-3 from pages 33 to 35 of the Main AEE document reproduced in **Appendix A** of my evidence.

Tunnel Depth and Gradient

5.8 Drawing number **AEE-MAIN-20**, on page 18 of the Hearing Drawing Set, shows is a long section of the main tunnel from Western Springs to Mangere, including an indication of the probable ground conditions based on available data. Selection of the preferred main tunnel vertical alignment included assessment of requirements for connection to the existing sewer system, ground conditions and associated tunnelling constraints, conveyance requirements, use of the main tunnel for storage during wet weather conditions, and operational requirements. This is discussed further below.

5.9 Based on the current concept design, the depth of the top of the main tunnel below ground surface ranges from approximately 22 m towards its northern end, to 110 metres under Hillsborough Road, to around 28 m at the Mangere WWTP. The link sewers range in depth up to around 85 m. These depths can be seen on Drawings **AEE-MAIN-21** and **AEE-MAIN-22** on pages 19 and 20 in the Hearing Drawing Set.

5.10 To allow for future design optimisations and flexibility, the final vertical location of the main tunnel is to be located within a 20 m high corridor. The main tunnel vertical corridor extends approximately from the top of the tunnel location shown on the long section above, to 15 m below the bottom of the tunnel. Link Sewers 1, 2 and 3 will be located within a 20 m vertical corridor that extends approximately from 2m above the top of the main tunnel location shown on the long section to 15 m below the bottom of the main tunnel. This means there is flexibility during detailed design stage to move the tunnels 15m deeper than assessed, but not shallower. The final level of the tunnels will be determined by the geological conditions along the alignment, the selected construction method, and the required hydraulic grade. The proposed vertical and horizontal envelopes of the main tunnel are illustrated in **Figure 2** below:

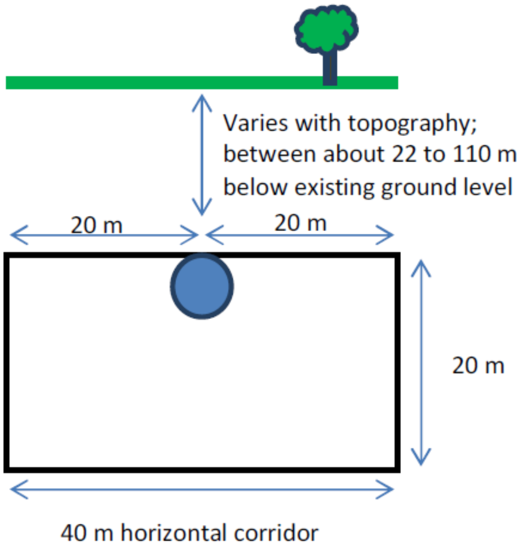

Figure 2: Main tunnel vertical and horizontal corridor

5.11 The gradient proposed for the main tunnel in the concept design is 1 in 800 from Western Springs to May Road and 1 in 1000 from May Road to Mangere WWTP. The gradients of the main tunnel are required to provide gravity driven conveyance to the proposed pump station at Mangere WWTP, and to ensure that solids and debris do not accumulate over time. The gradient of the link sewer tunnels varies, but is driven by similar requirements to the main tunnel. Link Sewer 1 is proposed in the concept design to be 1 in 500, Link Sewer 2 1 in 750, and Link Sewer 3 1 in 1000.

Tunnel Size and Shape

5.12 A range of tunnel sizes has been considered for the main tunnel and link sewer tunnels, taking account of hydraulic, operational and economic factors.

5.13 An internal diameter of 4.5 m is currently proposed for the main tunnel to address future wastewater conveyance capacity needs and provide sufficient storage for an appropriate level of overflow mitigation. The final finished diameter of the main tunnel will be determined by later detailed design analyses and the selected construction method. The proposed designations, the associated resource consent applications and the AEE are therefore based on construction of a tunnel with an internal diameter of between 3.5 m and 5 m. A circular shape is highly likely with the anticipated construction methods and has been adopted in the concept design.

5.14 An internal diameter of 2.4 m is currently proposed for the link sewer tunnels 1, 2, and 3. A portion of Link Sewer 3 (from May Road to Haycock Avenue) may be constructed using the same tunnel boring machine ("**TBM**") as the main tunnel at May Road, with the remaining section (Haycock Avenue to Pump Station 25) being 2.4 m diameter. As with the main tunnel, further design and construction detailing may result in different final tunnel diameters being selected. The proposed designations, the associated resource consent applications and the AEE are therefore based on construction of link sewer tunnels with an internal diameter of somewhere between 1.5 m and 3.5 m for the link sewer tunnels 1, 2, and 3, and 1.5 m and 5 m for Link Sewer 3 between May Road and Haycock Avenue.

Tunnel Liner

5.15 Both the main tunnel and the link sewer tunnels will have a structural liner for their full length. Sections of the main tunnel may have an additional liner placed on top of the structural liner to provide a barrier against corrosion.

5.16 A gasketed, precast concrete segment lining system is the most likely option for the main tunnel. **Photo 1** shows an example of gasketed precast concrete segments used to line Watercare's Hobson tunnel.

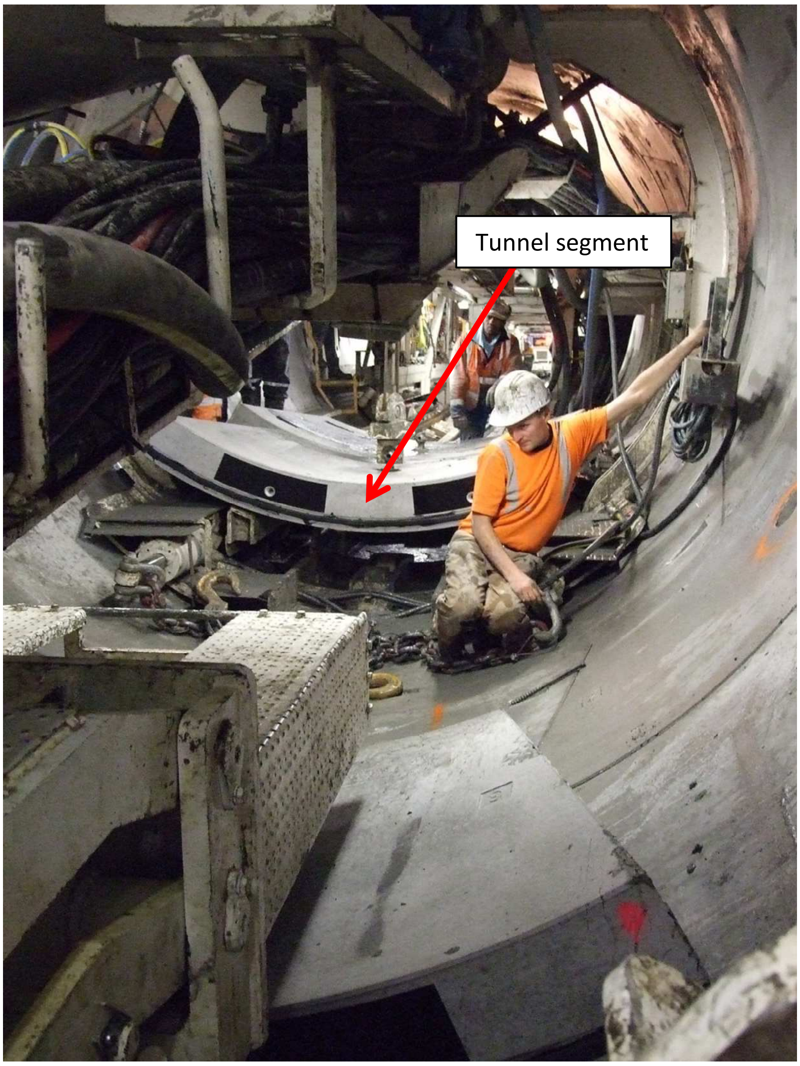

Photo 1: Precast liner segments being installed on Watercare's Hobson tunnel.

5.17 This full-perimeter lining system and associated grouting is installed by the TBM as it moves forward in the main tunnel. Segments are erected and bolted together to form a circular pipe ring shape, with gaskets sealing the joints between each segment. This will support and stabilise the ground during and after construction, minimise groundwater inflows, and maintain the safety of the excavation.

5.18 Compared to other tunnelling methods, such as installation of a liner after the tunnelling is complete (i.e. a "second pass liner system"), installation of a liner simultaneous to the construction of the tunnel provides significant mitigation to issues associated with ground settlement risks. This is consistent with the planned tunnelling construction approach for the main tunnel, and is the same approach used successfully for construction of the Hobson tunnel.

5.19 A video will be screened at the hearing by Mr. Cooper showing how segments are installed by a TBM during the construction process. As this video will show, the TBM installs the liner at the same time as the main tunnel is excavated.

5.20 Detailed design will carefully consider the need for any additional corrosion protection to be installed at particular points where long term corrosion is anticipated to be an issue. Corrosion protection can be incorporated as part of the fabrication of the liner segments before they are installed, or can be applied after the tunnel liner is installed. Materials used for protection are highly resistant to compounds and gases which cause corrosion in wastewater pipelines. The exact location and methods for installing corrosion protection will be developed during the detailed design process.

5.21 Link Sewers 1, 2 and 3 are proposed to be lined with a precast reinforced concrete jacking pipe, with the exception of the section of Link Sewer 3 from Haycock Avenue to May Road which will have a segmental lining similar to the main tunnel in the event it is constructed using the TBM. **Photo 2** shows an example of precast concrete jacking pipes used in a similar application.

Photo 2: Precast concrete jacking pipes

5.22 The concrete jacking pipes are also installed as the link sewers are constructed, and provide a similar level of protection against groundwater intrusion and settlement risks as the segmental liners used with a TBM tunnel.

Link Sewer 4

5.23 Link Sewer 4 comprises a smaller diameter pipeline which will connect a local sewer between the Western Interceptor at Witla Court in Mangere Bridge to the drop structure at Kiwi Esplanade Reserve. Link Sewer 4 is not a tunnelled section and requires no liner other than the pipe which will be installed using a traditional excavated trench construction method.

Typical Permanent Facilities at Construction Sites

5.24 The evidence of Mr Cooper will explain in detail the facilities to be provided at the construction sites during construction of the Central Interceptor. By contrast, my focus here is on the permanent facilities required at each of the sites (which of course need to be constructed as part of the Project).

5.25 I will start by providing a general description of the types of permanent features and facilities that need to be constructed. The facilities to be constructed will differ from site to site. As referenced in Section 4.1, I have prepared a Google Earth dynamic map for the Project and will use this at the hearing to help describe the permanent facilities. At the hearing I will:

(a) Zoom into some selected surface sites to explain typical permanent works features and facilities.

(b) Refer to concept schematics and photos of many of the features for illustrative purposes, although the final design of the structures may differ and will be determined during detailed design.

(c) Use two examples to point out the permanent features which are required:

(i) The proposed construction site at Western Springs. The details of this site are illustrated in Drawing **AEE-MAIN-1.1** and **AEE-MAIN-1.2** on page 21 and 22 of the Hearing Drawing Set.

(ii) The proposed Car Park site at Mount Albert War Memorial Reserve. The details of this site are illustrated in Drawing AEE-MAIN-2.1A on page 49 of the Hearing Drawing Set.

5.26 The key permanent features which are typical of many sites include the main access shafts, drops shafts, de-aeration tunnels, connection and control chambers, grit traps, and air venting and treatment systems. As noted above, these will be explained in the visual material at the hearing but are briefly explained below.

5.27 This is a general description of the various permanent features. The features to be constructed at each site are shown in the Hearing Drawing Set.

Access shafts and drop shafts

5.28 The Central Interceptor has been designed, as far as possible, to minimise operation and maintenance requirements. Two types of shafts are required:

(a) Permanent access shafts are required and these have been provided at the site of each connection point and at tunnel junctions for inspection and maintenance access.

(b) Where connections are made to the tunnels, wastewater inflows will need to drop over significant depths, releasing energy and entraining air. Suitably designed drop structures are required to avoid potential issues associated with this release of energy such as structural damage, the generation of air and hydraulic turbulence and odour generation.

5.29 At the main tunnel sites, separate access shafts and drop shafts have been allowed for with an interconnecting de-aeration tunnel as shown by the concept illustration below in **Figure 3** (Figure 5-2 in the AEE):

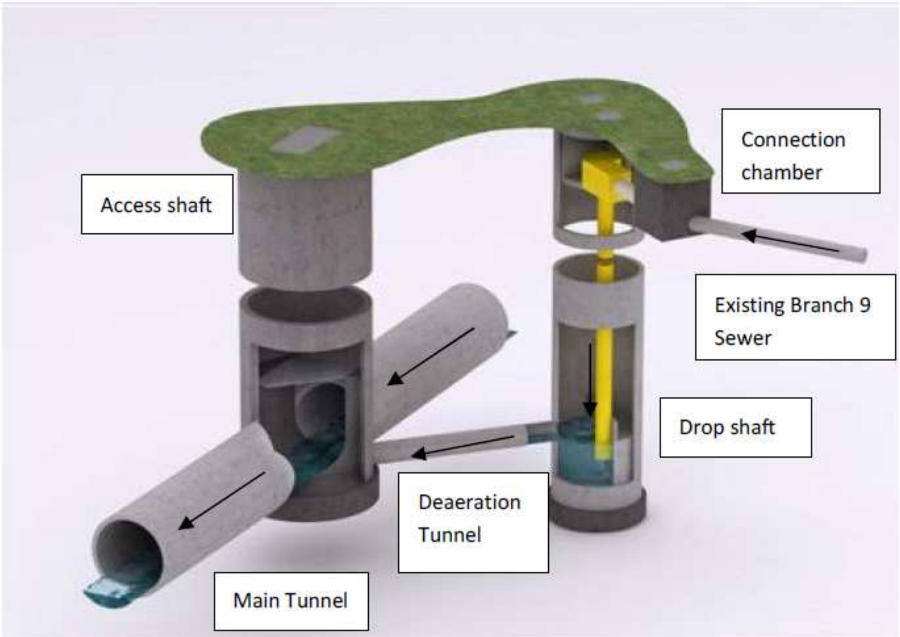

Figure 3: Indicative arrangement of access shaft, drop shaft, and de-aeration tunnel

5.30 By comparison, the link sewer sites will have combined access and drop shafts. This is possible because of the shallower depths and smaller flows, but is not possible for the access and drop shafts to the main tunnel.

Access shafts

5.31 The permanent access shafts will provide access to the main tunnel and link sewer tunnels and will generally be finished at ground level. However, at Pump Station 23 (Frederick Street) and Kiwi Esplanade the access shaft finished top levels will need to be raised up to 1.5 to 3 m above ground level. This is required in order to be above the maximum hydraulic level when the main tunnel fills to prevent overflow at these locations. The effect of these elevated structures can be mitigated by incorporating earthen mounds and other architectural elements, which will be discussed by Mr. Goodwin in his evidence.

5.32 Temporary access shafts will be required where the tunnel construction machinery (the TBM or Micro Tunnel Boring Machine ("**MTBM**")) is launched or retrieved. The temporary shafts will range in size and be somewhat bigger than the permanent shafts, particularly at the primary construction sites. These temporary shafts will be filled in and lined at the smaller diameter to form the permanent shafts at the end of main tunnel construction. The same applies for the shaft which will be used for the proposed Mangere Pump Station.

Drop shafts

5.33 Drop shafts are proposed for most sites. Several options have been assessed. The preferred type of drop shaft is the scroll vortex with plunge pool, similar to the type used on the Project Hobson. The vortex drop shaft operates by setting up a vortex in the flow, resulting in flow spiralling smoothly down the side walls of the drop structure to the base rather than simply plunging to the bottom. **Figure 4** below provides an illustration of a typical vortex drop shaft.

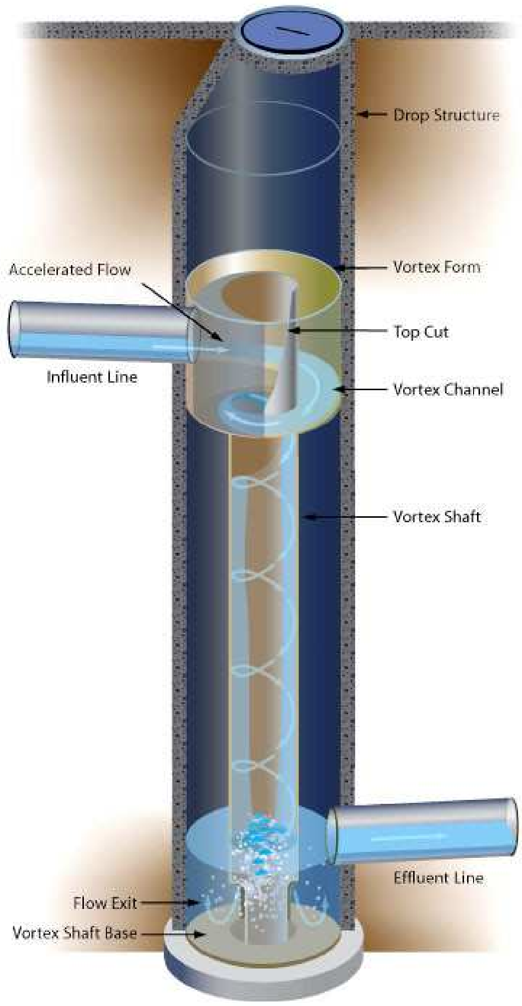

Figure 4: Typical Vortex Drop Shaft Arrangement (note: the effluent line connects to the main tunnel access shaft)

5.34 The diameter of the drop shafts varies depending on the incoming flows. They will generally be finished at ground level, apart from at Pump Station 23 (Frederick Street) and Kiwi Esplanade where they will be raised as described for the access shafts. One or more access covers will be provided for person and equipment access, including a hatch directly above the vortex to allow inspection. Access hatches will be designed to prevent unauthorised entry.

De-aeration tunnels

5.35 As shown above at **Figure 3**, de-aeration tunnels have been included at the main tunnel drop shaft locations. The de-aeration tunnel connects the drop shaft to the main tunnel. These comprise a length of hand driven concrete lined tunnel. These are designed to allow the air drawn down through the drop shaft to escape before it enters the main tunnel, reducing the potential for large and potentially damaging air pockets to be formed in the main tunnel when it is full during storage conditions. When the main tunnel is not full during storage modes, air expelled by the de-aeration tunnels into the drop shafts will be vented back into the main tunnel and treated at the proposed Mangere Pump Station air treatment facility ("**ATF**") which is discussed below.

Connection and control chambers

5.36 Connection and control chambers are proposed at connection points to provide inflow connections to the existing system and flow control features including control gates, stop logs or stop gates.

5.37 Automated control gates, housed in control chambers at several locations, will control inflows to the main tunnel. These gates are capable of controlling approximately 70% of all flows which will be diverted into the main tunnel, and are primarily there to prevent the main tunnel from overfilling. The control systems respond to both level sensors in the main tunnel and pumping rates at the proposed Mangere Pump Station to establish the need for limiting inflows. For purposes of the concept design development, control gates are set to close when the main tunnel approaches 70% of full depth at the top end at Western Springs, leaving some capacity for flows which cannot be diverted. The exact arrangement and settings of the control gates will be finalised during the detailed design stage.

5.38 The control gates and stop gates can be closed or partially closed, using the electric motor, to limit flows into the link sewers and main tunnel when the main tunnel is close to full, either in extreme weather conditions or in the event of failure of the proposed pump station. These gate systems will have a back-up mechanism which means they can be operated in the event of a power loss to the gate controls. Following closing of the gates, existing and new pressure relief points upstream of the gates would overflow. During a typical year of rainfall this is predicted to happen approximately 6 to 8 times, resulting in an average annual reduction of overflow volumes by approximately 80% once the main project works and CSO Collector Sewers are both completed.

5.39 As noted above, at the hearing I will illustrate typical arrangements of access shafts, drop shafts and control chambers by zooming in to the Western Springs and Mount Albert War Memorial Reserve locations in Google Earth. The features at each site can, however, be clearly seen in Drawings AEE-MAIN-1.1 and AEE-MAIN-2.1 on pages 21 and 38 of the Hearing Drawing Set.

Grit traps

5.40 Grit from the combined system will be collected at several locations where connections are made to combined sewers. New grit traps will be required at Motions Road, Western Springs and Pump Station 25 (Miranda Reserve) and the existing grit trap at Rawalpindi Reserve will continue to be used. A combined mixture of stormwater and wastewater will pass through the grit traps prior to the flow entering the tunnels. The grit traps will remove larger base load "grit" (such as large pieces of road seal chips, rocks and other debris) from the combined sewer areas, before flows enter the main tunnel. The majority of debris removed will come from stormwater runoff sources. Finer sediments and materials associated with wastewater will be passed down the main tunnel and pumped through to the Mangere WWTP for removal.

5.41 The grit traps will be similar to existing Watercare grit traps as shown on Figure 5-4 and 5-5 of the AEE. These are set out below as **Figure 5**.

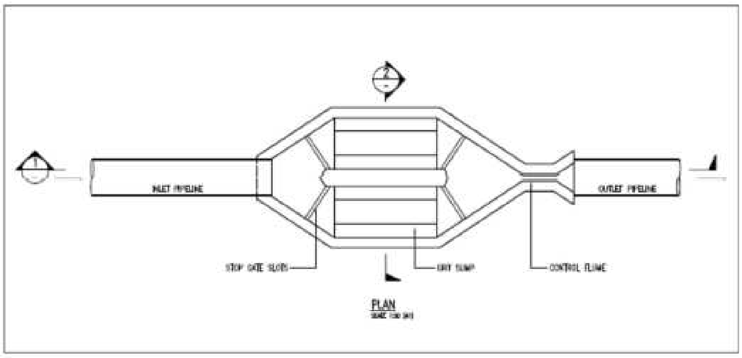

Figure 5-4 Typical grit trap arrangement

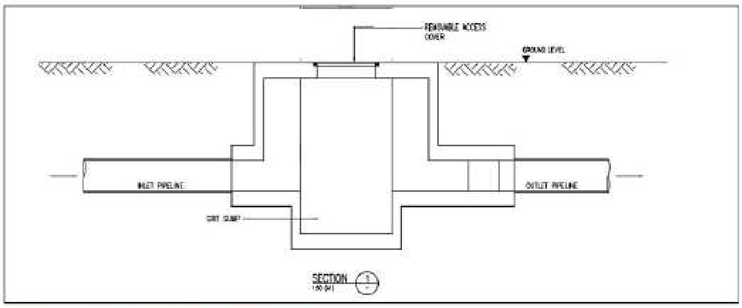

Figure 5-5 Typical grit trap section

Figure 5: Grit traps

5.42 The grit traps will be maintained under negative air pressure by the tunnel ventilation system at the proposed Mangere Pump Station to reduce the potential for odour during normal operation. They will require periodic cleaning to remove accumulated grit. Cleaning will occur in the same manner as for existing Watercare grit traps by the use of a mobile crane with a grab and sucker truck.

Air Flow and Odour Management

5.43 I will now describe the proposed air flow and odour management strategies for the main tunnel and link sewers. Management of air into, through and out of the main tunnel and link sewers is important to protect against odour and corrosion issues. It is also required to facilitate displacement of air when the main tunnel is filled to store excess wet weather flows periodically throughout the year.

5.44 The air flow and odour management system will be operated according to on-going conditions as described in the following scenarios. These scenarios will be referenced later on in my evidence to further explain how air from the Central Interceptor will be handled and treated. During the hearing I will provide an animation that will illustrate what happens during these four scenarios to explain how air will be managed, and how the tunnel will operate hydraulically.

(a) *Normal dry weather flow conditions (Scenario 1):* Wastewater flows are simply conveyed to the Mangere WWTP by the proposed Mangere Pump Station. The main tunnel is not storing any wastewater.

(b) *Wet weather flow conditions (Scenario 2):* Flows are higher. All current overflows from the system are captured and diverted to the main tunnel but the peak flows have not exceeded the capacity of limits imposed by the Mangere WWTP consent conditions. The main tunnel is not operating in storage mode, with the flows being conveyed to the Mangere WWTP by the proposed Mangere Pump Station.

(c) *Wet weather flow conditions as above but peak tunnel flows are greater than the consented capacity of the Mangere WWTP (Scenario 3):* All current overflows from the system are instead captured and diverted to the main tunnel but as peak flows have exceeded the consented capacity of the Mangere WWTP and the main tunnel is operating in storage mode, the proposed Mangere Pump Station is throttled and filling occurs from the downstream end of the tunnel at the Mangere WWTP.

(d) *Very large storm events (greater than a 2 year return period) (Scenario 4*): The main tunnel goes into storage mode and fills rapidly, creating an air pocket between the filled downstream end and a surcharged upstream section where flows exceed the conveyance and storage capacity.

5.45 The Central Interceptor will operate under Scenarios 1 and 2 for about 95 to 98% of the time (with variation depending on how much rainfall occurs in the year). Scenario 3 is predicted to occur around 6 to 8 times per year. Scenario 4 is predicted to occur around twice every five years.

Air treatment

5.46 The air flow management strategy for the Central Interceptor incorporates a combination of primary and secondary air treatment and involves a staged approach to construction of ATFs. In summary, the strategy involves:

(a) a primary ATF at Mangere Pump Station, with extraction fans drawing air through the main tunnel and link sewers for air treatment and discharge;

(b) a secondary ATF at Pump Station 23 (Frederick Street);

(c) a passive air treatment filter at Kiwi Esplanade; and

(d) additional ATFs at a later stage(s), if determined necessary, at May Road, Pump Station 25 (Miranda Reserve), and/or Western Springs. Similar strategies have been adopted at Watercare's Project Hobson tunnel and other similar tunnels overseas. In numerous cases, including Project Hobson, odour issues did not eventuate and additional air treatment was not required.

5.47 Under normal "dry weather" operating conditions (Scenario 1) the main tunnel will be maintained under negative air pressure, with air being continuously drawn into the main tunnel via air intakes and through the connections to the existing sewer network. Air will continue to be extracted, treated and discharged through the primary ATF under normal dry weather conditions and wet weather conditions when the main tunnel is not in storage mode (covering scenarios 1 and 2 described previously which represents 95 to 98% of the operating time). Maintaining negative air pressure throughout the main tunnel in these conditions ensures that odours will not be discharged at shaft sites along the alignment as air will be drawn in but not released.

5.48 When the main tunnel fills under certain wet weather events sufficient to cause the main tunnel to operate in storage mode (scenario 3), the air will be blocked from being extracted at the primary ATF. In this scenario, the air flow will reverse, pushing air back up the main tunnel and releasing it as the main tunnel fills. This will only happen when the wastewater has been very diluted with stormwater, meaning it will be less odorous. A secondary ATF is proposed to be installed at Pump Station 23 (Frederick

Street). This secondary ATF will aid in maintaining a negative air pressure throughout the main tunnel and will also treat odour at this shaft. The ATF will continue to ventilate and treat air once the lower end of the main tunnel fills in a storage condition (operational scenarios 1, 2, and the beginning of 3). Once the main tunnel fills to a certain level in the area of the Pump Station 23 site connection, the secondary facility will not operate as air will no longer be able to be extracted. This is estimated to occur for only 2 to 5% of the time.

5.49 If, after a period of operation, Watercare determines that there are odour issues associated with the Central Interceptor, then further options will be considered to supplement the initial odour management. During operation of the Central Interceptor, Watercare will monitor odour complaints at the various sites.

5.50 A similar approach was taken for the Project Hobson tunnel which has been on line for over three years. A primary ATF was installed at the pump station located at the bottom end of the Project Hobson tunnel using a biofilter system similar to what is proposed for the Mangere Pump Station as shown in **Photo 3** below. A secondary ATF was allowed for at the top end of the Project Hobson tunnel but has not been installed as odour complaints have not occurred.

Photo 3: Bio-filter located at the Project Hobson Pump Station

5.51 If odour is determined to be a problem, Watercare would look to implement additional ATFs as appropriate. The following options would be considered if necessary:

(a) An additional ATF can be installed at May Road to extract and treat air from Link Sewer 3 and the main tunnel between Western Springs and May Road if required in the future. This would boost the overall ventilation of the main tunnel and extend the time that a negative air pressure can be maintained in the main tunnel during Scenario 3.

(b) A primary/secondary ATF can be installed at Pump Station 25 (Miranda Reserve) to treat air from Link Sewer 3 if odour problems arise and require this.

(c) A secondary ATF can be installed at Western Springs to ventilate Link Sewer 1 and the upstream end of the main tunnel. This would be done if odour problems occur in this area, and addition of this ATF would result in a negative air pressure being maintained throughout Scenarios 1, 2 and 3.

5.52 The determination of whether additional ATFs are required will be established by Watercare based on complaints received in relation to odour. If complaints are received, then response procedures will be implemented and consideration will be given to the cause, frequency and intensity of odour. This would be an internal process and is consistent with Watercare's current management procedures for the wastewater network. Watercare does not propose to implement reviews at set frequencies or at set stages as, if there is no evidence of odour nuisance, a review would be unwarranted. In order to determine the need for any additional ATFs the following procedures will be implemented:

(a) Any customer complaints will be assessed, following existing standard practices, including:

(i) confirming that the Central Interceptor is the source of the odour; and

(ii) determining the operating mode of the Central Interceptor at the time of the complaint to ascertain whether the odour was associated with the tunnel.

(b) Assessment of the frequency of complaints and whether these have been repeat complaints related to a specific location. If it is determined that air was venting out of the shaft at the time of the complaint, monitoring will be undertaken to determine the frequency and duration of problematic odours.

5.53 If odour issues are significant in terms of frequency and duration, the appropriate treatment system for that shaft location will be implemented. The specific treatment system to be installed would be determined on a case-by-case basis having regard to recent operational experience at other sites and the latest technology which is available at that time. The time to implement a treatment system will be dependent on the scale of the system and availability. A likely timeframe range to implement an air treatment system is 1 to 12 months upon confirmation that action will be taken, though interim temporary measures are also possible.

Air intakes

5.54 Air intakes will be installed at a number of shaft sites as part of the air flow management strategy. These control air flows by drawing air in to balance air flows within the system. They will be manually adjusted during commissioning and operation of the Central Interceptor.

5.55 Air intakes have been allowed for at Western Springs, Lyon Avenue, May Road, Pump Station 23 (Frederick Street), Pump Station 25 (Miranda Reserve) and Haycock Avenue. During operational scenario 3, air cannot be extracted at the Mangere Pump Station ATF. In that scenario, air may vent out of these intakes as the main tunnel fills. This is estimated to occur approximately 6 to 8 times per year on average. Generally speaking the weather conditions will likely be raining and windy when these 6 to 8 events occur. As such it is not anticipated that this air will result in odour problems or complaints. Watercare will, however, monitor any complaints following procedures outlined in paragraph 5.52 above. If problems do occur, then supplementary ATFs described in paragraph 5.51 can be implemented to aid in mitigating this.

Pressure relief air vents

5.56 Infrequently during very large storm events (scenario 4, around twice in 5 years), an air pocket may be created between May Road and the Mangere ATF. Pressure relief air vents are proposed at Pump Station 23

(Frederick Street) and Kiwi Esplanade to release these air pockets. This air will not be treated, but is not expected to result in odour problems given the dilute nature of flow in the main tunnel and weather conditions associated with these activations.

5.57 During operational scenario 3, when air cannot be extracted at the Mangere ATF, air may also vent out of the pressure relief air vents at Pump Station 23 and Kiwi Esplanade. In these conditions the air at Kiwi Esplanade will receive some treatment through a passive air treatment filter proposed for this site. Air at Pump Station 23 will receive treatment through the secondary ATF filtering system proposed for this site.

5.58 The design and appearance of the structures will be determined as part of the detailed design. At Pump Station 23 the pressure relief air vent is likely to be combined with the ATF air vent. At Kiwi Esplanade it is proposed to incorporate the pressure relief air vent into a new toilet block structure.

Air vents

5.59 Air vents are required to discharge air after it has passed through the ATFs (apart from those using a biofilter such as the Mangere Pump Station site). At Western Springs, Pump Station 25 (Miranda Reserve), and Pump Station 23 (Frederick Street), these vents will be incorporated into the ATF building and will extend approximately 1 m high from the top of the building. At May Road, the air vent would be around 8 to 10 m high if this facility were to be installed. Again ATF facilities will only be constructed at Pump Station 25, May Road and Western Springs if there are odour issues associated with the tunnel operations.

Conclusion

5.60 The overall strategy for air management and treatment has been developed and incorporated into the proposed design, with input from international experts and has involved a review of similar overseas tunnels. Lessons from Watercare's Project Hobson described earlier, which has now been in operation for over three years, have also been incorporated into the design. It is apparent from the review that air management and treatment strategies vary widely and many cases have involved the installation of primary units (to maintain negative pressure during dry weather conditions) with provision for additional air treatment to be installed subsequently if required. More often than not these additional air treatment systems were not installed as odour issues did not occur. However, provision has been made in the design development for incorporation of these elements if required.

Wastewater Overflow Outlet Structures

5.61 New or replacement overflow outlet structures are proposed to be constructed at 7 locations (not including the proposed EPR structure at the Mangere Pump Station which is discussed in paragraph 5.68 below). **Table 5-5** of the AEE below provides a summary of these structures by location.

Site	Proposed works	Location
Western Springs CSO Collector	Upgrade existing overflow	Into pipe
Mount Albert War Memorial Reserve (AS1)	Existing overflow to be retained and upgraded	Into pipe
Lyon Avenue (AS2)	Remove existing overflow channel and replace with new culvert/pipe	Into stream
Haverstock Road (AS3)	New overflow (adjacent to existing overflow)	Into pipe
Motions Road (L1S1)	New overflow (x2) (close to an existing overflow)	Into stream
Rawalpindi Reserve (L2S1)	Improve existing overflows	Into stream
Norgrove Avenue (L2S2)	Replace existing overflows	Into stream

Table 5-5: Proposed overflow structures

5.62 These locations, which are all close to or adjacent to existing overflows, are upstream of control gates and are required so that in the event the control gates are closed, inflows to the main tunnel can be discharged in a controlled manner without causing flooding and damage. The overflows will only discharge when the main tunnel storage capacity is fully utilised (Scenarios 3 and 4, or approximately 6 to 12 times per year on average).

5.63 It is proposed that some new overflow structures be constructed rather than relying solely on existing overflows at these locations so that the structures:

(a) are designed on the basis of post Central Interceptor implementation flows;

(b) have a 100 year design life; and

(c) are located, where possible, in locations which are easier to access for inspection and maintenance purposes and which minimise environmental effects.

5.64 Designs are expected to meet the permitted activity standards for structures in watercourses in the Auckland Council Regional Plan: Air, Land and Water. Although new overflow structures are proposed, the volume and frequency of discharge at these locations will be significantly reduced. Other overflow structures in the network will remain as they are.

Mangere Pump Station Site Works

5.65 A pump station is required at Mangere WWTP to lift wastewater out of the main tunnel and pump it onwards to the inlet of the WWTP via a twin rising main. The concept design of the pump station includes elements which allow for careful control of flows into the Mangere WWTP, so as not to exceed allowable flow limits established in the current consent. Flows discharged by the pump station into the Mangere WWTP will automatically be ramped up and down based on the total measured flow into the plant. As the totals flowing into the Mangere WWTP approach the consented allowable daily volume limit, the pump station will automatically reduce flows such that the daily limit is not exceeded. Excess flow will be stored within the main tunnel during these conditions. The pump station will be of a similar concept to the recently constructed Pump Station 64 (Project Hobson) as shown in **Photo 4** below.

Photo 4: Pump Station 64 located at Watercare's Hobson tunnel.

5.66 A wet well/dry well arrangement with a dual wet well configuration housed below a superstructure containing electrical and control equipment and an overhead crane is proposed as shown in **Figure 6** (Figure 5-7 from the AEE) below. During the hearing I will zoom into the Mangere Pump Station location to explain the details using Google Earth.

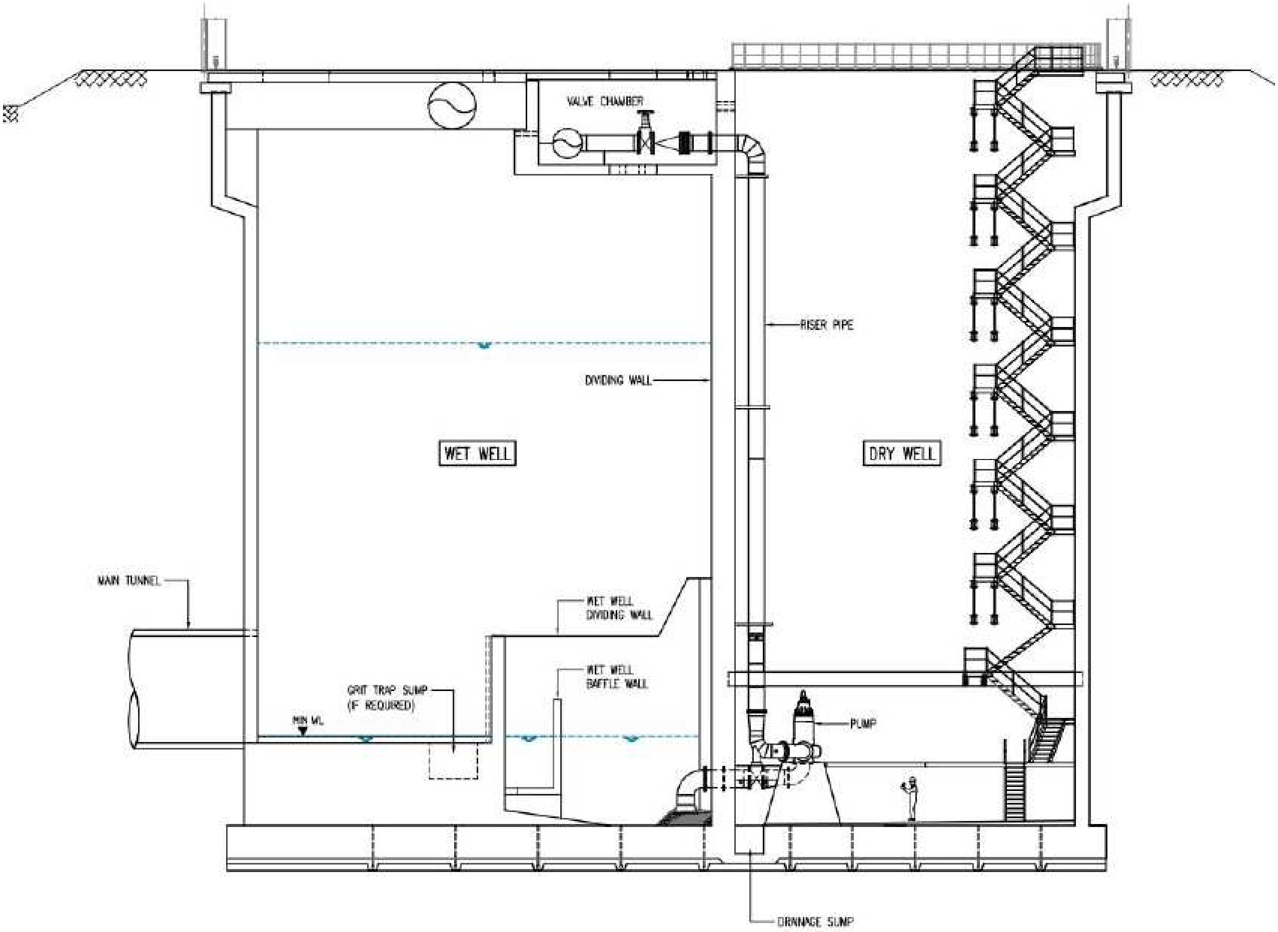

Figure 6: Pump station wet well/dry well arrangement

Emergency Pressure Relief

5.67 An EPR structure is proposed at the Mangere Pump Station site. This would allow for safe and controlled outflows in the event of extreme inflows to the main tunnel combined with an emergency event (e.g. pump station failure), thereby providing flooding protection for the main tunnel and Mangere Pump Station. Provision for an EPR structure at the Mangere Pump Station must be made to ensure that, under emergency situations, pressure can be safely released from the main tunnel without causing damage to the Mangere Pump Station or tunnel structures or causing uncontrolled overflows from shafts along the main tunnel alignment.

5.68 The likelihood of the EPR operating is very low, and would occur only where pump station failure coincided with a significant storm event that utilised all available storage in the main tunnel. Watercare's experience indicates that pump station failures are rare and caused primarily by power outage.

5.69 As stated in Section 5.11.5 of the AEE, activation of the proposed EPR at the proposed Mangere Pump Station requires a combination of events to occur. The AEE summarises the key events that, in combination, would lead to a potential activation of the EPR. The conclusion presented in the AEE is that the "EPR is unlikely to activate more than say once in every 50 years". We expand on that analysis below.

5.70 Activation of the EPR will only occur if there is failure of the Mangere Pump Station due to power loss or mechanical failure and it is not possible to bring the station back into service before the main tunnel is full. A number of elements have been included in the concept design of the Central Interceptor to minimise the likelihood of the EPR activating (e.g. control gates to restrict inflows to the main tunnel, pump redundancy in the pump station, tunnel sizing to provide for storage), and Watercare has measures in place to ensure continuity of power supply. These items are discussed below:

(a) Approximately 70% of the flows into the main tunnel can be controlled with inlet flow gates. If a problem occurs at the Mangere Pump Station, Watercare will have the ability to divert all but about 30% of the tributary flows away from the main tunnel, either into the existing trunk sewer system or to existing overflow locations. These gates will have fail safe features which means they can be activated without power should the power loss event be wide spread. Diversion of flows from the main tunnel by gate closure will reduce the rate of tunnel filling, the likelihood of EPR activation, and the magnitude of any flow at the EPR if it was to activate.

(b) The concept design for the proposed Mangere Pump Station includes mechanical redundancy such that if one pump fails, other pumps are in place and will automatically come on line. The pump station structure has also been designed to prevent flooding of the mechanical and electrical areas. The combination of these elements minimises the likelihood of a total mechanical failure of the pump station.

(c) If pump station failure occurs during a 10 year storm event it would take approximately 12 hours for the storage in the main tunnel to fill. The EPR would only activate once the tunnel is full. In dry weather conditions it would take closer to 48 hours for the main tunnel to fill if the pump station is out of service.

(d) If pump station failure occurs due to power outage, Watercare has backup generator services on standby. Based on current operational performance, the time taken to return power supply to the pump station using backup generators is expected to be within four hours, minimising the likelihood of EPR activation and the magnitude of any flow at the EPR if it was to activate.

(e) Further, the Mangere WWTP has a dual power supply feed which will be used to provide power to the Mangere Pump Station. This greatly reduces the chance of a power supply failure, and in particular, an extended power supply failure.

5.71 Numerous factors require consideration to estimate the probability of the EPR activating. These include an assessment of the combined probability of weather conditions, power loss to the Mangere Pump Station, and the time taken to implement measures that return the pump station to service. Each of these events has an independent likelihood of occurrence, and a combination of all (i.e. large storm event, pump station power loss and delays to mobilise backup power in sufficient time) is required to activate the EPR discharge.

5.72 In this regard, the likelihood of the EPR being called into service is very low. It would require failure of the Mangere Pump Station over an extended duration (many hours) coinciding with a significant storm event that utilised all available storage in the main tunnel. The likelihood of these events coinciding is extremely small and it is considered that the

EPR is unlikely to activate more than once in every 50 years. Additional details of the likelihood and causes of the EPR activating are provided in the Section 92 Response provided to the Council on 27 May 2013.

Permanent Site Access

5.73 Permanent access ways will be required at the shaft sites to allow for occasional inspection and maintenance access. Generally these will be constructed to form an all-weather trafficable area. Where appropriate and practicable, the use of material such as grass cell paving or similar will be used to enable tie in with surrounding grassed areas and green open space. The final design of permanent access will be influenced by the long term operational requirements for access at each site.

Stormwater Management (Permanent)

5.74 The permanent features that remain at the sites following construction will increase the impermeable area at almost all of the sites. The two notable exceptions are Western Springs Depot and the Mount Albert War Memorial Reserve Car Park site, both of which are fully sealed at present and there will be no increase in impervious area.

5.75 At sites where there is only a minor increase in impervious surface area from the existing situation (i.e. less than an additional 1,000m^2), storm water runoff will either enter existing overland flows to discharge to current receiving environments, or will be directed to the reticulated stormwater network.

5.76 At Pump Station 23 (Frederick Street) there will be a small increase in the existing impervious surface area of the site due to the permanent works. Much of the existing impervious area at the site is due to the site access. As the impervious area at this site will be over 1000 m^2, stormwater from the site will be treated with appropriate measures.

5.77 Five sites will involve more significant increases in impervious surface coverage. These sites are Western Springs, Haverstock Road, May Road, Mangere Pump Station, and Pump Station 25 (Miranda Reserve). Permanent stormwater treatment and indicative layouts for these sites have been developed and are illustrated on Drawings SW-MAIN-1, SW-MAIN-2, SW-MAIN-3, SW-MAIN-4 and SW-MAIN-5 on pages 25, 74, 92, 139, and 185.

5.78 All stormwater management devices will be constructed and maintained generally in accordance with Auckland Council's Technical Publication 10 "Design guideline manual stormwater treatment devices" ("**TP10**").

Operations and Maintenance

5.79 Watercare operates the wastewater network to safely manage dry and wet weather flows, to reduce and control odours and overflows, and to comply with all legal requirements. The Central Interceptor will provide conveyance for dry and wet weather flows and online storage capacity within the main tunnel for storm events.

5.80 Inspection and maintenance is likely to be similar to Watercare's current regime, including regular weekly/fortnightly checks of critical equipment such as the proposed Mangere Pump Station and ATFs and regular but less frequent inspection of control and connection chambers etc. Maintenance requirements would be identified and addressed as required. The Central Interceptor has been designed, as far as possible, to minimise operation and maintenance requirements. In particular, I note that:

(a) Ongoing access will be required at all shaft sites for inspection and maintenance and permanent vehicle access will be required. Generally access will be required approximately once per month for activities such as inspecting and maintaining flow controls, inspecting shafts, and checking air intakes. Grit traps will require emptying and cleaning approximately four times per year.

(b) The access shafts allow for personnel and equipment to gain access for any inspection and maintenance requirements, such as sediment or blockage clearance, tunnel repairs etc. At sites where the only permanent feature is an access shaft, routine access will only be required on an infrequent basis to carry out inspections unless maintenance is required. These routine activities will typically involve one vehicle movement each visit, although a mobile crane may also be required if maintenance is warranted.

(c) Routine inspection and maintenance will be required of ATFs approximately once a week. Replacement of odour treatment media will be required periodically. Actual requirements will depend on the type of treatment facility implemented.

(d) Watercare envisages that normal operation of the Mangere Pump Station would be from its existing central control room with the ability for local and manual operation as necessary. The pump station will be divided into two sides so that either side can operate independently during maintenance. An overhead gantry crane will lift workers and equipment into and out of the wet well and equipment into and out of the dry well for maintenance. Regular inspection and maintenance of mechanical and electrical equipment in the dry well would be required and would be accessed by lift and stairs.

6. CONSIDERATION OF ALTERNATIVE ALIGNMENT AND CONSTRUCTION OPTIONS

6.1 As discussed by Mr Munro, the concept of the main tunnel and link sewers was chosen as the overall preferred option to address the identified key Project drivers of critical asset duplication, capacity and control of targeted wastewater overflows. Mr Munro has explained the other alternative options which were considered and rejected prior to the Central Interceptor Scheme being selected as the preferred option. This includes options assessed as part of the Three Waters Strategy Plan, and additional options assessments conducted as part of the project work which preceded the concept design development.

6.2 I will now provide a description of the various alternatives considered for determining the preferred alignment and concept design of the Central Interceptor itself.

Main Project Works Alignment and Design Options

6.3 In developing the Central Interceptor a detailed evaluation of options has been undertaken, including:

(a) alternative alignments (horizontal and vertical);

(b) alternative configurations at construction and connection sites;

(c) alternative construction methods;

(d) alternative permanent works facilities; and

(e) operational provisions for managing discharges from the network.

Selection of the Main Tunnel Alignment

6.4 I have prepared a slideshow for the hearing to present an overview of the process followed to determine the preferred horizontal and vertical alignment of the main tunnel.

6.5 The development of the main tunnel alignment has involved the evaluation of hundreds of alternative alignments. Central to the consideration of the appropriateness of these alternatives has been:

(a) the need to provide connections to the key points in the transmission sewer network that address flow conveyance and future capacity requirements, and also where major overflow locations exist; and

(b) the duplication of the Hillsborough Tunnel and Manukau Siphon section of the Western Interceptor.

6.6 These key locations are shown on **Figure 1.1** of the Hearing Drawing Set.

6.7 Additional alignment evaluation criteria included:

(a) meeting hydraulic grade requirements to:

(i) ensure a self-cleansing velocity so that materials will not be deposited; and

(ii) allow for future possible extensions of the main tunnel into the Central City (the potential for the Waterfront Interceptor has been discussed in the evidence of Mr Munro);

(b) geotechnical constraints for tunnelling including basalt or other unfavourable ground;

(c) minimising environmental effects along the alignment including surface site locations;

(d) constructability considerations such as sites large enough for shaft installations; and

(e) the overall cost of each alignment option. Alignments were considered both in terms of their vertical and horizontal extent, and a range of potential construction methods were evaluated, included tunnelling, micro tunnelling, directional drilling and open trenching.

6.8 Multiple alignments were considered and a short-listing process was used to establish the more appropriate alignments which were then subjected to more detailed consideration. These shortlisted alignments were then compared by scoring each utilising a Multi Criteria Analysis process which took into account network functionality, operational factors, and environmental, social, cultural and economic considerations. Following the assessment of each shortlisted alignment, the preferred alignment was further fine tuned following site inspections and consultation with affected landowners. This allowed the alignment to respond to site-specific requirements and local factors which has resulted in an alignment that "fits" the surrounding environment to a high degree. **Figure 1.1** of the Hearing Drawing Set shows the outcome of this process to confirm the preferred horizontal alignment. I will illustrate this process with a number of powerpoint slides during the hearing.

Alternative Tunnel and Liner Options

6.9 The preferred main tunnel horizontal and vertical alignment, construction method, and liner type have all been subject to evaluation. Horizontal and vertical alignment considerations and options have been discussed previously, as well as envelopes required to optimise the final designs.

6.10 The main tunnel will most likely be constructed as a bored tunnel utilising a pressurised face TBM to allow for the poor ground conditions between Hillsborough Bay and the Mangere WWTP. Alternative tunnelling methods are possible, and final methods will be selected by the contractor. These methods could include some other form of TBM or use of a roadheader machine, which Mr Cooper will explain in more detail in his evidence.

6.11 Construction of the tunnel liner is important for managing the potential risk of land settlement and provide for the durability and conveyance needs of the wastewater network. The tunnel liner will most likely comprise a low permeability segmental liner placed by the TBM. This will address any long-term ground settlement risks and structural stability requirements. An unlined tunnel or a tunnel liner with high permeability construction would not meet engineering design requirements.

Odour Treatment Options

6.12 Where odour treatment facilities are proposed, a range of options have been considered for the type of treatment facility to be used. These include:

(a) Biofilters - these involve passing an air flow through a bed of organic media (wet compost, soil, wood chips), with the media acting as a surface for both physical adsorption processes and biological processes where bacteria growing on the media act to remove the odour generating molecules. Biofilters are generally lower in cost than other technologies, and are also simpler to maintain. They have a very low vertical profile (in many cases can be flush with the existing ground), but require an acceptable area to fit within as they are generally larger in area than other technologies such as bio-trickling filters (discussed below). Watercare has successfully used biofilters at a number of locations including the Mangere WWTP and Pump Station 64 (Orakei) referenced below in paragraph 6.13.

(b) Activated Carbon - air flow is passed through a bed of granular media (activated carbon) and odour molecules are physically adsorbed onto the media surface. These systems are usually installed where the peak air flow rates are fairly low, and the air discharges are periodic and not continuous.

(c) Biotrickling Filter - these scrubbers are similar to biofilters, but use a synthetic media packed into a tower configuration as opposed to natural wood chips spread out over a larger area.

The odorous gas stream passes up through the synthetic media within the tower in order to remove odorous compounds. These systems are typically applied when surface space is limited, the peak air flow rates are fairly high, air discharges are more continuous or the concentration of potential odours is high. This technology is typically much more expensive than biofilters, and the operation cost are higher.

(d) Biotrickling Filter and Activated Carbon - in some cases, a combination of biotrickling filters and activated carbon can be required due to the high peak air flows, limited space and particular aspects of the compounds in the air which can result in odours.

(e) Chemical Scrubbing - involves passing the airflow through a chemical mist, typically utilising an oxidising agent such as hydrogen peroxide to chemically remove the odour from the air.

6.13 As stated above Watercare currently operates biofilters at a number of sites on the wastewater network, including at the new Pump Station 64 at the downstream end of the Project Hobson tunnel. As a result of the biofilter currently in place at Pump Station 64, Watercare has received no odour complaints associated with the Project Hobson tunnel since it was implemented over three years ago. The biofilters have proven to be successful in terms of controlling odour, and are preferred due to reasons of cost and lower overall maintenance requirements. They also provide an advantage of having a very low vertical profile, making it easier to minimise visual impacts. At some sites such as Pump Station 23, space limitations will likely preclude the use of biofilters, and other systems like biotrickling filters will need to be considered.

Alternative Locations for EPR Discharge

6.14 As discussed above, an EPR point is needed so that in an extreme or emergency event inflows to the main tunnel can escape in a controlled manner without causing widespread flooding and damage. The EPR point needs to be at the low point in the system to operate simply by gravity and provide a "fail safe" back up that is not reliant on any form of mechanical or electrical equipment. This approach represents best practice engineering design.

6.15 These requirements dictate that the only feasible location to place an EPR is near the bottom end of the main tunnel which would discharge into the Manukau Harbour. Various sites were assessed for this, including the proposed location adjacent to the Mangere Pump Station, use of the existing Mangere WWTP discharge channel, Pump Station 25, Pump Station 23 and at Kiwi Esplanade. Sites other than the proposed Mangere Pump Station location proved to not be hydraulically feasible or presented risk in terms of operational access requirements.[2] The hydraulic capacity of the existing discharge channel is not sufficient for both the EPR and treated flows from the Mangere WWTP, which dictates that the EPR will have to discharge near the Mangere Pump Station along the Manukau Harbour foreshore. Options were assessed to extend the EPR further into the Manukau Harbour, such as the Purukau Channel, but this was determined to not be feasible. This would require pumping of flows which is not practical, nor would it work in a power outage scenario that results in the EPR activation.

6.16 Following consideration of various locations, Watercare determined that the proposed Mangere Pump Station site was the preferred location for the EPR due to its proximity to the Mangere WWTP, which offered site staffing with better support than other locations in the event of activation and better access for any maintenance requirements, and its remoteness from the public which reduced safety and public health risks. It was also the only location that could operate simply by gravity and not be reliant on any mechanical systems.

Alternative Construction Site Layouts

6.17 Alternative layouts for each of the construction sites have been considered during the development of the layouts now proposed. The design process has aimed to minimise impacts of the construction activities on neighbours and on site features, uses and values while still meeting key technical constraints. A summary of alternative considerations for each site prior to lodgement was presented in Table 7-2 of the AEE and further detail of the options considered for each site was contained in Part B of the AEE. The proposed layout for each site, as shown in the drawing set in Part C of the AEE, reflected the consideration of alternatives as at the date of lodgement. A number of these have been

2 More detail on this was provided in the Section 92 Response provided to the Council on 27 May 2013.

updated over the last 12 months, and the current proposed layout for each site is shown in the Hearing Drawing Set.

6.18 It is important to note that construction site layout options have been developed and modified based on inputs received from various parties during the consultation process (as described by Ms Petersen). Key factors in assessing each option include both technical requirements, environmental effects and the concerns of the local community. My evidence focuses on the technical requirements.

6.19 Examples of key technical considerations applied in the assessment of construction site layout options for Mount Albert War Memorial Reserve, Lyon Avenue, Keith Hay Park and Kiwi Esplanade are as follows:

(a) The key technical requirements at Mount Albert War Memorial Reserve include the need to connect to a local overflow, Watercare's Branch 8 sewer, and Link Sewer 2 which connects to the Orakei Interceptor and targeted overflows. This location requires an access shaft to the main tunnel, a drop shaft and a hydraulic control chamber.

(b) The key technical requirement at the Lyon Avenue site is connection to the combined sewer overflow, which is by far the largest overflow in the combined sewer system. This connection requires an access shaft to the main tunnel, a drop shaft and a hydraulic control chamber.

(c) The key technical requirements for the Keith Hay Park site include connections to Watercare's existing Branch 9 and 9B trunk sewers to provide additional conveyance capacity, and a permanent access shaft on the main tunnel for long term inspections and maintenance. This site will require a drop shaft and access shaft.

(d) The site at Kiwi Esplanade is required to access the tunnel both during construction and for long term maintenance. It is also required to provide an air venting point during very large storms to prevent hydraulic problems from occurring, and to also make a connection to the local system servicing the Mangere Bridge area. This location requires an access shaft, a drop shaft and a pressure relief air vent. The shafts need to be elevated approximately two meters above the ground due to hydraulic requirements.

6.20 Summary assessment tables for options considered at these four sites are included in Ms Petersen's evidence. The option assessments undertaken have included consideration of the key technical requirements I have noted. A wide range of options have been considered and the proposed route and construction site locations have been chosen to meet key technical requirements, and also minimise impacts on local communities and the environment to the extent practicable. In some cases, not all local community effects during the construction period can be fully avoided, remedied or mitigated to the extent some parties have sought, but in all cases these effects have been taken into account in the development of the concept design and changes have been incorporated at some sites where it was possible to do so.

7. RESPONSE TO SUBMISSIONS

Overflow Management by the Central Interceptor

7.1 The submission from St Lukes Environmental Protection Society ("**STEPS**") states a concern regarding centralising all of the overflows into the Meola Creek. While overflows will still be required along the Meola Creek, all overflows are not being consolidated to the Meola Creek. In fact the goal of the Central Interceptor tunnel is to reduce the total volume of overflows into the Meola Creek by approximately 80% for a typical year of rain. This is based on current measured volumes and estimated volumes resulting from future growth and development.

7.2 The goal is to achieve an 80% reduction of overflow volume into the Meola Creek (and other targeted urban streams) upon completion of the Central Interceptor Scheme, and to maintain this performance through the 50-year design life of the system. The Central Interceptor Scheme will have a significant beneficial impact by reducing wastewater overflows and associated pollution into Meola Creek and areas of the Waitemata Harbour around Meola Reef and Point Chevalier Beach.

Effects of the Central Interceptor on the Base Flows of Urban Streams

7.3 The submission from STEPS states a concern around the effects of the Central Interceptor on base flows in the Meola Creek. The Central Interceptor Scheme is only targeting control of wastewater overflows which activate during wet weather conditions, and as such are not a component of stream base flows. Stream base flows are defined as the water present when it is not raining. While rainfall and the effects on groundwater contributions do impact baseflow conditions, stormwater associated with wastewater overflows are not part of this as they only activate when it rains and do not contribute to the groundwater as they spill directly into the streams. In fact the Central Interceptor Scheme will have beneficial effects on the stream hydrology and associated aquatic habitat as it will reduce high peak storm flows in the stream which cause detrimental impacts on the environment.

The Amount of Additional Stormwater Associated with the Central Interceptor

7.4 The submission from Laingholm District Citizen's Association discusses concerns around the additional amount of stormwater associated with the main tunnel.

7.5 During dry weather conditions the main tunnel only collects and conveys flow already going the Mangere WWTP. It will not impact on the volume of wastewater delivered to Mangere WWTP in dry weather conditions.

7.6 During wet weather conditions the main tunnel has been designed to capture a large proportion of wastewater overflows which currently discharge from 122 locations into local streams and out to the Waitemata Harbour. These overflows contain a mixture of wastewater and stormwater, and discharge untreated at various locations including urban streams and coastal areas. As a result of the main tunnel these overflow volumes will be substantially reduced which results in a significant reduction of pollution to the environment. The amount or additional stormwater captured by the main tunnel and ultimately treated at Mangere WWTP is very small on an annual volumetric basis. The additional volume of wastewater and stormwater captured by the main tunnel and delivered to Mangere WWTP for treatment is less than 2% of the current total volume which goes through the plant on an average year.

8. RESPONSE TO COUNCIL PRE-HEARING REPORT

8.1 Section 15.1 of the Council's Pre-hearing Report requests that further evidence is provided in respect of the proposed EPR discharge, including the assumptions on the discharge scenario considered in the assessment of effects and the alternative EPR locations considered by Watercare. I respond to the following requests for additional information:

(a) the contributing catchment and planned pump station capacity;

(b) the storm scenario used to assess the EPR discharge;

(c) the quantity and quality of the EPR discharge and a comparison of pollution loads in EPR and permitted WWTP discharges;

(d) alternative locations considered by Watercare for the EPR discharge;

(e) the potential adverse effects on the environment; and

(f) the ability to pre-empt the EPR discharge occurring.

8.2 Evidence presented by Mr Roan and Ms Petersen will provide a response to clarifications requested in Section 15.1 of the Council Pre-hearing Report which are not addressed in my evidence.

The contributing catchment and planned pump station capacity

8.3 Map 1 in **Appendix B** depicts the entire wastewater area to be served by the Central Interceptor Scheme in normal flow conditions. Map 2 in **Appendix B** depicts the areas which could be diverted away from the Central Interceptor main tunnel in the event that the EPR would need to be activated.

8.4 The concept design for the Central Interceptor Scheme includes automated control and manual stop gates which can be operated to reduce and/or divert flows that will go into the main tunnel under normal flow conditions. Automated gates will close prior to an EPR activation as water levels in the tunnel will have already reached set points indicating the tunnel is full. If there is a problem with the proposed Mangere Pump Station, Watercare's operational staff will also have sufficient time to close additional manual operated gates to further isolate flows, as the tunnel provides up to a 12 hour storage time during a 10-year storm event (and even longer in smaller storm events). Essentially up to 70% of flows can be diverted away from the main tunnel, minimising the impact and likelihood of the EPR discharge. Flows which are diverted will either drain to the Mangere WWTP via existing trunk sewers, or will overflow at existing overflow locations that currently operate much more frequently than 1 time every 50 years.

8.5 The proposed Mangere Pump Station will have a maximum conveyance capacity of 6 m^3/s at startup, with the ability to ramp flows up and down based on available capacity at Mangere WWTP within the consented limits. There will likely be 6 pumps which have a combined capacity of 6 m^3/s. This provides multiple redundancy and also allows the rotating of each pump from duty to standby to optimise the long-term use and ensures that if one pump fails, other pumps are in place and will automatically come online. The hydraulic model was used to simulate the Central Interceptor Scheme with a 6 m^3/s pumping station capacity over a full five years of continuous rainfall data. This was done to ensure the pumping capacity is sufficient to achieve targeted results for overflow reductions, operate within the consented flow limits of the Mangere WWTP, and minimise the probability of EPR activation.

Storm scenario used to assess the EPR discharge

8.6 A 10-year return period design storm event was applied to the Central Interceptor Scheme hydraulic model to estimate a worst case scenario discharge event from the EPR if the proposed Mangere Pump Station failed. This is on the basis that peak stormwater inflows into the wastewater system would not increase beyond a 10-year storm event due to inlet capacity restrictions, and also the combined probability of the proposed Mangere Pump Station failing during a 10-year storm is in excess of a 1 in 50-year probability.

8.7 The 10-year storm event was developed on the basis of guidance provided by Technical Publication 108, developed by the former Auckland Regional Council (1999), which predicts a total 24-hour volume of rain of 120 to 130 mm. For this storm scenario the proposed Mangere Pump

Station was effectively shut down in the model for the entire design storm event (ie the full 24 hours). This resulted in a predicted discharge of 511,000 m^3 from the EPR. It is worth noting that for this simulation the rainfall was applied to the entire wastewater system tributary to the Mangere WWTP. This is a conservative assumption as in most storm events rainfall does not occur evenly across very large catchment areas like the simulation has done.

Comparison of pollution loads from EPR and permitted WWTP discharges

8.8 To assess the effects of pollution loads from the EPR discharge a comparison was made to permitted discharges from the Mangere WWTP, via the approved bypass, which occur during large storm event conditions. Monitoring and sampling data was reviewed for the approved bypass at the Mangere WWTP which activates during large storm events to prevent exceedance of the biological nutrient removal ("**BNR**") and primary unit process capacities. This approved bypass activates approximately 6 to 10 times per year during an average year of rain, and more frequently for greater than average years of rain. Flows which are bypassed are required to receive UV disinfection before being discharged.

8.9 Data from 2008 was reviewed to establish the activation of the approved bypass during large storm events, as the single largest event occurred on 28 July 2008, which resulted in 661,000 m^3 being bypassed around the BNR processes. While this was a large storm event, data from the Auckland Council rain gauge at Albert Park shows that the maximum 24 rainfall volume for this event was approximately 90 mm, indicating that the 28 July storm was less than a 5-year event. From this it can be concluded that for a 10-year storm event discharge from the EPR, the discharge volume from the EPR will be less than what is discharged via the approved bypass in a less than 5 year storm, and the frequency of discharge from the EPR, which has been estimated at no more than 1 event every 50 years (as opposed to 6 to 10 times each year for the approved bypass), is substantially less.

8.10 Additional analysis was also undertaken on the pollution loads associated with the 10-year storm EPR discharge and the largest discharge from the approved bypass which occurred in 2008. Sampling data from the Mangere WWTP during the 2008 storm event was reviewed to assess the bypass pollutant concentrations. This was done by averaging the concentrations of wastewater samples collected from the raw influent and influent to the BNR processes which accounts for the effect of primary treatment.

8.11 Flows in the approved bypass channel for these very large events are a mix of screened raw influent wastewater and wastewater which has received primary treatment. Parameters, including BOD, TSS, ammonia and TKN[3], were evaluated as they receive no treatment in the bypass channel as they are unaffected by UV disinfection (which is the only treatment that occurs in the approved bypass). These same parameters were evaluated for the EPR discharge by analysing samples collected from the Lyon Avenue CSO, which is by far the largest overflow in the system. (This is on the basis that flows discharging from the EPR during a 10-year storm would be consistent with the quality of a combined sewer overflow in terms of diluted concentrations.)

8.12 The results of this analysis shows that for the parameters assessed, the concentrations within the approved bypass channel are approximately 4 times higher than concentrations in the EPR discharge. The conclusion is that for a 10-year storm event a discharge from the EPR, with exception to bacteria, would contain pollution loads that are approximately 4 times less than the loads discharged from the approved bypass in less than a 5-year storm. Furthermore, over a 50-year period the pollution loads discharged from the EPR would be only a small fraction of what is discharged from the approved bypass. Although bypass flows do receive UV disinfection which reduces the pathogens, pathogens discharged from the EPR on the basis of no more than 1 time every 50 years would only have a temporary effect which can be managed through appropriate advisory notices and cleared through tidal flushing.

8.13 It is also worth noting that Watercare's proposed wet weather treatment facility, which is expected to be implemented in parallel with the Central Interceptor Scheme, will result in an enhanced treatment of approved bypass flows. As a result of this, total pollutant loads currently discharged to the Manukau Harbour will be further reduced even with loads from the EPR discharge included.

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3 Biochemical Oxygen Demand ("**BOD**"), Total Suspended Solids ("**TSS**") and Total Kjehldahl Nitrogen ("**TKN**").

Alternative locations considered for the EPR discharge location

8.14 The assessment of the options for the EPR discharge location was undertaken on the basis that the EPR must be able to operate by gravity with no required mechanical intervention that would be subject to failure in a power loss event. This is critical for the functionality of the EPR. Consideration was given to options for the discharge location of the EPR, including the proposed shoreline discharge and locations further out into the Manukau Harbour which would provide greater dilution. As noted above, Watercare considered various locations for the EPR and concluded that the current location was the preferred site that was both hydraulically feasible and presented the least risk in terms of operational access and overflow response requirements.

8.15 The Council Pre-hearing Report sought further information in relation to the feasibility of an EPR structure in the Purakau Channel as this option was considered by the Council's reporting planner to be a viable option to ensure better dispersion. Given the near shore topography and tidal ranges, a discharge location in the Purakau Channel would require a pipeline of approximately 4.5 km in length to be installed at a sufficient depth. This arrangement would likely require an additional pump station as the length of the pipeline would mean that the pipeline would be unable to operate by gravity.

8.16 This option would be unable to operate without an additional pumping station and could be subject to failure in a power loss event similar to the proposed Mangere Pump Station. This would actually defeat the purpose of having an EPR. In addition, it would be impractical given that the pump station would sit dormant for many years waiting for an EPR discharge to occur.

8.17 Assessment was made on the option of discharging into the existing Mangere WWTP discharge channel. The design capacity for the effluent channel is 20 m^3/s. The current consent allows for up to a peak flow discharge of 14 m^3/s over a 24 hour period and even higher for a shorter period. Given the potential peak flow rates from the EPR in a very large storm event, it was determined that the existing channel does not have sufficient capacity to convey both the Mangere WWTP discharge and the EPR discharge in a large storm event.

8.18 Given that the options of discharging further out into the harbour or use of the Mangere WWTP discharge channel were determined to not be technically feasible, the costs of these options were not investigated in detail.

Potential adverse effects on the environment

8.19 The Council Pre-hearing Report seeks further clarification on the potential adverse effects on the environment, including effects on sediment quality from the discharge of stormwater and toxic contaminants at the proposed location; effects on the shoreline of Ambury Park and Puketutu Island when considering existing and future use of open public space and esplanade reserves; effects from the potential discharge of litter and floatable solids (if any).

Stormwater discharges

8.20 Pollution loads from the EPR discharge including parameters associated with stormwater represent a small fraction of loads associated with the approved bypass. Furthermore the proposed wet weather treatment facility will further reduce stormwater pollution loads associated with the approved bypass, resulting in a net decrease in present day loads with the EPR discharge included.

Effects on Ambury Park and Puketutu Island

8.21 In terms of effects on the shorelines of Ambury Park and Puketutu Island, again the probability of the EPR discharging is no more than 1 time every 50 years. Given that pollution loads associated with a discharge from the EPR are much smaller than loads associated with the approved Mangere WWTP bypass, coupled with the infrequency of any discharge from the EPR, effects on shorelines would be no more than minor and short-term in nature. Mr Roan provides further comment on this in his evidence.

Potential discharges of litter and floatable solids

8.22 The concept design of the EPR includes the ability to screen any discharge, so it is not anticipated that litter and floatable solids would be a problem in the event of an EPR activation.

The ability to pre-empt the EPR discharge occurring

8.23 Monitoring systems will enable Watercare to predict activation of the EPR well in advance of an event. This includes telemetry systems which will monitor water levels in the tunnel and the operation of the Mangere Pump Station. In the event that the Mangere Pump Station ceases to operate, including a power failure, telemetry systems will provide an alarm indication to Watercare's operators. In this event storage time available in the tunnel will allow operators to take appropriate action to try and prevent or mitigate EPR activation, including mobilisation of portable generators or operating control gates to divert flow away from the main tunnel. Sensors in the tunnel will provide real time information on water levels and the rate of rise of water levels, which can be used to predict when an EPR activation would occur.

9. CONCLUSIONS

9.1 Development of the concept design, Notices of Requirement and consent applications for the Central Interceptor Project represents the culmination of a 4-year project which confirms that the Central Interceptor Scheme is the best practicable option to address the following key drivers:

(a) duplication of the ageing Western Interceptor to provide safe/long-term conveyance of wastewater across the Manukau Harbour to the Mangere WWTP;

(b) additional conveyance capacity to prevent overloading of existing trunk sewers due to planned growth and development within Auckland; and

(c) reduction of targeted wastewater overflows and associated pollution to address issues of public health, environmental and cultural effects.

9.2 The Central Interceptor Scheme represents international best practice in terms of methods for addressing issues of a similar nature and scale as discussed in paragraph 9.1. Relevant and similar examples include wastewater tunnel systems implemented in Sydney, Chicago, Cleveland, Indianapolis, Milwaukee, Washington DC, Boston, London and Brighton. In each of these cases, it was determined that a tunnel system similar to the Central Interceptor Scheme was the best practicable option compared to other options including system-wide sewer separation, local storage tanks, or local treatment systems.

9.3 Over 500 different alignment options for the Central Interceptor have been assessed, and the Project has been confirmed as the preferred alignment corridor. The associated 19 surface site locations are optimal in terms of the required functionality, minimising community effects, minimising construction risks, and providing a solution at the lowest possible whole of life cost.

9.4 The proposed methods and systems for construction, operation and control of the Project have all been demonstrated to work successfully during Watercare's recent implementation of the Project Hobson wastewater tunnel.

9.5 The concept design of the Project ensures that the system can be operated within the current limits of the existing Mangere WWTP consent. The storage functionality of the main tunnel will be utilised so that the current consented flow limits at the Mangere WWTP will not be exceeded when the main tunnel is commissioned.

9.6 The concept design of the Project includes controls and provisions to ensure it will operate in a safe and adequate manner under all conditions, including the loss of power or failure of key mechanical equipment.

9.7 The design includes an EPR structure at the proposed Mangere Pump Station located at the Mangere WWTP. The EPR would only activate due to the failure of the pump station resulting from a power loss or mechanical problems, and ensures that the tunnel would not overflow at other shaft sites along the alignment. Use of an EPR is common practice at any wastewater pump station to ensure that wastewater will not overflow at uncontrolled locations in the event of a pump station failure. With consideration of the redundancies designed into the proposed Mangere Pump Station, dual power feed into the Mangere WWTP, the ability of the main tunnel to store flows for up to 60 hours, and Watercare’s portable emergency power generator service – the probability of the EPR activating is less than 1 event every 50 years. Furthermore the effects of the EPR activating can be mitigated by diverting flow away from the Central Interceptor main tunnel using a series of automated and manual gates. Closure of these gates would result in overflows occurring at existing overflow points, but at present most of these overflows discharge almost every time it rains.

9.8 Benefits of the Project include long-term protection of the Manukau Harbour by providing a safe and robust conveyance pathway to the Mangere WWTP. In addition, the concept design of the Project provides a robust and flexible system which ensures that the areas served by this system will meet required wastewater performance targets as growth and development occurs to the maximum probable development limits. It provides a cost beneficial reduction of 18 wastewater overflows and associated pollution which impact urban streams and the Waitemata Harbour almost every time it rains, and enables the later construction of the CSO Collector Sewers to reduce a further 104 wastewater overflows. Furthermore the expected design life of this asset is in excess of 100 years. These benefits address the key issues that face Auckland and will ensure that the wastewater network within Auckland has the capacity to meet expected demand for the next 50 years and beyond.

9.9 Overflows which are captured by the Central Interceptor Scheme will be safely conveyed and treated at the Mangere WWTP. While the overflows represent a substantial impact to the local streams and harbour they currently discharge into during storm events, the total additional volume they impose on the Mangere WWTP is less than 2% on an annual average basis. State of the art treatment processes at Mangere WWTP ensure an adequate level of treatment and continued protection of the Manukau Harbour. This includes Watercare’s planned implementation of a wet weather treatment facility which will further enhance Watercare's ability to treat flows under large storm event conditions.

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